

Effects of Face Masks on Pulse Rate and Blood Pressure Components During Stairs Climbing

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ABSTRACT

Background: The use of face masks has been associated with physiological changes in body. This study aims to know the changes in pulse rate and blood pressure components after wearing face masks during stairs climbing.

Methods: An experimental study was conducted among 60 apparently healthy young adults between 18-35 years of age. The pulse rate and blood pressure of the participants were recorded during rest at ground floor and after climbing the stairs till 5th floor at brisk and regular pace without wearing the face masks. The uniform KN95 masks were distributed and proper coverage of nose, mouth and chin were ensured. After 5 minutes interval, the pulse rate and blood pressure were recorded again at rest in ground floor and after climbing stairs with use of KN95 masks.

Results: At rest, the difference in mean pulse rate was statistically significant after wearing masks in participants between 21-25 years of age (86.46 ± 14.59 bpm, $p=0.014$). After climbing the stairs, the mean pulse rate (131.16 ± 18.48 bpm), mean systolic blood pressure (137.67 ± 16.13 mmHg) and mean rate pressure product (182.87 ± 41.70) were higher in participants (age group: 26-30 years) wearing masks and the difference was statistically significant ($p=0.001$; 0.013 ; 0.001 respectively). During stairs climbing, the change in mean systolic blood pressure (32.66 ± 16.73 mmHg), mean pulse pressure (43.77 ± 24.64 mmHg) and mean rate pressure product (96.58 ± 37.23) were higher in participants (age group: 26-30 years) and the difference was statistically significant ($p=0.036$; 0.047 and 0.009 respectively).

Conclusions: The changes in systolic blood pressure, pulse pressure and rate pressure product are found to increase after wearing face masks during stairs climbing. It can be suggestive of increase workload to the heart by wearing face masks in addition to climbing the stairs.

Keywords: Blood pressure; face masks; pulse

INTRODUCTION

The use of face masks has been recommended worldwide during COVID-19 pandemic to minimize the risks of transmission.¹⁻⁴ This preventive measure is also associated with cardiopulmonary functional changes leading to occupational and physical stress.⁵ These changes are prominent during physical activities to meet the increasing body's demands. A study has found increase in mean heart rate (HR) from 75-94 bpm to 77-98 bpm by use of face masks at work.^{6,7} The increase

in HR was also seen in participants wearing facemasks during exercise with no changes in blood pressure (BP).⁸ A study conducted among 71 healthy subjects performing exercise by wearing masks showed higher peak Systolic Blood Pressure (SBP) (162.6 ± 2.5 mmHg, $p=0.048$) and increased peak HR (171.0 ± 13.7 bpm, $p<0.001$).⁹ The physical activity like stairs climbing can also be considered to look upon the effect of masks as it is incorporated in our daily activity and it meets the minimum requirement for cardiopulmonary fitness.¹⁰

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Thus this study is conducted to find the effect of face masks (KN95) in the cardiovascular parameters including pulse rate (PR) and BP components during stairs climbing.

METHODS

An experimental study was conducted in Kantipur Dental College, General Hospital and Research Centre, Basundhara, Kathmandu over a period of 6 months after getting the institutional ethical clearance. Sixty participants who were apparently healthy young adults in 18-35 years of age¹¹ were enrolled by convenience sampling technique from students and employees after informed and written consent. The participants with history of diagnosed cardiovascular, musculoskeletal or respiratory disorders were excluded. The sample size [N] was calculated taking mean and standard deviation (S.D) of heart rate after maximum load performance with and without wearing N95 masks¹² where $N = \frac{(Z\alpha + Z\beta)^2}{x(S.D1^2 + S.D2^2) / [\text{Mean 1} - \text{Mean 2}]}$

The anthropometric measures included height and weight measurements. The volunteers were allowed to rest at ground floor for 5 minutes without masks and resting PR and BP were taken. The volunteers were asked to walk briskly in regular pace¹³ upto 5th floor without wearing masks and immediately after completion of procedure similar cardiac parameters were measured. The participants were asked to step down stairs to the ground floor and asked to rest and wear KN95 masks for 5 minutes. The uniform valveless KN95 masks with 2 layers of filters were used for all participants and proper coverage of nose, chin and mouth were ensured. The similar vitals were taken again in ground floor at rest and after climbing same stairs in same participants but with wearing KN95 masks. The Body Mass Index (BMI)

i.e. weight in kg/height in cm² was calculated as an indicator of health. Pulse Pressure (PP) was derived by subtracting Systolic Blood pressure and Diastolic Blood Pressure (DBP). The rate pressure product (RPP) which is a measure of stress put on the cardiac muscle and indicates the energy demand of heart¹⁴ was calculated as $RPP = PR \times SBP / 100$.

The data were entered in SPSS-16 version and the descriptive calculations and mean comparison with paired t-test were done. The P value <0.05 was considered statistically significant, <0.001 highly significant and >0.05 not significant taking confidence interval of 95%.

RESULTS

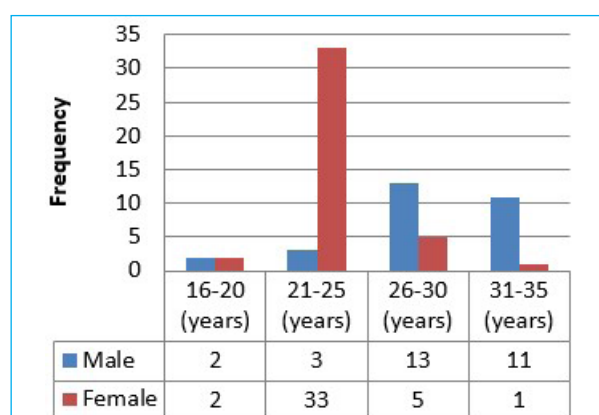


Figure 1. Gender wise distribution of the participants in different age groups (N=60).

The total numbers of participants were 60 with mean age 26.25 ± 3.87 years. The female participants were comparatively more than male with maximum female distribution between 21-25 years (Figure 1). The age range of the participants was between 18-35 years.

Table 1. Comparison of cardiovascular parameters with and without use of KN95 masks at rest (N=60).

Variables	Age group (years)											
	16-20		P value	21-25		P value	26-30		P value	31-35		P Value
Cardio Vascular Parameters	Without Masks (Mean \pm S.D)	With masks (Mean \pm S.D)		Without Masks (Mean \pm S.D)	With Masks (Mean \pm S.D)		Without Masks (Mean \pm S.D)	With Masks (Mean \pm S.D)		Without masks (Mean \pm S.D)	With Masks (Mean \pm S.D)	
PR (/min)	79.00 \pm 4.54	83.00 \pm 13.75	0.55	80.65 \pm 8.74	86.46 \pm 14.59	0.01	79.05 \pm 13.88	82.44 \pm 14.06	0.14	79.33 \pm 7.37	82.91 \pm 10.47	0.09
SBP (mmHg)	102.50 \pm 18.92	101.00 \pm 15.36	0.76	102.00 \pm 12.13	102.54 \pm 12.42	0.75	106.44 \pm 11.59	105.00 \pm 8.15	0.52	117.83 \pm 14.38	116.50 \pm 13.24	0.52
DBP (mmHg)	66.50 \pm 9.98	66.50 \pm 8.54	1.00	65.30 \pm 6.66	64.38 \pm 7.69	0.44	68.66 \pm 8.01	69.55 \pm 8.01	0.60	78.83 \pm 9.08	79.16 \pm 14.60	0.89
PP (mmHg)	36.00 \pm 9.38	37.00 \pm 6.21	0.84	36.69 \pm 10.39	38.15 \pm 10.33	0.40	37.77 \pm 7.15	35.44 \pm 8.08	0.39	39.00 \pm 8.50	37.33 \pm 7.49	0.64
RPP	80.72 \pm 13.26	82.77 \pm 12.05	0.83	82.12 \pm 11.88	88.30 \pm 16.00	0.05	84.90 \pm 21.64	86.28 \pm 14.53	0.67	93.42 \pm 13.28	95.89 \pm 11.24	0.46

During rest, the mean pulse rate increased after wearing of KN95 masks and difference in mean when compared without wearing masks was statistically significant ($P < 0.05$) in age group 21-25 years (Table 1). The mean of RPP also increased after wearing masks in all age group but the difference in mean when compared without wearing masks was not significant.

After stairs climbing, the difference in mean of PR,

SBP and RPP with and without masks was found to be statistically significant in age group 26-30 years ($P = 0.001$; $P = 0.01$; $P = 0.001$). The age group 31-35 years also had significant difference in mean of PR ($P = 0.002$) and RPP ($P = 0.004$) when comparing with and without masks. Similar comparison also showed the significant mean difference of RPP in age group 21-25 years ($P = 0.01$) (Table 2).

Table 2. Comparison of cardiovascular parameters with and without use of KN95 masks after stairs climbing (N=60).

.Variables	Age group (years)											
	16-20			21-25			26-30			31-35		
Cardio Vascular Parameters	Without Masks (Mean \pm S.D)	With masks (Mean \pm S.D)	P value	Without Masks (Mean \pm S.D)	With Masks (Mean \pm S.D)	P value	Without Masks (Mean \pm S.D)	With Masks (Mean \pm S.D)	P value	Without masks (Mean \pm S.D)	With Masks (Mean \pm S.D)	P Value
PR (/min)	136.25 \pm 1.50	136.50 \pm 17.67	0.97	140.08 \pm 18.21	143.96 \pm 21.18	0.10	119.61 \pm 21.72	131.16 \pm 18.48	0.001	123.50 \pm 22.58	135.83 \pm 15.11	0.002
SBP (mmHg)	135.00 \pm 23.35	132.00 \pm 17.66	0.60	136.85 \pm 13.43	140.92 \pm 13.78	0.05	130.67 \pm 12.49	137.67 \pm 16.13	0.01	144.00 \pm 15.06	146.50 \pm 19.65	0.52
DBP (mmHg)	57.50 \pm 5.25	53.50 \pm 6.80	0.36	56.61 \pm 7.56	56.69 \pm 8.65	0.95	59.44 \pm 11.26	58.44 \pm 10.81	0.64	70.66 \pm 9.07	69.91 \pm 11.64	0.66
PP (mmHg)	77.50 \pm 18.85	78.50 \pm 17.90	0.90	80.23 \pm 12.69	84.23 \pm 13.45	0.14	71.22 \pm 18.98	79.22 \pm 21.00	0.06	73.33 \pm 10.03	76.58 \pm 12.41	0.48
RPP	184.12 \pm 33.18	180.36 \pm 34.09	0.85	192.00 \pm 34.18	203.01 \pm 35.45	0.01	157.53 \pm 38.11	182.87 \pm 41.70	0.001	176.75 \pm 29.44	199.21 \pm 32.69	0.004

Table 3. Comparison of change in cardiovascular parameters with and without use of KN95 masks during stairs climbing (N=60)

Variables	Age group (years)											
	16-20			21-25			26-30			31-35		
Change in Cardio Vascular Parameters During stairs climbing	Without Masks (Mean \pm S.D)	With masks (Mean \pm S.D)	P value	Without Masks (Mean \pm S.D)	With Masks (Mean \pm S.D)	P value	Without Masks (Mean \pm S.D)	With Masks (Mean \pm S.D)	P value	Without masks (Mean \pm S.D)	With Masks (Mean \pm S.D)	P Value
PR (/min)	57.25 \pm 4.11	53.50 \pm 17.93	0.70	59.42 \pm 3.17	57.50 \pm 17.70	0.57	40.55 \pm 5.27	49.16 \pm 3.46	0.06	44.16 \pm 6.09	52.91 \pm 4.42	0.09
SBP (mmHg)	32.50 \pm 8.38	31.00 \pm 14.37	0.82	34.84 \pm 12.30	38.38 \pm 9.56	0.14	24.22 \pm 15.22	32.66 \pm 16.73	0.03	26.16 \pm 9.98	30.00 \pm 18.12	0.36
DBP (mmHg)	-9 \pm 6.63	-13 \pm 5.29	0.34	-8.69 \pm 7.69	-7.69 \pm 8.70	0.57	-9.22 \pm 9.30	-11.11 \pm 12.92	0.48	-8.16 \pm 6.17	-9.25 \pm 8.73	0.69
PP (mmHg)	41.50 \pm 10.75	41.50 \pm 14.54	1.00	43.53 \pm 15.85	46.07 \pm 13.39	0.48	33.44 \pm 20.09	43.77 \pm 24.64	0.04	34.33 \pm 10.12	39.25 \pm 14.29	0.33
RPP	103.40 \pm 20.83	97.58 \pm 39.10	0.74	109.87 \pm 34.40	114.71 \pm 30.93	0.40	72.62 \pm 40.31	96.58 \pm 37.23	0.009	83.22 \pm 34.00	103.32 \pm 37.63	0.038

The change in mean of SBP, PP and RPP were higher after wearing masks during stairs climbing and the difference in mean of change in these cardiovascular parameters with and without wearing masks were statistically significant in age group 26-30 years ($P=0.03$; $P=0.04$ and $P=0.009$ respectively). Similar significant difference in mean of change in RPP was also seen in age group 31-35 years ($P=0.03$) (Table 3). The change in PR without wearing masks had statistically significant negative correlation with BMI ($R=-0.34$, $P=0.007$). The changes in remaining cardiovascular parameters had no significant correlation with BMI. (Table 4).

Table 4. Correlation of BMI with change in cardiovascular variables during stairs climbing.

	Changes in (Without Masks)		Changes in (With Masks)		P	
	R	P	R	P		
BMI	PR	-0.34	0.007	PR	-0.10	0.447
	SBP	-0.097	0.462	SBP	0.028	0.834
	DBP	0.005	0.971	DBP	-0.176	0.179
	PP	-0.08	0.541	PP	0.114	0.387
	RPP	-0.249	0.055	RPP	0.001	0.991

DISCUSSION

The effect of wearing masks on cardiopulmonary functions has been a subject of interest. This study has found that the mean PR increased after wearing KN95 masks in resting condition and the difference in mean was statistically significant among participants between 21-25 years. Further, the participants wearing masks in age group 26-30 years had significant increase in mean PR, mean SBP and mean RPP after climbing stairs when compared without wearing masks. Similar finding was also found in a study done in Newzealand which reported increase in HR from 75-95 bpm to 77-98bpm after use of respirators among workers.^{6,7} A study conducted on 14 active healthy men on constant power exercise has also found peak HR (160.1 ± 11.2 bpm vs 154.5 ± 11.4 bpm, $p<0.01$) was larger when wearing surgical masks and no significant difference in BP was observed.⁸ The physiological responses of 71 healthy subjects to exercise with and without surgical masks showed increase in peak HR (171.0 ± 13.7 bpm vs 165.8 ± 15.7 bpm, $p<0.001$) and increase in peak systolic BP (162.6 ± 2.5 mmHg vs 160.9 ± 30.7 mmHg, $p=0.048$).⁹ Similarly, the physiological effect of wearing facemask during endurance exercise among 38 participants showed increase in HR at the end of exercise (HR without mask 151.4 ± 17.7 bpm, HR with mask 156.4 ± 17.4 bpm, $p=0.009$).¹⁵ However, a recent review article published on 2021 has concluded that the effects of various masks on physiological parameters

during physical activity are too small to be detected even during heavy exercise in healthy individuals.¹⁶

As mentioned earlier, this study has taken stairs climbing as a form of physical activity to see the cardiovascular changes under the effect of wearing KN95 facemasks as stairs climbing is incorporated in our daily activities and it also meets the minimum requirement for cardiopulmonary fitness. It has found that the difference in changes in mean SBP, mean PP and mean RPP was significant when the participants in age group 26-30 years climbed the stairs with and without wearing facemasks. The increase in SBP is physiologically associated with increase in cardiac output. The pulse pressure is increased with increasing SBP and decreasing DBP in which the latter being the result of increase in body temperature which decreases peripheral resistance. The increase in RPP is associated with increase in myocardial oxygen consumption due to increase workload to the heart.¹⁴ It has also found that the changes in cardiovascular parameters considered had no significant positive correlation with BMI after wearing facemasks. The literature however lacks the study of all these cardiovascular parameters considered and age-wise and BMI categorized study of the changes. Further, the changes seen in the participants didn't lead to any ill effect clinically after the experiment and also none of the participants withdrew during the research. This could be suggestive of the changes which weren't hazardous enough as an effect of wearing face masks. However, with future similar researches a definite conclusion can be drawn to implicate the finding wisely.

CONCLUSIONS

The use of KN95 masks is associated with increase in pulse rate at rest and increase in pulse pressure, systolic blood pressure and rate pressure product while climbing the stairs. These findings are suggestive of increase in work load of heart due to wearing of face masks.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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