Medycyna Pracy 2022;73(5):363–368
http://medpr.imp.lodz.pl/en

https://doi.org/10.13075/mp.5893.01246
ORIGINAL PAPER

THE USE OF PROTECTIVE MASKS AND THE LEVEL OF ARTERIAL OXYGEN SATURATION AT REST AND AFTER EXERCISE

Paulina Majek, Angelina Kaleta-Pilarska, Kamil Barański

Medical University of Silesia in Katowice, Katowice, Poland
Department of Epidemiology, School of Medicine in Katowice

Abstract

Background: Studies of influenza, and human coronaviruses provide evidence that the use of a medical mask can prevent the spread of infectious droplets from an infected person to someone else. After global public health emergency of coronavirus SARS-CoV-2 causing illness of COVID-19 was changing frequency of wearing a mask. Therefore, study was undertaken to assess whether the use of protective masks affects the level of oxygen saturation during rest and during exercise. **Material and Methods:** The test consisted of a non-invasive measurement of oxygen saturation by percutaneous determination of arterial oxygen saturation with the use of the pulse oximeter. Oxygen saturation was measured during rest and after physical exertion performed without a protective mask (2 types of masks were used: surgical and FFP2), as well as during rest and after physical exertion performed with the use of a protective mask. The analysis of the oxygen saturation, heart rate, blood pressure and respiratory rate included data on 48 subjects. **Results:** Comparing the post-exercise and pre-exercise values showed a significant difference between all of them. There were no differences found in any variables according to the mask/no-mask status. **Conclusions:** A short-term physical exercise performed in a group of healthy young people using protective masks did not affect oxygen saturation, heart rate, blood pressure and respiratory rate. Med Pr. 2022;73(5):363–68

Key words: physical exertion, oxygen saturation, COVID-19, SARS-CoV-2, coronavirus pandemic, protective masks

Corresponding author: Paulina Majek, Medical University of Silesia in Katowice, Department of Epidemiology, School of Medicine in Katowice, Medyków 18, 40-752 Katowice, Poland, e-mail: paulina.majek@gmail.com
Received: January 17, 2022, accepted: May 20, 2022

INTRODUCTION

Studies of influenza, influenza-like illness, and human coronaviruses provide evidence that the use of a medical mask can prevent the spread of infectious droplets from an infected person to someone else [1]. On January 30, 2020, a global public health emergency of severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2) causing illness of coronavirus disease-2019 (COVID-19) was announced [2]. At the beginning of the virus spread among the European population the regulations and the recommendations concerning public health were implemented, starting with social distancing, closing the borders, closing shops, places of culture and entertainment, ending with lock-down of the countries [3]. Also, voices about reduction of SARS-CoV-2 transmission while wearing protective masks were raised [4]. Thereafter, the obligation to wear protective masks was implemented in most of the countries. Significant differences still existed between European countries in terms of wearing a face mask outside to protect the individual, owing mainly to the differing legislation in the countries concerning masks [5,6]. On the other hand, dissemination of the requirement to wear masks in public places started a discussion on the usefulness of wearing masks and the side effects it could bring.

Before the era of COVID-19 pandemic protective masks were widely used by healthcare workers, mostly surgeons as protection for operated patient. The primary purpose of wearing masks was to protect the surgical patient from pathogens expelled on droplets from nose and mouth of surgical personnel during speech, coughing and sneezing, but more recently protective masks

Funding: this study was supported by Medical University of Silesia in Katowice, Department of Epidemiology, School of Medicine in Katowice (PCN-2-095/N/0/Z „Osobowość Typu D a akceptacja i przystosowanie do choroby u pacjentów z rakiem jelita grubego", Angelina Kaleta-Pilarska).

have been advocated as a protective barrier for the wearer from splashes and spills of body fluids [7]. The idea of wearing masks by surgeons was first announced by Mikulicz in 1987 [8].

Since this time the purpose and frequency of wearing a mask has changed and there is insufficient amount of literature data about masks usage and their physiological impact during other activities, in particular the physical exertion. Therefore, this study was undertaken to assess whether the use of protective masks affects the level of oxygen saturation during rest and during exercise. The obtained results could be the voice in discussion about the adverse effects of wearing masks.

MATERIAL AND METHODS

The study was conducted between October and November 2021 at the Faculty of Medical Sciences at the Medical University of Silesia in Katowice, Poland.

The study group consisted of 51 students of medical field, both sexes, who were not diagnosed with any chronic disease. Participation in the study was voluntary and anonymous, and all objects had to give an informed consent to participate. Participants had the right to refuse to participate without giving a reason. The study protocol was reviewed and approved by the Ethical Review Board at the Medical University of Silesia, Poland (decision number: PCN/CBN/0022/KB1/32/I/21).

The study was divided into 2 parts. First part of the test: measurements were provided at rest, and the second – after physical exertion, which was characterized by climbing the stairs to the fourth floor. All measurements taken after exercise took place immediately after the student entered the fourth floor. Estimated time to climb was 1 min. Both parts were performed twice, with and without the use of a protective mask (surgical and FFP2). After the first part of the experiment (without masks), students were asked to take a seat and breathe slowly for 15 min. After 15 min heart rate, blood pressure and respiratory rate were checked making sure they returned to initial values, to avoid influence of first physical exertion on measurements made with protection masks (second part).

The test consisted of a non-invasive measurement of oxygen saturation by percutaneous determination of arterial oxygen saturation with the use of the KONICA MINOLTA SENSING PULSOX-2 CE0088 pulse oximeter (Japan). Oxygen saturation was measured during rest and after physical exertion performed without a protective mask, as well as during rest and after physical exertion performed with the use of a protective mask. Additionally, the blood pressure was measured with the OMRON M2 CE0197 (Japan) blood pressure monitor and the respiratory rate was measured during rest, without and with the use of a protective mask, as well as after physical exertion, performed without and with the use of a protective mask. Using the visual dyspnea scale (modified 10-point *Borg Scale*), each participant was assessed for their level of dyspnea at rest without and with the use of a protective mask, as well as after exercise performed without and with the use of a protective mask. Modified Borg scale starts at number 0 where breathing is causing no difficulty at all and progresses through to number 10 where breathing difficulty is maximal [9–11].

The data was analyzed with the Statistica 13.0 package (data analysis software system). Normality of distributions of continuous variables was assessed by the Shapiro-Wilk test. Statistical significance of differences between continuous variables was analyzed by the independent samples t-test or the Mann-Whitney U test if the assumptions for the t-test were not met. According to the dependent samples, the t-test for depended variables was used or the Wilcoxon signed-rank test, if the distribution of continuous variables were not normal. Distribution of categorical variables was shown by frequencies and proportions along with 95% confidence intervals. Statistical testing to compare between categorical variables was completed using the independent samples χ^2 test or the Fishers exact test. The Fisher exact is warranted when the sample size is insufficient for the χ^2 test (the assumption is when any of the expected values is <5). Statistical inference was based on the criterion $p < 0.05$.

RESULTS

The study population

The study group included 51 students, aged 23–30. The median age of the study population was 24 (Q1 = 24, Q3 = 25) years old, with no differences according to sex ($p = 0.3$). The group consisted of 33 women (35.3%) and 18 men (64.7%), students from Medical University of Silesia in Katowice, Poland. During the study, 3 types of masks were worn: surgical masks were worn by 33 students (64.7%), FFP2 type of masks by 15 students (29.4%) and 3 students (5.9%) used cotton masks. Due to the lack of standardization and the inability to compare the cotton masks between each other, objects who used this type of protection were excluded from further analysis.

The data analysis

The analysis of the oxygen saturation (%), heart rate (bpm), systolic and diastolic blood pressure (mm Hg) and respiratory rate (breath/min) included data on 48 subjects. First part of the examination was made when the students did not wear protective masks. Comparing the post-exercise and pre-exercise values showed a significant difference between all of them. The following changes were revealed: decrease in oxygen saturation after the exercise (from 99% [Q1 = 99, Q3 = 100] to 98% [Q1 = 97, Q3 = 99], $p < 0.001$, the Wilcoxon signed-rank test), increase in heart rate (from 74.5±9.8/min to 101.5±22.1/min, $p < 0.001$, the t-test for dependent variables), systolic blood pressure (from 117.5±12.3 mm Hg to 135.5±16.3 mm Hg, $p < 0.001$, the t-test for dependent variables), diastolic blood pressure (from 75.4±7.4 mm Hg to 78.9±9.2 mm Hg, $p < 0.001$, the t-test for dependent variables), respiratory rate (from 12 [Q1 = 11, Q3 = 14.5]/min to 18 [Q1 = 16, Q3 = 20]/min, $p < 0.001$, the Wilcoxon signed-rank test). Analogous changes after the exercise were demonstrated in the second part of the examination, when student had to wear a protective mask: decrease in oxygen saturation (from 99% [Q1 = 98, Q3 = 100] to 97% [Q1 = 97, Q3 = 98], $p < 0.001$, the Wilcoxon signed-rank test), increase in heart rate (from 77.1±10.0/min to 107.0±25.1/min, $p < 0.001$, the t-test for dependent variables), systolic blood pressure (from 117.1±12.1 mm Hg to 138.3±15.6 mm Hg, $p < 0.001$, the t-test for dependent variables), diastolic blood pressure (from 73.5±7.5 mm Hg to 80.6±8.5 mm Hg, $p < 0.001$, the t-test for dependent variables), respiratory rate (from 13.3±2.5/min to 19.9±5.7/min, $p < 0.001$, the t-test for dependent variables). Most of students (68.8%) of students have worn surgical mask and the rest (31.3%) mask type FFP2.

The type of mask did not affect any differences in tested parameters (Table 1).

The findings were also compared among measurements done with and without masks. There were no differences found in any variables according to the mask/no-mask status (Table 2).

Subjects had to indicate their level of dyspnea on the dyspnea scale (*Borg Scale*) at rest and after the exercise twice, while wearing and without a protective mask. The highest level of dyspnea was 3 ("moderate" dyspnea) in case of dyspnea after the exercise whilst wearing a mask and was reported only by 6.3% of students. At rest with a mask only 2.1% of students had given an answer 2 ("slight" dyspnea), where answer 1 ("very slight" dyspnea) was presented by 27.1% and 0 ("nothing at all") by 70.8% students. To compare, while not wearing a mask at rest, the answer 1 was indicated by 2.1% of students and answer 0 by 97.9%. As mentioned above, after the exercise whilst wearing a mask 6.3% of students declared their dyspnea as "moderate" dyspnea, while no one declared it when the exercise was carried out without a mask, but the difference was not statistically significant ($p = 0.1$). Statistically more often the "slight" dyspnea was presented after the exercise with a mask (37.5%) than without a mask (14.6%, $p = 0.01$). With the same frequency after the exercise students declared "very slight" dyspnea (18.8% vs. 18.8%, $p = 1.0$), but no dyspnea was declared more often after the exercise without a mask (66.7% vs. 37.5%, $p = 0.004$). The results from the *Borg Scale* are presented in the Table 3.

Table 1. Comparison of the type of protective mask, study conducted among students, Medical University of Silesia, Katowice, Poland, March–May 2021

Variable	Participants (N = 48)		
	surgical mask (N = 33)	FFP2 (N = 15)	p
At rest			
oxygen saturation [%]			0.4*
M	99	99	
range	98–100	99–100	
heart rate [bpm] (M±SD)	75.6±9.2	80.3±11.1	0.1**
blood pressure [mm Hg] (M±SD)			
systolic	118.7±12.5	113.7±10.7	0.2**
diastolic	74.2±8.3	71.9±5.3	0.3**
respiratory rate [breath/min] (M±SD)	13.1±2.4	13.7±2.8	0.4**
After physical exertion			
oxygen saturation [%]***			0.1*
M	97	98	
range	96.5–98	97–99	
heart rate [bpm] (M±SD)	109.7±25.2	101.1±24.8	0.3**
blood pressure [mm Hg] (M±SD)			
systolic	138.5±17.5	137.7±11.0	0.9**
diastolic	80.4±9.0	80.9±7.6	0.8**
respiratory rate [breath/min] (M±SD)	19.2±5.8	21.4±.5.3	0.7**

* Mann-Whitney U test.
** The independent samples t-test.
*** Surgical mask: N = 32, FF2: N = 14, 2 data points were excluded from the analysis, due to present of outliers.

Table 2. Comparison between measurement with and without the protective mask, study conducted among students, Medical University of Silesia, Katowice, Poland, March–May 2021

Variable	Participants (N = 48)					
	at rest			after physical exertion		
	without mask	with mask	p	without mask	with mask	p
Oxygen saturation [%]			0.3*			0.06*
M	99	99		98	97***	
range	99–100	98–100		97–99	97–98***	
Heart rate [bpm] (M±SD)	74.5±9.8	77.1±10.0	0.2**	101.5±22.1	107.0±25.1	0.3**
Blood pressure [mm Hg] (M±SD)						
systolic	117.5±12.3	117.1±12.1	0.9**	135.5±16.3	138.3±15.6	0.4**
diastolic	75.4±7.4	73.5±7.5	0.2**	78.9±9.2	80.6±8.5	0.4**
Respiratory rate [breath/min] (M [Q1;Q3] / M±SD)	12 (11;14.5)	13.3±2.5	0.6*	18 (16;20)	19.9±5.7	0.1*

* Mann-Whitney U test.
** The independent samples t-test.
*** N = 46, 2 data points were excluded from the analysis, due to present of outliers.

Table 3. Comparison in dyspnea scale between measurement with and without the protective mask, study conducted among students, Medical University of Silesia, Katowice, Poland, March–May 2021

Level of dyspnea (*Borg Scale*)	Participants (N = 48)									
	at rest					after physical exertion				
	without mask		with mask		p	without mask		with mask		p
	n (%)	95% CI	n (%)	95% CI		n (%)	95% CI	n (%)	95% CI	
0 (nothing at all)	47 (97.9)	88.9–100.0	34 (70.8)	55.9–83.1	0.002*	32 (66.7)	51.6–79.6	18 (37.5)	24.0–52.7	0.004**
1 (very slight)	1 (2.1)	0.1–11.1	13 (27.1)	15.3–41.9	0.004*	9 (18.8)	9.0–32.6	9 (18.8)	9.0–32.6	1.0**
2 (slight)	0 (0)	0–7.4	1 (2.1)	0.1–11.1	0.5*	7 (14.6)	6.1–27.8	18 (37.5)	24.0–52.7	0.01**
3 (moderate)	0 (0)	0–7.4	0 (0)	0–7.4	–	0 (0)	0–7.4	3 (6.3)	1.3–17.2	0.1*
4 (somewhat severe)	0 (0)	0–7.4	0 (0)	0–7.4	–	0 (0)	0–7.4	0 (0)	0–7.4	–
5 (severe)	0 (0)	0–7.4	0 (0)	0–7.4	–	0 (0)	0–7.4	0 (0)	0–7.4	–
6	0 (0)	0–7.4	0 (0)	0–7.4	–	0 (0)	0–7.4	0 (0)	0–7.4	–
7 (very severe)	0 (0)	0–7.4	0 (0)	0–7.4	–	0 (0)	0–7.4	0 (0)	0–7.4	–
8	0 (0)	0–7.4	0 (0)	0–7.4	–	0 (0)	0–7.4	0 (0)	0–7.4	–
9 (very, very severe)	0 (0)	0–7.4	0 (0)	0–7.4	–	0 (0)	0–7.4	0 (0)	0–7.4	–
10 (maximal)	0 (0)	0–7.4	0 (0)	0–7.4	–	0 (0)	0–7.4	0 (0)	0–7.4	–

* Fisher exact test.
** χ^2 test.

DISCUSSION

The study was undertaken to assess whether the use of protective masks affects the level of oxygen saturation during rest and during exercise.

The authors' findings showed that physical activity in protective mask did not affect measured variables such as oxygen saturations, heart rate, blood pressure, respiratory rate. Additionally, there were no cases of moderate or severe dyspnea after the exertion performed with a mask.

As long as COVID-19 pandemic has started the obligation of wearing a protective mask has spread. Most places of public interest like, among others, gyms had to change their internal regulations to make it available for people. This has created a problem regarding a need to use face masks while exercise or other activities.

Since this time only some of publications concerning problem of wearing a mask, especially during physical exertion, has shown. Epstein et al. [12] have chosen 16 healthy male participants with average and high weekly physical activity. The participants performed dynamic stretching and a warm-up and then underwent exercise on a standard cycle ergometry ramp until exhaustion. Each subject performed the test 3 times: without a face mask, wearing a surgical and wearing an N95 respirator. The differences in heart rate (HR), respiratory rate (RR), oxygen saturation (SpO_2), and level of perceived exertion (on a scale range 1–10) did not reach statistical significance. Only wearing N95 respirator was associated with higher end-tidal carbon dioxide ($EtCO_2$) values at most phases of the exercise, compared to exercise performed without a mask [12]. It is important to emphasize that only well-trained men took part in the study, otherwise than in the study protocol, but the findings went similar conclusions.

Similar clinical study was conducted in Canada (Shaw et al. [13]), where eligible people were characterized by weekly physical activity, in this case, both sexes. The exercise was performed as a progressive cycle ergometer exercise to exhaustion while wearing a cloth face mask, a surgical face mask, or without a mask during 3 separate phases. No differences were found between time to reach the exhaustion among masks and no-mask condition. Heart rate, arterial blood oxygen saturation and rating of perceived exertion (10-point scale) were recorded every 30 s, additionally continuous-wave near-infrared spectroscopy (NIRS) was used to measure the oxyhemoglobin content of the legs' muscle. Again, like in the findings of this study, for arterial oxygen saturation, heart rate there were no differences at the end of exercise between a face mask and no mask conditions, as well as for NIRS-derived muscle tissue oxygenation index. Authors did not observed difference in rating of perceived exertion, which was measured as a level between 1–10 at the end of the exercise [13].

Another research connected with more intended physical effort, comparin to this research was made by Roberge et al. [7]. The study protocol was made on 20 heathy people (women and men) who have exercised on treadmill with speed 5.6 km/h for 1 h with and without wearing a surgical mask. They were being monitored for heart rate, respiratory rate, oxygen saturation, transcutaneous CO_2, SpO_2, core and skin temperatures, mask dead space heat and relative humidity, and skin temperature under the mask every 5 min. Moreover, volunteers' perceptions of exertion were assessed every 5 min using the *Borg Scale* (with scale range 1–20, where 6–12 means from "no exertion" to "fairly light exertion," 13–16 from "somewhat hard" to "hard," and 17–20 from "very hard" to "very, very hard"). The presented results showed some differences compared to the findings presented in this research, it has been shown that the mask group increased heart rate after the test, respiratory rate, and transcutaneous CO_2, but those physiological changes were not perceived subjectively as being associated with discomfort or exertion (in a *Borg Scale*). However, only 8% of the respondents did not report any complaints about wearing a mask, the rest have reported unquantified facial warmth, skin irritation, pinching of skin [7]. This aspect of low comfort of wearing masks needs to be emphasized, as it is shown in Szepietowski et al. study [14], where the online questionnaire-study was made. From a group of 2315 students almost 20% have reported facial itch related to face mask wearing [14]. Furthermore, already during the first SARS epidemic in Singapore, the unpleasant feelings related to wearing masks by healthcare workers were checked by Foo et al. [15]: 35.5% of the 307 staff who used masks regularly reported acne (59.6%), facial itch (51.4%), and rash (35.8%) from N95 mask use [15]. All these unpleasant sensations associated with protective masks can contribute to the reluctance to wear them and increase voices about side effects. To the authors best knowledge there is no available literature on low physical effort and wearing a mask, and therefore related more to everyday situations, except the authors' study and Person et al. [16] where the 6-minute walking test (6MWT) was performed. Healthy subjects (N = 44) aged 21.6±2.8 were tested for 6MWT twice: with or without a surgical mask. Distance, dyspnea (on visual analogue scale), heart rate and oxygen saturation were measured. Measurements did not differ according to mask/no mask conditions except from dyspnea which was significantly higher with surgical mask (5.6 vs. 4.6, $p < 0.001$, respectively) [16].

This study has several limitations, first of all, even if the number of respondents is greater than in other studies representing the topic, still the number of participants in the study is not sufficient for a full reference to the general population. History of disease was only excluded through a survey not a doctor's examination. Masks worn in the study was those brought by participants, so the type was not standardized.

CONCLUSIONS

A short-term physical exercise performed in a group of healthy young people using protective masks did not affect oxygen saturation, heart rate, blood pressure and respiratory rate. Additionally, it did not cause dyspnea greater than moderate (according to *Borg Scale*).

REFERENCES

1. World Health Organization [Internet]. Geneva: The Organization; 2014 [cited 2021 Dec 6]. Infection prevention and control of epidemic- and pandemic-prone acute respiratory diseases in health care. Available from: https://www.who.int/publications/i/item/infection-prevention-and-control-of-epidemic-and-pandemic-prone-acute-respiratory-infections-in-health-care.
2. Sohrabi C, Alsafi Z, O'Neill N, Khan M, Kerwan A, Al-Jabir A, et al. World Health Organization declares global emergency: A review of the 2019 novel coronavirus (COVID-19). Int J Surg. 2020;76:71–76. https://doi.org/10.1016/j.ijsu.2020.02.034.
3. Komisja Europejska [Internet]. Bruksela; 2020 [cited 2021 Dec 16]. Komunikat Komisji do Parlamentu Europejskiego, Rady Europejskiej i Rady COVID-19: tymczasowe ograniczenie innych niż niezbędne podróży do UE. Available from: https://ec.europa.eu/transparency/documents-register/detail?ref=COM(2020)115&lang=pl.
4. Zhang R, Li Y, Zhang AL, Wang Y, Molina MJ. Identifying airborne transmission as the dominant route for the spread of COVID-19. PNAS. 2020;117(26):14857–14863. https://doi.org/10.1073/pnas.2009637117.
5. Fondation Robert Schuman [Internet]. Paris; 2021 [cited 2021 Dec 16]. Available from: https://www.robert-schuman.eu/en/doc/actualites/FRS_Health_measures.pdf.
6. World Health Organization [Internet]. Geneva: The Organization; 2020 [cited 2021 Dec 6]. Advice on the use of masks in the context of COVID-19. Interim guidance. Available from: https://apps.who.int/iris/bitstream/handle/10665/331693/WHO-2019-nCov-IPC_Masks-2020.3-eng.pdf?sequence=1&isAllowed=y.
7. Roberge RJ, Kim JH, Benson SM. Absence of consequential changes in physiological, thermal and subjective responses from wearing a surgical mask. Respir Physiol Neurobiol. 2012;181(1):29–35. https://doi.org/10.1016/j.resp.2012.01.010.
8. Mikulicz J. Das Operiren in sterilisirten Zwirnhandschuhen und mit Mundbinde. Ein Beitrag zur Sicherung des aseptischen Verlaufs von Operationswuuden. Centralblatt für Chirurgie. 1987;24(26):713–717.
9. Borg GA. Psychophysical bases of perceived exertion. Med Sci Sports Exerc. 1982;14(5):377–381. https://doi.org/10.1249/00005768-198205000-00012.
10. Lung Foundation Australia [Internet]. [cited 2021 Dec 6]. Modified Borg Dyspnoea Scale. Available from: https://pulmonaryrehab.com.au/~resources/02_Patient_assessment/04_modified_borg_dyspnoea_scale.pdf.
11. Przybyłowski T, Tomalak W, Siergiejko Z, Jastrzębski D, Maskey-Warzęchowska M, Piorunek T, et al. Polish Respiratory Society guidelines for the methodology and interpretation of the 6 minute walk test (6MWT). Pneumon Alergol Pol. 2015;1(1):9–25. https://doi.org/10.5603/PiAP.2015.0048.
12. Epstein D, Korytny A, Isenberg Y, Marcusohn E, Zukermann R, Bishop B, et al. Return to training in the COVID-19 era: The physiological effects of face masks during exercise. Scand J Med Sci Sports. 2020,31:70–75. https://doi.org/10.1111/sms.13832.
13. Shaw K, Butcher S, Ko J, Zello GA, Chilibeck PD. Wearing of Cloth or Disposable Surgical Face Masks has no Effect on Vigorous Exercise Performance in Healthy Individuals. Int J Environ Res Public Health. 2020;17(21):8110. https://doi.org/10.3390/ijerph17218110.
14. Szepietowski JC, Matusiak Ł, Szepietowska M, Krajewski PK, Białynicki-Birula R. Face Mask-induced Itch: A Self-questionnaire Study of 2,315 Responders During the COVID-19 Pandemic. Acta Derm Venereol. 2020;100(10). https://doi.org/10.2340/00015555-3536.
15. Foo CCI, Goon ATJ, Leow YH, et al. Adverse skin reactions to personal protective equipment against severe acute respiratory syndrome – a descriptive study in Singapore. Con-tact Dermatitis. 2006;55(5):291–294.
16. Person E, Lemercier C, Royer A, Reychler G. Effect of a surgical mask on six minute walking distance. Rev Mal Respir. 2018;35(3):264–268. https://doi.org/10.1016/j.rmr.2017.01.010.

Publisher: Nofer Institute of Occupational Medicine, Łódź, Poland