Chest Heart Journal
Vol. 48, No. 2, July 2024

ORIGINAL ARTICLE

COVID-19 Infection, Immunization and Lung Function Parameters in a Community of Bangladesh: A Cross- Sectional Study

Mohammed Atiqur Rahman[1], Shamim Ahmed[2], Rajashish Chakrabortty[3], Samprity Islam[4], Golam Sarwar Liaquat Hossain Bhuiyan[5], Manal Mizanur Rahman[6], Susanta Kumar Paul[7], Kazi Rahila Ferdousi[8]

Abstract

Introduction: *COVID-19, caused by SARS-CoV-2, has affected millions worldwide, leading to significant acute and long-term health challenges. Post-COVID syndrome often includes persistent respiratory symptoms and reduced lung function, with limited data from Bangladesh on these sequelae.*

Aim: *This study aimed to assess socio-demographic, clinical, vaccination status, and lung function parameters in patients following COVID-19 infection and assess the effects of these parameters on post-COVID symptoms.*

Methods: *A cross-sectional study was conducted from August 2022 to July 2023 on 1,000 RT-PCR-confirmed COVID-19 recovered patients aged e"18 years in Gazipur, Bangladesh. Data on demographics, comorbidities, vaccination status, and clinical symptoms were collected through structured interviews. Lung function was assessed using spirometry (FEV1, FVC, FEV1/FVC), and the six-minute walk test (6MWD). Data analysis was performed using SPSS with descriptive and inferential statistics.*

Results: *The cohort was predominantly male (56.1%) and married (77.1%), with most patients aged >50 years. Underweight prevalence was high (38.1%), and 30.6% were current smokers. Hypertension (17.7%) and diabetes (10.2%) were the most common comorbidities. Common symptoms included fever (92.7%), cough (88.3%), breathlessness (53.6%), and fatigue (49.7%). Only 22.9% were fully vaccinated. Spirometry showed reduced lung volumes (mean FEV1: 1.78 L, FVC: 2.49 L) with a mean FEV1/FVC ratio of 77.26%. The 6MWD averaged 325.46 m, indicating impaired exercise capacity.*

Conclusion: *Fever, cough, breathlessness, and fatigue were the most common symptoms of COVID-19 infection. Mean spirometric parameters and six-minute walk distance were reduced in patients with COVID-19 infection even 4 weeks after recovery. The majority of respondents (72.8%) had received at least one dose of vaccination against COVID-19.*

Keywords: *COVID-19 infection, vaccination, lung function parameters*

[Chest Heart J. 2024; 48(2) : 83-89]
DOI: http://doi.org/10.3329/chj.v48i2.92797

Introduction

Coronavirus disease (COVID-19), first reported in December 2019 in Wuhan, China, is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The World Health Organization (WHO) declared COVID-19 a global pandemic on

1. Professor, Department of Respiratory Medicine, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh.
2. Associate Professor, Department of Respiratory Medicine, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh.
3. Associate Professor, Department of Respiratory Medicine, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh.
4. Assistant Professor, Department of Respiratory Medicine, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh.
5. Assistant Professor, Department of Respiratory Medicine, NIDCH, Mohakhali, Dhaka.
6. Medical Officer, Department of Respiratory Medicine, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh.
7. Medical Officer, Department of Respiratory Medicine, Khulna Medical College Hospital, Khulna, Bangladesh.
8. PhD Student, Department of Cardiology, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh.

Correspondence to: Dr. Mohammed Atiqur Rahman, Professor, Department of Respiratory Medicine, Bangabandhu Sheikh Mujib Medical University, Dhaka-1000, Bangladesh. Email: m_a_rahman88@yahoo.com

Submission on: 20 May, 2024 **Accepted for Publication:** 16 June, 2024
Available at http.//www.chabjournal.org

March 11, 2020, and as of September 12, 2022, over 586 million laboratory-confirmed cases and 6.42 million deaths had been reported worldwide.[1]

The pandemic has overwhelmed healthcare systems globally and caused substantial socioeconomic disruption due to prolonged lockdowns. Despite advances in clinical research that have improved understanding and management of SARS-CoV-2 infection, ongoing transmission remains a major challenge, due to the emergence of new variants driving successive waves of infection. In Bangladesh, over 2.01 million cases and approximately 29,307 deaths have been recorded.[2]

The most common initial symptoms of COVID-19 include fever, dry cough, tachypnea, and dyspnea.[3] Non-respiratory symptoms reported include confusion, chest pain, vomiting, nausea, anosmia, dyspepsia, skin rash, discoloration of fingers or toes, and viral conjunctivitis.[4,5]

COVID-19 vaccines have been shown to reduce SARS-CoV-2 infection, transmission, hospitalization, and mortality. In Bangladesh, vaccination began on 27 January 2021, with mass rollout starting on 7 February 2021. The Directorate General of Drug Administration (DGDA) approved seven vaccines (Pfizer–BioNTech, Moderna, Oxford–AstraZeneca, Sinopharm, Janssen, Sputnik V, and Sinovac). To date, approximately 140.5 million doses have been administered, with 85,287,956 individuals receiving at least one dose and 56,191,252 fully vaccinated.[6]

Aims and Objective

This study aims to assess symptoms of COVID-19 infection, lung function parameters, and COVID-19 vaccination status in the community. Materials and Method

Study Design

This cross-sectional study was conducted in Kaliakair, Gazipur, Dhaka, Bangladesh, over a period of one year from August 2022 to July 2023, following approval from the Institutional Review Board (IRB).

Inclusion Criteria

The study recruited participants aged above 18 years, with a confirmed RT-PCR positive diagnosis for COVID-19, who had recovered and passed at least four weeks after the infection.

Exclusion Criteria

Patients with history of dementia and active lung infections were excluded. Participants who had not fully recovered, were less than four weeks post-COVID infection or were unable to perform spirometry or six-minute walk testing were also not included.

Procedure and data collection

Participants who met the selection criteria were enrolled in the study after written informed consent. Sociodemographic information such as age, gender, marital status, and educational background was recorded. Data on COVID-19 diagnosis, infection severity, and type of care received (home care, hospitalization, or ICU admission) were collected. Information on pre-existing comorbidities, including diabetes, hypertension, asthma, chronic obstructive pulmonary disease (COPD), coronary artery disease, and smoking history, was also obtained. Participants' vaccination status (none, one dose, or two doses) was documented. Lung function parameters (FEV1, FVC, FEV1/FVC ratio) were determined using a handheld spirometer following standard protocols. Six-minute walk distance was also measured to assess exercise capacity and functional status. Participant confidentiality was maintained, and personal information was securely stored. No financial incentives were offered to participants.

Results

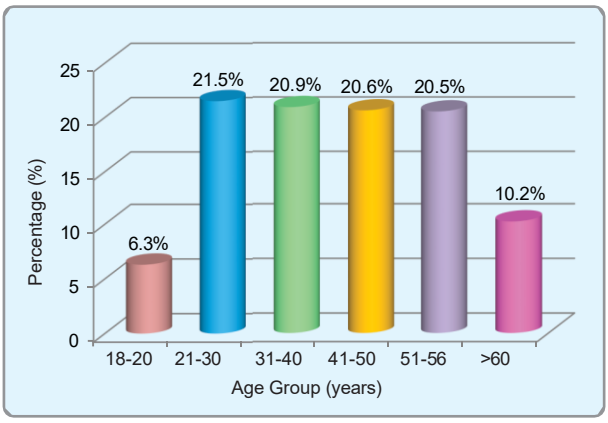

Figure 1: *Age Distribution of Participants (n=1000)*

Table-I
Socio-demographic characteristics of the Participants(n=1000)

Characteristics	
Age, years (mean +SD)	41.06(+ 13.97)
Sex, n (%)	
Male	561(56.1%)
Female	439 (43.9%)
Marital status	
Married	771(77.10%)
Unmarried	229(22.90%)
Educational status, n (%)	
No formal education	247(24.70%)
Primary school	185(18.50%)
Below Secondary school	146(14.60%)
Secondary school completed	209(20.90%)
Higher Secondary school completed	114(11.40%)
Graduate or Above	99(9.9%)

Table 2 presents the socio-demographic characteristics of the study participants. The mean age was 41.06 ± 13.97 years, with a male predominance (56.1%) compared to females (43.9%). The majority of participants (77.1%) were married.

Regarding educational attainment, nearly one-fourth (24.7%) had no formal education, while 18.5% had completed only primary education. A smaller proportion (14.6%) had education below the Secondary School Certificate (SSC) level. Notably, 20.9% had completed SSC, indicating that a substantial portion had at least basic secondary education. The proportion decreased further among higher educational levels, with 11.4% completing Higher Secondary Certificate (HSC) and only 9.9% attaining graduation or higher degrees

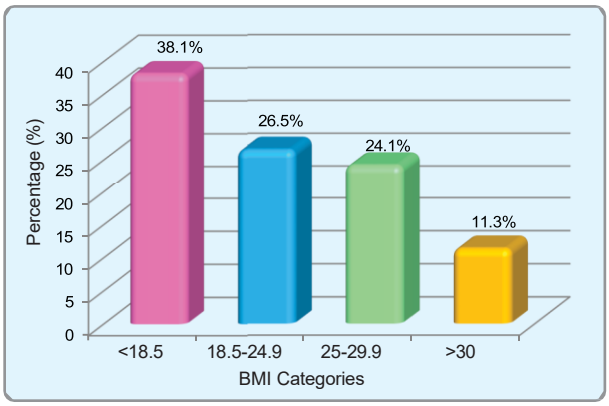

Figure 2: *Body Mass Index (BMI) of the Patients (n=1000)*

Figure 2 illustrates the Body Mass Index (BMI) distribution among 1,000 patients. The mean Body Mass Index (BMI) of the participants was 24.03+5.58 kg/m^2. Overall, 64.6% of participants had a BMI below 25, comprising 38.1% underweight and 26.5% normal weight individuals. In contrast, 35.4% were classified as overweight (24.1%) or obese (11.3%).

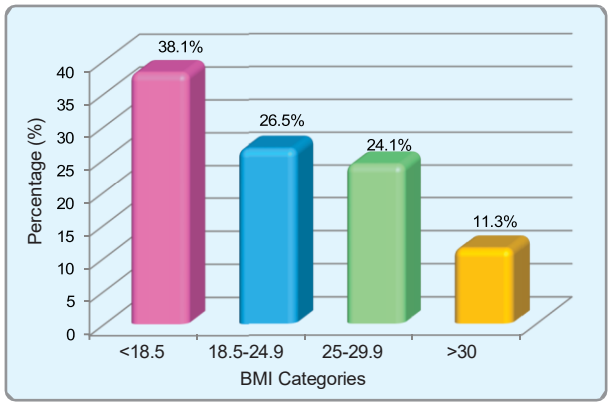

Figure 3: *Smoking Habit of the Study Subjects (n=1000)*

Figure 3 shows that one-third of participants (30.6%) were current smokers. Of the remaining 694 participants (69.4%), 23 (2.3%) were ex-smokers and 671 (67.1%) were never-smokers.

Table-II
Co-Morbidities of the Patients (n=1000)

Co-Morbidities	No.	Percentage
Hypertension	177	17.70
DM	102	10.20
Asthma	62	6.20
COPD	107	10.70
CVD	11	1.10
Coronary artery disease	23	2.30
CKD	21	2.10
Cancer	6	0.60

Table 2 presents data on the prevalence of co-morbidities among 1000 patients. Hypertension (17.70%) is the most common co-morbidity, followed by Diabetes Mellitus (DM) (10.20%). Asthma (6.20%) and Chronic Obstructive Pulmonary Disease (COPD) (10.70%) are present in a notable proportion of patients. Cerebrovascular Disease (CVD) (1.10%), coronary artery disease (2.30%), and chronic kidney disease (CKD) (2.10%) are less frequent. Only 6 patients (0.60%) have been diagnosed with cancer.

Table-III

Symptoms during COVID-19 infection

Respiratory symptoms	Nos.	Percentage
Fever	927	92.70
Cough	883	88.30
Breathlessness	536	53.60
Fatigue	497	49.7
Anosmia	344	34.40
Chest pain	251	25.1
Phlegm	193	19.30
Wheezing	134	13.40

Table 3 provides the distribution of COVID-19 symptoms among 1000 participants, including the number of participants and the percentage experiencing each symptom. Fever (92.70%) and cough (88.30%) are the most common symptoms. Breathlessness (53.60%) and fatigue (49.70%) were prevalent in almost half of the patients. Anosmia (loss of smell) is reported by 34.40% of participants, which is a well-documented symptom of COVID-19. Less common symptoms like wheezing (13.40%) and chest pain (25.10%) may indicate complications or comorbidities in some patients.

Table-IV

Site of Covid-19 care participants (n=1000)

COVID Care Site	No.	Percentage
Home	609	60.90
Inpatient	379	37.90
Intensive care unit	12	1.20
Total	1000	100

Table 4 presents data on where COVID-19 patients (N=1000) received care during their illness. The distribution of care sites provides insights into the severity of cases and healthcare system utilization. 379 patients (37.90%) were admitted as inpatients, meaning more than one-third of the cases required hospital care. 609 patients (60.90%) were treated at home, suggesting they had mild symptoms or stable conditions that did not require hospitalization. 12 patients (1.20%) required ICU admission, indicating they had severe or life-threatening complications. The ICU percentage is relatively low, which is expected since only the most severe cases (e.g., respiratory failure, multi-organ complications) require intensive care.

Table-V

COVID-19 vaccination dose (N1000)

No. of Doses	No.	Percentage
Single	499	49.90
Double	229	22.90
None	272	27.20
Total	1000	100

Table 5 provides the distribution of COVID-19 vaccination doses among 1000 participants. The high proportion of single-dose recipients (49.90%) suggests that many participants are in the process of completing their vaccination schedule. The unvaccinated group (27.20%) represents a significant portion of the population, which could reflect vaccine hesitancy, lack of access, or other barriers to vaccination. The fully vaccinated group (22.90%) is relatively small, indicating that a majority of participants may not yet have completed their vaccination schedule.

Table-VI

Pulmonary function & Exercise capacity among the study respondents (N=1000)

Spirometry parameters	Mean±SD
FVC (L)	2.49 (±0.76)
FEV1 (L)	1.78 (±0.69)
FEV1/FVC (%)	77.26 (±19.36)
Exercise Capacity Test	Mean±SD
6MWD, m	325.46(±84.20)

Table 6 provides spirometry and 6-minute walk test (6MWT) results for 1000 study respondents. The FEV1/FVC ratio is a key measure of airflow obstruction. A normal value is typically >70%. In our study, the mean value of FEV1/FVC ratio is 77.26% suggested that, on average, the study participants have normal airflow or restrictive airflow. However, the large standard deviation (±19.36) indicates significant variability. The 6MWD measures the distance a person can walk in 6 minutes, reflecting functional exercise capacity. The mean distance was 325.46 meters.

Discussion

The demographic data collected in this study provides critical context for understanding the overall trends in post-COVID-19 recovery. Our sample was composed predominantly of individuals between the

ages of 21 and 50. This age distribution may reflect the fact that this group experiences both moderate initial illness and a higher rate of comorbidities, which predispose them to prolonged symptoms after the acute phase.[7] In comparison, Chen et al. and Brooks et al. reported a higher prevalence of post-COVID symptoms in older populations, particularly those aged 60 and above, who are known to experience greater vulnerability to the virus.[4,8] However, our study found that the >60 age group accounted for only 10.20% of the sample, which could be due to higher mortality rates and greater challenges in accessing healthcare among the elderly in Bangladesh. This observation is consistent with global studies[9], which reported that the elderly are less likely to recover from severe COVID-19 and, therefore, are underrepresented in long-term follow-up studies. This study also found a slight male predominance in the patient population (56.10%), which is similar to other studies conducted in South Asia. Research by Guan et al. has shown that males tend to have higher rates of severe COVID-19 outcomes due to behavioral risk factors, such as higher smoking rates and more prevalent comorbidities like hypertension and diabetes.[3] This male predominance in long COVID cases could also be explained by differences in immune responses between genders, with females typically having a more robust immune response to viral infections but also a higher risk of developing autoimmune conditions.[10]

Smoking and Lung Function

This study was the high proportion of current smokers (30.60%) among participants, which significantly influences lung function. Smoking is a known risk factor for chronic respiratory diseases, and this is especially relevant in the context of COVID-19 recovery. Studies have shown that individuals with a history of smoking are more likely to experience severe complications from COVID-19, including acute respiratory distress syndrome (ARDS) and long-term pulmonary dysfunction.[11] The spirometry data collected in our study revealed that the mean FEV1 was 1.78 L, and FVC was 2.49 L, both of which are lower than the normal expected values for healthy adults. This suggests that the patients, particularly smokers, are at a higher risk for persistent pulmonary dysfunction. The finding is in line with Longue et al.[12], which documented significant reductions in FEV1 and FVC among smokers recovering from COVID-19. The FEV1/FVC ratio (77.26%) in our study also falls within the range of obstructive lung disease, a finding that echoes the results from Mo et al.[13], where smokers recovering from COVID-19 exhibited similar spirometry results. These findings underscore the need for targeted rehabilitation strategies for smokers recovering from COVID-19. These should include not only physical rehabilitation but also smoking cessation programs, as smoking exacerbates the risk of both short-term and long-term pulmonary complications. Additionally, healthcare providers should closely monitor lung function in smokers recovering from COVID-19 to prevent further deterioration of lung capacity.

Co-Morbidities and Their Impact on Lung Function

This study also revealed that a significant proportion of patients had pre-existing comorbidities, with hypertension (17.70%) and diabetes (10.20%) being the most common. This is consistent with previous studies[14], who found that individuals with underlying conditions, particularly cardiovascular diseases and diabetes, are at a heightened risk for severe COVID- 19 outcomes and long-term respiratory symptoms. Hypertension and diabetes have long been recognized as risk factors for poor prognosis in viral respiratory infections, and this study supports the hypothesis that these conditions contribute to persistent lung dysfunction post-COVID.[15] Study by Talman S et al.[16] on post-COVID pulmonary outcomes found that patients with pre-existing lung diseases, such as asthma and COPD, are more likely to experience sustained pulmonary abnormalities. In our study, 10.70% of participants had COPD, which is a known risk factor for reduced lung function and respiratory complications. These findings highlight the importance of a multidisciplinary approach to post-COVID care, where patients with comorbidities should receive specialized attention to manage their underlying conditions and prevent further lung damage.

Vaccination and Post-COVID Lung Function

Vaccination status was another critical variable in our study. We found that 27.20% of participants

were unvaccinated, 49.90% had received one dose, and 22.90% were fully vaccinated. This distribution reflects the challenges in vaccine accessibility and hesitancy observed in many countries, particularly in low- and middle-income regions such as Bangladesh. These findings are consistent with the study by Nalbandian et al.[14,17] which also observed that vaccination, while beneficial in preventing severe disease and death, does not fully prevent long-term respiratory consequences in some patients. However, the reduction in severe disease severity and hospitalization observed in vaccinated individuals suggests that vaccination plays a crucial role in reducing the overall burden of post-COVID respiratory issues. This aligns with the findings of Zerin et al.[5,6], which emphasized the importance of post-COVID rehabilitation programs, even for vaccinated individuals, to help restore lung function and improve quality of life.

Comparison with Other Studies

These findings are consistent with several studies conducted globally on post-COVID pulmonary outcomes. For instance, Ziauddeen et al.[18] found that even mild cases of COVID-19 can lead to significant long-term pulmonary sequelae, including reductions in FEV1 and FVC. Similarly, Tenforde et al.[19] reported that patients with pre-existing respiratory conditions, such as COPD and asthma, had worse outcomes following COVID-19 infection. Additionally, the study by Wisnivesky et al.[20] on post-COVID rehabilitation emphasized the importance of comprehensive care for individuals recovering from COVID-19, especially those with significant comorbidities. Our findings reinforce this by highlighting the need for targeted pulmonary rehabilitation programs for post-COVID patients, particularly those with chronic diseases like hypertension, diabetes, and COPD.

Conclusion:

Fever followed by respiratory symptoms was the most common symptom of COVID-19 infection. Lung function parameters were impaired even four weeks after infection. The majority of respondents (72.8%) had received at least one dose of COVID-19 vaccination.

Recommendations

1. Regular monitoring of symptoms and lung function of patients after COVID-19 infection.
2. Implement targeted pulmonary rehabilitation programs for individuals recovering from COVID-19, especially those with pre-existing conditions.
3. Enhance vaccination coverage and awareness to reduce the severity of COVID-19 and its long-term effects.

Acknowledgement

We would like to express our sincere gratitude to the participants for their time and willingness to participate in this study. We extend our thanks to the medical staff and health officers in Kaliakair, Gazipur, for their support during data collection. Special thanks to the institutional review board for their approval and guidance, and to all who contributed their knowledge and expertise, helping us to successfully complete this research.

Funding: Bangabandhu Sheikh Mujib Medical University

Conflict of interest: None declared

References

1. Biancolella M, Colona VL, Mehrian-Shai R, Watt JL, Luzzatto L, Novelli G, Reichardt JK. COVID-19 2022 update: transition of the pandemic to the endemic phase. Human genomics. 2022 Jun 1;16(1):19.
2. Lytton SD, Ghosh AK. SARS-CoV-2 variants and COVID-19 in Bangladesh—Lessons learned. Viruses. 2024 Jul 4;16(7):1077.
3. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, Liu L, Shan H, Lei CL, Hui DS, Du B. Clinical characteristics of coronavirus disease 2019 in China. New England journal of medicine. 2020 Apr 30;382(18):1708-20.
4. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, Qiu Y, Wang J, Liu Y, Wei Y, Xia JA. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. The lancet. 2020 Feb 15;395(10223):507-13.
5. Yang X, Yu Y, Xu J, Shu H, Xia JA, Liu H, Wu Y, Zhang L, Yu Z, Fang M, Yu T. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective,

observational study. The lancet respiratory medicine. 2020 May 1;8(5):475-81.

6. Zerin T, Haque S, Jahan S, Farjana NE, Begum MA, Islam S, Akter S. Strategic Plan and Limitations in Tackling Delta Variant Outbreak in Bangladesh.
7. Ayoubkhani D, Bermingham C, Pouwels KB, Glickman M, Nafilyan V, Zaccardi F, Khunti K, Alwan NA, Walker AS. Trajectory of long covid symptoms after covid-19 vaccination: community based cohort study. bmj. 2022 May 18;377.
8. Brooks D, Solway S. ATS statement on six-minute walk test. American journal of respiratory and critical care medicine. 2003 May 1;167(9):1287-.
9. Culver BH, Graham BL, Coates AL, Wanger J, Berry CE, Clarke PK, Hallstrand TS, Hankinson JL, Kaminsky DA, MacIntyre NR, McCormack MC. Recommendations for a standardized pulmonary function report. An official American Thoracic Society technical statement. American journal of respiratory and critical care medicine. 2017 Dec 1;196(11):1463-72.
10. Huang Y, Tan C, Wu J, Chen M, Wang Z, Luo L, Zhou X, Liu X, Huang X, Yuan S, Chen C. Impact of coronavirus disease 2019 on pulmonary function in early convalescence phase. Respiratory research. 2020 Jun 29;21(1):163.
11. Hui DS, Ei Azhar E, Madani TA, Ntoumi F, Kock RA, Dar O, Ippolito G, Mchugh TD, Memish ZA, Drosten C, Zumla A. The continuing epidemic threat of novel coronaviruses to global health-the latest novel coronavirus outbreak in Wuhang, China. International Journal of Infectious Diseases.;91.
12. Logue JK, Franko NM, McCulloch DJ, McDonald D, Magedson A, Wolf CR, Chu HY. Sequelae in adults at 6 months after COVID-19 infection. JAMA network open. 2021 Feb 1;4(2):e210830-.
13. Mo X, Jian W, Su Z, Chen MU, Peng H, Peng P, Lei C, Chen R, Zhong N, Li S. Abnormal pulmonary function in COVID-19 patients at time of hospital discharge. European Respiratory Journal. 2020 Jun 18;55(6).
14. Nalbandian A, Sehgal K, Gupta A, Madhavan MV, McGroder C, Stevens JS, Cook JR, Nordvig AS, Shalev D, Sehrawat TS, Ahluwalia N. Post-acute COVID-19 syndrome. Nature medicine. 2021 Apr;27(4):601-15.
15. World Health Organization. Obesity: preventing and managing the global epidemic: report of a WHO consultation.
16. Talman S, Boonman-de Winter LJ, De Mol M, Hoefman E, Van Etten RW, De Backer IC. Pulmonary function and health-related quality of life after COVID-19 pneumonia. Respiratory medicine. 2021 Jan 1;176:106272.
17. Sohn S, Savova GK. Mayo clinic smoking status classification system: extensions and improvements. InAMIA Annual Symposium Proceedings 2009 Nov 14 (Vol. 2009, p. 619).
18. Ziauddeen N, Gurdasani D, O'Hara ME, Hastie C, Roderick P, Yao G, Alwan NA. Characteristics and impact of Long Covid: Findings from an online survey. PloS one. 2022 Mar 8;17(3):e0264331.
19. Tenforde MW. Symptom duration and risk factors for delayed return to usual health among outpatients with COVID-19 in a multistate health care systems network—United States, March–June 2020. MMWR. Morbidity and mortality weekly report. 2020;69.
20. Wisnivesky JP, Govindarajulu U, Bagiella E, Goswami R, Kale M, Campbell KN, Meliambro K, Chen Z, Aberg JA, Lin JJ. Association of vaccination with the persistence of post-COVID symptoms. Journal of General Internal Medicine. 2022 May;37(7):1748-53.