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RESEARCH ARTICLE

Analyzing Vital Capacity in Short-Term COVID-19 Survivors between 20 to 40 years and over 40 years Population: Understanding Respiratory Health in New Normal situation

Jannatul Ferdaus Rickta[1], Md. Arafat[2*], Fatima Tus Johora Mukta[1], Md. Rezaul Islam[3]

[1]Department of Physical Education and Sports Science, Jashore University of Science and Technology, Bangladesh
[2]Department of Physical Education, Chittagong University of Engineering & Technology, Bangladesh
[3]Bangabandhu Textile Engineering College, Tangial, Bangladesh

Corresponding Author: Md. Arafat. Email: arafat4232@cuet.ac.bd
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Abstract
COVID-19 global coronavirus is a pandemic caused by coronavirus 2 (SARS-CoV-2). Coronavirus effect on multiple organ dysfunction but pulmonary function is most affected area of a patients. Pulmonary function or vital capacity have significance in the treatment of COVID affected patients. Vital capacity is defined as the maximal volume of air that can be exhaled from the lungs following maximal inspiration. Present study aim is to compare vital capacity between COVID-19 survivors and non-COVID populations. A total of eight hundred fifty-nine (859) subjects of different ages have been selected for the present study. The present study data were collected by the Multi-Functional Spirometer HI-801 for vital capacity, and the digital weighing scale was used for the measurement of body weight. The collected data was analyzed using descriptive statistics, the mean and the standard deviation (SD). An inferential statistically paired and independent t-test was applied to check the level of significance. The significance level was set at $p<0.05$. The results of this study, male COVID survivors between the ages of 20 to 40 have better vital capacity recovery than male COVID survivors over the age of 40, while female COVID survivors between the ages of 20 to 40 outperform female COVID survivors over the age of 40. Female COVID-19 survivors generally regain essential capabilities far more quickly than male survivors. We conclude that female COVID survivors recover vital capacity much faster than male COVID survivors.
Keywords: COVID-19; Vital Capacity; Multi-Functional Spirometer HI-801; Recovery Capacity

Introductions

Since its recent discovery, COVID-19, also known as a coronavirus, has caused serious disruptions due to its rapid spread and high death rate in over 192 nations worldwide (Huang. C et al.2020 & Yang. L et al. 2020). The global coronavirus disease of 2019 was a pandemic caused by coronavirus 2 (SARS-CoV-2) (Ren. S et al. 2020). The unique virus was discovered in an epidemic in Wuhan, an eastern Chinese city, in the last month of 2019.
But Wuhan authorities, specifically the Chinese government, were unable to control the rapid progress of the fatal virus within the city. As a result, the virus spread throughout China before spreading globally (Ren. S et al. 2020). Pneumonia, severe symptoms of acute respiratory distress syndrome (ARDS), and multiple organ dysfunction are

also common in patients with respiratory infections caused by COVID-19, such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS) (Huang. C et al.2020 & Yang. L et al. 2020). Investigations of pulmonary function or vital capacity have significance in the treatment of patients, particularly those who are COVID-19 survivors who have suspected or been diagnosed with respiratory diseases (Ranu. H et al. 2011) Vital capacity can be measured as forced vital capacity (FVC), slow vital capacity (SVC), and inspiratory vital capacity (IVC) (Chhabra, S. K. 1998). Vital capacity is defined as the maximal volume of air that can be exhaled from the lungs following maximal inspiration (Tow, A. E. et al. 2001). As a general measure of overall pulmonary function, the assessment of vital capacity can be helpful in identifying a patient's ability to sustain adequate gas exchange without having to exert themselves excessively when breathing (Tow, A. E. et al. 2001). The main drivers of individual variation in lung function include sex, body size, age, race, physical activity, and muscularity, in addition to other hereditary traits and present and past health (Maiolo. C et al. 2003). The amount of vital capacity in an adult male is 4.8 liters and in an adult female is 3.1 liters. Adult female lungs typically have between 10 and 12 percent less volume than adult male lungs of the same height and age (Bellemare, F. et al. 2003). Lung volumes increase steadily from birth to adulthood and the lungs mature at the age of 20–25 years, yet only minimal changes occur in the lung volumes over the following 10 years (Sharma, G., & Goodwin, J. 2006). Aging is linked to gradual changes in lung sizes and other pulmonary functions beyond 35 years (Zeleznik J. 2003). These changes include enhanced static lung compliance due to diminished alveolar elastic recoil and depressed chest wall compliance due to stiffening and increased outward recoil of the thoracic cage (Mittman, C. et al. 1965 & Janssens, J. P. et al. 1999). All the subjects gave their information, pulmonary function tests as they volunteered to participate in the study. The present study investigates COVID-19 survivors 20 to 40 years old and above 40 years old, both male and female, vital capacity. The present study also found that non-COVID 20- to 40-year-olds and people above 40 years of age, both male and female, have vital capacity. The main aim is to compare vital capacity between COVID-19 survivors and non-COVID survivors' populations.

Methods

A total of eight hundred fifty-nine (859) subjects of different ages have been selected for the present study. All subjects were living in their habitation, which is mixed by nature. Some personal information, such as age, BMI, sex, nationality, size of chest, chronic disease, non-communicable diseases, types of profession, and types of COVID-19 was collected. The present study data were collected by the Wright Pick flow meter (1960) for vital capacity, and the digital weighing scale was used for the measurement of body weight.
Using Kolmogorov-Smirnov and Shapiro-Wilks tests to scan the data and the data had a normal distribution (Arafat, Y. et al 2022). The collected data was analyzed using descriptive statistics, the mean and the standard deviation (SD). An inferential statistically paired and independent t-test was applied to check the level of significance. The significance level was set at $p<0.05$.Descriptive and for comparison, appropriate inferential statistical tools (SPSS) have been used for the analysis of the gathered data on vital capacity.

Results

In table number 1, a Kolmogorov-Smirnov and Shapiro-Wilks test ($p > .05$) and a visual inspection of box plots showed that the exam scores were approximately normally distributed for both samples, with skewness of 0.99 (SE =.44) and kurtosis of 3.89 (SE =.85) for the non-COVID males 20 to 40 years old and skewness of 0.497 (SE =.43) and kurtosis of -0.287 (SE =.79) for the non-COVID males above 40 years old.

Table 1: Test of Normality and Homogeneity of data in Non-COVID Male 20 to 40 years and Non-COVID Male above 40 years

Group	**Test of Normality**				
			Descriptive		
	Kolmogorov-Smirnov	Shapiro-Wilk		Statistic	Std. Error
Non-COVID Male 20 to 40 Years	*p*	*p*	skewness	0.99	.44
	.004	4.08	kurtosis	3.89	.85
Non-COVID Male above 40 years age	.082	4.08	skewness	0.497	.43
			kurtosis	-0.278	.79

Table 2: Difference between Non-COVID 20 to40 years Male and Non-COVID above 40 years male

Types of Subject	Number of Subjects	Mean	SD	df	't' Value	'*p*' Value
Non COVID male 20 to 40 Years	100	5.03	0.399	206	1.97	.05
Non-COVID Male above 40 years age	108	4.16	0.356			

It is clearly shown from table number 2 that the mean value of non-COVID males 20 to 40 years old is 5.03 liters, the standard deviation is.399, and for non-COVID males above 40 years old, the mean value is 4.16 liters, the standard deviation is.356, df 206, *t* value 1.97, *p*-value.05.

Table 3: Test of Normality and Homogeneity of data in Non-COVID Females 20 to 40 years and Non-COVID20 to 40 years Female

Group	**Test of Normality**				
			Descriptive		
	Kolmogorov-Smirnov	Shapiro-Wilk		Statistic	Std. Error
Non-COVID female 20 to 40 Years	*p*	*p*	skewness	0.19	.44
	.01	.0003	kurtosis	-0.71	.89
Non-COVID female above 40 Years	.014	.000	skewness	0.34	.33
			kurtosis	-1.12	.78

In table number 3, a Kolmogorov-Smirnov and Shapiro-Wilks test ($p>.05$), visual inspection of box plots showed that the exam scores were approximately normally distributed for both the samples, with skewness of 0.19 (SE

=.44) and kurtosis of -0.71 (SE =.89) for the non-COVID female 20 to 40-year-old people and skewness of 0.34 (SE =.33) and kurtosis of -1.12 (SE =.78) for the non-COVID female above 40-year-old people.

Table 4: Difference between Non-COVID 20 to40 years Female and Non-COVID above 40 years Female

Types of Subject	Number of Subjects	Mean	SD	df	'*t*' Value	'*p'* Value
Non COVID female 20 to 40 Years	128	3.77	0.28	237	1.97	0.05
Non COVID female above 40 Years	111	3.41	0.52			

It is clearly shown from table number 4, the mean value of non-COVID females 20 to 40 years old is 3.77 liters, the standard deviation is 0.28, and for non-COVID females above 40 years old, the mean value is 3.41 liters, the standard deviation is 0.52, df 237, *t* value 1.97, and *p* value.050.

Table 5: Test of Normality and Homogeneity ofdata in COVID 20 to 40 years male and COVID above 40 years male

Group	**Test of Normality**				
	Kolmogorov-Smirnov	Shapiro-Wilk	Descriptive	Statistic	Std. Error
COVID 20 to 40 years male	*p*	*p*	skewness	0.64	.44
	.03	.000	kurtosis	-0.77	.89
COVID above 40 years male	.07	.0004	skewness	0.54	.44
			kurtosis	-0.17	.89

In table number 5, a Kolmogorov-Smirnov and Shapiro-Wilks test ($p>.05$) and a visual inspection of box plots showed that the exam scores were approximately normally distributed for both the samples, with skewness of 0.64 (SE =.44) and kurtosis of -0.77 (SE =.89) for the COVID 20 to 40 year old male and skewness of 0.54 (SE =.44) and kurtosis of -0.17 (SE =.89) for the COVID above 40 year old male.

Table 6: Difference between COVID 20 to40 years male and COVID above 40 years male

Types of Subject	Number of Subjects	Mean	SD	df	*'t'* Value	*'P'* Value
COVID male 20 to 40 Years	101	4.81	0.63	202	1.97	0.05
COVID male above 40 Years	103	3.99	0.41			

It is clearly shown from table number 6, the mean value of COVID males 20 to 40 years old is 4.81 liters, the standard deviation is 0.63, and for COVID males above 40 years old, the mean value is 4.14 liters, the standard deviation is 0.35, df 202, *t* value 1.97, *p*-value.050.

Table 7: Test of Normality and Homogeneity of data in COVID 20 to 40 years female and COVID above 40 years female

Group	**Test of Normality**				
	Kolmogorov-Smirnov	Shapiro-Wilk	Descriptive	Statistic	Std. Error
COVID 20 to 40 years female	*p*	*p*	skewness	-0.69	.44
	.145	.003	kurtosis	1..18	.89
COVID above 40 years female	.0003	4.47	skewness	-0.13	.33
			kurtosis	-1.52	.78

In table number 7, a Kolmogorov-Smirnov and Shapiro-Wilks test ($p>.05$), and a visual inspection of box plots showed that the exam scores were approximately normally distributed for both the samples, with skewness of -0.69 (SE =.44) and kurtosis of 1.18 (SE =.89) for the COVID female 20 to 40 year old people and skewness of -0.13 (SE =.33) and kurtosis of -1.52 (SE =.78) for the COVID female above 40 year old people.

Table 8: Difference between COVID 20 to40 years female and COVID above 40 years female

Types of Subject	Number of Subjects	Mean	SD	df	'*t*' Value	'*P*' Value
COVID females 20 to 40 Years	100	3.47	0.28			
				206	1.97	0.05
COVID females above 40 Years	108	3.30	0.39			

It is clearly shown from table number 8 that the mean value of COVID females 20 to 40 years old is 3.47 liters, the standard deviation is 0.28, and for COVID females above 40 years old, the mean value is 3.30 liters, the standard deviation is 0.39, df 206, *t* value 1.97, *p* value.05.

Table-9: Vital Capacity recovery phenomenon 20 to 40 years & above 40 years Male and Female for both Non-COVID and COVID survivors

	Mean PFM Score(Liter)Non-COVID	Mean PFM Score(Liter)COVID	Mean PFM Score(Liter)(Non COVID -COVID)	Mean Difference (%)
Male 20-40 Years	5.03	4.81	0.22	4.37
Female 20-40 Years	3.77	3.47	0.30	7.95
Male above 40 years	4.16	3.99	0.17	4.09
Female above 40 years	3.41	3.30	0.11	3.23

It is clearly shown from table number 9 that the mean difference between non-COVID and COVID males aged 20 to 40 years is 0.22 liters, and the percentage of the mean difference is 4.37 liters. The mean difference between non-COVID and COVID females 20–40 years old is 0.30 liters, and the percentage of the mean difference is 7.95 liters. The mean difference between non-COVID and COVID males over 40 years old is 0.17, and the percentage of the mean difference is 4.09 liters. The mean difference between non-COVID and COVID females over 40 years old is 0.11, and the percentage of the mean difference is 3.23 liters.

Discussions

Concerns have been raised regarding the assessment of lung injury for released patients after the World Health Organization (WHO) classified coronavirus disease 2019 (COVID-19) as a pandemic on March 11, 2020. COVID-19 has been linked to numerous lung injuries, and these injuries have been widely reported (Mo. X. et al. 2020). Pulmonary function includes vital capacity, and COVID-19 impacts vital capacity (Anastasio. F. et al. 2121). The maximum amount of air that may be exhaled after the maximum amount of inspiration is referred to as vital capacity (VC) (David. S. & Sharma. S. 2019).

According to the results of this study, male COVID survivors between the ages of 20 to 40 have better vital capacity recovery than male COVID survivors over the age of 40, while female COVID survivors between the ages of 20 to 40 outperform female COVID survivors over the age of 40. Female COVID-19 survivors generally regain essential capabilities far more quickly than male survivors.

Lung volumes increase at the age of 20–25 years, and after 35 years, there are gradual changes in lung volumes and other pulmonary functions (Sharma, G., & Goodwin, J. 2006. & Zeleznik J. 2003). COVID-19 is a harmful factor for all ages, both male and female, and especially the aging population is a big concern (David. S. & Sharma. S. 2019 & Shteinlukht, T. 2021). Age is a major determinant in the development of internal organ and lung disease, and pulmonary disease has serious consequences for the aging population, according to previous research (Lowery, E. M. et al. 2013). Lung injury from COVID-19 is associated with a decline in pulmonary function following an infection (Anastasio, F. et al. 2021).

The current study indicates unequivocally that females recover from coronavirus infections far more quickly than males. Previous research has unmistakably demonstrated that women's immune systems are better able to fight off infections than men's (Anastasio, F. et al. 2021& Fink, A. L., & Klein, S. L. 2018), and this is because of a structural genetic difference (Pennell, L.M. et al. 2012). These findings imply that gonadal hormones might be involved in this sex disparity (Clark. A. S. & Goldman-Rakic, P. S. 1989). In this instance, the findings of the current study are consistent with earlier work.

Regular exercise increases pulmonary function, a sign of vital capacity, and physically inactive people have lower vital capacities than physically active people of the same sex, age, height, and weight (Taneja, S., & Bose, J. 2021. & Rong. C et al. 2008). Only work and physical activity cause a variety of physiological changes in the body (Panikulam, E. J. et al. 2016). The present study suggests that COVID survivors and non-survivors exercise regularly in their daily lives because of a healthy lifestyle. The instruments used for collecting data were not of a very high standard, and time and finances were limiting conditions for the study. In future research, more subjects and standard instruments will be used.

Conclusion

The finding of the present study is that the recovery phenomenon of vital capacity in 20- to 40-year-old male COVID survivors is better than that in above-40-year-old male COVID survivors. The present study also found that 20- to 40-year-old female COVID survivors are superior to the above-40-year-old female COVID survivors. In total, we conclude that female COVID survivors recover vital capacity much faster than male COVID survivors.

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Data availability statement: The article contains every one of the unique contributions that are featured in this manuscript.

Ethical statement: The study complied with every essential guideline for doing ethical review committee Faculty of Biological Science and Technology, Jashore University of Science and Technology, Bangladesh.

Authors contributions: JFR conceived the design research, collected the data and critically review the article. FTJM help to collect the data. MYA calculation and write the article.

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