ASSESSMENT OF LUNG FUNCTIONS IN MENOPAUSAL OBESE WOMEN AFTER COVID-19 RECOVERY

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ABSTRACT

Objectives: The COVID-19 pandemic has presented considerable challenges to global health services, as COVID-19 symptoms subsides and individuals became in the recovery phase of post-COVID-19-syndrome that requires evaluation of lung function and assessment of the consequences of this virus on lung health. The aim of this study to determine the effect of COVID-19 on lung functions after one month of recovery in obese menopausal women.

Methods: The COVID group (Group I) consisted of (20) obese menopausal women whom were recently recovered from mild-moderate COVID-19 for one month. The non COVID group (Group II) consisted of (20) obese menopausal women; whom were not be affected by COVID-19. Using spirometry, forced vital capacity (FVC), forced expiratory volume in first second (FEV1), and Tiffeneau index (FEV1/ FVC) would be measured in both groups.

Results: There was a statistically significant difference in all measured variables when compared between groups (I and II) in favor of group (II); FVC (p= 0.001), FEV1 (p= 0.001) and FEV1/FVC (p= 0.001).

Conclusion: COVID-19 had significant effect on lung function as it decreased FVC, FEV1 and FEV1/ FVC to the obese menopausal women who were affected by mild-moderate COVID-19, assumed home isolation during illness period and were recovered after one month in comparison to non COVID women.

Keywords: COVID-19, Personal protective equipment, Pulmonary function, Obesity, Menopause

I-INTRODUCTION

COVID-19, a pandemic caused by a new coronavirus, SARS-CoV-2, is linked to high rates of morbidity and mortality, and it poses huge, tremendous challenges to the globe’s healthcare systems. It tends to develop a self-limiting viral infection of mild to moderate severity. More than one in ten people experience severe respiratory symptoms, the most frequent of which is a viral pneumonia process, as a result, hypoxemic respiratory failure is common. COVID-19-related respiratory impairment is attributed to a reduction in diffusing capacity that appears to be proportional to disease severity and aligns with radiological interstitial alteration.

Men and women have different COVID-19 outcomes, highlighting the need of understanding the sex-related COVID-19 outcomes. Complex interactions based on sex chromosome complement, reproductive tissues, and the concentration of sex steroid hormones (testosterone estrogen, and progesterone) play a diverse role in COVID-19 outcomes. When compared to premenopausal women, postmenopausal women had a considerable shift in plasma sex hormone concentrations (e.g., estrogen and progesterone depletion). Estrogen and/or progesterone may also influence the innate and adaptive immune systems. However, it is unclear if premenopausal and postmenopausal women had different COVID-19 outcomes.

Menopause has been linked to an increase in respiratory problems. Reduced estrogen and progesterone levels may result in a reduced muscular strength, bronchial smooth muscle relaxation, and thoracic spine compression secondary to osteoporosis. Lung function declines rapidly in postmenopausal women. Airway smooth muscle
relaxation has been linked to estrogen and progesterone, which lowers their contractile response which explain the essential role of estrogen in collagen synthesis.8,9

In COVID 19, there is a clear link between being overweight or obese and the likelihood of being hospitalized or requiring treatment in intensive care units (ICUs). According to new research, obese persons under the age of 60 are more likely to be hospitalized. The COVID-19 pandemic has emerged at a time when the prevalence of overweight/obesity is increasing in almost all countries throughout the world. Practically all countries now have a prevalence of overweight/obesity more than 20%.10 Obesity alters the mechanics of the lungs and chest wall, resulting in asthma and asthma-like symptoms such as dyspnea, wheezing, and airway hyperresponsiveness. Obesity has a multifaceted impact on lung function, which is connected to both mechanical and inflammatory factors.11

This study was conducted to provide evidence about changes in lung function including (forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), and Tiffeneau index, in menopausal obese women after 1 month home recovery from COVID 19.

II- MATERIALS & METHODS

• Study Design:

The study was designed as a prospective, randomized trial. It was conducted between July 2021 and October 2021. The COVID group were consisted of (20) obese menopausal women who were affected by mild-moderate COVID-19, assumed home isolation during illness period and were recovered after one month. The non COVID group were consisted of (20) obese menopausal women; whom were not be affected by COVID-19. Using spirometry, we measured forced vital capacity (FVC), forced expiratory volume in first second (FEV1), Tiffeneau index (FEV1/FVC) in both groups.

• Participants:

A sample of 40 females was recruited from Outpatient Clinic, Badr University in Cairo, Egypt. Inclusion criteria were all women will be aged from 45 to 55 years old in menopause, their BMI will be from 30 to 34.9 kg/m2, participants recovered from mild to moderated signs and symptoms of COVID-19 after one month, ability to perform pulmonary function tests correctly, COVID-19 was diagnosed by positive polymerase chain reaction (PCR) testing on nasopharyngeal swab, oxygen saturation was ranged between 92–96% during illness period, CT chest shows ground glass opacity, their D-dimer was less than 0.5 μg/ml, two successive negative PCR were before included in study, participants were in home isolation during illness period. Exclusion criteria were chronic respiratory disease, chronic heart disease, diabetes mellitus, smoking, centralized isolation, severe COVID-19. All participants provided written informed consent.

• Interventions:

This study included women who survived COVID-19 and presented for clinical follow-up after mild to moderate COVID-19. We report on initial follow-up one month after mild to moderate COVID-19 according to the WHO severity classification. All patients provided written informed consent before inclusion. Ethics approval was gained before start of the study on July 1, 2021 (P.T.REC/012/003275).

Participants were divided into two groups: Group I (the study group) were consisted of (20) obese menopausal women who were recently recovered from mild-moderate COVID-19 for one month. Group II (the control group) were consisted of (20) obese menopausal women; whom were not be affected by COVID-19.

• Body mass index:

Body weight and height for all participants were obtained and body mass index (BMI) was calculated using standard techniques. All female their BMI will be from 30 to 34.9 kg/m2.

• Pulmonary function tests:

Outpatient pulmonary function tests were performed using Micro- lab portable spirometer (BF-II Portable spirometer, USA). Forced expiratory volume in the first second (FEV1), FVC, FEV1/FVC ratio were included in the analysis. There were many items included in preparing for pulmonary function test before evaluating subjects as:
Organizational structures

Workroom should be selected for participants evaluation then schedule could be planned on special days. Maintenance service prepared processes for sanitization service (toilet) for the private use of participants and disinfection carefully of the workroom.

The waiting room for participants should be well-ventilated and lit with natural light, with at least 2 m separated between seats. After every patient left, all the medical equipment used during testing should be carefully cleaned and sanitized, as well as the workroom.

Measuring equipment

Carefully all local infection control procedures should be followed, as reusable medical equipment and devices should be sterilized before they were used with the next patient.

Alcohol gel should be provided in all workplaces together with tissues or paper towels.

All parts including nasal forceps, spacers, adaptors, mouthpieces, nozzles, and filters should new.

Personal protective equipment (PPE)

Facemask, cap to protect hair, disposable gloves that should be changed between participants and disposable surgical scrubs.

Planning schedules and performing respiratory function tests.

Patients who have had COVID-19 should have had one month after negative polymerase chain reaction (PCR) test for COVID before scheduling an appointment for respiratory function tests.

When Planning schedules, we increased the period between participants as the workroom and devices should to be disinfected at the termination of each test.

We sent videos to participants on how respiratory function tests were done and that they should watch before their appointment. This would decrease the time they wanted to spend in the workroom. PFT: https://youtu.be/uAo0RFpIM1A. All participants should make hand-washing procedures on ingoing the workroom. Our Position and the participant’s chairs should be in the same direction to avoid face-to-face contact during test, and we should never remove facemask during the testing process.12

We changed certain items of their PPE (gloves, and scrubs) before assessment each patient. The results and explanation of the test sent to the participants by electronic means (e-mail).

- Outcome measures:

All variables as forced expiratory volume in the first second (FEV1), forced vital capacity (FVC), and FEV1/FVC ratio were included in the analysis one month after two successive negative PCR were before included in study.

- Statistical Analysis:

The data were collected and analyzed through two types of statistics by using SPSS version 17 as follows:

Descriptive statistics: the mean and standard deviation of each group were calculated for each parameter; mean (X) = summation of x / number of x and standard deviation (SD) = root square of variance.

Inferential statistics: comparing mean values of each parameter between the two groups was done by unpaired t- test. The probability in this study was > 0.05%.

III- RESULTS

A sample of 40 females with their age ranged from 45–55 years; body mass index (BMI) from 30-34.9 kg/m2; Fig(1) and divided equally into two groups, Group (I) and Group (II) as shown in table (1).

- Both groups were similar at baseline (P>0.05) regarding age and BMI (Table 1).
As indicated from descriptive data of both groups (I and II), the participant in two groups were homogenous and normality concerning age, height, weight and sex.

There was a statistically significant difference in all measured variables when compared between groups (I and II) in favor of group (II); FVC (p= 0.001) Fig (2), FEV1 (p= 0.001) Fig(3) and FEV1/FVC (p= 0.001) Fig(4) and (Table 2).

### Table 1. Demographic data of females in both groups.

<table>
<thead>
<tr>
<th>Items</th>
<th>Group (I)</th>
<th>Group (II)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>49.65±2.5</td>
<td>49.95±2.76</td>
<td>0.721NS</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>32.79±1.14</td>
<td>32.14±1.33</td>
<td>0.106NS</td>
</tr>
</tbody>
</table>

**NS** P > 0.05 = non-significant, **P** = Probability.

### Table 2. FVC, FEV1 and FEV1/FVC for the two groups.

<table>
<thead>
<tr>
<th></th>
<th>Group (I) n (20)</th>
<th>Group (II) n (20)</th>
<th>P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC</td>
<td>2.56±0.22</td>
<td>2.85±0.26</td>
<td>0.001S</td>
</tr>
<tr>
<td>FEV1</td>
<td>1.42±0.18</td>
<td>1.82±0.2</td>
<td>0.002S</td>
</tr>
<tr>
<td>FEV1/FVC</td>
<td>55.46±7.78</td>
<td>64.11±6.67</td>
<td>0.001S</td>
</tr>
</tbody>
</table>

* Inter-group comparison; ** comparison of the results of both groups. **NS** P > 0.05 = non-significant, **S** P < 0.05 = significant, **P** = Probability.

![Figure 1. BMI (kg/m2).](image)

![Figure 2. FVC.](image)
This study was reporting the respiratory follow-up outcomes after COVID-19 infection in Egyptian menopausal obese women who followed the recommended protocol of The Egyptian Ministry of Health and Population for management COVID-19 cases in home. After an average observation time of one month, our observational study reveals impairments occurred in pulmonary functions in post-menopausal obese women after recovery compared with post-menopausal obese women who not subjected to COVID 19 infection. The prevalence and extent of pulmonary function and physical impairment after different clinical courses of COVID-19 are still uncertain.

Patients with COVID-19 are known to have fever, cough, headache, loss of smell and deterioration of GI system in general. It is highly beneficial for offering follow-up checks and investigating reinfection possibilities of COVID-19 recovered patients.  

Literature on lung health in women is confusing and effects of hormonal status on the airways often appear to be heterogenous.  

At present, the long-term pulmonary consequences of COVID-19 remains speculative and should not be assumed without appropriate prospective study. Nonetheless, given the huge numbers of individuals affected by COVID-19, even rare complications will have major health effects at the population level.  

**IV- DISCUSSION**

**Figure 3. FEV1.**

**Figure 4. FEV1/FVC.**
The results of a previous study conducted by Fumagalli et al., suggested that COVID-19 may result in clinically relevant alterations in pulmonary function tests, with a restrictive pattern in 10 out of 13 patients at the time of hospital discharge. After 6 weeks, pulmonary function improved, but some degree of restrictive alteration persisted; which agrees the results of the present study. 16

1- FVC:

FVC is a direct function of the amount of inhaled air. It is the most important PFT, very sensitive to diseases that affect the lung elasticity and mechanical properties. A low FVC may be caused by either obstruction or restriction. The results of our study showed a significant decrease in FVC in both groups than normal values which agrees the results of a previous study conducted by Memoalia et al., that revealed a significantly decrease in mean FVC in menopausal group which may indicate a marker of premature death. 14

2- FEV1:

Not only is FEV1 (normal value 80%) the most widely used spirometry parameter, but it also remains the single most validated and clinically useful test of ventilatory function for assessment and management of airflow limitation. FEV1 is a universally reliable indicator in distinguishing between obstructive and restrictive lung diseases. The results of our study show a significant decrease in FEV1 in both groups which come in line with a previous study by Memoalia et al., in which the mean values of FEV1 of postmenopausal women were significantly less as compared to those of premenopausal women (P < 0.0001) which supports our results. 14

3- FEV1/FVC:

The quantity of air exhaled during the primary second is a fairly constant fraction of the FVC regardless of lung size. 14 within the current study, mean value of FEV1 /FVC of menopausal obese women after COVID 19 recovery was significantly less as compared to those menopausal obese women who not subjected to COVID 19 recovery.

A previous study conducted by Sonnweber et al., 2021 found that 100 days after diagnosis of COVID-19, a reduction in forced vital capacity (FVC) and/or forced expiratory volume in 1 s (FEV1) was found in 22% of patients, which agrees the results of the recent study. 17

On the other hand, a study was conducted by Rogliani et al., found that provides the preliminary evidence that in patients with mild-to-moderate forms of COVID-19 pulmonary opacity was totally recovered at follow-up, with no sign of any fibrotic abnormality. Interestingly, at follow-up also lung function and exercise capacity were in the normal range, which contradict the results of the present study. 18

The first study to explain PFT in patients following COVID-19 was published by Mo et al. and reported findings from 110 patients (age: 49 ±14 years; 50% female), who underwent testing, 27±9 days after symptom onset, in April 2020 in Guangzhou, China. The clinical group was mainly previously healthy individuals with mild (n = 24), moderate (n = 67) and severe disease (n = 19), only three patients had pre-existing lung disease which disagrees the results of the present study. 19

Explanations were reported from 45 patients (age: 54 ±8 years; 44% female), with mild (n = 12), moderate (n = 17) and severe disease (n = 16), by Frija-Masson and colleagues who also, as anticipated, reported that the rate of PFT abnormality was higher in patients with severe disease which agrees our results to some extent regarding non-severe form of infection. 20

In one of the greatest European studies up to the present time, Van den Borst et al. obtained PFT measurements from 124 patients with COVID-19 infection after 3 months of recovery. In this cohort, no differences in spirometry or static lung volumes were observed when comparing disease severity which disagree the results of our study. 21

In a previous study conducted on the survivors of COVID-19, the follow up showed that, at the baseline, the average FEV1/FVC was higher compared to upper limit of normality values (p=0.029), while FVC (p<0.001) and FEV1 (p=0.004) were lower compared to respective lower limit of normality values in enrolled patients. After 6 weeks, an overall improvement in pulmonary function was observed, but FVC was still lower than lower limit of normality values; supporting the results of the present study. 16

A meta-analysis recently reported that individuals who were obese or overweight showed significant relations with decreased force expiratory volume in 1 second (FEV1), forced vital capacity (FVC), and FEV1/FVC (%) values compared to normal weight adults and shown to be stronger in women than men due to physiological and hormone-related influences, agreeing the results of the present study. 22
A previous study conducted by Songur et al., concluded that Postmenopausal status is independently associated with increased odds of chronic cough plus phlegm, whereas it does not appear to be independently associated with FEV1 or FVC. These findings suggest that reproductive factors may influence women’s pulmonary health which supports the results of the present study.

In a large study of middle-aged women, the fully adjusted prevalence of abnormal lung function, particularly that of restrictive ventilatory disorder, was higher in women in late menopausal transition and menopausal stages compared to women in premenopausal stage which supports the results of the present study.

In the UK Biobank study, postmenopausal women had lower FVC than premenopausal women, with a tendency of progressively lower FVC in women with irregular menstruation and without menstruation. During a longitudinal analysis of the European Community Respiratory Health Survey, FVC declined rapidly and linearly during the menopausal transition and postmenopausal periods compared to premenopausal.

V- CONCLUSION

COVID-19 had significant effect on lung function as it decreased FVC, FEV1 and FEV1/FVC to the obese menopausal women who were affected by mild-moderate COVID-19, assumed home isolation during illness period and were recovered after one month in comparison to non COVID women.

- **Highlights:**
  - The COVID-19 pandemic has presented considerable challenges to global health services.
  - Determine the effect of COVID-19 on lung functions after one month of recovery in obese menopausal women.
  - COVID-19 had significant effect on lung function as it decreased FVC, FEV1 and FEV1/FVC to the obese menopausal women who were affected by mild-moderate COVID-19, assumed home isolation during illness period.

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**REFERENCES**