Innovative Journal of Medical and Health Science
Received 20 June 2022 | Revised 18 July 2022 | Accepted 25 July 2022 | Published Online 09 August 2022

DOI: https://doi.org/10.52845/IJMHS/2022/12-8-3
Inno J of Med Health Sci 12 (08), 1955-1966(2022)

RESEARCH ARTICLE

ISSN (P) 2589-9341 | (O) 2277-4939 IF:1.6

Effect of Incentive Spirometer on post COVID-19 Patient's Respiratory Outcomes

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Abstract
Background: The respiratory symptoms of COVID-19 often persist in most patients with moderate to severe infection after recovery. Respiratory exercises help post COVID-19 in pulmonary recovery/rehabilitation. Aim: investigate the effect of incentive spirometer on post-COVID-19 patient's respiratory outcomes. Hypothesis: patients who had successfully used the incentive spirometer will have better respiratory outcomes 6 weeks after the isolation period. Design:Quasi experimental research design (pre and post-test- time serial). Subjects: 30 adult male and female patients with COVID-19 in a convalescent stage. Sample: Apurposive sample. Setting: one of the COVID 19 follow-up outpatient clinics. Results: the mean age of the studied sample was 47 ±2.984. Half of the studied sample had no chronic diseases and 16.7%had a history of hypertension. The majority of the studied sample 90.7% had dyspnea in the first assessment as compared to 40% in the fourth assessment. The current study represents a highly significant statistical difference between the four assessments regarding the numerical Dyspnea Scale and Modified Medical Research Council (mMRC) Dyspnea Scaleandthe use of incentive spirometer ($\chi2 = 74.98$, df=21, P <0.001), ($\chi2=23$, df=3, p=0.001), ($\chi2 =36.08$, df=4,P<0.001)respectively, as well as a highly negative significant statistical correlation between incentive spirometer capacity and the Numerical Dyspnea Scale (rs = -0.867, P<0.001)and a moderate significant statistical negative correlation between incentive spirometer capacity and Modified Medical Research Council (mMRC)rs= -0.672/P=<0.001).and a moderate significant statistical negative correlation between incentive spirometer capacity and age (r= -0.491/P=<0.001). Conclusion:Respiratory exercises using an incentive spirometer have a positive effect on improving respiratory outcomes and decreasing the severity of dyspnea of post COVID 19 patients who had persistent pulmonary symptoms during the recovery phase. Recommendations:Further studies are necessary to establish whetherincentive spirometer is effective for the respiratory rehabilitation of COVID 19 patients.

Key terms: Incentive spirometer,post-COVID19, respiratory outcomes

1 | INTRODUCTION

The spread of the COVID-19 pandemic caused a huge burden a huge burden on health across the world with increased morbidity and mortality. According to the Egyptian Ministry of Health, the first COVID-19 cases in Egypt reported in the first quarter of 2020 increased dramatically to 419,460 by the 28th 2022 among the officially registered cases. The symptoms combined with COVID-19 range from mild upper respiratory tract symptoms to severe acute respiratory distress syndrome in addition to non-respiratory symptoms that have been documented in the literature. Lungs are the primary organs affected byCOVID-19; patients may suffer from constant loss or impairment in respiratory function even after being discharged as the most common symptoms of COVID-19 virus are fever, cough, bone pain, and respiratory problemseventually leading to pneumonia. Ali & Ghonimy, (2021), Torres-Castro, et-al., (2020).

Furthermore, Cares-Marambio, (2021) illustrates in a systematic review that the majority of COVID-19 patients complain of respiratory manifestations and the most prevalent pulmonary symptoms include dyspnea, chest pain, and cough as it occurs in more than 90% of cases and may continue for more than 3 weeks after hospital discharge. In the same line Nasserie(2021),reported that the most frequent COVID-19 symptoms include dyspnea, fatigue, and insomnia. COVID-19 patients may have decreased PaO2:FIO2 ratios due to intrapulmonary shunting. As well,Huang (2020), reports thatCOVID-19 affects negatively the lung diffusing capacity and reduces the intensity of respiratory muscle in more than one-half of the COVID-19 patients.

Therefore, it is possible that corona patients may benefit from respiratory rehabilitation, especially incentive spirometers (IS). Siddiq,(2020)states that pulmonary rehabilitation (PR) is an efficient intervention in patients with respiratory disorders to get better pulmonary outcomes and reduce mortality. Torres-Castro, et-al., (2020). Pulmonary rehabilitation is applied to lessen dyspnea, provide better exercise capacity, and improve quality of life in patients with respiratory diseases. The 2013 American Thoracic Society (ATS)/European Respiratory Society (ERS) explains that pulmonary rehabilitation involves, respiratory exercise with or without incentive spirometer, education, behavior change, and other different modalities, designed to enhance and get better physical and psychological state of patients with respiratory disease. Spruit,(2013).

Seyller (2021), proposed that incentive spirometer may be useful and good for pulmonary rehabilitation of COVID-19 patients through its mechanism of enhancing ventilation/perfusion mismatch and alveolar-PaO2 gradient, thus decreasing intrapulmonary shunting and the risk of atelectasis. An incentive spirometer is a bedside low cost medical tool commonly used for pre-operative patients to prevent postoperative complications or with certain lung problems such as pneumonia, chronic obstructive pulmonary disease, and bronchial asthma to promote lung expansion, increase lung capacity, and help better gas exchange through patient training on how to take slow, deep breathing. An incentive spirometer exercises the lungs to keep the alveoli sufficiently inflated as well as to promote gas exchange. Leader, (2021). The nurse has an important role to train the patient on how to use incentive spirometer and perform slow deep breathing and its benefit.

Therefore, the aim of this research is to investigate the effect of incentive spirometer on post COVID- 19 patient's respiratory outcome

Operational definition:

Respiratory outcome in the existing study refers to breathing pattern (rate, depth & Rhythm), dyspnea severity and respiratory volume capacity

Research significance:

Torres-Castro, et-al. (2020) reported in a systematic review that most COVID-19 patient's respiratory function is impaired especially the diffusion capacity. In the same line Anastasio, et-al, (2021) recommended respiratory rehabilitation as important in the management of post COVID-19 patients having clinical signs of disease.

Seyller, (2021) reported that although several health care settings prescribe incentive spirometer IS in their discharge plan of instructions for COVID-19 patients, it is not a universally agreed recommendation. There is no evidence supporting the presence of lung injury resulting from incentive spirometer and it has been successfully used in a variety of other pulmonary illnesses without resulting in any significant lung injury and it should be a part of management protocol for patients with mild and moderate COVID-19. An additional theoretical concern is that incentive spirometer increases the spread of the virus but not more than coughing or using inhaler and the patient is already being isolated.

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SUBJECTS AND METHODS

Aim of research:

Investigate the effect of incentive spirometer on post COVID-19 patient's respiratory outcomes

Research design:

Quasi experimental research design (pre and post-test-time serial). The study group involves 30 participants trained on how to use a spirometer

Subjects:

The study participants were 30 adult male and female patients with COVID-19 in a convalescentstageat one of the quarantined hospitals in Cairo

Inclusion criteria:

o Newly diagnosed moderate and severeCOVID-19 patient with respiratory symptom's in the convalescent stage and being confirmed by PCR- or computed tomography chest lesion (ground-glass opacity).
o After isolation period. The mean isolation period for all adult COVID-19 patients was 13.8 $\pm$ 6.1 days according to Liu, etal, 2020. From 7 21 days from the onset of the manifestations.
o Able to use incentive spirometer for at least 4 times/day (mouth control and conscious)
o Age: 18-60 year.
o Accept to participate in the study.
o Educated
o Have smart phone

The exclusion criteria:

Patients who have a complication or chronic diseases that may change patient prognosis.

Sample:

A purposive sample of 30 COVID 19 patient in the convalescence stage. The underlying rational of the selected number because the research was conducted during the pandemic of omicron and near half of the community were vaccinated and the prevalence of hospital admission decreased.

Research hypothesis:

The existing research hypothesizes that patients who had successfully used incentive spirometer will have better respiratory outcomes 6 weeks after isolation period.

Setting:

The first assessment of the current study was conducted in the COVID 19 outpatient follow up clinic at one of the quarantined hospitals in Cairo. The other 3 assessments, the participants had the right to choose to complete the remaining assessments in the outpatient clinic or through video call or zoom meeting.

Tools of data collectionL

Four tools were used to collect the data:

I: self-administered questionnaire: developed by the researchers in Arabic after massive literature review. It included four parts

Part I. Patient's demographic characteristics, designed to collect the baseline characteristics of the patients such as (age, gender, marital status, educational level, job, smoking status).

Part II. Patient's medical history assessment sheet, developed to assess the patient's past andcurrent medical history in the first assessment, e.g. (chronic disease, body weight, COVID-19 confirmation test, place of isolation, duration of isolation, Hemoglobin level, the oxygen therapy receivedduring confinement).

Part III. Major recent signs and symptoms: developed to assess the signs and symptoms of the patients related to respiratory problems and dyspnea along the 4 assessments stage of the research, it consists of (Dyspnea, chest pain, restlessness, cough, headache, Palpitation, Hyperthermia, Loss of taste, Fatigue or symptomless)

Part IV. Respiratory assessment: This part was developed to assess vital signs and the respiratory status of the patients along the 4 assessments stage of the research; it consists of (Respiratory rate, Breathing rhythm, Respiratory depth, Oxygen saturation, Pulse rate, Blood pressure, and Chest sound)

The tools' reliability was calculated using the SPSS with Cronbach's alpha value of 0.79 for self-administered questionnaire.

II: Modified Medical Research Council (mMRC) Dyspnea Scale:

The scale was adapted fromLaunois(2012) and translated into Arabicwithreverse translation. Dyspnea in daily living was evaluated by the mMRC scale which consists in four statements that describe almost the entire range of dyspnea from none (Grade 0) to almost complete incapacity (Grade 4) as well the scoring system was from 1 (which represent no dyspnea) to 5 which represent complete incapacity.

Reliability: It was calculated using SPSS with Cronbach's alpha value of 0.89 for translated mMRC.

III: Numerical rating scale for dyspnea severity. The tool was Adapted from **Janssens, et-al (2019)** Patients were asked to rate their shortness of breath by circling a number from 0 to 10, with 0 being no shortness of breath and 10 being severe unbearableshortness of breath. The score from 1 to 3 is considered as mild dyspnea, 4 to 6 as moderate dyspnea and 7 to 10 severe dyspnea. Tools' reliability calculated using SPSS with Cronbach's alpha value of 0.91 for translated Numerical rating scale for dyspnea severity

IV: Respiratory volume capacity using incentive Spirometer: developed by the researcher in Arabic from the gra7ding of the incentive spirometer itself. As follow

Grading	Scoring system
Less than 500 ml	1
From 500 to less than 1000 ml	2
From 1000 to 2000	3
From 2000 to 3000	4
From 3000 to 4000	5

As well ,tools' reliability calculated using SPSS with Cronbach's alpha value of 0.93 for self-administered Questionnaire.

Tools validity:

Content validity was completed to examine to which extent the used tools assess what was supposed to be measured .The established tools were examined by a panel of three chest physiologist and adult health care nursing experts to be sure that the included items were clear and suitable to achieve the aim of the current research.

Pilot study:

A pilot study was conducted on 10% of the sample to measure the feasibility, attainability, workability and simplicity of the research tools, as well astime required for achievement of each tool .Based on the pilot study, no modifications were done and the pilot sample was included in the research sample.

Ethical consideration:

The final approval for undertaking the study was obtained from Badr university ethical committee, BUC – Institutional animal care and use committee (approval number: BUC- IACUC-220911-4). Also, the approval was obtained from the hospital before stating the study. In addition,the aim of the research was clarified to all participants and confidentiality and anonymity were assured through coding the dataandan oral informed consent was gotten from the patient was Infected with COVID-19 in a convalescent stage. Participants were informed that the obtained data will be confidential ,and they had the right to withdraw at any time without any rational.

Procedure:

Upon getting the formal approval from the ethical committee at Badr University in Cairo to conduct the current research, an official agreement was gotten form the quarantined hospitals in Cairo to perform this research. **The current research** procedure was completed through three phases; preparatory; intervention; and evaluation phase. The preparatory phase started with developing and preparing the data collection tool and inserting it into a Google Form. Also, an instructional video about how to use an incentive spirometer was recorded in Arabic to guide the participants at home. The instructional video include demonstration about how to use the device accurately and record the measurements. The patients were instructed to complete the exercise three times a day for 6 weeks. Patients were instructed to call their primary care physician if a 20% or more decrease from their baseline was noted or if they experienced any new coughs, fever, or shortness of breath during the 30 days of exercise.

Once getting the approval of the selected place the intervention phase started. The researchers visit the covid 19 outpatients' follow-up clinic in the selected hospital 3 times a week from the beginning of April 2022 to the end of June2022 to obtain the sample that met the included criteria of the present research. After explaining the aim of the research to the selected sample, each patient was provided an intensive spirometer and interviewed for 20 minutes individually face to face for a training session on how to use an incentive spirometer using a demonstration and an instructional video. Each patient received through Whats App, the educational video and the data collection tool to be individually filed by each individual patient during the face-to-face interview during the first assessment.

The researchers get the WhatsApp phone number of each patient and sent the educational video and the data collection tool to each patient to fill out during face-to-face interviews to get the first assessment. The second and third assessments were done on the 2nd and 4thweeks respectively after the first assessment and the use of the incentive spirometer. Each patient had the right to choose the suitable method of meeting to complete the other assessments from a video call, zoom meeting, or face-to-face interview. During each assessment, the researchers ask the participant to demonstrate spirometer exercises three times and take the average reading of the spirometer. The last phase was **the evaluation phase**: the final assessment was completed 6 weeks after the first assessment and after using the incentive spirometer.

Statistical Analysis:

Data tabulated and analyzed using Statistical Package for the Social Science" (SPSS version. Relevant statistical analyses were done to test the obtained data . Descriptive and inferential statistics were performed such as: mean and standard deviations; frequency; percentage; correlation coefficient .The level of significance was considered at P ≤0.01

RESULT

Table 1. Frequency distribution of demographic characteristics for the studied sample (N=30)

Variable	NO	%
Age		
20< 30	13	43.3%
30 < 40	1	3.3%
40 < 50	12	40 %
50-60	4	13.4%
Mean= 47 ±2.984		
Gender		
Male	16	53.3%
Female	14	46.7%
Marital status		
Single	8	26.7%
Married	18	60.0%
Divorced	1	3.3%
Widow	3	10.0%
Education level		
Diploma	11	36.7%
University	19	63.3%
Job		
Not working	6	20.0%
Employee	19	63.3%
Business work	5	16.7%
Smoking		
Yes	5	16.7%
No	25	83.3%

The majority of the studied sample 83.3% did not smoke and the mean age of the studied sample was 47 ±2.984 years of Age. The studied sample age was almost equally divided, with 43% having between 20-30 years old and 40% between 40 to 50 years old. Around two-thirds of the studied sample, 63.3% were employees and had university education.

Table (2). Frequency distribution of the studied sample medical characteristics. (N=30)

Variable	NO	%
Chronic diseases		
Hypertension	5	16.7%
Diabetes & hypertension	2	6.7%
Diabetes, hypertension, & cardiac disease	4	13.3%
Hypertension & cardiac disease	2	6.7%
Renal diseases	2	6.7%
No chronic diseases	15	50.0%
Body weight		
Normal body weight	7	23.3%
Overweight	8	26.7%
Obesity	11	36.7%
Morbid obesity	4	13.3%
COVID 19 diagnosis confirmed through		
Chest computed tomography (CT)	11	36.7%
PCR	8	26.7%
Both	11	36.7%
Place of Isolation		
Home isolation	22	73.3%
Hospital isolation	8	26.7%
Duration of isolation		
Less than 7 days	10	33.3%

From 7 : 10 days	2	6.7%
From 10 : 14 days	15	50.0%
21 days	3	10.0%
Mean duration : 13.5 days STD: 1.066		
Did the patient receive oxygen therapy during the isolation period		
Yes	14	46.7%
No	16	53.3%
Hemoglobin level		
Normal	23	76.7%
Less than normal	7	23.3%

Half of the studied sample had no chronic diseases and 16.7% and 13.3% had a history of hypertension, diabetes mellitus, and hypertension respectively. Among the studied sample 36.7% were obese. The confirmed diagnosis of COVID- 19 was through computed tomography and or by both PCR and computed tomography. Most of the studied sample 73.3% were isolated at home and half of the studied sample isolation duration ranged between 10 to 14 days.

Table (3). Frequency distribution of respiratory assessment results before each assessment. Among the studied Group(N=30)

No. of assessment	**1st Assessment**		**2nd assessment**		**3rd assessment**		**4th assessment**	
	N	%	N	%	N	%	N	%
Respiratory rate								
From 14 : 20 br/min	21	70.0	23	76.7%	30	100.0	30	100.0
More than 20 br/min	9	30.0	7	23.3%	0	0	0	0
Breathing rhythm								
Regular	17	56.7	15	50.0%	24	80.0	26	86.7
Irregular	13	43.3	15	50.0%	6	20.0	4	13.3
Respiratory depth								
Deep	3	10.0	5	16.7%	19	63.3	20	66.7%
Shallow	27	90.0	25	83.3%	11	36.7	10	33.3%
Oxygen saturation								
Less than 90%	2	6.7%	0	0	0	0	0	0
From 90 : 95 %	18	60.0%	20	66.7	30	100.0	7	23.3%
More than 95%	10	33.3%	10	33.3	0	0	23	76.7%
Pulse rate								
From 60 : < 80 b/min	10	33.3%	3	10.0	24	80.0	24	80.0
From 80 : 100 b/ min	20	66.7%	27	90.0	6	20.0	6	20.0
Blood pressure								
Less than 120/80 mmhg	4	13.3%	6	20.0	0	0	0	0
From 120 /80 : 140/95 mmhg	20	66.7%	21	70	24	80.0	24	80.0
More than 140/95 mmhg	6	20.0%	3	10.0	6	20.0	6	20.0
Chest sound								
Normal	15	36.3%	17	56.7	26	86.7	26	86.7
Abnormal	20	66.7%	13	43.3	4	13.3	4	13.3

Table (3) shows that the majority of the studied sample 90% had shallow respiration in the first assessment as compared with 33.3% in the fourth assessment. Also, around two-thirds, 66.7% of the studied sample had abnormal chest sounds in the first assessment as compared with 13.3% in the fourth assessment.

Table (4). Frequency distribution of covid 19 follow up signs and symptoms for the studied sample before each assessment. (N=30)

No. of assessment	1st Assessment		2nd assessment		3rd assessment		4th assessment	
Signs	N	%	N	%	N	%	N	%
Dyspnea	27	90.7	19	63.3	18	60.0	12	40
Chest pain	6	20.0	3	10.0	2	6.7	0	0.0
Restlessness	24	80.0	21	70.0	20	66.7	15	50
Cough	18	60.0	15	50.0	0	0.0	0	0.0
Headache	13	43.3	2	6.7	6	20.0	0	0.0
Palpitation	23	76.7	14	46.7	13	43.3	12	40
Hyperthermia	0	0.0	0	0.0	0	0.0	0	0.0
Loss of taste	6	20.0	5	16.7	0	0.0	0	0.0
Fatigue	12	40.0	15	50.0	12	40.0	10	33.3
No signs	0	0.0	0	0.0	4	13.3	15	50

Table (4) illustrates that majority of the studied sample 90.7% had dyspnea in the first assessment compared with 60% and 40% in the third and fourth assessment respectively. Also, most of the studied sample 80% and 76.7% had restlessness and palpitation in the first assessment as compared with 50% and 40% in the fourth assessment respectively. Moreover, by the fourth assessment half of the studied sample had no signs and symptoms regarding covid 19.

Table (5). Frequency distribution of the studied sample responses in the 4 assessments regarding Modified Medical Research Council (mMRC) Dyspnea Scale (N=30)

No. of assessment	1st assessment		2nd assessment		3rd assessment		4th assessment		χ^2	df	30
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**			**P**
Too dyspneic to leave the house or breathless when dressing	8	26.7	5	16.7	1	3.3	0	0	23	3	0.001**
Walks slower than people of the same age	6	20	5	16.7	6	20	4	13.3			
Stops for breath after walking a few minutes	15	50	10	33.3	12	40	10	33.3			
Dyspnea with strenuous exercise	1	3.3	10	33.3	11	36.7	16	53.3			

significant if p value <0.01**

Table (5) shows that half of the studied sample 50% stops for breathing after walking a few minutes and 3.3% had dyspnea with strenuous exercise in the first assessment as compared with 33.3% and 53.3% in the fourth assessment respectively with a significant statistical difference between the four assessments (χ^2 = 23/df=3/p=0.001).

Table (6). Frequency distribution of the studied sample responses in the 4 assessments regarding the numerical Dyspnea Scale. (N=30)

NO. of assessment	1st assessment		2nd assessment		3rd assessment		4th assessment		χ^2	df	P
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**			
Mild	7	23.3	10	33.3	22	73.3	22	73.3	**74.98**	**21**	**<0.001**
Moderate	13	43.4	18	60	8	26.7	8	26.7			
Sever	10	33.3	2	2.7	0	0	0	0			

significant if p value <0.01**

Table (6) explains that 23.3%, 43.4%, and 33.3% had mild, moderate, and server dyspnea in the first assessment respectively as compared with 73.3%, 26.7, and zero in the third and fourth assessments respectively with a significant statistical difference between the fourth assessments (χ^2 = 74.98/df=21/P <0.001).

Table (7). Mean scores of the studied sample responses in the 4 assessments regarding the numerical Dyspnea Scale. (N=30). One way ANOVA

NO. of assessment	$\bar{x}$	SD	F	P
1st assessment	5.23	1.98	15.80	<0.001
2nd assessment	4	2.05		
3rd assessment	2.80	1.99		
4th assessment	2.3	0.99		
Total	3.58	2.117		

significant if p value <0.01**

Table (7) shows that of the studied sample in the first assessment regarding the numerical dyspnea scale were 5.23 in the first assessment and this result declined in the second, third and fourth assessment to be 4, 2.8, and 2.3 respectively with a significant statistical analysis between the four assessments (F/15.80. P. <0.001).

Table (8). Frequency distribution of the studied sample responses in the 4 assessments regarding the use of incentive spirometer (N=30)

NO. of assessment	1st assessment		2nd assessment		3rd assessment		4th assessment		χ^2	Df	P
	N	%	N	%	N	%	N	%			
Less than 500 ml	11	36.7	3	10	0	0	0	0	**36.08**	**4**	**<0.001**
From 500 to less than 1000 ml	9	30.0	14	47.7	4	13.3	2	6.6			
From 1000 to 2000	6	20.0	3	10	7	23.4	7	23.4			
From 2000 to 3000	4	13.3	8	26.7	16	53.3	18	60			
From 3000 to 4000	0	0	2	6.6	3	10	3	10			

significant if p value <0.01**

Table (8) illustrates that 36.7% and 13.3% had volume capacity regarding the use of incentive spirometers Less than 500 ml and from 2000 to 3000 respectively in the first assessment as compared with (zero% and 53.3%) and (zero and 60%) in the third and fourth assessment respectively with a highly significant statistical difference between the four assessments. (χ^2 **=36.08, df/4,P=<0.001)**

Table (9). Mean Score of the studied sample responses in the 4 assessments regarding the use of incentive spirometer. (N=30) One way ANOVA

NO. of assessment	$\bar{x}$	SD	F	P
1st assessment	2.10	1.06	18.748	<0.001
2nd assessment	2.73	1.23		
3rd assessment	3.60	0.86		
4th assessment	3.73	0.74		
Total	3.04	1.117		

significant if p value <0.01**

Table (9) that the mean volume capacity of the studied sample in the first assessment was 2.10±1.06 and this means increased by the second, third, and fourth assessments to be 2.73±1.23, 3.30±0.86, and 3.73±0.74 respectively with a highly statistically significant between the four assessments F=18.748/P=<0.001.

Table (10). Spearman's correlation of the studied sample between incentive spirometer capacity, numerical Dyspnea Scale and Modified Medical Research Council (mMRC)

	Numerical Dyspnea Scale		Modified Medical Research Council (mMRC)	
	r_s	P value	r_s	P value
incentive spirometer capacity	-0.867	<0.001	-0.672	<0.001
numerical Dyspnea Scale			0.647	<0.001

significant if p value <0.01**

Table (10) shows a highly negative significant statistical correlation between incentive spirometer capacity and Numerical Dyspnea Scale (r_s = -0.867/P=<0.001)and a moderate significant statistical negative correlation between incentive spirometer capacity and Modified Medical Research Council (mMRC) r_s = -0.672/P=<0.001),

Table (11). Pearson correlation of the studied sample related to numerical Dyspnea Scale, incentive spirometer capacity, age, and smoking

	Age		Smoking	
	r	P	r	P
numerical Dyspnea Scale	0.725	<0.001	0.360	0.50
incentive spirometer capacity	-0.491	<0.001	0.043	0.822

significant if p value <0.01**

Table (11) illustrates a highly significant statistical correlation between the numerical Dyspnea Scale and age (r=0.725/P<0.001) and a moderate significant statistical negative correlation between incentive spirometer capacity and age (r= -0.491/P=<0.001).

DISCUSSION

Regarding demographic characteristics: The majority of the studied sample of the current study did not smoke and their average age is the middle adulthood stage according to Erikson's theory, around two-thirds of the studied sample were employees and had university school education. **Regarding medical characteristics:** half of the studied sample had no chronic diseases, more than one-fourth had a history of hypertension, and more than one-third were obese and confirmed the diagnosis of covid 19 through computed tomography and the second third were confirmed by both PCR and computed tomography. Moreover, the current study revealed that most of the studied sampleswere isolated at home and half of the studied sample isolation duration ranged between 10:14 days.

Nopp et al(2022) noticed in their study that the mean age of 58 covid 19 patients undergoing pulmonary rehabilitation was 47 years which matched with the current study and 22.4 % had hypertension. Also, **Sun et al (2021)**support the current study as the mean age of all of their study done at the Hospital of Wuhan University in China and included (31 patients) post-acute covid 19 patients to evaluate the effect of pulmonary rehabilitation on patient prognosis were in the middle adulthood stage and nonsmoker. And **Kalantari et al (2021)** reported in a study done in Iran to assess the effect of covid 19 respiratory rehabilitation on fatigue and dyspnea that the mean age of the study and control group was 40.06 ± 10.54 and 41.33 ± 12.68.

Furthermore, **Gloeckl et al (2021)**contradict the current study result as they reported in their study done in Germany on 50 covid 19 patients that the majority of the studied sample previously complained of hypertension while agreeing with the current study result regarding the history of obesity as they determined that 30% of their study sample were obese.

Regarding respiratory assessment, the current study findings document that the majority of the studied sample had shallow respiration in the first assessment while this sign declined by the fourth assessment to include about one-third of the studied sample. Also, around two-thirds of the studied sample had abnormal chest sounds in the first assessment as compared with 13.3% in the fourth assessment. **Regarding covid 19 follow up signs and symptoms** The current study reported that the majority of the studied sample complained of dyspnea in the first assessment while this number declined to approximately 33.3% and 51.8% in the third and fourth assessments respectively. Also, most of the studied sample had restlessness and palpitation in the first assessment as compared with less than half in the fourth assessment. additionally, by the fourth assessment half of the studied sample had no signs and symptoms regarding covid 19.

Santana1, (2021) determined that symptoms indicate physical and functional harm such as shortness of breathing, cough, activity intolerance, exhaustion, and tiredness in covid 19 patients can last for several weeks or more after the recovery phase**. Gloeckl, et-al (2021)** agree with the current study results as they

report in their study on 50 mild to severe post covid 19 patients at a pulmonary rehabilitation clinic that most of covid 19 patients (73%) complain of dyspnea in the rehabilitation phase. Also, **Nopp, et al (2022)** determined that 70.7% of covid 19 patients in the rehabilitation phase had dyspnea. Regarding dyspnea assessment, the current study used two dyspnea scales; Modified Medical Research Council (mMRC) Dyspnea Scale; and numerical Dyspnea Scale. regarding the Modified Medical Research Council (mMRC) Dyspnea Scale, the current study documents that half of the studied sample stops for breathing after walking a few minutes anda few numbers had dyspnea with strenuous exercise in the first assessment but after intervention and using an incentive spirometer and by the fourth assessment, more than half of the studied sample had dyspnea with strenuous exercise with a significant statistical difference between the four assessments. Regarding the numerical Dyspnea Scale more three a fourth of the studied sample had moderate to severe dyspnea in the first assessment with a mean score of 5.23±1.98 while after intervention and by the fourth assessment more than two-thirds of the studied sample had mild dyspnea with a mean score 2.3±099 with a significant statistical difference between the four assessments.

Negi, et-al (2019) support the current study results as they proved in their randomized study done on 30 chronic obstructive pulmonary diseasesCOPD patients complain of moderate to severe dyspneathat the mean dyspnea score using the Modified Medical Research Council (mMRC) Dyspnea Scale after using inspiratory muscle training and incentive spirometer (1.47 ± 0.5164, 2.33±0.617 respectively) was improvedthan pre-intervention (3.47 ± 0.5164, 3.27±0.457 respectively) with a significant statistical difference (P=<0.0001). While **Moore, et-al (2018)** contradict the current study results as they reported intheir cross-over randomized study on pneumonia patients, that no significant statistical difference between the experiment group who use an incentive spirometer and the placebo group regarding perceived dyspnea and pulmonary vital capacity (p=0.19, p=0.23) respectively.

Moreover, **Aphridasari, et-al (2019)** reported in a pre/post design study done on 32 post tuberculosis patients that an incentive spirometer has a more positive effect than pursed-lip breathing improving inspiratory capacity (34.43±27.153%) (26.104±15.75%) (p=0.752) respectively, and the BORG dyspnea scale diminished in -0.94±0.574 in incentive spirometer group and -0.88±0.342 in pursed lips breathing group (p=0.838). Also, **Choi,et-al (2016)** boost the current study findings as they found in a randomized controlled study done to show the effect of incentive spirometer on pulmonary function of a child with cerebral palsy that forced expiratory volume FEV and forced vital capacity FVC improved after intervention in the experiment group as compared with the control group with a significant statistical difference (P= 0.005, P=0.000) respectively.

Furthermore, **Gloeckl, et-al (2021)** stated in their study a significant statistical difference (P= 0.003) regarding the modified Medical Research Council dyspnea scale. (mMRC) in pre and post pulmonary rehabilitation among moderate to severe covid 19 patients. Also, Nopp et-al 2022 support the current study finding as they indicated in their study a significant statistical difference <0.001 before and after pulmonary rehabilitation post covid 19 patients using Borg dyspnea score at max exertion and mMRC scale

Moreover, cohort with the current study, **Sun, et-al (2021)**who perform a pre/post-self-control study included 31 post-acute covid 19 patients at the Hospital of Wuhan University in China confirmed that after pulmonary rehabilitation using respiratory exercises, muscle training, and psychotherapy the modified Medical Research Council dyspnea scale. (mMRC) is improved with a significant statistical difference before and after pulmonary rehabilitation. Also, **Kalantari, et-al (2021)** support the current study result as they illustrated in their quasi-experimental study (intervention and control group) that was done in Iran on 60 covid 19 patients that the mean Borgdyspnea score of intervention and control group before implementing respiratory exercises were 4.10 ± 1.66/3.45 ± 1.73 respectively, while after intervention with two weeks and three months after were, 1.65 ± 1.42/2.15 ± 1.21, and 0.46 ± 0.66/1.28 ± 0.85 respectively with a significant statistical difference between the three assessment (P < 0.001).

Regarding the use of an incentive spirometer the current study revealed that the volume lung capacity of the studied sample improved by the fourth assessment with a mean score of 3.73±0.74 as compared with the mean score of the first assessment 2.10±1.06 with a significant statistical difference between the four assessments. Also, the current study displays a negative significant statistical correlation between incentive spirometer capacity and Numerical Dyspnea Scale and Modified Medical Research Council (mMRC). Also there is a highly significant statistical correlation between the numerical Dyspnea Scale and age and a moderate significant statistical negative correlation between incentive spirometer capacity and age

The current study result is congruent with **Toor, et-al. (2021)**study done in the USA on 48 post-covid 19 patientswho visit the outpatient rehabilitation clinicas they proved in their study that the medianinspiratory volume capacity improved bya percentage of 16% after practicing an incentive spirometer with 30 days as the inspiratory volume capacity baseline median was 1885.4 and after 4 weeks became 2235.4 with a

significant statistical difference (t=-4.59, p<0.0001). While **Seyller, et-al (2021)** and **Aakash, (2021)**in their study regarding the role of incentive spirometer on 155 covid 19 patients, from this number 41 patients used incentive spirometer with no significant difference between the two groups regarding mortality (OR = 0.649; p = 0.334) and intubation rates (OR = 0.925; p = 0.947) and the author's recommend for a further randomized trial to experimentwhether incentive spirometer is beneficial for covid 19 patients or not.

Furthermore, **Seyller, et-al (2021)**report that covid 19 patients have diminished PaO2:FiO2 percentage due to lung compliance / intrapulmonary shunting. Incentive spirometer act as placing the patient in a prone position to improve oxygenation for acute respiratory distress patients whether covid 19 related or not by reducing ventilation/perfusion mismatching and prohibiting the alveolar collapse. They think that an incentive spirometer must involve in the line and protocol ofcovid 19 patients that did not require intubation. Also,**Kaur, et-al (2020)** illustrated in a study done on 50 pre/post-operative patients that the patient mean performance level of the incentive spirometer 3 days after surgery(2.30± 0.558) was increased than preoperative performance (1.42± 0.558) with a significant statistical difference (t= 11.143, P= 0.00*).

Moreover, **Eltorai, et-al (2018)** in a systematic review regarding the efficacy of incentive spirometer on prevention of post operative respiratory complication. The authors proved that incentive spirometer may help in improving respiratory outcome post covid 19 but still more investigation and researches. **Yang & Yang, (2020)** mentioned that pulmonary rehabilitation for covid 19 patients whether during the disease or convalescence stage has a positive effect on the patient's general health including quality of life and improving respiratory outcomes, and alleviating dyspnea.

CONCLUSION

Respiratory exercises by using an incentive spirometer have a positive effect on improving respiratory outcomes and decreasing the severity of dyspnea of post COVID 19 patients who had persistent pulmonary symptoms during the recovery phase

RECOMMENDATIONS

Further studies are necessary to establish whether incentive spirometer is effective for the respiratory rehabilitation of COVID 19 patients

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