Med. J. Cairo Univ., Vol. 91, No. 2, June: 477-482, 2023
www.medicaljournalofcairouniversity.net

Impact of Aerobic Training on Cognitive Function and Quality of Life in Post Covid-19 Patients

NAWAL A. ABU SHADY, Ph.D.*; ADEL A. BADAWY, M.D.** and MAHMOUD A. FOUDA, M.Sc.*

The Departments for Neuromuscular Disorders and its Surgery, Neurology and Psychiatric Diseases**, Faculties of Physical Therapy* and Medicine**, Cairo* and Tanta** Universities*

Abstract

Background: Cognitive deficits among COVID-19 survivors are currently reported by few studies. These studies report cognitive deficits in mild and moderate cases of the infection, with significant impairment of executive functions, memory, and attention. In addition, cognitive deficits have been reported in studies performed in the acute phase of the infection and in recovered patients.

Aim of Study: To determine the therapeutic effect of aerobic training on cognitive function and quality of life in post covid-19 patients.

Patients and Methods: A referred diagnosed thirty post covid-19 patients with mild cognitive impairment from both genders, with age ranged from (45-55) years old, were randomly assigned to equal two groups: A study group and a control group. Study group received aerobic training on a folding pedal machine in addition to cognitive rehabilitation on a commercially available computerized cognitive training platform (CogniFitTM) and control group received only cognitive rehabilitation on a commercially available computerized cognitive training platform (CogniFitTM) for 18 sessions every other day for 6 weeks, 3 sessions/week, each session for 50 minutes. All patients were evaluated with the Mini Mental State Examination (MMSE) and the Montreal Cognitive assessment (MoCA) scale and the quality of life was assessed by the quality of life (QoL) scale. The study was done in outpatient clinics of Abu Kier general Hospital.

Results: The study revealed that there is a significant difference between study and control groups as the *p*-value was (0.001) which indicated that study group shows improvement in cognitive functions and quality of life style more than control group.

Conclusion: The study revealed that six weeks of aerobic training combined with cognitive rehabilitation on a commercially available computerized cognitive training platform (CogniFitTM) for patients was a beneficial approach and improve cognitive dysfunction and quality of life in post covid-19 patients.

Key Words: *Cognition – Covid-19 – Aerobic training – Computerized cognitive training.*

Correspondence to: Dr. Nawal A. Abu Shady, The Department for Neuromuscular Disorders and its Surgery, Faculty of Physical Therapy, Cairo University

Introduction

NOVEL coronavirus disease 2019 (COVID-19) infections, declared by the World Health Organization (WHO) as a pandemic, have had unprecedented global effects on people's daily activities and way of life **[1]**.

Approximately 55-75% of patients who have recovered from acute COVID-19 disease have been shown to be suffering from post-COVID syndrome with cognitive impairments affecting the quality of life **[2]**.

Few studies currently report cognitive deficits among COVID-19 survivors. These studies report cognitive deficits in mild and moderate cases of the infection, with significant impairment of executive functions, memory, and attention **[3]**.

The quality of life dimension is necessary to assess because represent the perceptions, comfort, and feelings experienced during and after COVID-19 by the individual. We must not forget that one of the most crucial purposes of rehabilitation is to improve the quality of life by maintaining, improving, and reacquiring activities of daily living **[4]**.

There is convincing evidence that exercise reduces cognitive decline in healthy older adults and those with mild cognitive impairment, the cognitive functions that benefit from exercises including executive function, attention, and processing speed. Emerging research also demonstrates that aerobic exercise can alter brain structure and function **[5]**.

These findings have sparked an interest in exercise as a potential intervention for COVID-19 -related cognitive impairment, So, the current study was designed to investigate the effect of aerobic training on cognitive function and quality of life in post covid-19 patients.

Patients and Methods

The purpose of the present study was to investigate the impact of aerobic training on cognitive function and quality of life in post covid-19 patients. All patients were referred from a neurologist after complete medical clinical investigations, as the patients were chosen and the study was done in outpatient clinics at Abu Keir General Hospital, this study was conducted at the period from May 2022 to December 2022.

Pre and post experimental design study. A thirty post covid-19 patients from both genders with age ranged from 45 to 55 years old, were recruited in this study from the Outpatient Clinics at Abu Keir General Hospital, the Patients were assigned to two equal matched groups randomly: Study group: consist of 15 post covid-19 patients and received an aerobic training on a folding pedal machine in addition to training on a commercially available computerized cognitive training platform (CogniFitTM) (20 minutes aerobic training on a folding pedal machine then 20 minutes for (CogniFitTM) training application), and Control group: Consists of 15 post covid-19 patients and received a training on a commercially available computerized cognitive training platform (CogniFitTM) for 40 min., 18 sessions every other day for 6 weeks, 3 sessions/week, each session for 40minutes for both groups.

Inclusion criteria:

Patients are complaining from cognitive impairment post covid-19. They were diagnosed with cognitive impairment by their respective neurological consultant. Duration of illness ranged from 1-3 months post covid-19. They were selected with no history of any other neurological problems. They were medically stable and consented to participate in the study. All patients had mild cognitive deficits with score <25 according to Montreal Cognitive Assessment scaleand from (18-23) according to Mini Mental State Examination (MMSE). All patients had normal and stable vital signs (heart rate, blood pressure, temperature, pain and respiratory rate). All patients were subjected to clinical and neurological examination. All patients had normal and stable vital signs (heart rate, blood pressure, temperature and respiratory rate). All patients had a good educational level enabled them to understand written words, numbers, and orders for procedures of assessment and treatment by the same physical therapist. The body mass index ranged from 20-30Kg/m^2.

Exclusion criteria:

Patients with cardiovascular problems (uncontrolled hypertension, unstable angina, significant coronary heart disease and/or congestive heart failure). Visual, auditory and other neurological disorders (eg: Multiple sclerosis, Parkinsonism... etc). Patients receiving medications that may affect cognition. Patients with depression. Patients with anxiety and seizures. Patients with Musculoskeletal problems (deformity or contracture). Medically unstable and uncooperative patients.

Data collection and intervention:

a- Assessment procedures:

*Patient preparation:*A brief explanation about the protocol of assessment was given to every patient. All patients were asked to read and sign a consent form before the conduction of study. The detailed general evaluation sheet was done to every patient. The patient weight and height were measured and recorded in the evaluation sheet with other information.

Montreal Cognitive Assessment Scale (MoCA): Is a widely used screening assessment for detecting cognitive impairment. It was designed to detect mild cognitive Impairment. It takes approximately 10 minutes to complete, 30-point cognitive screening instrument. It is used to assess different cognitive domains [short-term memory, visuospatial abilities, executive function, attention, concentration, working memory, language and orientation to time and place]. MoCA scores range between 0 and 30, A score of 26 or over is considered to be normal. The score has a high sensitivity (77%) and specificity (83%) for detecting mild cognitive impairment (MCI) in patients with stroke as determined by a score of <25 **[6]**.

Mini-Mental State Examination (MMSE) Scale: It was 11-questions measured these tested five areas of cognitive function: Orientation, registration, attention and calculation, recall, and language. The maximum score is (30) points. Due to its short administration period and ease of use it is useful for cognitive assessment in the post covid-19 patients. Scoring: 24-21 mild cognitive impairment. 20-10 moderate cognitive impairment. Less than 10 as severe cognitive impairment **[7]**.

b- For treatment:

All patients were randomly classified into two equal matched groups, each group consist of 15 patients.

Study group: Received an aerobic training on a folding pedal machine. The first five minutes of each session were dedicated to warming up exercise on the bicycle in the form of slow progression exercise (to decrease the risk of hypotension, musculoskeletal injury and cardiovascular complications), followed by the active phase of exercise for 10min., and finally cooling down phase for five min. with intensity and speed decreased gradually until reaching the resting heart rate (RHR), in addition to training on a commercially available computerized cognitive training platform (CogniFitTM) for 18 sessions every other day for 6 weeks, 3 sessions/week, each session for 40 minutes (20 minutes aerobic training on a folding pedal machine and 20 minutes for (CogniFitTM) training application).

Control group: The patients in this group treated by CogniFit applicationfor 40min. three times per week for six weeks. The CogniFit General Training program consisted of 33 tasks designed to train a broad range of cognitive abilities, the patients were trained to improve the attention, memory and the executive function domains through these games (Perfect tension for executive function training, lane changer and penguin explorerfor attention training and Match it and ant escape for memory training). CogniFit training sessions involve the completion of three tasks, delivered by the program in one block, and patients were instructed to complete two sessions (i.e., six tasks) on each day they trained. At the end of each block of three tasks, patients in the experimental condition received feedback about their performance in the form of a score that they could track as the training progressed.

Statistical analysis:

Unpaired *t*-test was conducted for comparison of subject characteristics between groups. Normal distribution of data was checked using the Shapiro-Wilk test. Levene's test for homogeneity of variances was conducted to test the homogeneity between groups. Mixed MANOVA was conducted to investigate the effect of treatment on MoCA, MMSE and QOLS. Post-hoc tests using the Bonferroni correction were carried out for subsequent multiple comparison. The level of significance for all statistical tests was set at $p<0.05$. All statistical analysis was conducted through the statistical package for social studies (SPSS) version 25 for windows (IBM SPSS, Chicago, IL, USA).

Results

Subject characteristics:

Table (1) showed the subject characteristics of the study group and control one. There was no significant difference between groups in age, weight, height and BMI ($p>0.05$).

Table (1): Comparison of subject characteristics between the group A and B.

	Group A	Group B	MD	*t*-value	*p*-value
	Mean ± SD	Mean ± SD			
Age (years)	39.8±4.24	38.4±5.08	1.4	0.81	0.42
Weight (kg)	74.86±12.71	77.73±10.86	–2.87	–0.66	0.51
Height (cm)	175.8±12.9	177.2±12.62	–1.4	–0.3	0.76
BMI (kg/m^2)	24.26±1.23	24.46±0.76	–0.2	–0.53	0.59

SD: Standard deviation. *p*- value: Probability value.

Effect of treatment MoCA, MMSE and QOLS:

Mixed MANOVA revealed a significant interaction effect of treatment and time (F=5.56, $p=0.004$). There was a significant main effect of treatment (F=3.32, $p=0.03$). There was a significant main effect time (F=124.57, $p=0.001$).

Within group comparison:

There was a significant increase in MoCA, MMSE and QOLS post treatment in both groups compared with that pre-treatment ($p>0.001$). The percent of change in MoCA, MMSE and QOLS of the study group was 18.45, 21.02 and 16.67% respectively and that in the control group was 12.77, 14.02 and 10.09% respectively.

Between group comparison:

There was no significant difference between groups pre-treatment ($p>0.05$). Comparison between groups post treatment revealed a significant increase in MoCA, MMSE and QOLS of the study group compared with that the control group B ($p<0.05$).

Table (2): Mean MoCA, MMSE and QOLSpre and post treatment of study and control groups.

	Pre-treatment	Post-treatment	MD	% of change	*p*-value
	Mean ± SD	Mean ± SD			
MoCA:					
Study Group	22±1.73	26.06±0.96	–4.06	18.45	0.001
Control Group	21.46±1.41	24.2±1.21	–2.74	12.77	0.001
MD	0.54	1.86			
	$p=0.36$	$p=0.001$			
MMSE:					
Study Group	20.6±1.72	24.93±0.79	–4.33	21.02	0.001
Control Group	20.4±1.95	23.26±0.88	–2.86	14.02	0.001
MD	0.2	1.67			
	$p=0.76$	$p=0.001$			
QOLS:					
Study Group	80.4±6.44	93.8±1.82	–13.4	16.67	0.001
Group	81.26±3.71	89.46±2.29	–8.2	10.09	0.001
MD	–0.86	4.34			
	$p=0.65$	$p=0.001$			

SD: Standard deviation. MD: Mean difference.
p-value: Probability value.

Discussion

The statistical results of the current study revealedthe aerobic training combined with computer-based cognitive rehabilitation was more effective for improving cognitive dysfunction in post covid-19 patients in the study group than only computer-based cognitive rehabilitation in control group. The assessments included the Mini-Mental state Examination (MMSE) scale, Montreal Cognitive Assessment (MoCA) and Quality of Life scale (QOLS).

The result of the current study was agreed with Hsu et al., **[8]**, who stated that aerobic training may positively impact cognitive performance among older adults with mild subcortical ischemic vascular cognitive impairment (SIVCI). Specifically, improving neural efficiency underlies the effect of aerobic training on cognition. These findings extend growing evidence that physical activity should be considered as a potential recommendation to enhance brain function and executive functions for this clinical population.

The result of the current study was supported also by Hill et al., **[9]**, who reported that Cognitive training, stimulation, and rehabilitation provided via digital devices are promising strategies for maintaining the cognitive function of healthy older adults and people with mild cognitive impairment (MCI). Computerized cognitive interventions are not only useful for improving cognition, memory, and attention but also have a positive influence on the psychosocial functioning of older adults with MCI. Similarly, it was demonstrated that computerized cognitive training's beneficial effects remained on both short-term and long-term in people with preserved cognitive function.

The result of the current study was agreed with Alghadiret al., **[10]**, who stated that physical activity status, inflammatory status, and oxidative stress played a pivotal role on cognitive performance of healthy older adults and concluded that supervised moderate aerobic training for 24 weeks has a positive significant effect in improving cognitive functions via modulating redox and inflammatory status of older adults.

The results of the present study agreed with Slimani et al., **[11]**, who demonstrated that Physical activity is an effective therapeutic method in older patients with heart failure (HF), with small to moderate effects on quality of life (QoL), aerobic capacity, and cardiac function, irrespective of sex and training mode.

The findings of the conducted study also were supported by Song and Yu, **[12]**, who found that the participants in their study had remarkable improvement in vitality, positive outlook on oneself and overall life satisfaction. This improvement in cognitive function would possibly result in such positive changes on one's health perception.

The findings of the conducted study disagreed with Young et al., **[13]**, who demonstrated that there was no evidence that aerobic exercise or increased fitness was necessarily results in improvements in cognitive performance in healthy older adults without known cognitive impairment.

The results of the present study were disagreed with Lan et al., **[14]**, who reported that no compelling evidence was provided regarding improvements to everyday functioning, contradicting many claims made by “brain training” companies which imply that their product can generalize to day-to-day skills. Thus, whilst “brain training” is suitable for enjoyment and entertainment purposes, these training packages may not yet be sufficiently developed, refined, and tested to promote any meaningful change in cognitive functioning-particularly functioning in everyday life.

Conclusion:

From the previous obtained statistical results of present study, it could be concluded that the study group that received aerobic training combined with cognitive rehabilitation on a commercially available computerized cognitive training platform (CogniFitTM) mobile application showed a significant improvement in post covid-19 patients with cognitive impairment compared to the control group who received cognitive rehabilitation on a commercially available computerized cognitive training platform (CogniFitTM) mobile application only, so aerobic training combined with computerized cognitive training platform (CogniFitTM) should be considered a potential rehabilitation program and should be indicated as an effective, reliable, noninvasive modality at physical therapy clinics for post covid-19 patients with cognitive impairment.

References

1- AHORSU D.K., IMANI V., LIN C.-Y., TIMPKA T., BROSTRÖM A., UPDEGRAFF J.A. and PAKPOUR A.H.: Associations between fear of COVID-19, mental health, and preventive behaviours across pregnant women and husbands: An actor-partner interdependence modelling. International Journal of Mental Health and Addiction, 2020.

2- HUANG C., HUANG L., WANG Y., LI X., REN L., GU X., et al.: 6-month consequences of COVID-19 in patients

discharged from hospital: A cohort study. Lancet, 397: 220-32, 2021.

3- ZHAO S., LIN Q., RAN J., et al.: Preliminary estimation of the basic reproduction number of novel coronavirus (2019-nCoV) in China, from 2019 to 2020: a data driven analysis in the early phase of the outbreak. Int. J. Infect. Dis., 92: 214-217, 2020.

4- INOUE S., HATAKEYAMA J., KONDO Y., HIFUMI T., SAKURAMOTO H. and KAWASAKI T.: Post-intensive care syndrome: Its pathophysiology, prevention, and future directions. Acute Med. Surg., 6: 233-246. doi: 10.1002/ams2.415, 2019.

5- MAKIZAKO H., LIU-AMBROSE T., SHIMADA H., et al.: Moderate-intensity physical activity, hippocampal volume, and memory in older adults with mild cognitive impairment. J. Gerontol. A Biol. Sci. Med. Sci., 70 (4): 480-486, 2014.

6- NASREDDINE Z.S., PHILLIPS N.A., BÉDIRIAN V., et al.: The Montreal Cognitive Assessment, MoCA: A brief screening tool for mild cognitive impairment. J. Am. Geriatr. Soc., 53 (4): 695-9. doi:10.1111/j.1532-5415.53221, 2005.

7- AREVALO-RODRIGUEZ I., SMAILAGIC N., CIAPPONI A., SANCHEZ-PEREZ E., GIANNAKOU A., FIGULS M. and CULLUM S.: "Mini-Mental Status Examination (MMSE) for the detection of Alzheimers disease and other dementias in people with mild cognitive impairment (MCI). Cochrane Database of Systematic Reviews, 107: 13423-12589, 2015.

8- HSU C.L., BEST J.R., DAVIS J.C., et al.: Aerobic exercise promotes executive functions and impacts functional neural activity among older adults with vascular cognitive impairment. Br. J. Sports Med. Published Online First, 0: 1-9, 2017.

9- HILL N.T.M., MOWSZOWSKI L., NAISMITH S.L., CHADWICK V.L., VALENZUELA M. and LAMPIT A.: Computerized cognitive training in older adults with mild cognitive impairment or dementia: A systematic review and meta-analysis. Am. J. Psychiatry 174: 329-340. doi: 10.1176/appi.ajp.2016.16030360, 2017.

10- ALGHADIR AHMAD H., GABR SAMI A. and AL-EISA EINAS S.: Effects of Moderate Aerobic Exercise on Cognitive Abilities and Redox State Biomarkers in Older Adults. Oxidative Medicine and Cellular Longevity, 1-8. doi:10.1155/2016/2545168, 2016.

11- SLIMANI M., RAMIREZ-CAMPILLO R., PARAVLIC A., HAYES L.D., BRAGAZZI N.L. and SELLAMI M.: The Effects of Physical Training on Quality of Life, Aerobic Capacity, and Cardiac Function in Older Patients with Heart Failure: A Meta-Analysis. Front Physiol. Nov. 12; 9: 1564. doi: 10.3389/fphys.2018.01564. PMID: 30483145; PMCID: PMC6241114, 2018.

12- SONG DAN and YU DORIS S.F.: Effects of a Moderate-Intensity Aerobic Exercise Program on the Cognitive Function and Quality of Life of Community-dwelling Elderly People with Mild Cognitive Impairment: A randomized Controlled Trial. International Journal of Nursing Studies, S0020748919300604-. doi:10.1016/j. ijnurstu. 2019.02.019, 2019.

13- YOUNG J., ANGEVAREN M., RUSTED J. and TABET N.: Aerobic exercise to improve cognitive function in older people without known cognitive impairment. Cochrane Database of Systematic Reviews, (4), 2015.

14- LAN NGUYEN, KAREN MURPHY and GLENDA ANDREWS: A Game a Day Keeps Cognitive Decline Away? A Systematic Review and Meta-Analysis of Commercially-Available Brain Training Programs in Healthy and Cognitively Impaired Older Adults. Neuropsychology Review, doi:10.1007/s11065-021-09515-2, 2021.

تأثير تدريبات الأيروبيك على وظيفة الادراك وجودة الحياة فى مرضى ما بعد كوفيد ١٩

أجريت هذه الدراسة لتحدد ما إذا كان هناك تأثير على الادراك وجودة الحياة باستخدام تدريبات الأيروبيك فى مرضى ما بعد كوفيد ١٩ لمدة ٦ أسابيع متتالية بواقع ثلاث جلسات أسبوعياً يوماً بعد يوم ومدة الجلسة ٤٠ دقيقة للمجموعتين وأجريت هذه الدراسة بالعيادات الخارجية بمستشفى أبو قير العام.

تم اختيار ثلاثون (٣٠) مريضاً من الجنسين كعينة لهذه الدراسة تتراوح أعمارهم ما بين ٤٥ إلى ٥٥ عاماً يعانون من ضعف فى وظائف المعرفة والادراك فى مرضى ما بعد كوفيد-١٩، وتم توزيع المرضى عشوائياً إلى مجموعتين متساويتين :

مجموعة الدراسة والمجموعة الضابطة : وقد أخذت مجموعة الدراسة برنامج العلاج عن طريق تدريبات الأيروبيك بالإضافة إلى برنامج تدريب الدماغ المستند إلى تطبيقات الهاتف المحمول (كوجنى فيت) والمجموعة الضابطة أخذت برنامج تدريب الدماغ المستند إلى تطبيقات الهاتف المحمول (كوجنى فيت) فقط وتم تقييم جميع المرضى قبل وبعد البرنامج العلاجى بستة أسابيع. وتم التقييم باستخدام استبيان للمرضى جميعاً لفحص الحالة العقلية (الادراك والمعرفة)، واستبيان مونتريال المعرفى واستبيان جودة نمط الحياة.

أظهرت النتائج الإحصائية أنه يوجد فروق ذات دلالة إحصائية واضحة بين المجموعتين حيث أظهر العلاج بتدريبات الأيروبيك بالإضافة إلى برنامج تدريب الدماغ المستند إلى تطبيقات الهاتف المجمول (كوجنى فيت) لمدة ستة (٦) أسابيع لمجموعة الدراسة أنه أكثر تأثيراً وتحسناً على مرضى ضعف وظائف المعرفة والادراك فى مرضى ما بعد كوفيد-١٩ حيث وجد تحسن ملحوظ فى وظائف الادراك وجودة نمط الحياة لديهم مقارنة بالمجموعة الضابطة التى استخد مت برنا مج تدريب الدماغ المستند إلى تطبيقات الهاتف المجمول (كوجنى فيت) فقط، ولذلك يوصى باستخدام وسيلة تدريبات بالاضافة إلى برنامج تدريب الدماغ المستند إلى تطبيقات الهاتف المحمول (كوجنى فيت) ضمن برنامج العلاج الطبيعى التأهيلى لما له من تأثير واضح وفعال و آمن فى تحسن الادراك والمعرفة وجودة نمط الحياة لمرضى ضعف وظائف المعرفة والادراك فى مرضى ما بعد كوفيد-١٩.