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Case Study

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EFFECTS OF WHOLE BODY VIBRATION ON LONG COVID SYNDROME SYMPTOMS – A SINGLE CASE STUDY

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ABSTRACT

Background: More than 760 million people had a COVID-19 infection. Many of them are not recovered even though symptoms like cough or fever are gone. Patients suffer from fatigue, depression, attention deficits and decreased motor fitness. Exercise therapy is well investigated in different disorders, as well as Whole Body Vibration. For this, a training intervention using Whole body vibration as a smooth therapeutic alternative to medication is investigated in this study. **Materials and Methods:** A 54 year-old female Long Covid patient underwent a training intervention on a vibration platform (12-weeks, 1 x/week 30 min, each set lasting 60 s with a rest between sets of 60 s). Investigated were depression (BDI-II), fatigue (FAS), attention (d2-test), and motor fitness before and after the intervention. **Results:** Improvements in depression, fatigue and attention are visible as well as improvements in trunk strength, flexibility, and endurance. **Conclusions:** Whole body vibration seems to be a good alternative to improve Long Covid syndrome symptoms. For this, a pilot study should follow.

KEYWORDS: Long Covid, Exercise therapy, Whole body vibration, Rehabilitation.

INTRODUCTION

By the end of April 2023, more than 760 million people are or have been infected with COVID-19. Nearly seven million people have died from or with COVID-19.[1] Many people are not well for a long time after symptoms such as cough or fever have resolved, or the symptoms persist for a very long time. Long Covid refers to this persistent symptomatology over four to 12 weeks on the one hand, but also Post Covid if they persist after 12 weeks.[2]

Symptomatology in Long Covid syndrome is varied. The most common symptoms appear to be fatigue associated with poorer physical fitness, depression, and concentration problems.[3,4]

For the everyday life of those affected, this means that perhaps even elementary activities such as housework, shopping or working are severely restricted or no longer possible at all. The patients are quickly exhausted and often need breaks. For some patients, participation in the sense of the ICF is no longer possible.[5] The following figure 1 illustrates how the Long Covid Syndrome affects the domains of the ICF.

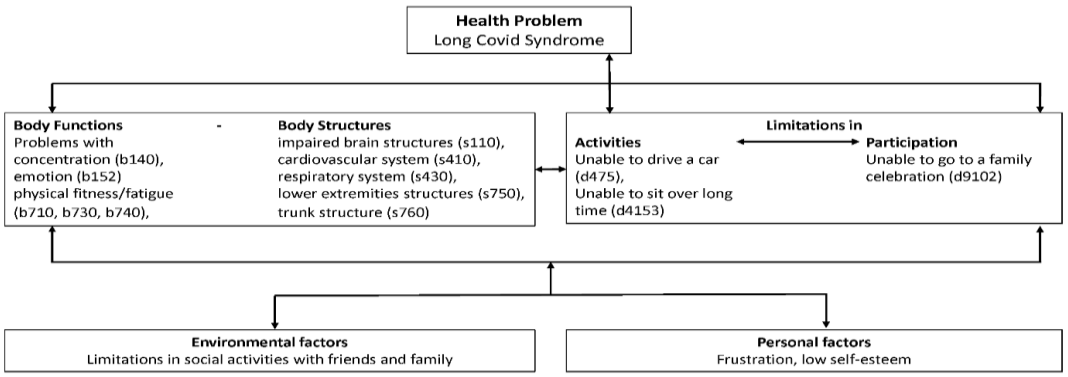

Figure 1: Meaning and impact of long covid syndrome in terms of ICF (adapted from[5])

Those who suffer from the health problem "Long Covid Syndrome" may have problems with concentration, emotions (depression), physical fitness and fatigue in the field of body functions. This is due to damaged body structures, in the area of brain structures, in the cardiovascular system, respiratory system, structures of the lower extremities and trunk. This affects activities, especially possibly mobility. The affected person is unable to drive a car. Thus, she or he is also limited in her or his participation, because of this she or he cannot attend a family celebration. She or he is thus limited in social activities with friends and family, this creates frustration and reduces self-esteem.

Much research is being done in the area of conventional therapy, such as antiviral drugs, antibody treatment or plasma therapy.[6] A review has shown that to date there are no concrete studies on the effectiveness of exercise therapy on symptomatology.[7]

Exercise therapy is well investigated in many different patient groups who suffer from depression, fatigue, cognitive or motor deficits: Carek, Laibstain and Carek[8] constate in their review that physical exercise is an effective alternative treatment to medication in depressive and anxiety syndromes. Gujral, Aizenstein, Reynolds III, Butters and Erickson[9] want to show why exercise could help to improve the symptoms of depression: Some brain structures that are associated with depression possibly could be influenced in a positive matter, e. g. hippocampal volume and regional tissue density, prefrontal cortex, striatum or white matter. Hilfiker, Meichtry, Eicher, Balfe, Knols, Verra and Taeymans[10] show in their meta-analysis that exercise has a significant positive effect on fatigue in cancer patients, as well as the meta-analysis by Razazian, Kazeminia, Moayedi, Daneshkhah, Shohaimi, Mohammadi, Jalali and Salari[11], that shows positive effects of exercise on fatigue in multiple sclerosis patients. Northey, Cherbuin, Pumpa, Smee and Rattray[12] summarize that exercise improves cognitive functions. Physical activity is thought to influence various aspects of cognitive mechanisms. The physiological mechanisms, such as increased cerebral blood flow, altered release of neurotransmitters, structural changes in the central nervous system, and altered arousal levels, are based on physical changes that are a consequence of physical activity. Similarly, it is possible that physical training selectively increases angiogenesis, synaptogenesis, and neurogenesis. In addition, there are consistent data at the molecular, cellular, behavioral, and systems levels supporting the notion that physical activity is beneficial to cognition.[13]
Whole Body Vibration (WBV) is a smooth form of exercise therapy. Here, the patient stands or sits on a vibration platform in a predetermined standardized manner or performs strengthening or stretching exercises on the plate. There are different systems: vertical and sinusoidal vibrating plates. There are practically no side effects, only a few contraindications that must be taken into account.[14,15] In the last 20 years there have been a lot of studies with different patient groups who suffer from depression, fatigue or cognitive deficits, which have tested the effectiveness of both short and long term applications, as well to improve motor abilities: Chawla, Azharuddin, Ahmad and Hussain[16] show that especially WBV has a significant positive effect on depression, anxiety, stress and quality of life compared to an exercise program without vibration. The study by Peng, Yang, Wu, Zhang, Wu, Li, Shi, Hou, Zhang, Ma, Xiong, Pan and Zhang[17] shows in a rat model why these effects of WBV on depression and stress could be reached: It could reverse depressive-like behavioral disorder, inhibit neuronal degeneration, alleviate neuronal damage and pathological changes of glial cells, enhance trophic factor expression, and improve downregulation of dendritic and synaptic proteins after chronic restraint stress. The effect could be mediated by reducing neuronal degeneration in the hippocampus and improving the expression of synaptic proteins. It is concluded that WBV training exerts multifactorial benefits on depression, supporting its use as a promising new therapeutic option to improve depression-like behaviors in depressed individuals. Moretti, Tenório, Holanda, Campos and Lemos[18] constate that there are no effects of WBV on fatigue in fibromyalgia patients, in contrast to Collado-Moreno, Adsuar, Olivares, del Pozo-Cruz, Parraca, del Pozo-Cruz and Gusi[19] who are in the opinion that WBV has a positive effect on fatigue in this patient group, but it depends on the duration and the vibration plate used, favoring the Galileo system. Wen, Leng, Hu, Hou and Huang[20] summarize in their review that WBV can improve cognitive functions, especially attention and inhibition, even in a short term intervention. Positive effects of WBV on flexibility are shown in the review by Fowler, Palombo, Feland and Blotter.[21] Here, improvements seem to be dependent from amplitude and frequency used. WBV can improve coordination, too, as shown in the review by Duquette, Guiliano and Starmer[22], which investigated the effects of WBV on motor functions in cerebral palsy patients. A further review summarizes the significantly positive effects on leg strength.[23] Gloeckl, Heinzelmann and Kenn[24] show in their review that WBV can significantly improve endurance capacity in COPD patients.

As shown, exercise and especially WBV can improve depression, fatigue, cognition and motor fitness in various disorders.

So far there is no study with Long Covid patients. However, the application is already recommended during treatment in the hospital.[25]

For this, the present single case study wants to investigate the effect of WBV on the described Long Covid symptoms.

Hypothesis

A 12-week workout with a vibration plate will improve physical fitness, concentration, depression, and fatigue in Long Covid syndrome.

MATERIAL AND METHODS

Sample of persons

One female participant, 54 years old, regularly physically active until corona infection in October 2022 (about 4 hours per week of housework and gardening, about 6 hours per week of walking). No concomitant diseases, 1.61 m tall, 56.5 kg. Long Covid syndrome was suspected by the primary care physician because she complained of constant fatigue, concentration problems, and restricted breathing.

Variable sample

BDI-II: Beck Depression Inventory, second edition. Here, a total of 21 questions are answered regarding pessimism, sadness, feelings of failure, loss of pleasure, self-worth, fatigue, energy, etc. Between 0 and 3 points are awarded per task. All points are added to a total score. A classification of the total score is made as follows: 0 to 13 points = no depression, 14 to 19 points = mild depression, 20 to 28 points= moderate depression, 29 and more points = severe depression.[26] The total score of the questionnaire is evaluated.

FAS: Fatigue Assessment Scale. The questionnaire consists of ten questions about physical and mental fatigue, tiredness, concentration, etc. The total score of the questionnaire is evaluated. Between 1 and 5 points are awarded for each task. All points are added up to a total value. A classification of the total score is made as follows: 10 to 21 points = no fatigue, 22 to 34 points = moderate fatigue, 35 to 50 points = extreme fatigue. A minimally important difference is given as 4 points or 10% change.[27] The total score of the questionnaire is evaluated.

D2 test: D2 test for measuring the ability to concentrate. The test consists of 14 test rows with "d" and "p," each with one to four small dashes at the top and/or bottom. For each row, the respondent has 20 seconds to circle as many "d "s with 2 dashes. For the 40- to 60-year-old age group, a GZ (total number of items processed) of 340 or an F% (proportion of errors) of 17.4% with a SW (standardized value) of 87 is classified (corresponding to the 10th percentile), a GZ between 366 and 392 or an F% between 17.3% and 8.9% with a SW between 90 and 93, a GZ of 453 or an F% of 4.7% with a SW of 100, a GZ of 506 or an F% of 2.5% corresponds to a SW of 106, a GZ between 541 and 567 or an F% between 2.4 and 1.1% corresponds to a SW of 110 to 113, a GZ of 628 or an F5 of 1.0% corresponds to a SW of 120.[28] Total number of items processed (GZ), correctly solved items (R), incorrectly solved items (F), proportion of errors (F%), total number minus errors (GZ-F), and standardized value (SW) are evaluated.

Motor fitness test: Testing of motor abilities (fitness) with the tasks hop run, ball grasping, ball throw with rotation, figure-eight circles in one-leg stand, walking backwards (coordination), sit-ups, push-ups, standing long jump (strength), shouldering out, stand&reach (flexibility) and 2 km walking (endurance). With the exception of walking, the subject has two attempts at each task. The items are scored according to age and gender as follows (50 to 59 year-old women): 5 x rhythmic hop run with arm circles = 1 point, 5 x grasping the ball without dropping the ball = 1 point, throwing and catching the ball with a full rotation around the longitudinal body axis = 1 point. 5 x circles of eight without touching the ground or knocking over a cone = 1 point. Speed while walking backwards > 0.39 m/s = 4 points, 0.34 - 0.39 m/s = 3 points, 0.30 - 0.33 m/s = 2 points, 0.25 - 0.29 m/s = 1 point, < 0.25 m/s = 0 points. Trunk flexion: > 8 cm = 4 points, 3 - 8 cm = 3 points, 0 - 2 cm = 2 points, -5 - -1 cm = 1 point, < -1 cm = 0 points. Out-shoulder (acromion width - grip width): < 56 cm = 4 points, 56 - 66 cm = 3 points, 67 - 73 cm = 2 points, 74 - 84 cm = 1 point, > 84 cm = 0 points. Situps per 40 seconds: > 13 = 4 points, 11 - 13 = 3 points, 9 - 10 = 2 points, 7 - 8 = 1 point, < 7 = 0 points. Standing long jump: > 124 cm = 4 points, 109 - 124 cm = 3 points, 97 - 108 cm = 2 points, 82 - 96 cm = 1 point, < 96 cm = 0 points. Push-ups per 40 seconds: > 12 = 4 points, 11 - 12 = 3 points, 9 - 10 = 2 points, 7 - 8 = 1 point, < 7 = 0 points. 2 km walking: < 16:01 min = 4 points, 16:01 - 17:06 min = 3 points, 17:07 - 18:02 min = 2 points, 18:03 - 19:07 min = 1 point, > 19:07 min = 0 points.[29] The raw scores and age- and gender-normalized scores of the tasks as well as the total score are evaluated.

Treatment sample

Training once a week for 30 minutes over a period of 12 weeks with a vibration plate (Galileo Med Advanced). A frequency of 20 Hz was applied with a set length of one minute followed by a set break of one minute. The exercises (number of sets, static/dynamic) were increased in the course of the weeks according to the personal feeling of the test person as follows: In the first training session, two sets were performed in a hip-width stance with slightly bent knees for familiarization. This was followed by one set each of static squat position (hip-width stance, mark 1.5), static situp position, static push-up position (hands shoulder-width, mark 2.5, arms slightly flexed). From the fourth week, the number of sets was increased to two for all exercises. From the seventh week, the mentioned exercises were performed dynamically. From the ninth week, the number of sets was increased to three for squats and situp. In the eleventh week, the number of sets for push-ups was also increased to three. At the end of each training session, a limbering up session took place in a hip-width stance with the upper body bent forward-downward.

RESULTS AND DISCUSSION

The following table 1 provides an overview of the results in pre- and posttest in BDI-II, FAS, D2 test and motor fitness test.

Table 1: Results in pre- and posttest of the Beck Depression Inventory BDI-II, Fatigue Assessment Scale FAS, d2-Test (GZ = total number of processed items, R = correctly solved items, F = incorrectly solved items, F% = error percentage in %, GZ-F = total number of processed items minus errors, SW = standard value) and fitness test (RV = raw score, SV = standard value).

Variables	Pretest	Posttest	Change
BDI-II	12	5	-7
FAS	31	22	-9
D2 GZ	371	419	+48
D2 R	117	152	+35
D2 F	40	38	-2
D2 F%	10.78	9.07	-1.71
D2 GZ-F	331	381	+50
D2 SW	91	96	+5
Hop run RV (number of correct hops)	5	5	0
Ball grasping RV (number of correct grasps)	5	5	0
Ball throw with rotation RV (number of correct rotations)	0	0	0
Figure-eight circles RV (number of correct eights)	5	5	0
Walking backwards RV (m/s)	0.41	0.45	+0.04
Stand& Reach RV (cm)	15	16	+1
Shouldering out RV (cm)	33	28	-5
Situp RV (number of correct situps)	0	13	+13
Push up RV (number of correct push ups)	8	14	+6
Standing long jump RV (cm)	95	52	-43
2 km Walking RV(min)	18:38	17:18	-1:20
Hop run SV	1	1	0
Ball grasping SV	1	1	0
Ball throw with rotation SV	0	0	0
Figure-eight circles SV	1	1	0
Walking backwards SV	4	4	0
Stand&Reach SV	4	4	0
Shouldering out SV	4	4	0
Situp SV	0	3	+3
Push up SV	1	4	+3
Standing long jump SV	1	0	-1
2 km Walking SV	1	2	+1
Fitness Total Value	9.17	11.83	+2.66

There are both decreases in values (BDI-II, FAS, D2 F, D2 F%, shouldering out RV, standing long jump RV and SV, walking RV, and throw with rotation SV), increases in values (D2 GZ, D2 R, D2 GZ-F, D2 SW, walking backwards RV, stand&reach RV, situp RV and SV, push ups RV and SV, and walking SV). Some values show no change (hop run RV and SV, ball grasping RV and SV, throw with rotation RV and SV, figure eight circles RV and SV, walking backwards SV, stand&reach SV and shouldering out SV).

Improvements and consistent results are shown throughout. Only the standing long jump showed a deterioration.

The test person showed a reduction of seven points in the BDI-II. She already showed no depression in the pretest with a value of < 13 points[26], although this was already on the borderline to mild depression with 12 points. This symptom has thus improved. This is consistent with the findings of Chawla et al.[16] who show a significant positive effect of WBV on depression.

In the FAS, a reduction of nine points can be observed. In the pretest, the result is to be classified at the upper limit of medium fatigue, in the posttest at the lower limit.[27] Thus, this symptom has also improved. This result is consistent to Collado-Moreno et al.[19] who are in the opinion that WBV has a positive effect on, depending on the duration and the vibration plate used, favoring the Galileo system.

In the D2 test, 48 more items were processed in the posttest and 35 more were solved correctly. The error

rate has thus decreased by 1.71 %. Thus, the total number minus errors has also improved and the classification of the standard value has risen from the 5th quintile to the 4th quintile.[28] Thus, it can be assumed that the concentration performance has improved. This is consistent with the findings from Wen et al.[20] who summarize in their review that WBV can improve cognitive functions, especially attention.

In the area of physical fitness, the only improvement in coordination was in walking speed when walking backwards; the remaining tasks remained unchanged, with hop run, ball grasping and figure-eight circles already having been achieved in the pretest. In the pretest the total score for coordination was 3.5, in the posttest also 3.5, only 0.5 points below the maximum score. Flexibility increased slightly, with an improvement of one cm in stand&reach and 5 cm in shouldering out. The standardized scores of these tasks were already given the maximum score in the pretest. In the pretest, the total flexibility score was four, and in the posttest it was also four, so the maximum score was achieved in each case. In the situps there was an increase of 13 correctly performed situps, in the push-ups there were six more than in the pre-test. Not only was the raw score increased, but the standardized score also improved by three points in each case. In the standing long jump, there was a deterioration of 43 cm and a related reduction of the standardized value by one point. In the pretest the total strength score was 0.67, in the posttest 2.3. In walking an improvement in running time of 1:20 minutes can be noted, which at the same time means an improvement of the standard value by one point. The total score of the fitness test improves by 2.66 points.

In coordination and flexibility, no increase was expected in the posttest due to the good values in the pretest. Nevertheless, small improvements could be achieved in the raw scores of the flexibility tests. With an age of 54 years, the test person is in the range of late adulthood, which is characterized by a decrease in motor performance if no training takes place.[30] There is a clear difference between exercisers and non-exercisers in coordination and flexibility.[31] The improvement in flexibility is consistent with the findings by Fowler et al.[21], as well as the improvement in coordination to Duquette et al.[22]

The trunk strength has improved significantly. This was to be expected, since exactly these muscle groups were also trained. In late adulthood, strength continues to decline, although this decline can be slowed, or even prevented or reversed, through regular training.[32] Strengthening exercises not only strengthen the muscles themselves, but also increase self-confidence, body awareness, and confidence in movement.[30] The improvement in strength is consistent to the findings by Osawa et al.[23]

Nevertheless, the performance in the standing long jump (leg strength) deteriorated, although an improvement could have been expected here, as described at Osawa et al.[23] This may be due to the fact that the floor of the gymnasium had been freshly sealed shortly beforehand and could therefore have been somewhat more slippery than in the pretest. The participant expressed fear of falling at this point and may not have jumped with full force because of this. To prevent this problem, the standing long jump could be performed on two gymnastics mats (total length 4 m) placed one behind the other with the trailing edge against a wall. This provides a non-slip surface and the fear of falling or slipping away can be reduced.

There is an improvement in the 2 km walking of 1:20 min. This is consistent to the findings by Gloeckl et al.[24] who show an improved endurance capacity. However, this improvement could also have been due to an increase in strength in the leg muscles, as no specific endurance exercises were performed, but the focus was on strengthening exercises.

CONCLUSIONS

The present single case study was able to show that an improvement of depressiveness, fatigue, concentration and physical fitness in Long Covid syndrome is possible, even if an exercise session takes place only once a week. Therefore, a pilot study should follow to compare the effectiveness of one with two training sessions per week. It seems to be important that the intensity is regularly adapted to the subjective condition of the test persons (individualization), or if the training leader determines that an increase in the number of sets or transition from static to dynamic exercises seems to be useful.

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