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Review

Whole-Body Vibration Exercise: A Possible Intervention in the Management of Post COVID-19 Complications?

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Featured Application: COVID-19 survivors had muscle fatigue or weakness, difficulty sleeping, and anxiety/depression. The WBV exercise can have clinical effects on the clinical conditions of post-COVID-19 in a similar way in different populations already studied.

Abstract: COVID-19 infection frequently leaves the infected subjects with impairments of multi-organs, the so-called post COVID-19 syndrome, which needs to be adequately addressed. The perspective of this narrative review is to verify the possible role of whole-body vibration exercise in the post-COVID-19 rehabilitation of these patients. Publications reporting the use of WBV exercises to counteract fatigue, muscle weakness, neurological manifestations, pain, quality of life, quality of sleep, lung commitments, and mental conditions in different clinical conditions were selected. Considering all the findings described in the current review, it seems that WBV exercise might be potentially useful and effective in the rehabilitation of post COVID-19 syndrome, being able to positively influence fatigue, muscle weakness, and quality of life without any side-effects. Controlled studies are mandatory to define the best protocols to be proposed, which need to be tailored to the individual and clinical characteristics.

Keywords: COVID-19 survivors; post COVID-19 syndrome; whole-body vibration; exercise; symptoms

1. Introduction

In the beginning of the outbreak related to the coronavirus disease 2019 (COVID-19) pandemic, the actions were focused on avoiding the transmission and spread of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and addressing the surge of critically ill patients in acute care settings. Indeed, on 29 April 2020, over 3 million confirmed cases have been accounted globally [1]. SARS-CoV-2 is a ribonucleic acid (RNA) virus, directly damaging the respiratory system, with a serious impairment of the immune system, exacerbation of the underlying medical conditions, and eventually systematic failure and death [2]. Additionally, Li et al. 2020 [3] have reported that the effects of COVID-19 are not only confined to the respiratory tract, being also able to spread through the central nervous system determining neurological diseases [3]. Moreover, Ciaffi et al., 2020 [4] have pointed out that also various musculoskeletal or autoimmune manifestations can be associated with COVID-19.

Thousands of individuals with COVID-19 have been hospitalized in all the world, and other millions of individuals have been required to be isolated in restricted spaces due to the COVID-19. Consequently, this dramatic and undesirable change in lifestyle led to immobilization (hospitalization and bed rest), quarantine, and physical inactivity determining a second-wave attack on the health and wellbeing of the infected as well as in general population. Despite a relevant number of deaths that occurred due to the COVID-19, a greater number of infected individuals have survived with different and undesirable clinical consequences, the so-called post-COVID-19 syndrome [5]. Consequently, it is expected that as time passes these patients, who survived to the acute infection who were but not completely restored to their initial health status, will require the need of treatment and/or rehabilitation [6]. Recent evidence indicates that COVID-19 survivors can present muscle weakness or fatigue, sleep difficulties, and depression or anxiety and that those more strongly affected in the hospitalization period presented severe impaired pulmonary capacity, being the main target population for intervention of long-term recovery, after 6 months of acute infection [7].

It is also essential to take into consideration other events related to COVID-19 that can favor different outcomes. The association between COVID-19 and thromboembolic events has been studied considering the physiopathology of this pandemic disease. In this context, it is relevant to know that the administration of anticoagulant drugs can promote hemodynamic homeostasis and protect against the observed coagulopathy. Thus, therapeutic targets have been proposed through the knowledge of unbalanced procoagulant/anticoagulant factors that leads to the impairment of endogenous antithrombotic activity during SARS-CoV-2 infection [8–10]. Events such as cardiac arrhythmias (atrial fibrillation, supraventricular tachycardia, complete heart block, and ventricular tachycardia) can occur in patients who are infected, recovering, or recovered from COVID-19. It is necessary to point out that anticoagulation therapy is not indicated, unless atrial fibrillation is also present, but considering COVID-19 patients, this practice needs additional studies [11,12]. COVID-19 infections can be also favor fibrosis process and, in this context, Nintedanib [13] has been used as an option of therapy intervention despite its interaction with anticoagulants. It is suggested that this medicine could increase the bleeding risk, thrombosis, and lead to thrombocytopenia. Thus, if anticoagulant therapy is necessary, a possibility is that the concomitant administration of DOACs and nintedanib—especially considering drug-monitored therapy—has been used in patients at high risk of bleeding complications [14]. These effects related to the DOAC/nintedanib may relevant if it is proposed an intervention with whole-body vibration (WBV) exercise due this type of intervention has been used to improve peripheral circulation in elderly individuals [15], the endothelial function in elderly patients with cardiovascular diseases [16], blood flow kinetics in different populations [17], blood flow in the legs of healthy young adults [18,19], and blood flow and activating muscles in the legs of patients with spinal cord injury [20]. Moreover, Szopa et al., 2021 [21] reported that WBV exercise improved lower limb circulation in myelomeningocele patients, increasing velocity and reducing resistivity in all tested arteries.

Considering the beneficial effects of WBV exercise that are described, the perspective of this narrative review is to identify possible role of whole-body vibration (WBV) exercise in post-COVID rehabilitation of these patients.

Comparing the clinical conditions of the post-COVID-19 survivors and the well-established clinical effects of the WBV exercise in different populations with similar symptoms, it is possible to hypothesize the possible role of this modality of exercise in the post COVID-19 rehabilitation. The objective of this narrative review is to present and summarize scientific evidence aimed to quantify the use of WBV exercises in different populations with similar symptoms in post-COVID-19 patients.

2. Symptoms and the Clinical Status of the Post-COVID-19 Individuals

COVID-19 is a respiratory infectious disease that can cause respiratory, physical, and psychological long-term dysfunctions in patients [6], exerting a negative impact on physical, cognitive, mental, and social health status also in patients with a mild presentation of the disease [22,23]. Previous outbreaks of coronaviruses have been associated with persistent pulmonary function impairment with initial symptoms as cough and dyspnea [24,25], muscle weakness, pain, fatigue, depression, anxiety, vocational problems, and reduced quality of life (QoL) of different degree [26]. Moreover, the impairment of the immune system has also been associated with multi-organ systemic failure [2].

The COVID-19 infection is reported to potentially increase the prevalence of chronic pain (CP), especially with stressors extending over many months [27]. CP must be considered in the context of the biopsychosocial model, where symptoms are the result of a complex and dynamic interaction between biological, psychological, and social factors [28,29]. Underlying predisposing mechanisms include genetic factors, previous pain experience, and traumatic events that could be physical or emotional [30]. It is now clear that COVID-19 itself is linked with painful symptoms—including arthralgia, myalgia, headache, chest pain, and abdominal pain—and even those subjects not admitted to critical care environments might suffer from pain demanding opioids for symptom treatment [31,32].

As it is pointed out, despite being clinically cured, some patients still find difficulties to return to their normal daily life and work due to persistent dysfunctions, as part of the disease's consequences [33]. It is described that the post COVID-19 rehabilitation patients would consider the main physical dysfunctions, such as sleep disorders, decreased activity endurance, and respiratory dysfunction [6]. In some clinical conditions, the duration of permanence in the intensive care unit is relatively long, with prolonged immobilization in prone position. Some specific problems have been described, including severe muscle weakness and fatigue, joint stiffness, dysphagia, (neuro) psychological problems, impaired functioning concerning mobility, activities of daily life, and work. In addition, Wang et al. 2020 [34] have reported that a post-hospitalization pulmonary rehabilitation might be suggested to all individuals hospitalized with COVID-19 to counteract the possible risk of long-term disability.

The notion that patients surviving to procedures in an intensive care unit (ICU) with mechanical ventilation for several weeks can be discharged at home without further medical attention is a dangerous illusion. The longer a patient remains in the ICU, the higher the risk for long-term physical, cognitive, and emotional complications. The major risk factors are cognitive impairments, acute brain dysfunction, hypoxia, hypotension, and glucose dysregulation [35]. It is considered that the pandemic will cause an aftershock: recovery from the consequences of severe respiratory illness and the secondary disabilities that result from intensive care treatments, including critical illness polyneuropathy (CIP) and critical illness myopathy (CIM), as part of the post-intensive-care syndrome (PICSy) [36].

The exercise has shown to be an effective therapy for most of the chronic diseases with direct effects on both mental and physical health. There are improvements of physical fitness components (cardiorespiratory fitness, muscular strength, and coordination-agility) that are causally related with the physiological functions of the main organ systems (respiratory, circulatory, muscular, nervous, and skeletal systems) and indirectly implicated in the appropriate functioning of other systems (endocrine, digestive, immune, or renal systems) [37–40]. Therefore, exercise might be a general intervention to the management of the COVID-19 patients [41].

3. Methodology

The search was performed in PubMed, Scopus and Embase database on 3 March 2021 using the following keywords "whole body vibration and fatigue", "whole body vibration and muscle weakness", "whole body vibration and neurological manifestations", "whole body vibration and pain", "whole body vibration and quality of life", "whole body vibration and quality of sleep", "whole body vibration and lung", and "whole body vibration and mental conditions".

The inclusion criteria were articles in English language that presented results involving the WBV and the specific condition according to the keywords described in human beings. The exclusion criteria were reviews articles, letters, editorials, chapter of books, articles involving experimental models, and other language.

Considering the diversity of the findings and the conditions of the interventions in the selected studies, statistical pooling of the data was not appropriate. Therefore, relevant information of the current review was summarized in a narrative form.

4. Results and Discussion

According to the inclusion criteria, thirty-three publications were selected. The condition, demographic data, objectives, parameters, type of vibrating platform, positioning and results are presented in the tables related to the symptoms of that COVID-19 survivors that might be management with WBV exercise.

4.1. Exercise as an Intervention in the Management of COVID-19 Patients

Ranasinghe et al. 2020 [42] have reported that improving host immunity and mitigating the negative effects of isolation via physical activity is strongly justified. Exercise should be done in moderate intensities and volumes during the current pandemic, which is a nutritionally, psychologically, and socially challenging environment in the presence of a virulent viral organism. Proactively creating innovative health promotion models with technology and government involvement with best available evidence should be encouraged to reduce physical inactivity during the current COVID-19 pandemic and after.

Considering the aim of this narrative review, WBV exercise would be important to the management of the COVID-19 patients. Individualized protocols with WBV consider the (i) posture of the individual, standing or sitting on an ancillary chair with the feet on the base of the vibrating platform (VP); (ii) biomechanical parameters, such as, frequency, peak-to-peak displacement; (iii) number of expositions (bouts) to the mechanical vibration (MV) in a session; (v) number of sessions; (vi) periodicity of the sessions; and (vii) length of the intervention [43,44]. WBV exercise is generated due to the contact of the individual with the base of a VP. In this case, the MV produced in the VP is transmitted to whole body of the subject. WBV exercise can lead to physiological responses that contributes to increasing power and muscle strength [45–47], decrease the pain [48,49] and fatigue [50,51], improve the QoL [49,52], improve quality of the sleep [53], and aid with neuro-cognition and mental disturbances [54–56]. Considering the lung commitments, WBV exercises can decrease the risk of dyspnea [51] and improve QoL [57].

Tables 1–8 show some clinical conditions, in various populations that were submitted to intervention with WBV exercise, that are like the symptoms observed in the COVID-19 patients.

Table 1. Different populations submitted to WBV exercise, with symptoms also observed in the COVID-19 patients: fatigue.

Study	Condition	Demographic Data	Objective	Parameters	Type of Vibrating Platform	Positioning	Results
Alentorn-Gelli et al., 2008	FM	*n* = 36 women with FM. Age 55.97 ± 1.55 years EVG: exercise and WBV, EG: exercise, and CG: control.	To evaluate the effects of a 6 weeks of traditional exercise with supplementary WBV to improve physical functioning, health status and main symptoms in women with FM.	Frequency: 30 Hz Amplitude: 2 mm	Vertical	(a) static squat at 100° of KF; (b) dynamic squat between 90 and 130° of KF; (c) maintained ankle plantar-flexion with legs in extension; (d) flexo-extension of the right leg between 100 and 130° of KF; (e) flexo-extension of the left leg between 100 and 130° of KF; and (f) squat at 100° of KF shifting the body weight from 1 leg to the other.	Results suggest that a 6-week traditional exercise program with supplementary WBV safely reduces pain and fatigue, whereas exercise alone fails to induce improvements.
Corbianco et al., 2018	Parkinson's disease	*n* = 20 males with idiopathic Parkinson's disease Age 51–66 years WBVT: WBV training AER: Aerobic treadmill training	To evaluate the effect on spasticity on energy cost and adaptations after exercise and recovery phases, by means of the oxygen consumption measurement and the assay of metabolic biochemical substrates	Frequency: 26 Hz Amplitude: 4 mm Acceleration: 106.64 m/s^2	Alternating vibrating platform	Semi squat position	WBV training does not appear to need an additional time of recovery and requires less feeling of fatigue, whereas AER demands a desirable recovery time after the session.
Escudero-Uribe et al., 2017	RRMS	*n* = 48 15 male/33 women WBV *n* = 16 BT *n* = 14 CG *n* = 18	To evaluate the effects of a 12-week, twice-weekly combined training programme on fatigue, gait pattern, mood, and quality of life in persons with RRMS.	Amplitude 3 mm, average Frequency 4 ± 1 Hz.	Zeptor Med System	Squat position with slight flexion at the knees, hips, and ankle joints for 90 s.	WBV combined with an exercise programme significantly help reducing the perception of fatigue and improve mood in persons with mild to moderate RRMS.

FM—fibromyalgia; AER—aerobic treadmill training; KF—knee flexion; RRMS—relapsing-remitting multiple sclerosis; WBV—whole-body vibration; BT—balance trainer; CG—control group.

Table 2. Different populations submitted to WBV exercise, with symptoms also observed in the COVID-19 patients: muscle weakness.

Study	Condition	Demographic Data	Objective	Parameters	Type of Vibrating Platform	Positioning	Results
Hsiao et al., 2019	KOA	*n* = 49 patients with KOA post total knee replacement WBV: Control:	To evaluate the effects of early WBV intervention in patients after total knee arthroplasty.	Frequency: 8–10 Hz Amplitude: 2 mm	Vertical	Standing position with hands on the walker	WBV intervention in patients early post total KOA showed significant immediate effect in increasing knee extensor strength and decreasing calf swelling.
Fuzari et al., 2019	CKD	*n* = 16 patients with CKD of both genders aged over 40 years WBV and Sham	To assess the efficacy of WBV training in patients with CKD on hemodialysis in the interdialytic period.	Frequency: 35 Hz Amplitude: 2 and/or 4 mm	Vertical vibration	Patient stood on the platform and remained in a semi-squat static position (knees at 30° flexion) and the upper limb contralateral to the arteriovenous fistula, slightly flexed while supporting on the VP and with feet 20 cm apart.	WBV training improves MVIC of knee extensors in patients with CKD on hemodialysis in the interdialytic period. WBV training could be considered in the management of patients with CKD.

Table 2. *Cont.*

Study	Condition	Demographic Data	Objective	Parameters	Type of Vibrating Platform	Positioning	Results
Claerbout et al., 2012	MS	*n* = 55 hospitalized persons with MS MS control group (*n* = 17) (WBV-full group, *n* = 20) (WBV-light group, *n* = 18).	To investigate the additional effects of a 3-week exercise program, performed on a WBV platform, on muscle strength and functionality.	Frequency: 30–40 Hz Amplitude: 1.6 mm	Vertical vibration	six exercises: static unipodal (right and left leg) and bipodal squat as well as a dynamic squat, toes-stand and lunge.	A 3-week exercise program on a vibration plate significantly improved muscle strength, but not functionality, in persons with MS.
Trans et al., 2009	KOA	*n* = 52 female (60.4 years ± 9.6) Control (*n* = 17) VibF (*n* = 18) VibM (*n* = 17)	To assess the effect of WBV exercise on muscle strength and proprioception in female KOA.patients	Frequency: 24–30 Hz Amplitude: not reported	Oscillating platform	Subjects stands with bent knees and hips on the platform (Static)	VibM yielded increased muscle strength, while VibF showed improved TDPM.

VP—vibrating platform; CKD—chronic kidney disease; HD—hemodialysis; MS—multiple sclerosis; KOA—knee osteoarthritis; WBV—whole body vibration; MVIC—maximum voluntary isometric contraction; VibM—WBVexercise regime on a platform; VibF—WBVexercise on a balance board; TDPM—proprioception (threshold for detection of passive movement).

Table 3. Different populations submitted to WBV exercise, with symptoms also observed in the COVID-19 patients: neurological manifestations.

Study	Condition	Demographic Data	Objective	Parameters	Type of Vibrating Platform	Positioning	Results
Liao et al., 2015	Stroke	*n* = 36 (26 men/10 women) Age = 57.3 (10.7) (1) no WBV, (2) low-intensity WBV, and (3) high-intensity WBV	To examine the influence of WBV intensity on the magnitude of BF and TA muscle activity and its interaction with exercise and severity of motor impairment and spasticity among individuals with chronic stroke.	(1) PV turn off (2) 20 Hz, 0.60 mm, 0.96 g, (3) 30 Hz, 0.44 mm, 1.61 g.	Synchronous vibrations	Positions; Standing, Semi-squat, Deep squat, Weight-shifted-forward, Weight-shifted-backward, Weight-shifted-to-the-side, Forward lunge, and Single-leg-standing.	Exposure to the low-intensity and high intensity protocols led to a significantly greater increase in normalized BF and TA EMG magnitude in both legs compared with no WBV. The EMG responses to WBV were similar between the paretic and non-paretic legs and were not associated with level of lower extremity motor impairment and spasticity.
Ahlborg et al., 2006	Spastic diplegia	*n* = 14 WBV group: *n* = 7 (4 men/3 women), Age = 32 (24–41) years. RT group: *n* = 7 (4 men/3 women), Age = 30 (21–39) years	To verify effects of WBV training compared with RT in adults with CP considering spasticity, motor performance and muscle strength after 8 weeks.	11 different levels of intensity with a frequency of 25–40 Hz	Device called NEMES-LSC (Nemesis BV, Hengelo, The Netherlands).	Static standing position with hips and knees in 508 of flexion	Spasticity decreased in knee extensors in the WBV group. Muscle strength increased in the RT group at the velocity 308/s and in both groups at 908/s. 6mWT and TUG test did not change significantly. GMFM increased in the WBV group.
Kaut et al., 2014	SCA type 1, 2, 3, or 6	*n* = 32 EG: *n* = 17 Age = 61.2 ± 12.3; female/male 7:10 SG: *n* = 15 Age = 57.3 ± 12.7; female/male 5:10	To test the hypothesis that symptoms of SCA1, 2, 3, or 6 might be improved by SRT	EG: frequency 6 to 6.5 Hz,3 mm; with five stimuli of 60 s duration; resting time was 60 s. SG: 1 Hz, 3 mm	Stochastic vibration, SR-Zeptor device®	Both groups stand on the platform wearing shoes and had to adopt a semi-squat position with knees slightly flexed	The use of SRT whole-body training before active physiotherapy might have an even larger effect than both treatments applied independently.

WBV—whole-body vibration; EMG—electromyography; BF—biceps femoris; TA—tibialis anterior; RT—resistance training SRT—stochastic resonance therapy; CP—cerebral palsy; 8MW—time needed to walk 8 m; 6mWT—Six-Minute Walk Test; TUG—Timed Up and Go test; GMFM—Gross Motor Function Measure; SCA—spinocerebellar ataxia; EG—experimental group; SG—sham group.

Table 4. Different populations submitted to WBV exercise, with symptoms also observed in the COVID-19 patients:pain.

Study	Condition	Demographic Data	Objective	Parameters	Type of Vibrating Platform	Positioning	Results
Corum et al., 2018	Patellofemoral pain	*n* = 34 WBV group = 18 Age = 32.7 ± 7.3 years Control group = 16 Age = 33.7 ± 7.7 years	To investigate the effects of WBV training on isokinetic muscular performance, pain, function, and quality of life in patients with PFP	Frequency fixed at 35 Hz, Peak-to-peak displacement: 2 mm in the first four weeks, 4 mm during the second four weeks.	Vertical oscillating vibration platform	Positions: Lunge-step, semi-squat, ball-squeeze squat, and dynamic squat.	This study showed the superiority of eight weeks of WBV training plus home exercise over home exercises alone in patients with PFP.
Alev et al., 2017	Fibromyalgia	*n* = 20 WBV group *n* = 10 Control group *n* = 10	To reveal the short- and long-term effects of WBV on pain and physical status.	30 Hz frequency and 2 mm amplitude	'Compex Winplate' (Uniphy Elek-tromedizin GmbH and CoKG)	(a) static squat at 100° KF (b) dynamic squat between 90 and 130° KF for every single leg (c) dynamic squat between 90 and 130° KF for both legs at the same time (d) ankle flexion-extension, 100° KF (e) squat at 100° KF shifting the body weight from one leg to another.	Patient group treated with WBV plus exercise had significant symptomatic improvement at the 6th month which may be considered as a chronic training effect.
Sá-Caputo et al., 2018	MSy	*n* = 44 WBV exercise group (*n* = 29) control group (*n* = 15)	To assess the acute effect of WBV exercise, with 5 Hz (low frequency, on the PL, trunk flexibility, and cardiovascular responses (BP and HR).	Frequency: 5 Hz Peak-to-peak displacements of 2.5, 5.0, and 7.5 mm (0.12, 0.25, and 0.35 g).	Alternating/ oscillating vibration	Sitting in a chair with the feet on the platform with KF	WBV exercise exposure with low frequency (5 Hz) is responsible in inducing physiologic parameters that can promote in decreasing the PL and to improve the flexibility and to maintain cardiovascular responses (HR and BP) in s MSy subjects.

PFP—patellofemoral pain; KF—knee flexion; PL—pain level; WBV—whole-body vibration; BP—blood pressure; HR—heart rate; MSy—Metabolic syndrome.

Table 5. Different populations submitted to WBV exercise, with symptoms also observed in the COVID-19 patients: quaity of life.

Study	Condition	Demographic Data	Objective	Parameters	Type of Vibrating Platform	Positioning	Results
Paineiras-Domingos et al., 2020	Metabolic syndrome	*n* = 33 patients (i)WBVEeG, *n* = 17, 15 females/02 males, 61.1 ± 8.4 years (ii) CG, *n* = 16, 14 females/02 males, 58.2 ± 9.1 years	To evaluate the effects of WBVE on QoL and CPL in individuals MSy.	CG: peak to peak displacements: 2.5, 5.0 and 7.5 mm, frequency 5 Hz. WBV groups: the frequency was progressively increased in one unit for each session up to 14 Hz in the ending of protocol.	OVP	St in a chair placed in front of the platform with flexion of the knees. Their feet were on the platform base in three positions. WVE groups: second session to the last session, they were standing in squat position	Improved of QoL (physical and psychological domains) as accumulative effect; reduced the CPL in the acute interventions in the first and in the last sessions.

Table 5. *Cont.*

Study	Condition	Demographic Data	Objective	Parameters	Type of Vibrating Platform	Positioning	Results
Neves et al., 2018	COPD	*n* = 20 WBVT = 10, Age = 63.8 ± 8.1 years Control group = 10 Age = 63.5 ± 7.8 years	To investigate the effects of WBVT on QoL and physical and inflammatory-oxidative parameters in patients with COPD	Amplitude of 2 mm and frequencies that progressively increased each 4 weeks, beginning with 30, followed by 35 and 40 Hz, with the root mean squared acceleration in vertical axis was 1.45, 1.83 and 2.25 g respectively.	Synchronic vibrating platform	Static squatting with 30° of knee flexion, with their feet 28 cm apart, barefoot and with upper limbs holding the platform bars	The WBVT showed beneficial effects on physical measures and QoL in stable moderate COPD patients and did not change the inflammatory-oxidative biomarkers. WBVT also showed to be capable of improving cardiorespiratory and muscle components related to exercise capacity, QoL, and peripheral muscle strength in moderate COPD patients.
Carvalho-Lima et al., 2017	MSy	*n* = 21 Age = 66.65 ± 2.90 years (i) CG = 7; (ii) WBVE1 = 7; (iii) WBVE2 = 7.	To evaluate the effect of WBVE on the QoL of individuals with MetS.	CG: peak to peak displacements of 2.5, 5.0 and 7.5 mm and frequency of 5 Hz. WBV groups: the frequency was progressively increased in one unit for each session up to 14 Hz in the ending of protocol.	OVP	Sat in a chair placed in front of the platform with flexion of the knees. Their feet were on the platform base in three positions. WVE groups: second session to the last session, they were standing on the platform base in squat position	One or two times per week of WBVE, with a progressive and increased frequency improves the QoL of patients with MSy in different domains of the WHOQOL-BREF.
Wang et al., 2016	KOA	*n* = 99 WBVE + exercise *n* = 49 Only exercise *n* = 50	To determine effects of WBV exercise associated with QRE versus QRE only on pain, physical function, biomarkers in serum and urine, ADL, and QoL in patients with KOA.	Frequency:35 Hz; Amplitude: 4- to 6-mm displacement (theoretically providing an additional 1.0 g of peak acceleration).	Vertical vibration device	Guided to stand on the vibration platform without shoes and with knees slightly flexed	WBVE in combination with QRE provided over a 24-week period improved symptoms, physical function, ADL, and QoL in patients with KOA to a great extent and was superior to QRE only in most outcomes.
Çevik Saldıran et al., 2020	Non-alcoholic fatty liver disease patients	*n* = 31 aerobic with WBV (*n* = 15) aerobic without WBV (*n* = 16)	To examine the effectiveness of including exercises with WBV to aerobic training in terms of metabolic features and QoL	Frequency: 30 Hz Amplitude: 2–4 mm	Vertical-sinusoidal vibration platform	Different postures	Aerobic training with and without the WBV was effective in physical adaptation and improving the QoL in many well-being domains.
Jamal et al., 2019	PDPN	*n* = 26 (16 males/10 woman) Experimental group (*n* = 13) CG (*n* = 13)	To determine the efficacy of WBV therapy on pain, neuropathy disability score, balance, proprioception and QoL in patients with PDPN.	Frequency: 12 Hz Amplitude: 5 mm	Alternating vibration	Barefoot on the platform evenly distributing their body weight on both feet with knees bent at 20 degree	WBV proved to be beneficial in terms of neuropathic pain, neuropathy disability score, balance measures and QoL in patients with PDPN. WBV therapy is a safer and feasible treatment to improve functional capacity in all domains of SF-36 questionnaire.

Table 5. *Cont.*

Study	Condition	Demographic Data	Objective	Parameters	Type of Vibrating Platform	Positioning	Results
De Melo Marinho et al., 2020	Renal transplant	*n* = 5 age: 43–52 years; body mass: 67.1 kg; height: 1.60 m	To evaluate the effect of a 12-week WBV training program on quadriceps muscle strength, quadriceps thickness, the 6mWT, respiratory muscle strength and QoL in adults with a kidney transplant	Frequency: 35 Hz, Amplitude: 2–4 mm	Synchronous	Standing and stationery, feet 20 cm apart in a semi-squat position (15° knee flexion) and upper limbs slightly flexed and holding on to the platform.	Improvement in the quadriceps muscle strength, respiratory muscle strength, distance walked and QoL.
Pessoa et al., 2016	Elderly adults	*n* = 28 Resistance (*n* = 9), WBV (*n* = 9), WBV + resistance exercises (*n* = 10)	To evaluate effects of WBV on respiratory muscle strength, thoracoabdominal ventilation, and QoL in the elderly adults.	Frequency: 35 Hz. First month (2-mm amplitude and 10 sequences of 1 min); Second month (4-mm amplitude and 15 sequences of 1 min); Third month (4-mm amplitude and 20 sequences of 1 min).	Vertical vibration, triaxial platform	Barefoot, keeping their knees semi-flexed at 15°	WBV groups improved SF-36 scores in functional capacity, physical aspects, energy, pain, and general heath domains. The WBV is a training that could improve respiratory muscle strength and QoL and promote different ventilatory strategies in chest wall and thoracoabdominal compartments in healthy elderly adults.

CG—control group; OVP—oscillating/vibrating platform; WBVEG—whole-body vibration exercise group; CPL—chronic pain level; WHO—World Health Organization; COPD—chronic obstructive pulmonary disease; WBV—whole-body vibration; 6mWT—6-min walk test; QoL—quality of life; QRE—quadriceps resistance exercises; ADL—activities of daily living; KOA—knee osteoarthritis; PDPN—painful diabetic peripheral neuropathy; MSy—metabolic syndrome.

Table 6. Different populations submitted to WBV exercise, with symptoms also observed in the COVID-19 patients: quality of sleep.

Study	Condition	Demographic Data	Objective	Parameters	Type of Vibrating Platform	Positioning	Results
Figueiredo Azeredo et al., 2019	MSy	*n* = 19 (i) GFF: *n* = 9 (ii) GFV: *n* = 10 (58.79 ± 12.55 years old, 1.62 ± 0.09 m height, 86.27 ± 15.03 kg body mass).	To investigate effect of WBV exercise on parameters related to the sleep quality in MSy individuals.	GFF: Peak to peak displacements of 2.5, 5.0, and 7.5 mm and with a frequency of 5 Hz. GFV: Peak to peak displacements of 2.5, 5.0, and 7.5 mm and with a frequency of 5 up to 16 Hz.	VP	Squat position, barefoot and with (130° knee flexion). Dynamic and static squats interspersed sessions.	WBVE intervention was capable of interfering with physiological mechanisms with effects on the WC and HR, leading to the improvement of the quality of sleep in MSy individuals.

GFF—group frequency fixed; GFV—group frequency varied; MSy—metabolic syndrome; OVP—oscillating/vibrating platform; WC—waist circumference; HR—heart rate.

Table 7. Different populations submitted to WBV exercise, with symptoms also observed in the COVID-19 patients: lungs capacity impairment.

Study	Condition	Demographic Data	Objective	Parameters	Type of Vibrating Platform	Positioning	Results
Braz Junior et al., 2015	COPD	*n* = 11 (8 males, 3 females)	To investigate the effect of WBV training on functional performance and QoL of subjects with COPD.	Frequency of 35 Hz for 30 or 60 s at either high amplitude (4 mm) or low amplitude (2 mm) vibration	Vertical vibration	Subjects in a static position, in a semi-squatting position at an angle of 120–130° with the upper limbs lightly flexed in support	WBV improved the functional capacity in the 6 MWT of patients with COPD and all domains of the SGRQ.
Gloeckl et al., 2017	COPD	*n* = 74 WBVT group (*n* = 37) Age 65 ± 8 years Control group (*n* = 37) Age 63 ± 9 years	To investigate the determinants of improved exercise capacity following WBV training	High frequencies (24 to 26 Hz) and 5 mm peak-to-peak displacement wearing flat soled shoes.	Side-alternating vibration platform	Patients performed knee and hip flexion between 90°–120° during each squat movement, without holding on to anything	WBV training improved the neuromuscular performance, as opposed to muscular strength or central cardiovascular adaption.
Lage et al., 2019	COPD	*n* = 26	The first stage sought to evaluate the cardiorespiratory responses to different types of squats. The second stage aimed to evaluate the cardiorespiratory responses to different vibration frequencies and characterize the exercise intensity.	Static squatting associated with WBV (frequencies: 30, 35, and 40 Hz; amplitude: 2 mm) dynamic squatting associated with WBV (frequency: 35 Hz; amplitude 2 mm	Vertical vibration platform	Squatting position with their feet 28 cm apart, barefoot, and with the upper limbs holding the platform bars	WBV exercise, at different vibration frequencies, leads to an increase in VO2, HR, and SpO2 in subjects with COPD. The static squats caused a higher variation in HR than dynamic squats, with no difference between groups.

WBV—whole body Vibration; QoL—quality of life; COPD—chronic obstructive pulmonary disease; PR—pulmonary rehabilitation; 6MWT—min walk test; VO2—oxygen consumption; HR—heart rate; SpO2—oxygen saturation; SGRQ—The St. George Respiratory Questionnaire.

Table 8. Different populations submitted to WBV exercise, with symptoms also observed in the COVID-19 patients: mental conditions.

Study	Condition	Demographic Data	Objective	Parameters	Type of Vibrating Platform	Positioning	Results
Amonette et al., 2015	Health individuals	*n* = 12 (8 men and 4 women) (*n* = 12); age: 28.2 ± 6.4 years; height: 174.3 ± 2.3 cm; weight: 82.7 ± 4.6 kg.	To determine if the head accelerations using a common WBV exercise protocol acutely reduced neurocognition in healthy subjects, and investigated differential responses to WBV plates with VV and RV.	Frequency: 30 Hz Peak to peak displacement: 4 mm 5 series Duration: 2 min each series Interval: 1 min Total duration WBV: 10 min	Vertical Vibration And Alternating/Oscillating vibration	The subjects were positioned on the vibration plate with their feet 20.6 cm apart, with of knee flexion.	A single bout of static squats with of knee flexion while undergoing WBV exercise at 30 Hz with 4 mm of vertical displacement does not cause a significant decrease in neurocognition, does not affect visual or verbal memory.
Lam et al., 2018	Mild or moderate dementia	*n* = 51 WBV training (*n* = 25) Control group (*n* = 26)	To evaluate the effects of WBV added to a routine activity program on lower limb strength, balance, and mobility among community-dwelling individuals with mild or moderate dementia, compared with the routine program alone.	WBV at 30 Hz, 2-mm peak-to-peak amplitude	Vertical vibrating platform	While standing on the vibration platform, participants performed static (knee maintained at 90° flexion) and dynamic semi-squats (range of knee movement between 20° and 90° of flexion).	WBV training is feasible and safe to use with people with mild or moderate dementia. However, it did not lead to further improvement in physical function and quality of life than the usual activity program provided at the daycare centers.

Table 8. *Cont.*

Study	Condition	Demographic Data	Objective	Parameters	Type of Vibrating Platform	Positioning	Results
Fuermaier et al., 2014	ADHD	n = 100 Healthy individuals (n = 83) 43 woman/40 male Individuals with ADHD (n = 17) 9 woman/8 male	To explore the effects of WBV on attention in a group of healthy individuals and in a clinical sample of individuals with cognitive dysfunctions, i.e., adults with ADHD	30 Hz vibration frequency and 4 mm vibration amplitude	Synchronic vibration	Sitting in upright position throughout the whole experiment, in a chair attached to the vibrating platform, the arms on the rest and the feet on the wood platform.	WBV was demonstrated to improve cognitive performance of healthy individuals as well as of individuals with ADHD.
Fereydounnia and Shadmehr 2020	Lumbar hyper-lordosis	n = 30 woman With hyper-lordosis (n = 15) Without hyper-lordosis (n = 15)	To evaluate the immediate effects of WBV on the neurocognitive parameters in women with and without lumbar hyper-lordosis	30 Hz, 5 mm, and 5 min	Vertical vibration	The participants stood bare feet on both feet without any movement on the WBV platform.	WBV had positive immediate effects on the reaction time in both groups, however, it had negative effects on anticipatory skill with high speed in women with normal lumbar lordosis.
Kim and Lee; 2018	Senile dementia	n = 18 experimental group (n = 9) control group (n = 9)	To provide foundational material to improve QoL in patients with senile dementia.	It began with the frequency of 20 Hz, and it increased gradually as 5 Hz every 2 weeks.	Vertical vibration	The exercise involved 5 sets of the standing position, squat position, and sumo squat position lasting for 2 min, and between the positions, they took a rest for 1 min	WBV improve QoL in patients with senile dementia by stimulating their muscle spindles and sensory organs only with the amplitude and the number of vibrations with no burden of physical activity and enhancing their EEG activation and cognitive function through the responses of the neuromuscular system.
Heijer et al., 2015	Healthy children	n = 55 (27 males, 28 woman)	To examine whether WBV has acute effects on cognition, more specifically inhibition, on healthy 8–13-year-old children.	The vibration frequency was set at 30 Hz and the vibration amplitude was set at 4 mm.	Vertical vibration	The children were then asked to take place on the chair on the *Vibe 300*, and instructed to sit in upright position throughout the whole experiment, with the arms and hands on the rest and both feet on the platform, and to keep body movements to a minimum.	Three-minute WBV treatments had significant beneficial effects on inhibition in this sample of healthy children. Especially the repeated application (three times) of WBV treatment appeared beneficial for cognition.
Fuermaier et al., 2014	Adult with ADHD	n = 1	To examine prolonged effects of WBV on cognitive functions in a patient with a diagnosed ADHD	30-Hz vibration frequency and 4-mm vibration amplitude	Vertical vibration	Was mounted wooden chair on a wooden platform vibrating. The participants sit on the chair in upright position, the arms on the rest and both feet on the wooden platform. The participant was further instructed to keep body movements to a minimum.	WBV was shown to improve neuropsychological test performance of an adult with ADHD, it remains unknown how long these effects last and to what extent the improvements as measured in neuropsychological tests can be generalized to functioning in daily life (e.g., academic or occupational setting).

Table 8. *Cont.*

Study	Condition	Demographic Data	Objective	Parameters	Type of Vibrating Platform	Positioning	Results
Regterschot et al., 2014	Young adults	*n* = 132 (112 woman, 21 males)	To investigate the acute effects of passive WBV on executive functions in healthy young adults.	Each participant underwent six times a passive WBV session with a frequency of 30 Hz and an amplitude of approximately 0.5 mm.	Vertical vibration	Participants were instructed to sit in an upright position against the back of the chair throughout the whole experiment, with their arms on the armrests and their feet on the wooden plate. In addition, they were instructed to keep body movements to a minimum.	Two minutes passive WBV has positive acute effects on attention and inhibition in young adults, notwithstanding their high cognitive functioning which could have hampered improvement.

WBV—whole-body vibration; ADHD—attention-deficit/hyperactivity disorder; VV—vertical vibrations; RV—rotational vibrations; EEG—electroencephalogram.

4.2. WBVE and Fatigue

Persistent fatigue following SARS-CoV-2 infection is common and independent from the severity of initial infection [58]. Fatigue is also described as a symptom of some diseases, and the effect of interventions with WBV exercise has been studied in populations with this clinical symptom. In general, WBV exercise in different protocols alone [59] or associated with aerobic exercise [46] has been reported to reduce the fatigue. In Table 1 are shown information reported from publications evaluating the effect of WBV exercise in different populations. Alentorn-Gelli et al., 2008 [60], studied women with Fibromyalgia, Corbianco et al., 2018 [61], men with Parkinson's disease and Escudero-Uribe et al., 2017 [62], males and women with Multiple Sclerosis. In the samples, in general, women and men were evaluated, totaling 73 individuals. Regarding the WBV exercise protocol of the studies, the number of sessions varied from 12 to 24 sessions and the time of exposure to the mechanical vibration from 3 to 20 min. Regarding the frequency, there was a range from 3 to 26 Hz. The studies also differed in relation to the type of VP used.

Alentorn-Gelli et al., 2008 [60], reported a protocol of WBV exercise during 6 weeks/12 sessions, twice a week, 90 min/day. Each session was composed of six exercises (30 s each) that were repeated six times with a recovery of 3 min between repetitions. The experimental group performed the same protocol without vibratory stimulus. The authors suggested that 6 weeks of traditional exercise including supplementary WBV safely decreases fatigue and pain, whereas only exercise not induce improvements in women with Fibromyalgia. Corbianco et al., 2018 [47], found that WBV training does not seems to require an extensive time of recovery and promotes minor perception of fatigue, whereas aerobic treadmill training requests a desirable recovery time after the session. The isometric protocol consisted in 1-min 20 series in semi squat position with a 1-min restore. Escudero-Uribe et al., 2017 [62], reported that WBV exercise combined with an exercise program significantly helped to reduce the perception of fatigue and improve mood in persons with mild to moderate relapsing-remitting multiple sclerosis (RRMS), after 12 weeks/24 sessions twice a week, performing five repetitions with 1-min breaks.

4.3. WBVE and Muscle Weakness

Musculoskeletal or autoimmune manifestations are associated with COVID-19 [4]. Authors described that WBV exercise might enhance the muscle status. Regarding muscle weakness, the studies by Hsiao et al. 2019 [63] and Trans et al. 2009 [64] were both performed in patients with knee arthritis, while those by Fuzari et al. 2019 [65] and Claerbout et al. 2012 [66] were performed in patients with chronic kidney disease (CKD) and multiple sclerosis (MS), respectively. All these Authors reported a positive significant effect of WBV in muscle strength. In the three studies [63–66], vertical vibration was used, but the VP models differed among the studies. The time of exposure to mechanical vibration varied from 3 to 30 min and the frequency used varied from 8 to 40 Hz. In relation to the total sample size, 172 individuals were engaged in the works (Table 2).

For Hsiao et al., 2019 [63], after one session/day, two sets/session of five-minute with three-minute rest interval during the post-operative day 2 and day 3; the control group received equal procedures, with the vibrating machine off, the WBV intervention in individuals with recent full knee arthroplasty showed acute effetcs improving the knee extensor strength and diminishing calf swelling. Fuzari et al., 2019 [65] investigated 12 weeks/3 months twice a week on alternate days, with 1-min vibration periods interspersed with 30 s of passive rest. The sham group was triggered by a DC motor in a device specifically created for this purpose and pointed that WBV training improves maximum voluntary isometric contraction of knee extensors in patients with CKD on hemodialysis in the interdialytic period. WBV training could be considered in the management of patients with CKD.

Claerbout et al., 2012 [66], reported that a three-week exercise program on a vibration plate significantly improved muscle strength, but not functionality, in persons with MS, after evaluated 3 weeks/10 sessions, with exercises were followed by 1 min relaxation, gradually increased from 30 s to 45 s to 60 s while vibration frequency increased from 30 Hz to 35 Hz to 40 Hz respectively. The total training duration ranged from 7 to 13 min. Changes in training program variables were applied at sessions 4 and 8. Trans et al., 2009 [64] assessed the effect of WBV exercise on muscle strength and proprioception in female patients with KOA, during eight-week intervention period time by enhancing the amount of repetitions in single session, training duration per day of 3–5 min. The relation between rest and working time was 1:1.

4.4. WBVE and Neurological Manifestations

It is pointed out that, as the COVID-19 pandemic progresses, reports of neurological manifestations are increasing. These manifestations can be considered as direct effects of the virus on the nervous system, para-infectious or post-infectious immune-mediated disease, and neurological complications of the systemic effects of COVID-19 [67]. The effects of WBV exercise on neurological manifestations have been evaluated in some different populations. The studies assessing the effects of WBV on neurological manifestations were those by Liao et al., 2015 [68]; Ahlborg et al., 2006 [69]; and Kaut et al., 2014 [70]. In general, the sample consisted of 82 individuals of both sexes. All studies used different VP models. Regarding the studied population, a difference was observed among the studies, being individuals with effusion in the study by Liao, patients suffering with spastic diplegia in the study of Ahlborg et al., 2006 [69] and with cerebellar pin ataxia in the study of Kaut et al. [70]. The frequency used in the studies ranged from 6 to 40 Hz (Table 3).

For Liao et al., 2015 [68], the main effect of intensity was significant. It was investigated a protocol with a complete set of eight static exercises was repeated three times, the duration of the rest period between the different exercises was set at 1-min, and the control group receiving the same procedures, with the vibration machine off. Exposure to the low-intensity and high intensity protocols led to a significantly greater increase in normalized biceps femoris and tibialis anterior electromyography (EMG) magnitude in both legs compared with no WBV. The intensity × exercise interaction was also significant, suggesting that the WBV-induced increase in EMG activity was exercise-dependent. The EMG responses to WBV were similar between the paretic and non-paretic legs and were not associated with level of lower extremity motor impairment and spasticity.

Ahlborg et al., 2006 [55] found that the spasticity decreased in knee extensors in the WBV group. Muscle strength increased in the resistance training group at the velocity 308/s and in both groups at 908/s. Six-Minute Walk Test and Timed Up and Go test did not change significantly. Gross Motor Function Measure increased in the WBV group. These data suggest that an 8-week intervention of whole-body vibration training or resistance training can increase muscle strength, without negative effect on spasticity, in adults with cerebral palsy. The protocol consisted in WBV group exercised three times weekly over eight weeks. In each session was performed 5 min warming up, approximately 6 min of WBV training (rest included) and finished with a short program of muscle stretching. The RT group exercised three times weekly over eight weeks. Each session consisted of the same type of warming up and stretching, but instead of WBV training this group performed RT in a leg press device. Three sets of 10–15 repetitions were performed with 2 min of rest.

Kaut et al., 2014 [70] identified that WBV as a supplementation to active physiotherapy, in a protocol with four series of SRT on four different days. Furthermore, the use of stochastic whole-body training before active physiotherapy might have an even larger effect than both treatments applied independently.

4.5. WBVE and Pain

CP management during the COVID-19 pandemic is a challenging process, especially with growing evidence that COVID-19 infection is associated with myalgias, referred pain, and widespread hyperalgesia [71]. The benefits of the WBV exercise on pain level have been reported by Alev et al., 2017 [72] in individuals with fibromyalgia, Sá-Caputo et al., 2018 [73] individuals with Metabolic syndrome (MSy) and by Corum et al., 2018 [74] in individuals with patellofemoral pain (PFP). These studies used a different model of VP and vibration protocol. The number of sessions ranged from 12 to 24 sessions, the time of exposure to vibration ranged from 30 to 60 s and the frequency used ranged from 30 and 35 Hz and 2 to 4 mm in amplitude. Sá-Caputo et al., 2018 [59], studying individuals with MSy on an alternating oscillating VP, frequency-5 Hz, peak-to-peak displacement (ranging from 2.5 to 7.5) demonstrated the ability of WBV exercise in the decrease of pain level. In relation to the number of participants, there were 98 individuals.

Corum et al., 2018 [74] showed the superiority of eight weeks of WBV training plus home exercise over home exercises alone in patients with PFP. It was investigated three days a week with at least one day between each session for eight weeks (total of 24 sessions), for 20–30 min per session. Four different types of WBV exercises in three sets were applied for 30 or 45 or 60 s/set with a 30 s rest period between sets and a 60 s rest period between exercises. WBV training is a feasible and efficient exercise intervention for the management of patients with PFP. However, patients should be assessed with etiologic factors causing their knee pain for the most appropriate treatment of PFP due to its multifactorial nature. It is believed that the study contributes to evidence in WBV research by providing an efficient protocol. Alev et al., 2017 [58] considered that individuals that performed WBV plus exercise presented significant symptomatic improvement at the sixth month (chronic training effect), after a protocol performed in four weeks, twice a week. There were six different kinds of exercises, with 30 s each and six repeats with a recovery of 3 min between repetitions. The exercise protocol consisted of dynamic (isotonic) and static (isometric) muscular contractions. Sá-Caputo et al., 2018 [73] pointed out that WBV exercise with low frequency-5 Hz promoted changes in physiologic parameters that contribute to reduce the PL and to improve the flexibility and to maintain to cardiovascular responses, considering heart rate (HR) and blood pressure in MSy individuals. The protocol consisted of three bouts (1 min each) of WBV exercise, followed by 1 min of interpesed restThe total time of intervention was 17 min (Table 4).

In addition, there are already systematic reviews emphasizing the benefits of WBV in CP in different clinical conditions [75–77].

4.6. WBVE and Quality of Life

The negative impact of the COVID-19 on health-related QoL e has been demonstrated in various populations [78]. WBV training exercise can improve the QoL of individuals in different clinical conditions, as reported by Paineiras-Domingos et al., 2020 [49] and Carvalho-Lima et al., 2017 [79] in patients suffering from MSy, Neves et al., 2018 [80] in Chronic Obstructive Pulmonary Disease (COPD), Wang et al., 2016 [34] in knee osteoarthritis (KOA), Çevik Saldıran et al., 2020 [81] in non-alcoholic fatty liver disease patients, Jamal et al., 2019 [82] in painful diabetic peripheral neuropathy, de Melo Marinho et al., 2020 [83] in renal transplantation, and Pessoa et al., 2016 [84] in elderly adults. The samples consisted of individuals of both sexes tested on vertical and alternating platforms. The frequency used ranged from 5 to 40 Hz and the peak-to-peak displacement from 0.8 mm to 7.5 mm. The duration of the WBV training exercise consisted of 6 to 24 weeks. In all studies, positive effects of WBV on the QoL were observed.

Paineiras-Domingos et al., 2020 [49] investigated a protocol performed weekly (one and two sessions a week) for 10 weeks. The session was performed with 1 min or vibration followed 1 min of rest. This sequence was repeated more two times. The CG followed the same protocol-treated group, however, kept the platform off. They found that WBVE in MSy individuals is capable significantly (i) to promote an improvement of QoL considering the physical and psychological domains, as accumulative effect; and (ii) to reduce CP level in the acute interventions in the first and in the last sessions. Therefore, WBVE would represent a suitable and useful physical activity that could be included in health programs for MSy individuals, following the World Health Organization recommendations, and Carvalho-Lima et al., 2017 [79], found the WBVE improving the QoL of patients with MSy in different domains of the WHOQOL-BREF, in a same protocol (one or two times per week) with a progressive and increased frequency.

Neves et al., 2018 [80] concluded that the WBVT was related to beneficial effects on physical measures and QoL in patients with stable moderate COPD and did not change the inflammatory-oxidative biomarkers. The protocol was 3 times/week on alternate days, for 12 week, performing six series of 30 s with 60 s of rest between each series. The control group performed equal procedures, with the vibrating machine off. Moreover, the WBVT showed to be an integrated method, capable of improving cardiorespiratory and muscle components related to exercise capacity, QoL, and peripheral muscle strength in moderate COPD patients.

For Wang et al., 2016 [34] WBVE in combination with quadriceps resistance exercises (QRE) provided over 24-week period improved symptoms, physical function, ADL, and QoL in patients with KOA to a great extent and was superior to QRE only in most outcomes. This was observed after a total exposure time of 30 min per day (vibration 60 s, interval rest 60 s), 5 days/week for 24 weeks. Çevik Saldıran et al., 2020 [81] concluded, after an eight-week individualized exercise program with 15 min WBV, that aerobic training with and without the WBV was effective in physical adaptation and improving the QoL in many well-being domains; however, it was understood that there was no need to add the WBV for better recovery of QoL.

Jamal et al., 2019 [52] used a protocol with four bouts of three min sessions with 60 s rest between bouts, three times a week. The protocol was performed over six weeks and it was pointed that WBV proved to be beneficial in terms of neuropathic pain, neuropathy disability score, balance measures and QoL in patients with painful diabetic peripheral neuropathy. It was verified that individuals with advanced stages of neuropathy that present difficult-to-perform exercise programs, WBV could be considered as safe and feasible intervention to improve functionality, considering all domains of SF-36 questionnaire. This exercise is extremely easy to be performed and no present side effects on neuropathic symptoms.

De Melo Marinho et al., 2020 [82] reported that an improvement in the quadriceps muscle strength, respiratory muscle strength, distance walked and QoL evaluated in only a few transplant recipients was observed following this 12-week WBV protocol (two weekly sessions, on alternative days); while Pessoa et al., 2016 [83] showed that the WBV groups improved SF-36 scores in functional capacity, physical aspects, energy, pain, and general heath domains. The training lasted for 12 consecutive weeks, three times per week for approximately 60 min per session. They concluded that WBV is a training that could improve respiratory muscle strength and QoL and promote different ventilatory strategies in chest wall and thoracoabdominal compartments in healthy elderly adults (Table 5).

4.7. WBVE and Quality of Sleep

Sleep disorders are a frequent finding in the post-COVID-19 syndrome [84]. Moreover, there are clear evidence indicating that disturbed sleep might be among the strongest risk factors for the subsequent development of neurodegenerative diseases. Trabelsi et al., 2020 [85] investigated the relation between the level of physical activity and sleep in quarantined subjects and concluded that, to maintain health during home confinement, physical-activity promotion and sleep hygiene education and support are strongly warranted.

Therefore, considering the post-COVID-19 symptoms, it would be important to incorporate questions about sleep hygiene and quality into the routine clinical practice [85]. Figueiredo Azeredo et al., 2019 [53] evaluated effects of WBV on quality of the sleep in MSy individuals, in a protocol lasting six weeks, twice a week. The fixed group frequency performed 60 s of intervention (10 s of vibration exposition and 50 s of non-vibration exposition) plus 60 s of non-vibration in each bout; and the varied group frequency performed 60 s of vibration and 60 s of non-vibration in each bout. The WBV exercise was performed by 3 bouts (from 1 to 4 week); 4 bouts (from 5 to 8 week); and 5 bouts (from 9 to 12 week). The total time was 18, 24 and 30 min respectively. Clearly, this study demonstrated that WBV promoted improvements in the quality of the sleep of these individuals. It was concluded that the WBV improved parameters such as waist circumference and HR), improving the sleep quality in MSy subjects. WBVE might be a relevant intervention to improve parameters related to poor quality of sleep (fixed frequency and varied frequency groups) and in the daytime sleepiness in MSy subjects that performed the protocol of varied frequency (from 5 to 16 Hz), as described in the Table 6.

4.8. WBVE and Lungs Capacity Impairment

Lung commitment is found in individuals with COVID-19 and in the post COVID-19 survivors [34]. Braz Junior et al., 2015 [57] and Gloeckl et al., 2017 [86], investigated the effects of the WBV exercise in individuals with COPD. They used VP that generates mechanical vibration. However, each study used a different model of vibrating platform and vibration protocol. The number of sessions ranged from 12 to 24 sessions, the time of exposure to vibration ranged from 30 s to 60 s and the frequency used ranged from 24 to 30 Hz and 2 to 5 mm in amplitude. In relation to the total sample, it was composed of 85 individuals. Improvements in different clinical parameters were found in COPD individuals such as on the functional capacity, QoL, neuromuscular performance, cardiorespiratory responses, and muscle components related to exercise capacity [66,74].

Braz Junior et al., 2015 [57] pointed that the WBV may potentially be a safe and feasible way to improve functional capacity in the 6MWT of patients with COPD undergoing a training program on the vibrating platform as well as in all domains of the St. George Respiratory Questionnaire. The protocol was performed in three sessions per week on alternate days with 4 weeks at low intensity and 8 weeks at high intensity. For the first 4 weeks, training was carried out for 10 min, with 30 s of low intensity training (2 mm) interspersed with 60 s of standing rest. For weeks 5–8, training was conducted for 15 min, and from weeks 9–12, training was conducted for 20 min, with 60 s of high intensity training (4 mm) interspersed with 30 s of standing rest in an anatomical position. Gloeckl et al., 2017 [86] verified the effect of four sets of two-minute duration performed three times a week on non-consecutive days. It was considered that the secret behind the positive effect of WBVT on exercise performance in patients with COPD may be related to improvements in neuromuscular performance, as opposed to muscular strength or central cardiovascular adaption. WBV training may be highly beneficial when incorporated into PR programs for COPD patients especially, with impaired balance performance and low exercise capacity. Lage et al., 2019 [87], added that the WBV exercise, at different vibration frequencies, leads to an increase in oxygen consumption, heart rate, and oxygen saturation in subjects with COPD. Six series of 30 s with 60 s of rest interval between each series over four weeks was investigated. Furthermore, WBV exercise in COPD patients has been a safe exercise at all frequencies and types of squats, without causing dyspnea and fatigue (Table 7).

4.9. WBVE and Mental Conditions

It is pointed out that the COVID-19 infection can, directly or indirectly, influence the central nervous system, potentially causing neurological diseases. In consequence, chronic COVID-19-related disease processes have the potential to cause serious and undesirable mental illnesses, including depression, anxiety, and sleep disorders [88]. Moreover, it has been reported that patients with COVID-19 experienced high levels of anxiety, depression, and stress, and the result of a randomized trial highlights the effectiveness of cognitive behavioral therapy (CBT) in improving the psychological health among patients with COVID-19 [89]. WBV exercise seems to improve parameters related to the cognition. Amonette et al., 2015 [90]; Regterschot et al., 2014 [91]; and den Heijer et al., 2014 [92] investigated the effects of whole-body vibration exercise on neurocognition in healthy subjects, Lam et al., 2018 [93] in mild or moderate dementia and Kim & Lee, 2018 [56] in women with senile dementia, Fuermaier et al., 2014 [94,95] study in attention-deficit/hyperactivity disorder (ADHD) individuals and Fereydounnia et al., 2020 [54] in women with lumbar hyper-lordosis. These authors performed their experiments using different mechanisms (vibration vertical and alternating vibration) and different models of the vibrating platform. The time of exposure to vibration varied from 30 s to 2 min and the frequency used from 30 Hz and 2 to 5 mm in amplitude. In relation to the total sample, it was composed of individuals of both sexes and different conditions, and the protocol of vibration variety the acute to accumulative effects.

Amonette et al., 2015 [90], studied a protocol of WBV exercise in 4 different days, with 3–14 days between test sessions, where the subjects completed five sets of 2-min repetitions of static squats in each exercise session. It was concluded that a single bout of static squats with of knee flexion while undergoing WBV exercise at 30 Hz with 4 mm of vertical displacement does not cause a significant decrease in neurocognition, does not affect visual or verbal memory, reaction time or impulse control measured using ImPACT, but motor processing and speed can be increased after VV. It is likely that the head accelerations resulting from this protocol are insufficient to cause acute injury.

Regterschot et al., 2014 [91] investigated the effects of 12 sessions, with each session (passive WBV or control) lasted two minutes, and a rest period of three minutes while sitting on the WBV chair (without vibration). It was showed that two minutes passive WBV has positive acute effects on attention and inhibition in young adults, notwithstanding their high cognitive functioning which could have hampered improvement.

Lam et al., 2018 [93] concluded that the WBV training is feasible and safe to use with people with mild or moderate dementia. However, it did not lead to further improvement in physical function and quality of life than the usual activity program provided at the daycare centers, in a protocol performed 9 weeks (18 sessions), 2 days per week.

Kim & Lee, 2018 [81], pointed out that the WBV can be used in the improvement of the quality of life of subjects with senile dementia showing enhancement in EEG activation and cognitive function through the responses of the neuromuscular system. The improvement would be obtained by stimulating of muscle spindles and sensory organs through the mechanical vibration without additional burden of physical activity. The protocol was performed with WBV exercise during five times a week for eight weeks, whole body stretching was done mildly, as warm-up and warm-down exercise.

Den Heijer et al., 2014 [92], reported that 3-min of WBV presented reduction on inhibition in healthy children. The experiment itself consisted of six trials. Each trial started with a three-minute period which was either (A) a period of WBV (vibration condition), or (B) a resting period of no vibration (non-vibration condition). The repeated application (three times) of WBV presented improvements on cognition. WBV have been correlated with higher intelligence and younger age, but not related to ADHD symptoms. Fuermaier et al., 2014 [94,95] described a protocol of WBV using 30 Hz (frequency) and 4 mm (vibrating amplitude) in healthy and ADHD individuals. It was pointed out that the WBV improved cognitive performance of healthy and ADHD subjects. WBV can be considered as a type of exercise cheap and easy to be applied. Then, it might be a useful in the clinical practice. Additionally, it was found that the WBV was shown to considerably improve neuropsychological test performance of an adult with ADHD, it remains unknown how long these effects last and to what extent the improvements as measured in neuropsychological tests can be generalized to functioning in daily life (e.g., academic or occupational setting). Improvements in the performance of neuropsychological test after WBV intervention indicate the clinical relevance of this kind of exercise in the management of individuals with neuropsychological commitments, as the ADHD.

Fereydounnia et al., 2020 [54] investigated the effect of WBV in one session with five sets of 1-min vibration and 30 s of rest between each set and concluded that the WBV has the potential to enhance neurocognition. WBV had positive immediate effects on the reaction time in both groups; however, it had negative effects on anticipatory skill with high speed in women with normal lumbar lordosis; these negative effects appeared to be due to mental fatigue in the participants (Table 8).

It is important to take care with the use of WBV exercise in COVID-19 survivors due to the increased thromboembolic risk in these individuals. Thromboembolic risk in COVID-19 survivors is a possible and severe complication. Klok et al. 2020 [96] described a 27% occurrence of venous thromboembolism critically COVID-19 subjects in the ICU. Of these, 81% evolved to an acute pulmonary embolism despite thromboprophylactic medication. Acute thrombosis is a contraindication for WBV and therefore caution is needed and the use of WBV in COVID-19 survivors requires careful evaluation by interdisciplinary teams, pondering the risk–benefit ratios of this intervention.

It is well-known that COVID-19 leads to the commitment of the human health due to injuries in the respiratory tract and central nervous and musculoskeletal systems [3,4], among other specific organs and tissues. Some symptoms observed in the COVID-19 patients are fatigue [97], muscle pain [98], sleep disorders [99,100], and respiratory symptoms [101], these symptoms being also present in individuals with different diseases, such as metabolic syndrome [49,53,73,79], knee osteoarthritis [63,64], and COPD patients [57,80,86,87] which have profited by the management with WBV exercise.

WBV exercise has been described as a potential intervention/training modality in sport, exercise, health, and rehabilitation. Muscle force and power increase for athletes, the aged, and those with diseases due to WBV exercise are reported. The action mechanism involved in WBV exercise response would be explained through neural factors as tonic vibration reflex, in which the muscle spindle plays a role in activating the muscle. Moreover, effects of the WBV exercise in the central nervous system could lead to neuroendocrinological responses that could justify the effect of this kind of exercise intervention at various organs [102,103]. These effects would justify the use of WBV exercise in COVID-19 survivors.

Although, there are limitations, this narrative review is based on the best available knowledge of the effects of WBV exercise in several clinical contexts that might be extrapolated to post COVID-19 subjects. However, it is relevant to consider that this study is a theoretical approach and lacks validation in the context of COVID-19. The potential prescription and employment of WBV in selected COVID-19 patients will require careful evaluation by multidisciplinary teams, asked to carefully evaluate the risk–benefit ratios, monitor the efficacy of WBV exercise, and tailor the personalized protocols to the clinical conditions of everyone.

The strength and future applications of the WBV exercise in COVID-19 survivors are related to the effects of this kind of exercise in different populations that have similar impairments to the COVID-19 survivors. Then, it is possible to suggest some specific practical applications of WBV exercise for the improvement of post COVID-19 rehabilitation and QoL. Furthermore, Fernández-Lázaro, 2020, [104] reported that physical exercise training exerts immunomodulatory effects, and the current study is suggesting a type of exercise (WBV exercise) to management of COVID-19 survivors.

5. Conclusions

It is possible to conclude that WBV exercise would be useful to the management of different some symptoms, such as fatigue, neurological manifestations, pain, a reduced QoL and quality of sleep, lung capacity impairment, and mental conditions of COVID-19 patients. On addition, the use of WBV is a complementary alternative allowing COVID-19 patients to increase the work panel optimizing the weekly monotony.

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