

## Safety and application of the vibratory platform in hospitalized patients: a systematic review

### Segurança e aplicação da plataforma vibratória em pacientes hospitalizados: uma revisão sistemática

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**ABSTRACT | INTRODUCTION:** A short period of hospitalization, if accompanied by immobility, may be able to promote a decline in musculoskeletal functions, generating a negative impact on functionality and quality of life. As a result, the adoption of therapeutic strategies such as the use of the vibrating platform (PV) has become increasingly common. **OBJECTIVE:** To systematize evidence on the functionality and safety of the application of PV in hospitalized adult patients. **METHODS:** Systematic review, registered at PROSPERO with code CRD42019119672. Developed in the bases: LILACS, SciELO, MedLine / PubMed, EBSCOhost and PEDro. Keywords and keywords: "Whole body vibration", "Intensive Care Units", "hospitalization", "muscle strength", and "functional capacity". Included studies that analyzed the effects and safety of the application of PV in hospitalized adult patients. Methodological quality was assessed using the Downs and Black scale. **RESULTS:** Included 2 studies, a randomized clinical trial and another controlled intervention study. The sample varied between 24 and 40 subjects, of both sexes, mean age  $52 \pm 4$  years, with a diagnosis of COPD and varied conditions. There was an improvement in the distance covered in the six-minute walk test and a decrease in the time of the sit and stand test, an increase in irisin levels and an improvement in quality of life, in relation to the vital signs parameters, there was no significant change. The methodological score was on average 16. **CONCLUSION:** The results indicate that PV seems to be viable and safe, and may have favorable effects on functionality for treatment in hospitalized adult patients, being an alternative for early rehabilitation.

**KEYWORDS:** Intensive Care Units. Hospitalization. Muscle strength.

**RESUMO | INTRODUÇÃO:** Um curto período de hospitalização, se acompanhado de imobilidade, pode ser capaz de promover declínio das funções musculoesqueléticas, gerando impacto negativo na funcionalidade e qualidade de vida. Com isso, tem-se tornado cada vez mais comum a adoção de estratégias terapêuticas como o uso da plataforma vibratória (PV). **OBJETIVO:** Sistematizar evidências sobre a funcionalidade e a segurança da aplicação da PV em pacientes adultos hospitalizados. **MÉTODOS:** Revisão sistemática, registrada na PROSPERO com código CRD42019119672. Desenvolvida nas bases: LILACS, SciELO, MedLine/PubMed, EBSCOhost e PEDro. Descritores e palavras-chave: "Whole body vibration", "Intensive Care Units", "hospitalization", "muscle strength", e "functional capacity". Incluídos estudos que analisaram os efeitos e a segurança da aplicação da PV em pacientes adultos hospitalizados. A qualidade metodológica foi avaliada através da escala *Downs and Black*. **RESULTADOS:** Incluídos 2 estudos, um ensaio clínico randomizado e outro estudo de intervenção controlado. A amostra variou entre 24 e 40 sujeitos, de ambos os sexos, média de idade  $52 \pm 4$  anos, com diagnóstico de DPOC e condições variadas. Houve uma melhora na distância percorrida no teste de caminhada de seis minutos e diminuição no tempo do teste de sentar e levantar, aumento dos níveis de irisina e melhora na qualidade de vida, em relação aos parâmetros dos sinais vitais não teve alterações significativas. O escore metodológico foi em média 16. **CONCLUSÃO:** Os resultados indicam que a PV parece ser viável e segura, podendo trazer efeitos favoráveis na funcionalidade para o tratamento em pacientes adultos hospitalizados, sendo uma alternativa para a reabilitação de forma precoce.

**PALAVRAS-CHAVE:** Unidade de Terapia Intensiva. Hospitalização. Força muscular.

## Introduction

In the hospital environment, the assistance provided by rehabilitation professionals aims to recover and / or preserve clinical and functional conditions, as well as to restore the autonomy capacity for basic and instrumental daily activities of patients as close as possible to their state prior to hospitalization<sup>1</sup>. According to the North American Nursing Diagnosis Association, immobility is a notable factor of functional limitations in the hospitalized individual, being characterized as a state of movement restriction<sup>2</sup>.

This prolonged immobility promotes deleterious effects on the musculoskeletal system through several mechanisms that increase proteolysis and reduce muscle trophism<sup>3</sup>. In addition, it has been shown that even a short period of hospitalization, if accompanied by akinesia, may be able to promote a decline in the power of the limbs, generating a negative impact on functionality<sup>4</sup>.

The persistence and severity of muscle weakness also generate aggravating factors, a higher rate of morbidity and mortality, in addition to increased costs related to health care<sup>5</sup>. However, there are strategies to combat this inactivity, such as early mobilization. This practice can reduce unfavorable adaptations and complications generated by hypomobility in the bed, thus optimizing the motor condition of those who are exposed to mobility work<sup>6</sup>.

There are several mobilization strategies by which it is possible to maintain, minimize and / or increase functional capacity. Among them, we can highlight the patient's removal from the bed through controlled walks; seated in armchairs; use of neuromuscular exercises; functional electrostimulation; use of orthostatic board, cycle ergometer among others<sup>7-11</sup>. However, the choice of appropriate therapy depends on factors such as the level of collaboration, clinical condition and hemodynamics of the subject, in addition to the availability of resources from the unit in question<sup>12</sup>.

In addition to the proposed mobilization therapies, it has become increasingly common to use the vibrating platform (VP) as an alternative tool to combat hypokinesia, since its application produces sinusoidal oscillations that promote neuromuscular activation<sup>13</sup>. Therefore, it has been shown that exposure to forces applied to tendons and muscles through VP, tends to improve muscle performance<sup>14</sup>. VP for effectively stimulating the neuromuscular system of individuals is responsible for improving cardiorespiratory capacity and muscle strength<sup>15</sup>. In critically ill patients, this strategy stimulates muscles and improves muscle metabolism, so it may have the potential to prevent and / or treat muscle weakness<sup>16</sup>.

Despite the previously reported benefits of applying VP in other outcomes in different populations, its applicability in the hospital environment as a therapeutic potential to prevent the worsening of deleterious effects during hospitalization is not well defined. Thus, the present research aimed to assess the effects on functionality and the safety of the application of the vibrating platform in hospitalized adult patients.

## Methods

### Outline

It is a systematic review, designed based on the criteria established by the guideline Preferred Reporting Items for Systematic Reviews and Meta-Analyses - PRISMA<sup>17</sup>, to answer the research question based on the PICO strategy (Population, Intervention, Comparison, Outcomes) : in adult hospitalized patients is the use of the vibrating platform safe and / or does it add functionality benefits when compared to a control intervention? The protocol for this review is registered in the database for the systematic review study PROSPERO, under registration CRD42019119672.

## Eligibility criteria

Original intervention articles were included, which compared VP groups versus control groups, which analyzed the effects or the safety of a physiotherapy program with VP in hospitalized adult patients ( $\geq 18$  years), of both sexes. There were no restrictions on the time of publication of the studies or the language.

## Non-inclusion criteria

Studies with patients in an outpatient setting, or, rehabilitation centers, study protocols, studies not indexed in the databases, in addition to pilot studies.

## Search strategy

Searches for potential studies were carried out between August and December 2018 by two independent reviewers, and if there were any differences, a third reviewer would be requested. A new search was carried out in August 2020 for possible updates of new studies. During this period, the LILACS, SciELO, MedLine / PubMed, EBSCOhost and PEDro databases were consulted. The studies were screened using the descriptors and keywords: " Whole body vibration ", " Intensive Care Units ", " hospitalization ", " muscle strength ", and " functional capacity ". The term "Whole body vibration" and "Functional Capacity" because they are not indexed in the Health Sciences Descriptors (HSD), were defined after consultation with a specialist in the area, thus several crossing strategies were carried out, as detailed in Chart 1, to avoid losing studies in the area. The Boolean operators AND and OR were used for crossing strategies.

## Selection of studies

The screening process for the articles took place initially by reading the titles and abstracts. Then, studies that did not meet the eligibility criteria were excluded. Thus, the scientific works that met the established criteria were recovered for reading the text in full, a new assessment as to the eligibility and extraction of the outcomes of interest in this systematic review.

Chart 1. Crossings performed according to the selected databases

DATA BASE	"CROSSINGS"
LILACS, SciELO, EBSCOhost	"Whole Body Vibration" AND "Hospitalization"
	"Whole Body Vibration" AND "Intensive Care Units"
	"Whole Body Vibration" AND "Muscle Strength" OR "Functional Capacity" AND "Hospitalization"
Pubmed / MEDLINE	"Whole Body Vibration" AND "Hospitalization"
	"Whole Body Vibration" AND "Intensive Care Units"
	"Whole Body Vibration" AND "Muscle Strength" AND "Functional Capacity"
PEDro	"Whole Body Vibration" AND "Hospitalization"
	"Whole Body Vibration" AND "Intensive Care Units"
	"Whole Body Vibration" AND "Muscle Strength"
	"Whole Body Vibration" AND "Functional Capacity"

## Data extraction

The study data were extracted by two reviewers independently and summarized in tables. These data include the study design, the characteristics of the samples and interventions, the control group, the analyzed outcomes and the main results obtained.

## Outcomes of interest

Functionality was analyzed as an improvement in the distance covered in the 6-minute walk test and in the quality of life, in addition to the increase in muscle strength. Safety was assessed according to patients' clinical parameters such as vital signs and the incidence of adverse effects.

## Study quality and risk of bias

For the methodological analysis of the articles that met the inclusion criteria, the Downs and Black scale<sup>18</sup> was used, punctuated in 27 questions that were divided into 5 domains: way of reporting results (10 items), external validity (3 items), internal validity - bias (7 items), confounding factors (6 items) and power of the study (1 item). For each question, score 0 was applied, if the article was not relevant to what is being evaluated, and score 1 when it presented

a positive response to the requirement, except for item 5, which has a maximum score of 2. Item 27 was modified as used in other studies<sup>19,20</sup>, where the score ranging from 0 to 5, becomes 0 to 1, where 0 if the article did not present the sample size calculation, and 1 did.

## Summary of results

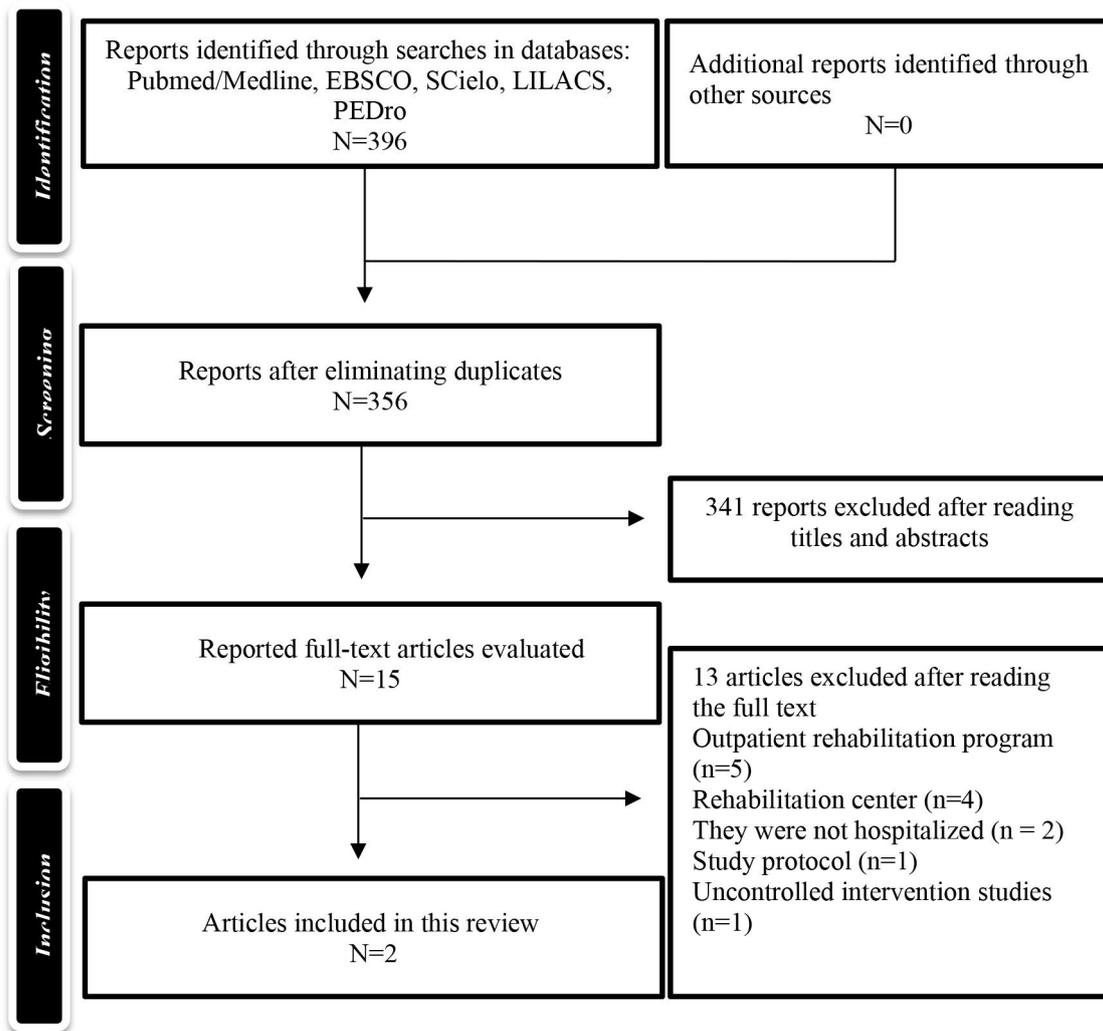
This study does not fit a synthesis with meta-analysis due to the studies found evaluate different outcomes.

## Results

### Selection of studies

396 studies were identified, of which 40 were excluded due to duplication in the databases. After eliminating duplicate studies and exclusions based on the analysis of titles and abstracts, 15 articles were considered eligible to read the full text. Subsequently, 13 articles were excluded for not meeting the eligibility criteria. Thus, only 2 studies<sup>21,22</sup> were included in the present review. The Figure 1 summarizes the process of selecting studies that make up the scope of this systematic review.

Figure 1. Flowchart for sorting and selecting articles



### Methodological Quality Analysis of studies

The studies were evaluated for their methodological quality using the Downs and Black scale criteria divided into 5 domains, used to evaluate both randomized and non-randomized studies. The score could range from 0 to 28, with no minimum score, so the greater the number of items covered by each study, the greater its methodological quality was considered.

The average of the methodological score was of 16 points. The study with the highest score was that of Greulich et al.<sup>21</sup> compared to Boeselt et al.<sup>22</sup>. Among the criteria for assessing methodological quality by Downs and Black, the main limitations were related to the lack of "blinding"; do not clearly describe the eligibility criteria; not reporting adjustments for confounding factors and the low statistical power to be able to detect important effects, since no study did sample size calculation or power, besides the different outcome variables of the study. (Table 1)

**Table 1.** Data on the quality of studies by domain

	Greulich et al <sup>21</sup>	Boeselt et al <sup>22</sup>
	<b>Score</b>	<b>Score</b>
<b>Report results</b>	11/11	11/11
<b>External validity</b>	2/3	1/3
<b>Bias</b>	6/7	4/7
<b>Selection bias</b>	3/6	0/6
<b>Power</b>	0/1	0/1
Total score Downs and Black		
	19/28	13/28

1. Objective / hypothesis of study; 2. Main outcomes to be assessed in the introduction or methods; 3. Characteristics of the patients included eligibility criteria; 4. Interventions of interest described; 5. Distribution of the confounding factors of each group; 6. Main findings of the studies described; 7. Estimates of random variability in the data of the main findings; 8. Adverse effects reported; 9. Characteristics of lost patients described; 10. Confidence intervals or p values for the main findings; 11. Subjects called to participate were representative of the population; 12. Subjects prepared to participate were representative of the population; 13. Teams, places and facilities representative of the treatment that most patients receive; 14. Blinding patients to the type of intervention they received; 15. Blinding of outcome measures; 16. Exploratory analysis; 17. Same follow-up time; 18. Adequate statistical tests; 19. Adherence to the intervention; 20. Outcome measures validated and reliable; 21. Patients in different intervention groups were recruited from the same population; 22. Patients in different intervention groups were recruited in the same period of time; 23. Study subjects randomized to intervention groups; 24. Randomized intervention was hidden from patients and staff; 25. Adequate adjustment of confounding factors in the analyzes; 26. Patient losses taken into account in the analysis and 27. Power to detect clinical important effects.

Table 2. Design of the selected studies

AUTHOR / YEAR	OBJECTIVE	KIND OF STUDY	N SAMPLE		POPULATION		OUTPUTS	VARIABLES	INTERVENTION PROTOCOL	RESULTS
			IG	CG	IG	CG				
Greulich et al, 2014 <sup>21</sup>	To analyze whether VP added to conventional physiotherapy in hospitalized and exacerbated COPD patients would be safe and improve functional capacity and quality of life.	Randomized clinical trial	20	20	14 females with an average age of 66.4 years, 1 patient in stage 2 of COPD, 11 patients in stage 3 and 8 patients in stage 4. Average hospitalization time of 8.63 days.	12 females with an average age of 70.4 years, 1 patient in stage 1 of COPD, 4 patients in stage 2, 7 patients in stage 3 and 7 patients in stage 4. Average hospitalization time of 8.58 days.	Lung function: (FEV1); 6MWT and TSL; SGRQ questionnaire; COPD assessment test; PGC1- $\alpha$ and Irisina; Safety.	CG: 5 min mobilization to the bedside and standing; 5 min passive muscle movements; 10 min of breathing exercises IG: 5 min of mobilization to the bedside and orthostatism; 5 min of passive muscle movements; 10 min of breathing exercises; 3x2 min / day in PV.	$\uparrow$ FEV1 in both groups; $\downarrow$ in the time of TSL in the IG (19.19 $\pm$ 7.43 seconds to 17.02 $\pm$ 7.04 seconds); $\uparrow$ in the distance covered in the 6MWT in the IG (167.9 $\pm$ 117.46 m for 263.45 $\pm$ 124.13); $\uparrow$ in the SGRQ questionnaire in the activity domain for the IG; $\square$ for the COPD assessment test between groups; $\uparrow$ in PGC1- $\alpha$ levels for IG (460.02 $\pm$ 262.28 ng / ml for 529.26 $\pm$ 260.76 ng / ml); $\uparrow$ irisine levels for IG; (785.96 $\pm$ 423.93 ng / ml) at 1195.85 $\pm$ 875.7 ng / ml); in the safety outcome for VP, no adverse events were observed.	
Boeselt et al, 2016 <sup>22</sup>	To determine the safety of whole body vibration for patients admitted to an ICU with a RASS of -1 and 0.	Intervention study	12	12	7 female patients with an average age of 41.8 years admitted to a pulmonary and cardiac ICU with an average length of stay of 15 days.	12 healthy male volunteers with an average age of 31.3 years.	Heart rate (HR); SaO <sub>2</sub> ; BP; EMG of the quadriceps femoris (vastus lateralis) Safety.	Treatment performed in two stages, first stage: Patient in supine position undergoes training with VP for 3 min on the 25° inclined bed. Second stage: Performing the VP with dumbbells.	Heart rate there was a slight $\uparrow$ in the IG in the first part of the training; BP there was a slight transitory $\uparrow$ for the IG in the second part of the training; $\square$ SaO <sub>2</sub> for both groups; EMG showed $\uparrow$ of the electrical activity of the quadriceps femoris during VP in control subjects; in the outcome, safety for VP did not observe any damage to the patient.	

VP: Vibratory Platform, CG: Control group, IG: Intervention group, COPD: Chronic obstructive pulmonary disease, FEV1: Final expiratory volume in the first second, 6MWT: Six-minute walk test, TSL: Sit and stand test 5 times, SGRQ: Saint Georges Quality of Life Questionnaire,  $\uparrow$ : Increase,  $\downarrow$ : Decrease,  $\square$ : There was no significant difference, ICU: Intensive Care Unit, RASS: Richmond agitation and sedation scale, HR: Heart rate, SaO<sub>2</sub>: Peripheral oxygen saturation, BP: Blood pressure, EMG: Electromyography.

## Study characteristics

The general characteristics are summarized in Table 2, such as the methodological procedures and the main results. Regarding the methodology, both studies were controlled, with 1 being a clinical trial and the other a non-randomized intervention study. The sample size varied between 24 to 40 patients, totaling 64 individuals, of both sexes, with a mean age of 52.4 years. Both evaluated the use of VP as to safety issues, varying in terms of viability analysis (varied diagnoses), and functional capacity and quality of life (diagnosis of COPD).

Regarding the safety outcome, the incidence of adverse effects was not observed, in addition to not showing any significant changes in the clinical parameters represented by the vital signs of individuals submitted to the application of VP. As for the functionality aspect, an increase in the distance covered in the 6-minute walk test (6MWT) was observed -  $167.9 \pm 117.46$  m to  $263.45 \pm 124.13$  - and a decrease in time in the sit and stand test. stand up (TSL) -  $19.19 \pm 7.43$  seconds to  $17.02 \pm 7.04$  seconds -, in addition to the increased levels of irisin in the intervention group that underwent VP. There was also a positive correlation of quality of life observed in the Saint Georges questionnaire (SGRQ). The exposure sessions at VP were with an average time of 4.5 minutes. Table 3 shows the parameters used in each study. These characteristics differed in terms of exposure time.

**Table 3.** Characteristics of the vibrating platform in the studies analyzed

	Greulich et al, 2014 <sup>21</sup>	Boeselt et al, 2016 <sup>22</sup>
<b>Model</b>	GalileoTM	GalileoTM
<b>Frequency (Hz)</b>	26 Hz	24 Hz
<b>Exposure time</b>	3x2 min	4 min

## Discussion

It was possible to observe that VP seems to be safe and promote an improvement in functionality in adult hospitalized patients, since the incidence of adverse effects was not observed, in addition to also not showing significant changes in vital signs. In addition, there was an improvement in distance walked during the 6MWT and decrease the time in the SRT, increased serum levels of irisin muscle activity markers and one improvement in quality of life. It is important to note that to achieve the proposed functional objectives, must overcome the challenge of choosing strategies representing a minimum stress cardiorespiratory and neuromuscular without exceeding the physiological limits for this population. This is a major challenge in daily practice in the hospital area, as patients are often stereotyped and underdoses of exercise are carried out without programming a defined goal<sup>23,24</sup>.

Several studies with VP have already shown to be beneficial in outcomes and varied populations such as increased muscle strength, balance, functional capacity, maintenance of bone mass and in the elderly, patients with COPD, Multiple Sclerosis and Stroke , although in the hospital environment there are terms few studies were found<sup>25-29</sup>.

Thus, when thinking about the safety of these and any other patient, vital signs are important indicators of therapeutic tolerance<sup>30</sup>. Marker such as heart rate (HR); blood pressure (BP) and peripheral oxygen saturation (SpO2), must not exceed limits established in the safety criteria<sup>31</sup>.

A classic guideline published in 2007 by Stiller, about the safety of mobilization of critical patients, suggests maintaining the HR 50 to 60% of its maximum predicted value during the mobilization<sup>31</sup>. Both rises above this percentage falls as the HR after the start of any activity, can evidence the physical mismatch for the intensity or the type of exercise employee<sup>32</sup>.

In the work of Boeselt et. al.<sup>22</sup> evaluated in that article, HR averages were found in values extremely close to those suggested by Stiller, both in the group that performed VP alone, and in the group that performed VP associated with the use of dumbbells. It is known that several factors may contribute to a higher baseline and instability HR in critically ill patients, so their behavior should be taken into account along with other aspects by the therapist at the time of the approach<sup>29,33,34</sup>.

Regarding the other vital signs, it was only possible to observe oscillations in SpO<sub>2</sub> and diastolic blood pressure in the group of critically ill patients, who were submitted to the use of VP with dumbbells. Although present, these changes never exceeded the criteria defined by Stiller, who points to falls in SpO<sub>2</sub> > 4% or changes in BP > 20% as worrisome<sup>31</sup>.

Therefore, in the study by Boeselt et al.<sup>22</sup> none of the evaluated vital signs showed undesirable behavior; however, these responses regarded as satisfactory, could be justified by stimulation motor lower than necessary. To counter this theory, one electromyography was performed on one of the volunteers, under the same conditions of VP, clearly demonstrating the increased activity of the quadriceps muscle. This proof could in this case, ratify the execution and effectiveness of the technique in question, without prejudice to HR, PA and SpO<sub>2</sub>.

The second work examined by our study was that of Greulich and collaborators<sup>21</sup>. In this case, it was possible to conclude that hospitalized patients with exacerbated COPD benefited from a physical therapy program combined with the use of PV. Both safety and clinical optimizations were highlighted positively. The improved physical performance seen in the 6MWT and the SRT, may be justified p or

adaptations neuromorphological caused by VP. The vibration promotes m synchronization of motor units, optimization of the stretching process and inhibition of the antagonist muscles, which possibly favor the restoration of the functional question<sup>35</sup>.

In agreement with the use of VP, elevations in serum levels of irisina reinforces ram advantages of VP seen in Greulich article<sup>21</sup>. This important cytokine is secreted by the skeletal muscle as a result of its activation and is linked to a series of positive effects on energy metabolism. Therefore, the more associated with the release of irisin, the more effective the exercise in question appears to be<sup>36</sup>.

Lastly, in accordance with the physical and clinical improvement, although the work Greulich<sup>21</sup> could notice a positive correlation of the quality of life observed in the survey of SGRQ and n CAT-score. It was found that patients who underwent VP improved substantially in "activity" domain, reflecting mainly the CAT-score a trend of improvement in quality of life. As in the work by Boeselt<sup>22</sup>, no adverse effects were found related to the use of VP.

When it comes to safety and functionality in hospitalized patients, it is important to highlight that the isolated choice of VP should be enough. Various factors such as intensity, duration, volume, frequency, among others; they are crucial for the success of any therapy related to physical exercise and must be thought of individually, respecting the peculiarities of each patient. However, although it seems to be a viable technique, it should be noted that there is a time for its application and a cost involved, which limits its application in the hospital environment, reinforcing the importance of the techniques currently applied by the therapist.

There are some limitations in this review that must be considered. Firstly, the small number of studies found, in addition to the different types of protocols applied without the necessary detailing of parameters and putting an end to the methodological quality presented by the works.

## Conclusion

We conclude that VP appears to be viable and safe and may have favorable effects on functionality for treatment in hospitalized adult patients, as an alternative strategy for early rehabilitation. However, we still cannot say that such therapy is effective, due to the lack of studies with the VP modality in the hospitalized population. Thus, it is necessary to conduct new clinical trials with better methodological rigor in this population.

## Author contributions

Moura RF and Gomes VA participated in the conception, design, search, interpretation of results and writing of the scientific article. Santos ACN participated in the conception, design and writing of the scientific article. Barbosa RM participated in the design, interpretation of results and writing of the scientific article. Martinez BP of the interpretation of results and writing of the scientific article.

## Competing interests

No financial, legal or political conflicts involving third parties (government, companies and private foundations, etc.) have been declared for any aspect of the submitted work (including, but not limited to, grants and funding, participation in advisory council, study design, preparation of manuscript, statistical analysis, etc.).

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