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Is High-Speed Resistance Training an Efficient and Feasible Exercise Strategy for Frail Nursing Home Residents?



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A B S T R A C T

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High-speed resistance training (HSRT) has been strongly recommended by experts in the field as a possible strategy to manage frailty in older adults; however, investigations to support this hypothesis are still lacking. Frailty is highly prevalent in nursing home residents and understanding if HSRT might contribute to frail patients' care is an urgent issue. Notably, frail older adults who live in long-term institutions commonly present reduced joint flexibility and cognitive resiliency. These characteristics might reduce the efficiency and feasibility of HSRT in frail nursing home residents. In the present, an evidence-based discussion about this topic is offered.

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Reduced physical function is a cardinal component of physical frailty.^{1,2} For a long time, dynapenia, age-associated loss of muscle strength, was mentioned as a major problem and a key mediator between morphological changes on muscle architecture and mobility limitations.^{3,4} It is little wonder that sarcopenia is deemed as the biological substrate of physical frailty.⁵

However, numerous studies have reported that some physical capabilities, such as walking and climbing stairs, are more dependent on muscle power, the capacity to generate strength in a short time interval, than on muscle strength.^{6,7} These findings led experts in the field to recommend high-speed resistance training (HSRT) as a possible exercise therapy to contribute to frailty management.^{8–11} Such recommendations are based on the fact that HSRT involves performing concentric muscle contractions as fast as possible in an attempt to provide maximal neuromuscular stimulation to improve muscle power.^{8–11}

These enhancements in muscle power occur in response to the recruitment of type II muscle fibers, those more associated with force generation and muscle hypertrophy,¹² mediated by the velocity of muscle actions used during HSRT.^{13,14} Notably, this pattern of fiber recruitment is also observed during traditional resistance training (TRT) programs.^{15,16} However, although TRT elicits this scenario by increasing the accumulation of metabolites and muscular tension due to the physiological stress caused by exercise sessions performed at high intensity and/or volume,¹⁷ HSRT is dependent only on the

neuromuscular stimulus,^{13,14} so that improvements in physical performance have been observed even in HSRT programs conducted with low and moderate loads.¹⁸

Numerous trials, systematic reviews, and meta-analyses have noted improvements in the neuromuscular function of robust older adults who performed HSRT programs and frail people who participated in multicomponent exercise programs that included HSRT.^{19–22} However, no reported clinical trials have investigated the effects of HSRT on frailty status in frail older adults. The study of Reid et al.,²³ for example, offered promising results by describing that HSRT improved muscle power in mobility-limited older adults, but extrapolations to frail people need to be done with caution, given that participants were community-dwellers and were mobility-limited according to self-report. Hence, it is still early to generalize the use of this exercise therapy as an instrument for frailty management.

In addition, a recent subgroup analysis of a small randomized clinical trial reported that a TRT program was more effective than HSRT to reverse frailty status and improve neuromuscular parameters in frail older adults who lived in long-term institutions (LTIs).²⁴ In this study, frailty was assessed using a modified frailty phenotype,² and participants performed exercise interventions composed of 4 lower limb resistance exercises twice a week, over 16 weeks.

Results indicated that 10 participants, 5 in each intervention group (62.5%, 45.4%), returned to the prefrail condition, and 2 participants (12.5%, 9.0%), 1 in each intervention group, returned to robust condition after TRT and HSRT, respectively. Weight loss, sedentary behavior, and physical exhaustion were improved after resistance training programs. According to the authors, reduced joint flexibility and the inability to sustain attention over a long period might have affected the capacity of frail older adults to adequately perform HSRT.²⁴

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Hence, as both reduced joint flexibility and cognitive resiliency are common characteristics of frail nursing home residents, the effectiveness and feasibility of HSRT in this population becomes questionable.

Case

It would be possible to mention many cases that we have observed during our projects and daily in clinical practice. Nevertheless, we believe that the following case genuinely represents the focus of the present discussion. Mr. Oliveira is a 78-year-old male stroke survivor with physical frailty, sarcopenia, hypertension, cognitive impairment, and previous history of alcohol abuse. Psychological evaluation indicates the presence of depressive symptoms and problems with anger management. He constantly complains of loneliness. Mr. Oliveira has been living in the LTI for 2 years since his younger brother died. In a common day, he wakes up at approximately 6:30 to 7:00 AM, is monitored by nurses, has breakfast, and remains in the garden listening to the radio or watching TV until lunch time. After eating, he frequently performs the same activities. He attends to the rehabilitation unit to receive analgesia and massages according to his self-will. He can consume all the foods proposed by the nutritionist, although he is partially toothless and identified with poor oral health.

Mr. Oliveira participated in a small randomized clinical trial that compared the effects of TRT and HSRT programs on frailty status.²⁴ He performed HSRT sessions twice a week over 12 weeks. Sessions were composed of 4 exercises for lower limbs: (1) squat on the chair, (2) seated unilateral hip flexion, (3) seated unilateral knee extension, and (4) bilateral calf raise, which were performed 8 times (sets) with 3 to 5 repetitions at moderate intensity. Before starting the exercise protocol, Mr. Oliveira was adapted to the exercise protocol for 4 weeks. He showed high adherence to exercise sessions because he was interested in regaining his physical independence. According to him, this was the main reason why he could not take care of himself.

Two major obstacles were noted during HSRT. First, Mr. Oliveira's acceleration phase during concentric muscle contractions was substantially reduced because of impaired knee and hip range of motion (ROM). Second, he was noticeably unable to keep focused on performing movements at high speed, even if verbal encouragement was provided before each repetition. His inability to pay attention was sometimes evident from the beginning of the exercise sessions. When asked why this occurred, he used to report that it was hard to keep in mind so much information (ie, motor and breath patterns, number of repetitions, and muscle velocity).

Particularly, when compared with other nursing home residents who performed a TRT program,²⁴ Mr. Oliveira showed smaller improvements in physical function.

Have Frail Institutionalized Older Adults Sufficient Flexibility to Adequately Perform HSRT?

The major characteristic of HSRT programs is the execution of concentric contractions as fast as possible.²⁵ This motor pattern is expected to enhance the recruitment of type II muscle fibers,²⁶ those capable of producing force and increasing their size, improving both muscle strength and velocity, and consequently muscle power. However, the velocity of muscle actions is not the unique requisite of HSRT, given that long acceleration phases and short deceleration periods are required to achieve maximum gains in muscle power.^{27–29} This means that patients should be able to accelerate over a great portion of the concentric phase, otherwise only suboptimal training stimuli will be offered.^{27–29}

Notably, numerous studies have noted that exercises performed using small or restricted ROM at the end of the concentric phase

produced significantly lower mean power and velocity than those performed using large ROM.^{28,29} In addition, authors have observed that muscle contractions accelerated up to 60% during exercises performed with constrained ROM, whereas acceleration occurred practically across the entire contraction when no restrictions on ROM were imposed.²⁹ Greater acceleration was accompanied by higher muscular electrical activity.²⁹ This scenario is of particularly concern in frail institutionalized older adults and it is one of the major features that limits the prescription of HSRT to this population.

Low physical activity levels are a common behavior in LTIs,³⁰ and a cardinal characteristic of frail patients.^{1,2} In fact, nursing home residents who need assistance or are totally dependent on help to transfer might remain seated for more than 20 hours.³⁰ During this period, patients are vaguely stimulated, so that, as in the case presented, their most frequent activities include watching TV, talking to friends, or napping.³¹

Such pattern of sedentary behavior is similar to that observed in patients after fractures because muscles persist inactive in shorted positions for long periods, leading to significant loss of sarcomeres in series and increase in the content of connective tissues, contributing to substantial reduction in muscle length and flexibility.^{32–34}

As a consequence, frail institutionalized older adults, as Mr. Oliveira, might experience smaller gains in physical function in response to HSRT because reduced ROM limits the duration of velocity development across muscle contractions, likely generating less power and recruitment of type II muscle fibers.

Have Frail Institutionalized Older Adults Sufficient Cognitive Resiliency to Perform HSRT?

There is no evidence in the literature on the mental workload of HSRT on frail institutionalized older adults. However, researchers have argued that exercise training might stimulate cognitive function by requiring that practitioners remember the number of repetitions, sets, and exercises and for visualizing and recalling body and weight positions.³⁵ Hence, the mental costs of exercise tasks probably increase according to the number and complexity of exercise variables.

These characteristics might be particularly problematic to frail institutionalized older adults due to the high prevalence of cognitive deficits, higher risk of dementia, and poor mental health commonly observed in this population.^{36–40} Moreover, low educational level is frequently noted in people admitted to nursing homes.^{41,42} Of note, a recent pilot study reported that frail institutionalized older adults showed reduced episodic memory after a unique session of HSRT.⁴³

When these data are interpreted in light of our case study, they suggest that HSRT might be a cognitively demanding task to frail nursing home residents, specifically for those untrained. The need to combine the numerous variables and to concentrate in performing movements at high velocities may be the main obstacles. In addition, no studies have used objective measures to assess and compare the velocity of concentric muscle actions during TRT and HSRT in frail people, so that it is not possible to ensure that muscle contractions have been truly accomplished at high velocities.

Implications for Practice and Research

HSRT has been highly recommended by experts in the field as a possible strategy to manage frailty in older adults.^{8–11} However, empirical evidence of the effectiveness of this modality of exercise has been provided only in community-dwelling older adults,^{19–22} despite the few studies that combined HSRT with other exercise modalities.⁴³ Frailty is highly prevalent in LTIs,^{44,45} and some studies have suggested that nursing home residents might be more affected than community-dwellers and hospitalized people.⁴⁵ Then, understanding

whether HSRT can contribute to frailty management in nursing home residents becomes an urgent topic in the care of older adults.

Reduced joint mobility and diminished resiliency to cognitively demanding tasks are common features in frail institutionalized older adults and 2 major obstacles that likely reduce the efficiency and feasibility of HSRT in this population. Data to support this hypothesis are still lacking, although a recent subgroup analysis of a small randomized clinical trial have observed that TRT is a better option to reverse frailty and improve neuromuscular function in comparison with HSRT.²⁴

However, improving muscle power in frail institutionalized older adults is vital to contribute to the management of these patients. Accordingly, HSRT might be included in the exercise routine after patients have performed flexibility programs aimed to improve hip and knee ROM, for example. Such an approach could have cooperated with better gains in neuromuscular function after HSRT by Mr. Oliveira.

Notably, there is no consensus on flexibility programs that might restore or at least improve flexibility in nursing home residents, and it is an important topic that can be addressed in future studies. Another important topic that deserves further attention is the effect of HSRT on mental workload in frail people. Finally, large randomized clinical trials are needed to test the effectiveness and to compare HSRT with other exercise modalities.

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