Speed-power based training in the elderly and its potential for daily movement function enhancement

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Abstract

Resistance exercise is widely recommended strategy to improve functional ability and quality of life of the elderly. Novel resistance exercises approaches, such as flywheel exercise have recently emerged as superior alternatives to traditional methods. Eccentric exercise methods are well documented to elicit different and often the more pronounced effect on physical ability and function of the elderly. By reviewing the relevant scientific literature, we found that only limited studies have investigated the effects of flywheel exercise in the elderly, however, the results are very promising. Thus, more research is desired to explore the effect of flywheel exercise type in elderly individuals.

Key Words: older adults, seniors, strength, power, training.

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With continuous ageing of the world's populations it is important to investigate methods which may facilitate the physical ability and functional capacity of an older individual. One of the most detrimental changes, associated with ageing, is a 1-2% loss of muscle mass per year. This loss is associated with a 1-5% decrease in muscle strength and power,[1] impaired balance,[2] kineasthesia,[3] and consequent decline in the quality of daily functional activities. Thus, preserving muscle mass and muscle activation should be one of the main approaches for maintaining daily function ability and independence in old age. One of the effective methods for prevention of changes caused by aging is resistance training. With appropriate training methods, older people can slow down sarcopenia, increase the cross-sectional area of fast-twitch muscle fibers, improve muscle strength which positively influence daily function ability. Until now, traditional resistance exercise with high-loads (hypertrophy) methods and methods for improving muscle activation have been recommended to counteract negative effects of aging.[4,5] Literature suggests that the ability to produce power declines faster than strength, especially in the proximal muscles of the lower limbs compared to the upper limb.[6] This negatively affects postural control, movement function and increases the risk of falls,[7] which suggests that proper loading of the proximal body parts in the elderly may be very effective. Recent studies have shown that resistance training that includes performing repetitions with maximal velocity results in higher performance gains and greater associations with the physical and functional abilities of the elderly compared to strength training alone.[8]

Previous resistance training studies used different types of loading and equipment: body-weight training,[9] training with elastics,[10] and different weight devices.[11] In general, all training methods have a positive effect on the physical abilities of the elderly. However, exercise training that is designed solely to increase the maximum strength, may not elicit significant improvements in balance or functional abilities. Traditional resistance exercise methods are limited by the load which an individual is capable to overcome in the concentric phase of muscle contraction and because of that they have less potential for developing rapid strength and power. During daily tasks, the elderly are constantly confronted with eccentric contractions, i.e., the muscular contractions during which the active muscle group is lengthening/braking (walking down the stairs, sitting down and getting up, balance maintenance, etc.) The load exerted by the active muscle group during breaking to the

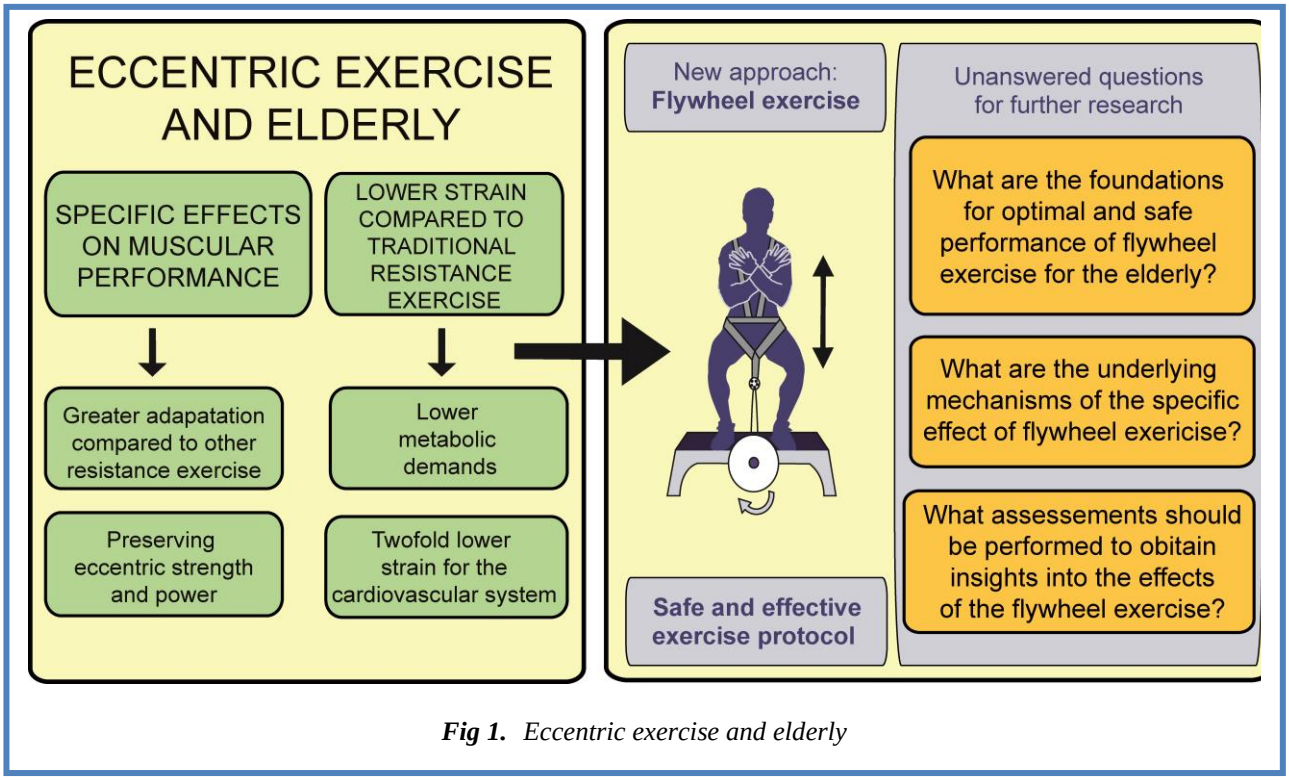

Fig 1. *Eccentric exercise and elderly*

external load represents a different and potentially better stimulus for neuromuscular adaptation in the elderly (Figure 1). Exercise that enables high power development and includes eccentric contraction can be performed on flywheel devices. Flywheel exercise allow for resistance training at different speeds in the concentric and eccentric mode of muscle contraction, therefore it has good potential to affect the daily movement function in the elderly. However, there is a lack of evidence regarding the intensity of flywheel exercise that would allow systematic progression and personalization of exercise protocols for maximizing training effects and considering terms of safety for the elderly population.

Materials and Methods

We systematically reviewed flywheel intervention studies on the elderly population that included both muscle power and at least one index of functional performance as an outcome measure. Several international scientific databases were searched for peer-reviewed articles with the following keywords (and combinations): elderly, flywheel, iso-intertial, eccentric, exercise. The studies were critically reviewed and qualitatively compared.

Results and Discussion

Although the general concept of eccentric exercise is well known, there are still many open questions regarding the implementation of flywheel exercise for the elderly. There are only three studies in the literature that have used flywheel devices to train healthy elderly people. In one study involving 24 older individuals, a group that trained knee extensors for 12 weeks using a flywheel device had better long-term results compared to a group that trained using free weights.[12] In the flywheel exercise group, there was a significant increase in the peak isokinetic power of knee extensors, an increase in the gastrocnemius tendon stiffness, and an improvement in postural balance compared to the other group. Another study reported an increase in knee extensor strength, a decrease in LDL cholesterol, and improved quality of life in the group of elderly who trained on flywheel device, while the group that performed aerobic interval training improved only in terms of aerobic capacity and blood pressure.[13] The only study on the elderly that used an flywheel squatting device reported significant positive effects of flywheel exercise on mobility, power, and balance, although it was compared only with a non-exercise control group.[14] In summary, flywheel studies in healthy elderly people reported similar or greater increases in muscle power. This may confirm flywheel exercise as a potentially superior method to prevent sarcopenia compared to other resistance exercise methods. Moreover, implementation of training that includes eccentric overload improves postural balance of the elderly.[12,15] Two studies, including elderly participants with chronic non-communicable diseases, also verify the potential of flywheel exercise for the elderly (increase in muscle mass, strength and power of the injured side, improvement in postural balance, gait characteristics and daily function).[16,17] Although the number of studies that investigated the effects flywheel training for the elderly is very small, their findings report important muscular, functional and clinical adaptations.

With flywheel training, we can safely achieve heterogenic and economic exercise effects, which in practice prove to be important characteristics of exercise in the elderly. To date studies have not provide answers about appropriate intensity, progression, optimal volume, tempo, and exercise adjustment for the elderly that would maximize the effects of exercise. In one study, the intensity was systematically adjusted and the final result was a 28% increase in the maximum power of the knee extensors.[12] However, the findings of this study are limited to localized effects, since the exercise protocol contained flywheel knee extension in a seated position. In the study where they compared aerobic interval training with flywheel training in the elderly, the authors did not report the intensity of the flywheel training,[13] making the comparison between the studies impossible. In the only study in which the elderly performed squats on flywheel device,[14] the authors reported difficulties in determining exercise intensity. This can explain the absence of muscle adaptations. At the same time, the lack of effects of flywheel exercise on balance was though to be the consequence of short duration of the exercise intervention (6 weeks). Based on the literature, there is a lack of evidence on the field of flywheel exercise loading and its prescprition. More research is needed to provide information on approprate personalization and planning of the training process in order to maximize the effect of the exercise and ensure safety. To date, studies have not provided much insight into the relevant chronic effects of systematic and adapted flywheel exercise for the elderly. Exercise protocols and load intensities within these studies have not been designed in view of scientific evidence and necessary adjustments for the elderly population. Moreover, evidence of underlying exercise mechanisms and measurement procedures for their verification of are largely unexplored. Flywheel training on squatting device imitates daily activities, such as sitting down and getting up, which are crucial for the elderly as they are strongly associated with the mobility and daily function. With appropriate and systematic loading, flywheel exercise may represent a superior stimulus for improvements in proprioception and kinesthetic sense, compared to weight training. All to all, this training modality offers innovative solutions for individualized training progression (load, tempo, postural stability and is more economical for the elderly (parallel strength and balance training). In view of the outlined paucity of evidence, our plan is to obtain a better insight into the potential that this type of resistance training has for changing force-velocity-power profile in elderly. This would complement previously used testing approaches we used in past interventional studies in elderly.[18] Namely, improving velocity dominance in the force-velocity profile seems to have significant functional relevance (balance control, gait initiation, change of direction; and prevention of falls as a result).[19] Results on initial methodological considerations and protocols development will be presented.

List of acronyms

None

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Authors contributions

NŠ and HK contributed to review problem definition and review conception. NŠ, DS and ŽK did the literature search, papers acquisition, selection and information extraction, as well as drafted the paper.

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Conflict of Interest

The authors declare they have no financial, personal, or other conflicts of interest.

Ethical Publication Statement

We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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