# Resistance Exercise and Balance Ability

Subjects: Sport Sciences

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Resistance exercise (RE) could be used to improve balance in older adults. Performing RE alone could be a time-efficient compromise for individuals who are unwilling or unable to perform large volumes of exercise or different exercise modalities.

Keywords: balance ; strength ; resistance exercise

## 1. Introduction

Regular physical activity is known to have numerous immediate and long-term benefits for an individual and the society, spanning from (but not limited to) reduced mortality [1], higher quality of life [2][3][4], increased independence, and reduced risk of falls in older adults [5][6], improved cognitive abilities [7][8], and reduced incidence of several chronic non-communicable diseases [9][10]. A considerable amount of work has been committed to providing the best physical activity guidelines to obtain these benefits [11][12]. Typically, a combination of different exercise modalities (e.g., resistance exercise, aerobic activities, flexibility training, balance exercises) are advised [11][12]. With that in mind, the World Health Organization has been stressing that one in four adults are not active enough to elicit significant health benefits, and up to 80% of the World's adolescent population is insufficiently physically active [13]. Indeed, most recent investigations are showing a very similar picture [14][15].

The literature is abundant with studies that explored the barriers and facilitators of physical activity in different populations [16][17][18], which is helpful to practitioners and researchers for designing interventions and training programs. Due to the unwillingness or poor motivation of many individuals to perform regular high-volume exercise, it is also reasonable to explore which types of exercise have the largest overall effect on health-related outcomes. For instance, resistance exercise (RE) and balance/stability training are both advocated as important components for improving physical function in the elderly [5][6], and both muscle strength and postural control are paramount for athletic performance [19][20] and efficiency and independence in everyday life [21]. If the training of one of these abilities produces a positive effect on the other, it could be put forward as a primary recommendation for individuals who are willing to perform the only limited volume of exercise. In this review, we investigated whether RE training elicits improvements in balance ability. As the sufficient balance/postural control ability is desired for all populations, especially for the elderly in connection to reduce the likelihood of falls [22] and increased independence in activities of daily life [23], it is practically and clinically useful to explore alternative interventions that could improve balance, other than interventions targeting balance and stability directly. Such interventions could promote better overall function and well-being, which is especially crucial for individuals who are not willing to perform a lot of exercise. RE is promoted as one of the most important measures to prevent sarcopenia [24]. If RE is also beneficial for balance in adults, it could also be recommended for them as the primary exercise modality choice when their time is restricted, and it could help prevent (later in life) both sarcopenia [24] and problems, associated with poor balance.

It has been shown that individual physical abilities are positively related. For instance, Wilson et al. [25] have reported that isometric hip strength is positively related to Y-balance test scores in healthy participants. Furthermore, quadriceps strength has been shown to be associated with the limits of stability in young women [26]. However, strength and balance may not be related in older adults [27]. While this observation suggests that multi-component programs could be the optimal approach to improve the health of older adults, it could be more time and cost-efficient to introduce exercise modalities that promote the broadest effects; i.e., one type of training promoting the increase of more than one physical ability. Indeed, it has been suggested that RE may promote an increase in balance ability in addition to increases in strength and power, both in the adult [28][29][30] and older populations [31][32][33][34]. Specifically, moderate to large effects of RE were found for various dynamic balance and mobility tests, such as functional reach test [32][33], timed-up-and-go test [34], and single-leg standing test [33]. These studies have already indicated some important characteristics of RE that need to be considered when the purpose is to improve the balance. For instance, Shiotsu et al. [33] reported improvements in various functional balance tests in older adults after high-intensity (60–70% 1RM) RE, but not after lower intensity (40–50% 1RM) RE. Moreover, Asadi et al. [30] have demonstrated very large effects of plyometric RE on star-excursion balance test scores in adults.

## 2. Discussion

The purpose of this paper was to systematically review the RCT studies that explored the effects of RE on balance ability. We found that studies have consistently shown moderate to large improvements in balance ability following RE in adults and older adults, whereas only one study in children was found. It should also be noted that within the adult subgroup, all studies involved young adults (age 19–23). Nevertheless, these results imply that RE could offer an alternative approach to improve balance in adult and older participants. The secondary aim of this study was to explore the effects of various moderator variables, such as participant characteristics (age, gender, body composition) and intervention characteristics (duration, intensity, volume, type, etc.). Due to the small number of studies with common outcome measures, the appropriate statistical procedures (subgroup analyses or meta-regressions) could not be performed. Therefore, only a limited qualitative discussion is provided later in the discussion regarding the effects of moderator variables.

Previous studies have shown that strength and balance are related [25][26] and that RE may elicit significant improvements in balance ability [27][28][29][31]. This systematic review supports this by providing strong evidence from RCT studies. Therefore, RE could be an optimal choice when various barriers [16][17][18] prevent the individuals to engage in large volumes of exercise. This might be particularly important for older adults because physical exercise is paramount for them to prevent falls and maintain independence [5][6]. The performance of tests included in the meta-analysis (i.e., the functional reach test, single-leg stance, and timed-up-and-go test) are all indicative of the risk of falls [22][35]. The improvements in the balance test were consistent across studies, even though the baseline ability of the participants varied across studies. The consistent moderate or large improvements of scores seen in the present systematic review implies the RE substantially lowers the risk of falls. Indeed, RE has been directly shown to decrease the risk of falls, either as a standalone intervention or as a part of multi-component interventions [5]. Shiotsu et al. [33] reported that the balance ability of older adults (as assessed through functional reach test, single-leg standing, and timed up and go test) was improved after moderate-intensity, but not low-intensity RE intervention. Therefore, moderate- and possibly high-intensity RE is likely superior to low-intensity RE in terms of the effect on balance. Moreover, an abundance of recent studies has shown that speed-power training elicits greater positive effects on the physical ability and function of older adults, compared to traditional strength training [36].

There is more than one possible underlying mechanism for the improvements in balance seen after RE. One of the simplest explanations is that most balance tests require at least some level of strength, which could be particularly evident for older adults. The second explanation could be that RE introduces some level of instability that must be compensated by the body. Previous studies have shown stability-specific strength gains [37] when comparing RE with different levels of instability (e.g., machines as a low instability approach; free weights as high instability approach). However, there were not enough studies in the present review to compare the effects of different RE types on balance ability. Overall, the improvements seemed to be elicited by RE regardless of the instability. Similar tasks-specificity is also present for stability and balance exercises (i.e., the most pronounced exercise effects are observed within the tasks used during training) [38]. Perhaps even more surprisingly, balance training alone has also been reported to elicit significant strength gains in adult [39] and older adult participants [40], and even in the rate of force development [41]. It seems however, that such effect are only seen when participants are untrained, as it was noted that these effects are absent when the balance training is preceded by a period of strength training [41] and that there are is no additional effect of balance training performed concomitantly with RE [42]. The exact underlying mechanism behind the concomitant improvements in strength and balance remains elusive, though previous studies have implicated the involvement of changes in corticospinal excitability [38]. Moreover, it was shown that RE reduces intracortical inhibitory networks within the primary motor cortex (M1) and corticospinal pathway [43] and increases the propagation velocity of action potentials along the muscle fibers [44], which could in turn influence automatic and voluntary muscle actions for maintaining balance.

It should be noted that the interaction between the RE and improvements does not imply that RE should be always used as a preferential mode of exercise. For instance, RE is advised in combination with aerobic exercise in patients with cardiovascular diseases or risk factors [45], and RE must be used with caution in some cases, such as with hypertension patients [45][46]. Moreover, multi-component exercises programs are likely more effective than single-component programs [5][47]. The results of this study only imply that performing RE alone offers a good approach which will likely balance ability. With that in mind, future studies should address the remaining questions, such as the effects of exercise intensity, the type of the load, and the type of muscular contraction on balance ability and possibly other motor abilities in different populations. The specific effects of high-intensity exercise [36] and eccentric exercise [48] on muscular strength and physical function have already been addressed, however, it remains unknown how different forms of RE influence balance and other motor abilities. In light of task-specific adaptations to training [38], it could be speculated that RE under unstable conditions could bring the best of both worlds. These alternative forms of RE were omitted in this review, however, there is some evidence that training on unstable surfaces could induce significant and concomitant improvements in muscle strength, power, and balance in healthy older adults [49]. In summary, the choice of exercise modality should be carefully planned based on the available individual's time, his/her physical status and motivation, while acknowledging both task-specificity of adaptations, as well as expected transfers of training effects to different motor abilities.

The secondary aim of this study was to explore the effects of various moderator variables, such as participant or intervention characteristics. Due to a smaller number of studies, only a limited qualitative discussion is provided here. Most studies included participants of both genders, which suggests that both females and males improved balance ability with RE. Within older adult studies, 2 studies (3 experimental groups) consisted of female participants. There was no clear trend for the effect of gender regarding functional reach test, however, in one of the studies (2 experimental groups) with female participants, there were no improvements in timed-up-and-go tests. One study on older adults included only males and reported the highest increases in star-excursion balance tests among all included studies. However, it should be noted that this study was also very specific in other aspects, such as being the only one to include plyometric exercise [30]. Collectively, our results suggest that both genders improved balance with RE, with a possibility of smaller effects in females.

The participants' age was very consistent in both subgroups; therefore, it is very difficult to even speculate whether the age is an important factor for the observed effects. One study stood out slightly with somewhat older participants (80.0 ± 4.1 years) and showed smaller effects of RT on a single-leg standing test score compared to some other studies conducted with older adults. However, the same study also had a shorter training period (only 3 weeks), which is a more likely explanation for lower effects. In the adult subgroup, most interventions lasted for 6 weeks, except one lasting 4 weeks, therefore, no indication of intervention duration could be deduced.

Because the magnitude of the effects was mostly quite consistent across studies, it is impossible to determine the effects of type of load, exercise intensity and volume, weekly frequency, and targeted muscle groups. As noted, one study of shorter duration (3 weeks) showed lower effects, which indicates that interventions of longer durations should be conducted. A study by Shiotsu et al. [33] implicated that intensity should not be too low, as their group that used lower intensity (40–50% 1RM) improved less in a single-leg standing test than the group that used higher loads (60–70% 1RM). No other indication for the effect of intensity was observed. It could be that, at least in adults, plyometric exercise is more effective compared to strength, power, or strength-endurance exercise modalities. Namely, the study by Asadi et al. [30] reported by far the largest improvements in star excursion balance tests. While we could not statistically compare different interventions, it seems that different RE modalities (free weights, bodyweight exercises, elastic exercise, and resistance machines) are all effective. Moreover, we found evidence for improvements in the balance following RE that was targeted at the full-body, only lower limbs, only trunk, and lower limbs in combination with the trunk, and even for RE targeting a single joint (ankle). Therefore, combining lower limb and trunk RE is likely the best for improvements in balance. Most of the interventions were performed 2–3 times per week, which is in accordance with the current guidelines for RE [11][12]. Collectively, most of the examined studies presented a positive effect of RE on balance ability, regardless of the intervention duration, load type, or other characteristics. At this point, it is impossible to reliably determine the optimal RE training for improving balance.

## 3. Conclusions

This systematic review has shown that RE interventions may significantly improve balance ability in adult and older adult participants. This finding has important practical implications, as RE could be used to improve both muscular strength and power, as well as balance at the same time. Strength training, power training, and strength-endurance training targeting primarily lower limb musculature, with different types of load (bodyweight, elastic, free weight, and resistance machines) were shown to be effective. RE interventions designed for improvements in balance ability should be sufficiently long (4 weeks and more) and be conducted in accordance with general RE. Although multi-component exercise programs should still be prioritized when possible, performing RE alone could be a time-efficient compromise when trying to improve overall physical fitness.

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