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REVIEW ARTICLE OPEN ACCESS

Home-based Resistance Training Health Benefits for Older Adults: An Evidence-Based Approach to Enhancing the Physiological Functions

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Background: Older adults are typically characterized by Frailty, disability, falls, fractures, loss of independency and chronic diseases. Home-based resistance training using body weight, weighted vests and belts, elastic bands, dumbbells or other portable implements can positively influence the physical and physiological capacities of elderly people. Home-based resistance training can maintain lean body mass, which in turn, provides required strength for proper execution of daily tasks. Moreover, elevated resting metabolic rate as a result of increased muscle mass can reduce some of multiple cardiovascular and metabolic risk factors. Further, osteogenic response of mechanical loading may improve bone mineral density and content. This reduces fall-related fractures.

Conclusion: Home-based resistance training as an important part of exercise training provides a valuable opportunity for older adults to increase physical activity and take advantage of exercise benefits for overall health and quality of life. However, more research is needed to provide reliable recommendations.

Keywords: Aging, resistance training, home setting, physical abilities, chronic diseases

Introduction

The declined human physiological capabilities are an inexorable implication of the biological aging process. Deficiencies in the function of cardiovascular, respiratory, metabolic and neuromuscular systems are responsible for decreased functional capacities, as well as fatigue and slow movements that occur with aging. These age-related declines in the capacities of physiological systems not only deteriorate exercise performance, but also causes lesser ability to perform the activities of daily living (1). Aging typically coincides with decrease in muscle mass and increase in fat mass. The decrements in muscle mass are associated with risk of osteoporosis, frequency of falls and fractures. Throughout the entire life span, maintaining a balance between muscle and fat mass is crucial. A decrease in muscle mass may impair the metabolic rate, and increased fat deposition exposes the individual to type II diabetes, hypertension and other cardiovascular and metabolic diseases (2). Thus, the more passed years of life, the greater probability of chronic diseases, putting people at risk of frailty, disability and loss of independence (3).

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Although age, genotype and sex are considered non-modifiable, exercise is the main modifiable elements of physiological function (4). It is well established that resistance training, especially when incorporated into a comprehensive fitness program, can cause positive alterations in muscle morphology and function, resulting in enhanced functional performance within daily living (5-7). Furthermore, resistance training can have favorable health outcomes; positively affects the cardiovascular system, for example, reduces blood pressure and resting heart rate (8-10); reduces risk factors associated with non-insulin-dependent diabetes (11,12); and prevents osteoporosis (13, 14).

However, poor adherence to exercise programs is known a barrier against increasing physical activity among older adults, particularly those who have inactive life style and those who are faced with functional limitations. Substantial number of individuals chooses to exercise out of the group-based setting. Home-based exercise program allow an individual to exercise at his or her personal ambience which surrounded by family, without the need to travel. This help individuals particularly those with limitations in exercise time, facility accessibility and transportation, resulting in decreased barriers of physical activity (15).

Hence, the purpose of this short review is to characterize the health benefits of home-based resistance training among older adults with a preliminary brief discussion about age-related structural and physiologic alterations.

Body composition and anthropometry

The aging process is accompanied by reduced fat-free mass and further deposit in adiposity, while obesity has been demonstrated an underlying cause of disability among older adults (16). Obesity especially central obesity is associated with elevated risk for chronic diseases which are indirectly related to loss of function. It is well recognized that body fat amount and its distribution is a strong predictor of diabetes, hypertension, hyperlipidemia and other cardiovascular diseases (17), and more recently, waist circumference (as a surrogate measure of central obesity) has also been shown to be related to debility among older adults (18). Moreover, comparison between genders has shown that old women tend to possess greater amount of adiposity compared to old men, placing them at higher risk for physical disability (19).

In those older adults who maintain energy balance to manage their body weight, reduced energy intake and nutrients can contribute to nutritional deficiency. This especially hazards most frail older adults. For these individuals, Resistance training can be an effective way to increase energy expenditure, decrease fat mass and maintain lean body mass which is the metabolically active tissue (20, 21). Handfuls of studies have investigated the impacts of home-based resistance training on body composition among older adults. However, it appears to be beneficial for reducing age-related adverse effect on body composition. A long-term study (22) indicated that home-based resistance training maintained lean body mass gains induced by gymnasium-based resistance training in sedentary, overweight men and women with type II diabetes (aged 60-80 years). This positive effect was also confirmed by another study (23). Women with low Bone mineral density took advantage from home-based resistance training using weighted belts, elastic band and dumbbells. They were able to maintain body composition and to reduce age-associated alterations.

Atrophy and weakness of quadriceps femoris muscle is a feature of knee osteoarthritis. Thus, the exercise programs which can strengthen this muscle group is of crucial importance for improving the function and reducing pain and disability. Results from 41 patients with osteoarthritis aged 55 to 75 years demonstrated that supervised home-based resistance training 3 times per week for 6 weeks led to increased (4.3%) quadriceps cross sectional area (24). Further, 12-month resistance training with a combination of supervised gym sessions and home sessions caused an increase (12.2%) in triceps surae cross sectional area (25). Triceps surae contractures are associated with foot and ankle pathology. Achilles tendon contractures have been shown to shift plantar foot pressure from the heel to the forefoot (26), while plantar flexors of elderly men are weaker than young cohort and maximal voluntary contraction torque relative to muscle volume is reduced (25).

Additionally, a research surveying the effects of 12 weeks of non-instrumental resistance training using body weight plus rubber tubing on body composition and fat distribution of healthy elderly men and women showed a significant decrease in waist circumference, preperitoneal fat thickness and thigh fat thickness along with increased thigh muscle thickness. However, body weight, fat mass and fat-free mass did not change after 12 weeks (27).

Bone mineral density

It is widely known that risk for fractures is strongly associated with bone diminution with aging in both of men and women (28). Among men over the age of 70 years, the loss of bone mass occurs 2 to 4 times more rapidly than men under the age of 60 years. Interestingly, the greatest amounts of bone loss (5%) among women happens within first couple of years after menopause and afterward it remains 2 to 3 percent annually, while this is 1 to 2 percent for men (29).

Exercise training has been shown to be essential for maximizing peak bone mass and reducing bone attenuation (30). However, no all types of exercise may result in improved bone mass. In this case, the results related to the impacts of aerobic training on bone mass still remain debatable. Resistance trainings are frequently used to enhance bone mass among elderly people. The mechanical stresses on bone which are provided by resistance trainings has been identified a causal factor of osteogenesis (29).

Several studies (23, 28, 31-33) on the effects of home-based resistance training on bone mineral density (BMD) revealed controversial findings. A 2-years randomized, controlled trial on elderly women in hormone therapy demonstrated that moderate intensity home-based resistance training in upper and lower body resulted in improved BMD. The amounts of improvement in total femoral BMD and trochanter BMD were 1.5% and 2.4% for lower body exercise group and 1.8% and 2.5% for upper body exercise group, respectively. The findings suggest a systemic response rather than site-specific response to moderate intensity resistance training. Collectively, the results of this study showed that moderate intensity home-based resistance training inverted the process of bone diminution and improved the femur BMD (23). Furthermore, a home-base program of squat exercise in conjunction with line dancing and foot stamping exercises reduced lower extremity bone loss in postmenopausal elderly women (33).

On the contrary, no significant improvement in femoral neck and lumbar spine BMD after 12

months of home-based strength training combined with aerobic training and stretching in elderly women with symptomatic osteoporosis-related vertebral fractures (32). Similarly, strength training for lower limb in concert with balance and impact trainings in community-dwelling elderly women had no significant effect on bone mineral density (28). Plus, 30-months supervised home-based impact trainings resulted in non-significant impact on BMD. Nonetheless, positive effects were observed on trochanter bone mineral content (BMC). Further, exercise reduced frequency of fall-related fractures (31).

Functional abilities

Conceptually, physical fitness represents the physical capacities which is required for independently performing basic activities of daily living without early fatigue. Aging process tend to reduce physical fitness factors (strength, endurance, agility and flexibility), and make an elderly individual faced with difficulties in daily tasks and normal functioning (34). However, physiological impairments which are associated with debility and loss of independency are potentially reversible using an accurate exercise intervention (35).

Substantial number of studies have shown dramatic improvements in strength (22, 24, 25, 33, 36-48), balance (33, 35, 41, 43, 47), mobility (40, 46), agility (43, 47), flexibility (47), endurance (43), cardiovascular fitness (37, 47), quality of life (32, 36, 40, 49), and physical abilities (28, 35, 37, 39, 44-46, 48-50) with various home-based resistance training programs.

Overwhelming majority of these studies have focused on strength because its outstanding importance for elderly people. Although reduced strength is not the only factor contributing to declines in physical performance, it remains as one of the most important determinant for maintaining physical abilities. Declined physical abilities increases the chance of nursing home placement. While, elevated strength has been shown to foster spontaneous physical activities in elderly men and women (21).

A 10-week study seeking to elucidate association of lower extremity strengthening and improvements in physical performance and disability demonstrated a significant relationship of strength with mobility skills, gait speed and falls efficacy. Interestingly, the significant impact of strength on chair rise was observed in those who were more impaired (46). The results clearly demonstrate the huge impact of strength on functional abilities among elderly population.

Minimally supervised home-based resistance training in conjunction with balance exercises and general physical activity in 72 community-dwelling men over the age of 70 years were completely safe and resulted in great adherence (97%) and improved physical performance (35). However, short-term predominantly home-based progressive resistance exercise program in people with chronic obstructive pulmonary disease resulted in modest improvement in knee extensors strength and relatively poor adherence. Forty-four percent of participants were not able to complete exercises (42). These findings highlights the necessity of identifying those key factors influencing the of home-based resistance training programs for various population in terms of effectiveness and adherence.

Metabolic and cardiovascular markers

It is well-recognized that older adults are quite susceptible to metabolic abnormalities such as dyslipidemia, and this is most likely due to improper nutrition, inactivity or aging process itself. However, obesity, diabetes and other me-

tabolic diseases contribute to dyslipidemia (51). These risk factors plus hypertension can be in association with some abnormalities in cardiovascular structure and function such as atrial stiffness and impaired endothelial function. Skeletal muscles are known as metabolically active tissue and strong determinant of resting metabolic rate. Thus, it is postulated that resistance training and subsequent increment in muscle mass may reduce multiple cardiovascular and metabolic risk factors (52).

A meta-analyze (53) indicated that resistance training improves lipid profile. Moreover, results of studies supports positive effects of resistance training on glycemic control among elderly patient with type-II diabetes. Here, the question is whether these favorable improve-ments remains when supervised exercise training is withdrawn (22). Besides, over 80 percent of diabetic patients are obese. It has been shown that considerable number of obese individuals is bothered by their appearance, and this can lead to decreased participation in community activity. Therefore, home-based resistance training can be a conscious approach to track and to maintain long-term improvements in purposed markers among older adults (36).

Home-based resistance training using body weight and rubber tubing exercises in non-diabetic older adults improved lipid profile and blood pressure. After 12 weeks of training, an increase in HDL-C, and a decrease in triglyceride, HbA_{1c} and diastolic blood pressure were observed (27). Another short-term training program using 11 resistance exercises at home showed significant improve in HDL-C (60±1 vs 62±1 mg/dl) and triglyceride (115±5 vs 106±4 mg/dl) among older adults. However, no significant change was observed in total cholesterol, plasma glucose, insulin or HbA_{1c} (54).

A six-month gymnasium-based resistance training followed by home-based setting did not change the fasting blood glucose, serum insulin and insulin sensitivity. Further, decreased HbA_{1c} after gymnasium-based training did not properly maintained using home-based training. The authors believe that decreased adherence and exercise volume and intensity can be counted as the suppressive factors against the effectiveness of home-based training for improved glycemic control (22).

Conclusion

Although the numerous benefits of home-based resistance training for improving physical abilities are well-documented, the effectiveness of such setting on body composition, bone mineral density, metabolic profile, and cardiovascular risk factors of older adults needs further research. In most cases, home-based training has been well-tolerated by older adults. While, many of elderly people are restricted in their home and do not access to the exercise facilities. For them, resistance training at home provides fascinating options for making alterations in their life style. Collectively, a properly designed home-based resistance training can serve as a cost-benefit intervention for reducing or even reversing the age-related declines in physiologic functions, improving physical and physiological functions and independency in activities of daily living, reducing fall-related fractures, and ultimately for enhancing the quality of life among older adults

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