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Traditional and pyramidal resistance training systems improve muscle quality and metabolic biomarkers in older women: A randomized crossover study

Alex S. Ribeiro [a,*], Brad J. Schoenfeld [b], Mariana F. Souza [a], Crisieli M. Tomeleri [a], Danielle Venturini [c], Décio S. Barbosa [c], Edilson S. Cyrino [a]

[a] Study and Research Group in Metabolism, Nutrition, and Exercise, Londrina State University, Londrina, Brazil
[b] Exercise Science Department, CUNY Lehman College, Bronx, New York, United States
[c] Department of Pathology, Clinical and Toxicological Analysis, Center of Health Sciences, University Hospital, Londrina State University, Londrina, Brazil

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ABSTRACT

The purpose of this study was to compare the effect of RT performed in a pyramid (PR) and traditional (TD) straight set training system on muscle quality and metabolic biomarkers in older women. Twenty-five physically independent older women (67.6 ± 5.1 years, 65.9 ± 11.1 kg, 154.7 ± 5.8 cm) performed a RT program in TD and PR training systems in a balanced crossover design. Measurements of muscle quality, serum levels of C-reactive protein (CRP), glucose (GLU), total cholesterol, high-density lipoprotein (HDL-C), low-density lipoprotein (LDL-C), and triglycerides (TG) were obtained at different moments. The TD program consisted of 3 sets of 8–12 repetitions maximum (RM) with a constant weight for the 3 sets, whereas the PR training consisted of 3 sets of 12/10/8 RM with incremental weight for each set. The training was performed in 2 phases of 8 weeks each, with a 12-week washout period between phases. Significant ($P < 0.05$) improvements were observed in both groups for muscle quality (TD = +8.6% vs. PR = +6.8%), GLU (TD = −4.5% vs. PR = −1.9%), TG (TD = −18.0% vs. PR = −11.7%), HDL-C (TD = +10.6 vs. PR = +7.8%), LDL-C (TD = −23.3% vs. PR = −21.0%), and CRP (TD = −19.4% vs. PR = −14.3%) with no differences between training systems. These results suggest that RT improves muscle quality and metabolic biomarkers of older women independently of the training system.

1. Introduction

Various morphological alterations are associated with biological aging that ultimately affect health and quality of life in older individuals. Reduction of muscular strength and skeletal muscle mass are two of the most significant changes that occur with aging, and the maintenance of muscle mass and strength is a fundamental component of health, functionality, and quality of life at older ages (Manini and Clark, 2012). The maximal force produced per unit of muscle mass can be defined as muscle quality (Fragala et al., 2015). Such approach may be a more meaningful and sensitive indicator of muscle function than the analysis of muscular strength or muscle mass alone (Fragala et al., 2015).

Aging is also associated with biochemical alterations that increase the risk of developing cardiovascular disease, which is the major cause of morbidity and mortality at older ages (Zaslavsky and Gus, 2002). Among the risk factors, serum blood levels of glucose (GLU) and lipid profile have been shown to have a greater impact on cardiovascular disease risk in women compared to men (Tan et al., 2010). Chronic inflammation has also been implicated as playing a role in cardiovascular disease (Davison and Davis, 2003). To this end, elevations of C-reactive protein (CRP), an inflammation biomarker, may be considered an important independent indicator of mortality for cardiovascular and metabolic diseases (Pai et al., 2004).

Resistance training (RT) is an intervention that has been recommended to counteract the age-related dysfunctions (American College of Sports Medicine, 2009; Garber et al., 2011). In addition to its effects on enhancing muscular strength and muscle mass, RT provides numerous additional benefits to older adults that may directly impact cardiovascular disease risk including positive improvements in GLU tolerance, lipid profile (Conceicao et al., 2013; Kelley and Kelley, 2009; Williams et al., 2011), and a reduction in inflammatory biomarkers (de Salles et al., 2010; Phillips et al., 2012; Stewart et al., 2007).

The principal guidelines to RT prescription (American College of Sports Medicine, 2009; Garber et al., 2011) recommend the use of same loads related to a given repetitions zone, a training system known as traditional or straight set training. Such recommendations

* Corresponding author at: Carmela Dutra Street 862, Jataizinho, PR 86210-000, Brazil.
E-mail address: alex-silvaribeiro@hotmail.com (A.S. Ribeiro).

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are based on abundant evidence about the effectiveness of this training system. However, other training systems have been developed over time by personal trainers, athletes, and practitioners in an attempt to maximize benefits. Among the different RT systems, the pyramid is a very popular training system and frequently used by athletes and non-athletes in order to improve the muscle mass and muscular strength. The pyramid training system is characterized by inverse relationship between the weight lifted and the number of repetitions performed. There are three types of pyramid training system known as ascending pyramid, descending (reverse) pyramid, and triangle pyramid. In the ascending pyramid system, the weight increases while the number of repetitions decreases with each set. On the other hand, in the descending pyramid system the weight decreases while the number of repetitions increases with each set. Finally, the triangle pyramid system is a combination of the two systems previously described (ascending and descending pyramid). It is worth highlighting that the ascending pyramid is the most popular pyramid RT system, probably because many individuals tend to prefer start light to warm up the muscles.

Hypothetically, the alterations in these important variables (weight and number of repetitions) may optimize the metabolic and mechanical stimuli necessary for muscle protein accretion (Schoenfeld, 2010). Additionally, manipulation of volume and intensity can also promote other important metabolic responses, with a positive impact on the lipid profile (Lira et al., 2010; Sheikholeslami Vatani et al., 2011) and in inflammation biomarkers (Calle and Fernandez, 2010), since metabolic and inflammatory changes induced by RT may be dependent on the specific characteristics of the program (Calle and Fernandez, 2010; Lira et al., 2010; Sheikholeslami Vatani et al., 2011). Therefore, the purpose of this study was to compare the effects of RT performed in a pyramid vs. traditional straight set training systems on muscle quality and metabolic biomarkers in older women. We hypothesized that the pyramid training system would provide superior improvements in the outcomes induced by RT.

2. Methods

2.1. Participants

Participant recruitment was carried out through newspaper and radio advertisings, and home delivery of leaflets in the central area and residential neighborhoods. All participants completed health history and physical activity questionnaires and met the following inclusion criteria: 60 years old or more, physically independent, free from cardiac or orthopedic dysfunction, not receiving hormonal replacement therapy, and not performing any regular physical exercise for more than once a week over the six months preceding the beginning of the study. Participants passed a diagnostic, graded exercise stress test with 12-lead electrocardiogram reviewed by a cardiologist and were released with no restrictions for participation in this study. Forty older women were accessed for eligibility. After individual interviews, 11 were dismissed as potential candidates because they did not meet the inclusion criteria for the study. The remaining 29 older women were selected for participation and then randomly divided into one of two groups according to the RT system: a group that performed RT in the traditional straight set training system (TD, n = 14) or a group that performed RT in the pyramid training system (PR, n = 15). A total of 25 participants (67.6 ± 5.1 years, 65.9 ± 11.1 kg, 154.7 ± 5.8 cm, and 27.5 ± 4.5 $kg \cdot m^{-2}$) completed all stages of the experiment, and were included in the analyses. The reasons for withdrawal were reported as lack of time, difficulty of displacement, lack of motivation, and personal reasons. Adherence to the program was satisfactory, with all subjects participating in >85% of the total sessions. Fig. 1 is a schematic representation of participant recruitment and allocation. Written informed consent was obtained from all subjects after a detailed description of study procedures was provided. This investigation was conducted according to the Declaration of Helsinki, and was approved by the local University Ethics Committee.

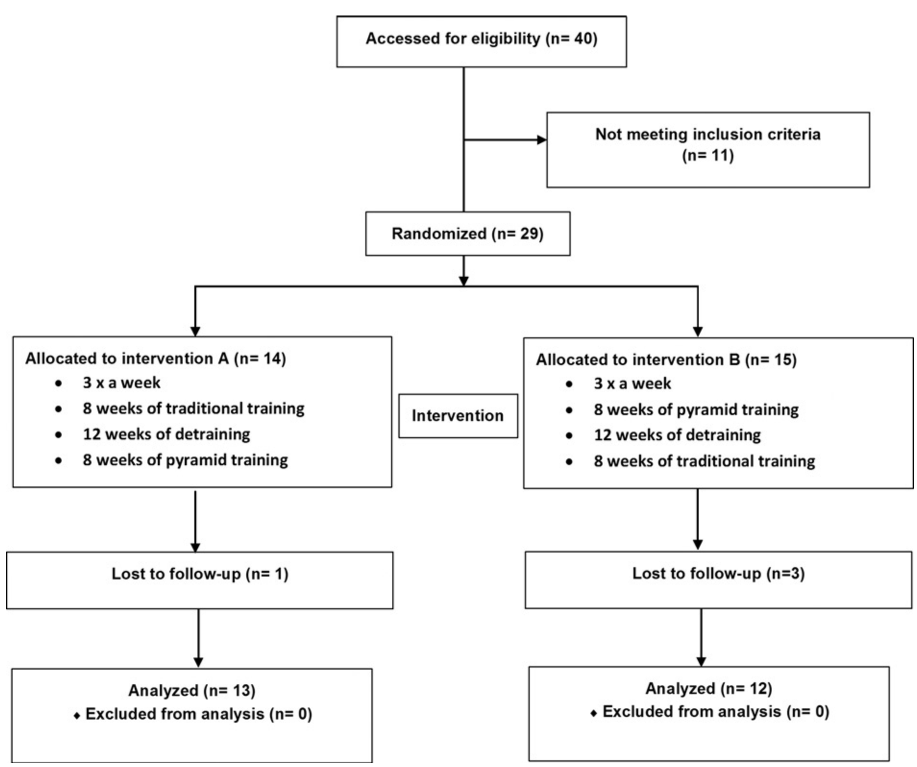

Fig. 1. Schematic representation of participants' recruitment and allocation.