Experimental Gerontology 99 (2017) 80–86

Contents lists available at ScienceDirect

Experimental Gerontology

journal homepage: www.elsevier.com/locate/expgero

Mini review

A minimal dose approach to resistance training for the older adult; the prophylactic for aging

James P. Fisher[a,*], James Steele[a], Paulo Gentil[b], Jürgen Giessing[c], Wayne L. Westcott[d]

[a] Southampton Solent University, East Park Terrace, Southampton, UK
[b] Faculdade de Educação Física e Dança, Universidade Federal de Goias, Goiânia, Brazil
[c] InstitutfürSportwissenschaft, Universität Koblenz-Landau, Germany
[d] Quincy College, Quincy, MA, USA

ARTICLE INFO

Editor: Christiaan Leeuwenburgh

Keywords:
Strength
Health
Longevity
Quality of life
Behaviour
Adherence

ABSTRACT

A plethora of research has supported the numerous health benefits of resistance training as we age, including positive relationships between muscular strength, muscle mass and reduced all-cause mortality. As such, resistance training has been referred to as medicine. However, participation and adherence remains low, with time constraints and perceived difficulty often cited as barriers to resistance training. With this in mind, we aimed to summarise the benefits which might be obtained as a product of a minimal dose approach. In this sense, participation in resistance training might serve as a prophylactic to delay or prevent the onset of biological aging. A short review of studies reporting considerable health benefits resulting from low volume resistance training participation is presented, specifically considering the training time, frequency, intensity of effort, and exercises performed. Research supports the considerable physiological and psychological health benefits from resistance training and suggests that these can be obtained using a minimal dose approach (e.g. ≤ 60 min, 2 d-wk^{-1}), using uncomplicated equipment/methods (e.g. weight stack machines). Our hope is that discussion of these specific recommendations, and provision of an example minimal dose workout, will promote resistance training participation by persons who might otherwise have not engaged. We also encourage medical professionals to use this information to prescribe resistance exercise like a drug whilst having an awareness of the health benefits and uncomplicated methods.

1. Introduction

There is an abundance of evidence highlighting the physiological benefits of resistance training (RT); including decreased gastrointestinal transit time (reducing the risk of colon cancer (Koffler et al., 1992)), increased metabolic rate (Campbell et al., 1994), reduction in low back pain (Bruce-Low et al., 2012), increased bone mineral density (Huovinen et al., 2016), reduced blood pressure (Westcott et al., 2009), and improved muscle quality and insulin sensitivity in persons with type-2 diabetes (Brooks et al., 2007). More so than these specific health benefits, evidence has supported that muscular strength (Newman et al., 2006; Ruiz et al., 2008) and muscle mass (Srikanthan and Karlamangla, 2014) are predictors of longevity and reduction in all-cause mortality. Whilst increased strength and muscle mass are often goals of RT, and justifiably so due to the health benefits of these adaptations, it was recently noted that a primary objective of persons undertaking RT is "*to have a biological age equal to, or lower than, our chronological age*" (Fisher et al., 2014a). This is evidently a realistic objective based on the following studies. Melov et al. (2007) reported that following 6 months of RT participants with an average age of 68 years showed mitochondrial characteristics similar to persons with a mean age of 24 years. Candow et al. (2011) reported that 22 weeks of RT eliminated the strength and muscle mass deficit of older men when compared to 18–31-year-old men. And Yarasheski et al. (1993) reported that basal fractional rate of muscle protein synthesis, whilst lower in the elderly compared to young men and women; increased to a comparable rate following only 2 weeks of RT. Combined, these health benefits are not only important for all members of the population for healthy aging, but might play a particularly crucial role in older adults given the associated sarcopenia and dynapenia, as well as risk of falls and fractures (Tinetti et al., 1988).

* Corresponding author.
E-mail addresses: james.fisher@solent.ac.uk (J.P. Fisher), James.steele@solent.ac.uk (J. Steele), paulogentil@hotmail.com (P. Gentil), giessing@uni-landau.de (J. Giessing), wwestcott@quincycollege.edu (W.L. Westcott).

http://dx.doi.org/10.1016/j.exger.2017.09.012
Received 29 June 2017; Received in revised form 24 August 2017; Accepted 13 September 2017
Available online 28 September 2017
0531-5565/

2. Methods

Position stands by the likes of the American College of Sports Medicine (ACSM) might be interpreted to support the necessity for complicated, high-volume RT programmes (Ratamess et al., 2009), which might serve to deter engagement and adherence. Indeed, time constraints and perceived difficulty are often cited as barriers to RT (Trost et al., 2002; Winett et al., 2009). As such, we aimed to assess what benefits might be attained from, and what might constitute, a minimal dose approach to RT. For this commentary, we considered some of the seminal literature considering a variety of positive physiological and psychological health adaptations resulting from RT, including those where details of volume and frequency were included/could be calculated. It is worth noting that this is not an exhaustive review and word constraints prevent greater analysis. However, this article is intended to determine the approximate minimal necessary volume and frequency to identify a 'minimal dose' of RT for the evidenced health benefits.

2.1. Dosage

Whilst emphasis has been placed on the considerable health benefits of RT, many people might not realise that these positive responses have been attained using a low to moderate dose of RT. For example, in the above studies participants performed RT for low- (~20 min, to ~35 min (Brooks et al., 2007)) to moderate- (~40 min (Campbell et al., 1994) and ~60 min (Huovinen et al., 2016)) volumes, 3 days/week. Notably, time might be saved by performing only multi-joint exercises, as opposed to the addition of single joint exercises. For example, Gentil et al. (2016) suggested that use of only multi-joint exercises appears to produce similar increases in strength and muscle mass as higher volumes of training through the addition of single-joint exercises.

Furthermore, whilst some authors have reported more favourable increases in strength and hypertrophy by performing multiple sets of an exercise (Krieger, 2009; Krieger, 2010; Schoenfeld et al., 2016), in older adults, there seems to be no consistent benefit beyond single-set RT. For example, Cannon and Marino (2010) reported that younger and older women showed similar increases in knee extension muscle strength and size when performing RT with one or three sets per exercise after 10 weeks, with no significant interactions between age or number of sets and time. Abrahin et al. (2014) found similar gains in functional tests, as well as strength and muscular endurance of older women after performing 24 sessions with either one or three sets per exercise. Galvão and Taaffe (2005) compared the effects of 20 weeks of one vs. three sets per exercise and found inconsistent results. The high-volume group showed greater increases in maximal strength for seated row, triceps extension, and leg extension as well as muscular endurance in the chest press and leg press. However, there were no between-group differences in biceps curl, chest press, leg press and leg curl maximum strength as well as in isometric and isokinetic knee extensor peak torque. Furthermore, improvement in functional tests and body composition also did not differ between groups. More recently, Radaelli et al. (2014) compared the effects of 20 weeks of one vs. three sets of resistance exercise in older women and reported favourable increases for the multiple set group for knee extension 1-repetition maximum (1RM), but no between-group differences for increases in elbow flexion 1RM. In fact, a meta-analysis by Silva et al. (2014) suggested that variance in load (55–84% 1RM), volume (1–6 sets), or frequency (1–3 days/week) did not produce significantly different strength increases in adults over 55 years.

In further support of the proposed low-volume approach for strength increases; Koffler et al. (1992) used a single set for upper body exercises and 2 sets for lower body exercises reporting strength increases of (mean ± standard deviation) 41 ± 5% ($p < 0.001$) and 45 ± 6% ($p < 0.001$), respectively. Fisher et al. (2014b) reported significant ($p < 0.001$ to $p = 0.014$) strength increases in older males (mean = 55 ± 10 years) and females (mean = 55 ± 11 years) as a result of performing 2 weekly workouts with an average of only 5 multi-joint exercises per workout. Mean strength increases by exercise were: pull-down = 68 and 91%; chest press = 55 and 59%; seated row = 65 and 81%; overhead press = 39 and 58%; and leg press = 38 and 59%, for males and females, respectively. Each exercise was performed on a standard weight-stack resistance machine for only a single set each (equating to approximately 12 min per workout). Westcott et al. (2009) reported data from 1619 males and females aged between 21 and 80 years who performed 10 weeks of combined aerobic and resistance training 1 ($n = 81$), 2 ($n = 845$) or 3 ($n = 693$) days/week. Each exercise session was completed within 1 h, with only 20 min of RT; a single set of 10 standard weight-stack resistance machines performed to volitional fatigue for between 8 and 12 repetitions. All groups showed significant improvements in systolic and diastolic blood pressure with progressive improvements in body fat reduction and muscle mass increase aligned with greater training frequency.[1] The authors also reported a drop-out rate of only 9%, and adherence of 84%, 83% and 80% for the 1, 2 and 3 days/week groups, respectively. Most recently Steele et al. (2017) reported significant increases in strength and functional tasks (e.g. a stair climb task, carrying of shopping basket task, and chair rise task) and wellbeing following 6 months of high effort, twice weekly resistance training using a single set of leg press, chest press, seated row, knee extension, knee flexion, trunk extension and trunk flexion exercises.

However, despite these very positive findings we should consider that some studies have produced equivocal data. For example, Walker et al. (2017) considered strength, muscle activation and muscle mass for the quadriceps of older adults (64–75 years) performing reduced RT. Following 12 weeks of 2 days/week RT, participants were divided in to those continuing at the same frequency and those reducing training to only 1 day/week, for a further 24 weeks. Both strength and muscle activation continued to increase in both groups with no significant between-group differences. However, the authors reported reductions in CSA for the reduced frequency group. It might be that muscle function can be sustained with low frequency training whereas muscle mass requires RT of 2 days/week to be maintained.

2.2. Additional health benefits

Further benefits to RT have been identified including myokine release; hormones released by skeletal muscle tissue which serve to combat metabolic disorders (Schnyder and Handschin, 2015), improved cognitive functioning (Nagamatsu et al., 2012), and an array of psychological health benefits including; a reduction of fear of falling in the frail elderly (Yamada et al., 2011), improved sleep quality in depressed older adults (Singh et al., 2005), reduced anxiety (Cassilhas et al., 2007), reduced depression (Singh et al., 1997) and improved self-esteem (Tsutsumi et al., 1998). Whilst some of these RT doses were also low- (≤ 60 min, 2 days/week (Nagamatsu et al., 2012; Yamada et al., 2011; Singh et al., 2005)) and moderate- (45–60 min, 3 days/week (Cassilhas et al., 2007; Singh et al., 1997; Tsutsumi et al., 1998)) in volume, other studies failed to provide sufficient details to determine a training time. Research has supported that the main motivator for older adults to participate in RT would be "…*to feel good mentally and physically*…" (Burton et al., 2016). Combined the psycho-social benefits and physiological adaptations outlined would serve to improve quality of life and encourage older adults to be more interactive and engaged in daily activities and socialisation.

[1] It is worth acknowledging that an aerobic exercise component during the 1-hour session might have expedited positive blood pressure and body composition adaptations.