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The Influence Weekly Resistance Training Frequency on Strength and Body Composition

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Abstract The main objective of the study was to compare the effect of different weekly frequencies of resistance training (RT) on strength and body composition in untrained individuals who participated in a corporate wellness program after a three-month period. 48 men and 36 women within the ages of 30 to 45 years old were selected and they were divided into four groups that trained either two, three or four times per week, and a control group. Each group followed the same RT program. The participants completed 3 sets of 10-12RM of each exercise, with the exception of the abdominal crunch that followed a 15-20RM rep range per set. The loads were readjusted every time the upper training zone limit was surpassed. The rest interval between sets and exercises was between 60-90 seconds long. All sessions were supervised by a Physical Education professional with experience in resistance training. Anthropometric measurements and 10RM tests were done to analyze dependent variables. All groups presented significant increases in 10RM loads in all exercises ($p < 0.05$) and no differences were noted between groups ($p > 0.05$). Muscle mass was not significantly altered in any of the groups ($p > 0.05$). Body fat percentage was only reduced in the group that trained four times per week ($p < 0.05$). It was concluded that in a period of up to twelve weeks and for untrained individuals, even small weekly doses of RT can promote positive adaptations in strength and that when it comes to reducing body fat percentage, more frequency may be necessary.

Keywords Performance, Strength training, Muscle mass, Physical fitness, Health improvement

1. Introduction

The number of studies involving resistance training (RT) has increased significantly in the last few decades. Along with that, so has the increase of the importance given by professionals to this form of training when it comes to promoting health. Institutions, such as the American College of Sports Medicine (ACSM), support the importance of RT for health improvement. As per their most recent recommendation, the ACSM mentions that scientific evidence demonstrates that the benefits of exercise for health improvement and maintenance and physical fitness are indisputable, being that RT is responsible for offering gains in strength and muscle mass, lowering body fat and improving flexibility, components that are increasingly important for health in general [1].

Despite the growing favorable evidence of RT and the amount of media promotion about the benefits offered through its practice, incorporating a training program has been a challenge for people and one of their main arguments is a lack of time. The weekly frequency of training (number of training sessions done throughout the week) may influence varying success rates and must be studied in order to verify the dose-response effect of RT. Many studies have sought out to compare the influence of different numbers of weekly strength training sessions. These studies show examples of several untrained individuals in various age ranges [2-12] and some, besides strength increase, also demonstrated changes in body composition [2, 9, 13]. However, there has been a fewer number of studies within this scope that address middle-aged adults that have simultaneously investigated the sum of variables mentioned previously. Benton et al. [14] found similar results in strength and muscle mass comparing two or three weekly RT sessions performed by middle-aged women for eight weeks. In another study, Serra et al. [15] evaluated the effect of weekly frequency of RT sessions on strength in middle-aged men. The groups trained either two, three or four times per week for eight weeks and at the end of the experiment, it was concluded that two to four sessions per week were enough to produce significant gains in strength. In both studies, there

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were limitations in terms of variables investigated, as well as the number of subjects and gender.

Therefore, the objective of this study was to compare the influences of different weekly frequencies of RT on strength and body composition in untrained men and women within the ages of 30 and 45 years old, participants of a corporate wellness program.

2. Methods

2.1. Participants

Eighty five untrained individuals participated in this study (48 men and 36 women), aged between 30 and 45 years old. The group was divided into 4: a control group (CG) (n=10, 5 men and 5 women), a group that trained twice per week (G2) (n=26, 14 men and 12 women), a group that trained three times per week (G3) (n=32, 22 men and 10 women), a group that trained four times per week (G4) (n=16, 7 men and 9 women). In order to participate in the study, subjects had to appear to be healthy, not present motor limitations or difficulties, not present a history of heart disease or chronic illness, not have done RT for at least a year and respond negatively to all the questions in the Physical Activity Readiness Questionnaire (PAR-Q) [16]. The individuals also had to agree to not participate in any other type of regular physical exercise besides the prescribed resistance training program for the duration of the study, as well as not consume any type of nutritional supplement. The training adherence rate of the groups was around 95%.

All subjects signed a consent agreement form based on CONEP (National Committee for ethics in Research) regulations 466 (2012). The procedures of this study were approved by the Rio de Janeiro Federal University Committee of Ethics under the authorization number 300.003 on May 23rd, 2013.

2.2. Procedures

Initially, total body mass, skin fold and body measurements were taken using, respectively, a mechanical scale with stadiometer (Filizola®, Brazil), skin fold calipers with a precision point of 0.1 mm (Cescorf®, Brazil), and metal tape measures (Cescorf®, Brazil). The 10RM tests were performed with RT equipment (Technogym®, Italy). Total body mass, skin fold and body measurements were taken. All anthropometric measurements were performed according to the International Society for Advancement in Kinanthropometry (ISAK) norms. The collection of anthropometric data was taken in pre and post-workout states (after three months of training). Body fat percentage was calculated using the Jackson and Pollock [17] equation for 7 skin fold areas, the margin of technical error was calculated through an Intra-assessor (ETMintra). For such, twenty study volunteers were assessed on two different days, at the same time of day (in the morning) and by the same assessor. The ET Mintra calculation was chosen based on procedures recommended by Perini et al. [18].

All groups went through a one-week (three sessions) practice period in order to familiarize themselves with the exercises that would be used throughout the study. This method was used in order to guarantee that all who were being assessed were adept to exercise sequence, loads and intervals used. Prior to this phase, participants were assessed on their 10RM in two non-consecutive sessions in order to verify the reproducibility of the test. An interval of 48 hours was given between sessions. During this period, participants were advised not to do any other form of exercise in order to not interfere with the obtained results. The exercises were tested in the following order: wide-grip front lat pull down using a high pulley machine, leg press and machine chest press. The exercises were chosen due to their widespread availability in training centers and for being relatively easy to execute. Furthermore, exercises that involved a variety of muscle groups were chosen in order to better assess the influence of frequency of training in such muscle groups. The 10RM load was determined in up to three attempts with a five-minute rest interval between each one. After obtaining the 10RM load to be used for a chosen exercise, intervals of no less than ten minutes were adhered to before moving on to the next exercise test. The highest 10RM reached on either test day was considered.

Aiming to reduce the margin of error within the 10RM tests, the following strategies were adopted [19]: a) standard instructions were given before the test b) the participant was instructed on proper technique and execution of the exercises c) the assessor had to pay close attention to the position and posture used by the participant at the time of measurement since small variations of joint positioning involved in the movement could force recruitment of other muscles, leading to erroneous interpretations of the obtained score d) verbal encouragement was given aiming to maintain a high level of stimulation e) the free weights used in the study were weighed on a precision scale prior to testing.

After the practice phase, the training phase was initiated. The training program included eight exercises to be executed in the following order: wide-grip front lat pull down with high pulley, leg press, machine chest press, seated leg extension, seated row, seated leg curl, seated shoulder press and abdominal crunch.

With the exception of the first three exercises, all other exercises had their order altered each month (following the principles of the alternate by segment method). The participants completed 3 sets of 10-12RM of each exercise, with the exception of the abdominal crunch that followed a 15-20RM rep range per set. The loads were readjusted every time the upper training zone limit was surpassed. The rest interval between sets and exercises was between 60-90 seconds long [20]. Prior to each training session, the participants were to complete two warm-up sets (15 repetitions using 50% of their training load used for the first and second exercise of the program). All sessions were supervised by a Physical Education professional with experience in resistance training. At the end of the three-month training period, all procedures used for the

10RM were repeated in order to verify possible gains in strength.

3. Statical Analysis

The intra-cluster correlation coefficient (ICC) was calculated in order to verify the reproducibility of the 10RM tests. All data was presented using the means and deviation standard. In order to verify normality and homogeneity of the data, the Kolmolgorov-Smirnov and Bartlett tests were performed, respectively.

The data of body composition presented normal distribution of probability and met the homogeneity criteria, parametric tests were chosen as a means to compare pre and post-workout states, as well as among groups. This practice was not repeated when it came to 10RM testing and the data collected as it did not follow normal distribution. Therefore, non-parametric tests were opted for.

As such, aiming to verify the differences between pre and post-workout states for each group, the paired t-test was used to compare anthropometric data in order to verify the differences between pre and post-workout states. For the 10RM tests, the Wilcox non-parametric test was used.

Maintaining the comparison of different interventions between groups as an objective, a calculation of the delta factor was done for each group. As such, a one-way ANOVA test, followed by the Tukey post-hoc test, was used to determine possible differences of delta factors. In order to compare data regarding to the 10RM test, the Kruskal-Wallis test, followed by the Mann-Whitney test, was used.

In all cases, the statistical significance level $p < 0,05$ was adopted. The SPSS 20.0 software was used for analysis.

Additionally, effect size (ES) calculations were performed to determine magnitude of differences. The Rhea Scale [21] was used in order to classify the magnitude of the effect.

4. Results

The ICC was elevated between the 10RM tests and retests (r = 96) and (r = 98) in pre and post workout states, respectively. The 10RM loads were increased in the three exercises tested after a period of three months of training in all groups ($p<0.05$, table 3) except in the CG. No significant differences were observed between groups ($p>0.05$, table 3). The delta averages were higher according to weekly frequency, demonstrating more strength gains in G4. In regards to effect size, the results after 3 months of training were "trivial" and "small" in all groups.

Table 1. Characteristics of males subjects (mean ± standard deviation)

Groups	Age (years)	Height (cm)	Body mass (kg)
GC (n = 5)	40 ± 10	181.3 ± 5,4	93.74 ± 11.28
G2 (n = 14)	37 ± 9	178.5 ± 7,3	86.70 ± 16.35
G3 (n = 22)	36 ± 12	176.3 ± 5,8	83.28 ± 12.62
G4 (n = 7)	34 ± 7	176.34 ± 2,8	78.91 ± 9.43

Table 2. Characteristics of females subjects (mean ± standard deviation)

Groups	Age (years)	Height (cm)	Body mass (kg)
GC (n = 5)	42.4 ± 13	157.6 ± 9.0	71.28 ± 19.50
G2 (n = 12)	33.5 ± 6	164.4 ± 4.1	60.60 ± 6.58
G3 (n = 10)	32 ± 5	165.1 ± 5.8	59.42 ± 5.64
G4 (n = 9)	35.7 ± 4	162.8 ± 4.7	63.17 ± 8.25

Table 3. Results of 10RM tests

		Wide-grip front Pull Down on pulley			
	Pre-workout	Post-workout	p value	ES	Δ
GC	37.7 ± 16.4	36.00 ± 16.2	0,102	-0.10 (trivial)	-4.5
G2	42.6 ± 20.7	48.50 ± 20.7*	0,001	0.30 (trivial)	13.7#
G3	44.4 ±13.9	51.30 ± 13.9*	0,001	0.49 (trivial)	15.4#
G4	40.6 ± 20.3	48.60 ± 21.8*	0,001	0.39 (trivial)	19.5#
		Machine Chest Press			
GC	37.1 ± 21.9	36.3 ± 21.9	0,650	-0.10 (trivial)	-3.8
G2	41.2 ± 25.6	49.9 ± 30.2*	0,001	0.33 (trivial)	21.2#
G3	46.6 ±20.8	59.7 ± 25.1*	0,001	0.67 (small)	30.9#
G4	42.1 ± 27.9	55.6 ± 36.2*	0,001	0.48 (trivial)	32.1#
		Leg Press			
GC	101.0 ± 25.6	98.3 ± 24.4	0,068	-0.10 (trivial)	-2.8
G2	108.9 ± 49.1	128.9 ± 54.5*	0,001	0.40 (trivial)	18.2#
G3	120.2 ±48.0	149.0 ± 57.7*	0,001	0.59 (small)	24.0#
G4	128.8 ±55.4	168.1 ± 89.0*	0,001	0.70 (small)	30.6#

*Data is presented in kg; ES: Effect Size; Δ: delta average; *Significant statistical differences noted between pre-workout out post-workout results; significant statistical differences in GC in 3 months of training; #Significant statistical differences in regards to the GC with p = 0,001

Table 4. Body Composition Results

	Pre-workout	Post-workout	p value	ES	Δ
			Body Fat Percentage (%)		
GC	28.6 ± 10.2	29.6 ± 9.9	0,063	3.74 (large)	1.0
G2	22.4 ± 6.6	22.5 ± 6.9	0,820	0.48 (trivial)	0.1
G3	20.2 ± 5.9	19.7 ± 5.6	0,247	-0.07 (trivial)	-0.4
G4	22.4 ± 7.9	20.8 ± 7.4*	0,016	-0.19 (trivial)	-1.5#✝
			Muscle Mass (kg)		
GC	28.7 ± 9.4	28.9 ± 9.5	0,539	0.02 (trivial)	0.2
G2	29.5 ± 7.6	29.7 ± 8.1	0,516	0.03 (trivial)	0.2
G3	31.1 ± 6.3	31.5 ± 6.4	0,128	0.06 (trivial)	0.4
G4	27.6 ± 5.5	28.2 ± 6.1	0,147	0.09 (trivial)	0.5
			Waist Circumference (cm)		
GC	97.8 ± 13.4	100.4 ± 13.2*	0,013	0.18 (trivial)	2.5
G2	88.3 ± 11.5	88.7 ± 12.8	0,492	0.03 (trivial)	0.4
G3	89.5 ±12.2	89.4 ± 11.3	0,894	-0.01(trivial)	-1.4
G4	86.6 ± 9.5	85.0 ± 8.2	0,096	-0.16 (trivial)	-1.5

*ES: Effect Size; Δ: delta average; *Significant statistical differences between pre-workout and post-workout results *Significant statistical differences in GC in 3 months of training; #Significant statistical differences in regards to the GC with p = 0,020; ✝ Significant statistical differences in regards to the G2 with p = 0,046

Body Fat percentage was not altered after the intervention period in GC, G2 and G3 (p>0.05). Only G4 demonstrated significant reduction in body fat percentage after three months of training (p<0.05, table 4). The intergroup comparison did not demonstrate any differences between groups GC, G2 and G3. Significant differences were noted between G4, GC and G2 (P<0.05, table 4). Muscle mass was not significantly altered in all groups (p>0.05, table 4). An increase in waist circumference was noted in the CG after three months (p<0.05, table 4). No intergroup differences were observed using this variable (p>0.05). The effect size was "trivial" [21] for all variables, except for body fat percentage in the CG, which experienced an increase in this variable with an effect size considered "large".

5. Discussion

The findings obtained in the experiment revealed significant increase in strength in the three different weekly training frequencies investigated, without significant differences between groups, indicating that, for untrained individuals, a small volume of training may be enough to induce positive adaptations for this variable. In body composition, no changes in muscle mass and waist circumference were noted after the three-month intervention period. However, body fat percentage was only decreased significantly in G4, indicating, in this case, the importance of a higher training dose in order to see changes in this variable.

Despite the lack of statistical significance of strength gains in the intergroup comparisons, a dose-response effect was observed in the delta average of the study. Taaffe et al. [12] reported an increase in strength in upper and lower body exercises in groups of elderly participants who trained throughout 24 weeks, with a weekly training frequency of either once, twice or three times per week. The authors did not observe significant differences when comparing groups. McLester et al. [9] also assessed strength gains according to different weekly RT frequency. The results reported increase in all tested exercises, highlighting the leg press as the only exercise to present a significant difference between groups (one to three times per week). The volunteers were young adults with RT experience and the intervention period lasted twelve weeks.

Similar results of the aforementioned, noting increases in strength according to periods of, at least, eight weeks of RT and comparing one, two and three weekly sessions, have been described in previous literature [5, 2, 10]. These studies, as well as the present study, do not observe significant differences in strength gains in upper and lower body muscle groups between the tested groups. A possible explanation is that the development of strength does not depend solely on weekly training frequency, but also on factors, such as, for example, the rest interval length between each session [22] and the initial strength level of the participants [10]. The present study reports increases in strength and a small increase in muscle mass in groups G3 and G4, indicating that the gains in strength are possibly due to the neural adaptation component. As such, it is possible to improve coordination between agonist and antagonist muscle groups, increase number of motor units recruited, as well as increase the firing rate enabled for a higher performance in strength [23].

In regards to body fat percentage, only G4 demonstrated significant reduction after the intervention period. Partially, these results corroborated with the studies that analyzed the relation of weekly training frequency and its influence on body fat percentage. McLester et al. [9] compared RT when training one or three times per week in body fat percentage and strength in men and women within the ages of 20 and 30 years old. The intervention lasted twelve weeks and included nine exercises for both upper and lower body muscle groups at 80% of their 1RM, maintaining the same training volume per group. Their conclusions did not reveal any differences between groups for the analyzed variables. In the Benton et al. [14] study, the effect of three and four weekly training sessions of RT on body composition and strength in middle-aged women was assessed. Their results indicated improvements in body composition. However, the intergroup comparison did not present significant differences. Even though the results of the Benton et al. [14] study corroborate with the present study, it is noted that the authors used different RT programs with the intention of maintaining the same weekly training volume of exercises. In the present study, the same RT programs were used in all groups which made the weekly training volume differ between them in relation to weekly frequency. Fisher et al. [8] studied women over the age of 60 with a training program that included both aerobic and strength training exercises in order to determine ideal training frequency. One, two and three weekly sessions were compared within a 16-week period. No significant differences in body fat percentage were found between groups. As such, their findings corroborate with our study in regards to differences between groups that trained two or three times per week in which nothing significant was noted. In this context, the aforementioned results are in agreement with those observed in this study, reinforcing that the difference between numbers of weekly training sessions and its effect on body fat percentage is related to weekly frequency of RT equal or superior to four times per week.

In terms of results found in relation to muscle mass and abdominal circumference, even though no significant differences were found between groups, the presence of the dose-response effect was found in regards to the increase of the delta average in groups with a higher weekly training frequency. Such findings are in agreement with previous studies which also found no significant differences in muscle mass and waist circumference between assessed groups, with weekly frequencies varying between one and three times per week and training periods lasting between eight and sixteen weeks [8-10].

6. Conclusions

In dose-response effects comparisons, improvements were observed in the investigated variables, influenced positively by the number of RT sessions per week. However, results shown for two and three times per week are very similar, showing greater differences starting at four times per week for the body fat percentage variable.

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