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Effects of functional resistance training on muscle strength and musculoskeletal discomfort

Efeitos do treinamento resistido funcional na força muscular e desconforto musculoesquelético

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Abstract

Introduction: Functional resistance training (FRT) is becoming increasingly popular to improve physical fitness of practitioners, however, yet there are gaps in knowledge about effectiveness of FRT in relation conventional resistance training (CRT) in several ambits, as musculoskeletal complaints. **Objective**: Compare the effect of FRT and CRT in the musculoskeletal discomfort and magnitude of gain in muscle strength in healthy women. **Methods**: 52 women was divided into three groups, FRT (n = 15; 22 ± 2.35 years): functional resistance training; CRT (n = 14; 22.5 ± 1.78 years): conventional resistance training and CG (n = 13; 20.6 ± 1.10 years): no type of intervention. The training was periodized in 30 sessions over 12 weeks with 3 sessions per week. For the muscle strength variable used the 1RM test and for the musculoskeletal discomfort variable, the Nordic Musculoskeletal Questionnaire (NMQ). Regarding the statistical analysis, all results took into consideration a 5% level of significance. **Results**: Considerable gain in muscle strength was observed for all exercises in both training groups. In addition, there was a tendency in CRT to relate a more musculoskeletal discomfort; presented 27.3% more complaints compared FRT in the MNQ. **Conclusion**:

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The FRT was as effective as the CRT for improving muscle strength, furthermore, there was a tendency for FRT to cause less musculoskeletal discomfort.

Keywords: Strength Training. Exercise Movement Techniques. Musculoskeletal Pain. Muscle Strength.

Resumo

Introdução: *O treinamento resistido funcional (TRF) está se tornando cada vez mais popular para melhorar a aptidão física dos praticantes, entretanto, ainda não está totalmente esclarecido sobre a eficácia do TRF em relação ao treinamento resistido convencional (TRC) em diversos âmbitos, como queixas de desconforto osteomuscular.* ***Objetivo****: Comparar o TRF e TRC nas queixas de desconforto osteomuscular e na magnitude de ganho de força muscular em mulheres saudáveis.* ***Métodos****: O estudo foi composto por 52 mulheres divididas em três grupos: TRF (n = 15; 22 ± 2.35 anos): treinamento resistido funcional, TRC (n = 14; 22.5 ± 1.78 anos): treinamento resistido convencional e GC (n = 13; 20.6 ± 1.10 anos): nenhum tipo de intervenção. O treinamento foi periodizado em 30 sessões durante 12 semanas com três sessões semanais. Para a variável força muscular utilizou-se o teste de 1RM e para as queixas osteomusculares, o Questionário Nórdico de Sintomas Osteomusculares (QNSO). Em relação a análise estatística, todos os resultados levaram em consideração o nível de 5% de significância.* ***Resultados****: Notou-se ganho considerável de força muscular para todos os exercícios em ambos os grupos de treinamento. Além disso, observou-se uma tendência no TRC a relatar um maior número de queixas osteomusculares, apresentando 27,3% mais queixas comparadas ao TRF no QNSO.* ***Conclusão****: O TRF foi tão eficaz quanto o TRC para melhorar a força muscular, e, ainda, houve uma tendência de que o TRF provoque menores quantidades de desconfortos osteomusculares.*

Palavras-chave: *Treinamento de Resistência. Técnicas de Exercício e de Movimento. Dor Musculoesquelética. Força Muscular.*

Introduction

The resistance training model (RT) more known and practiced currently is the conventional which involves exercises performed with free weights or machines that isolate specific muscles in order to increase the strength more effectively (1). However this model of RT does not take into account the movements along a movement plane, which in turn are required in activities of daily living or in sports performance (2).

Thus, the functional resistance training (FRT) is gaining increasingly fans in clinical practice and has been considered as a better alternative compared to conventional resistance training (CRT) by provide improvement in muscle strength, endurance, coordination and balance (3, 4).

Several concepts have been proposed for the FRT. Rikli and Jones (5) define the FRT as exercises that provide the ability to perform safely and independently activities of daily living without fatigue. Brill (6) define the FRT as training which uses multiple parts of the body simultaneously, providing a balance between the upper and lower limbs and trunk, thus providing greater neuromuscular activation and consequently better musculoskeletal adaptation. Whereas Cosio-Lima et al. (7) describe the FRT as the ability of the neuromuscular system to stabilize the body through dynamic and isometric contractions in response to stressors such as unstable surfaces.

Recently Lagally et al. (8) studied the physiologic and metabolic responses to FRT in younger adults and found that the exercise program performed promoted caloric expenditure levels that were associated with maintaining health according to the American College of Sports Medicine. Furthermore, Weiss et al. (3) found that both the FRT and the CRT are equally beneficial for increasing endurance, balance and muscle strength during a training program of seven weeks in healthy participants.

Tomljanovic et al. (9) performed a study to determine the effects of functional training compared to conventional training, both with duration five consecutive weeks and frequency of three times a week, in the anthropometric variables, explosive strength, agility and speed in youth. The authors concluded that functional training is most indicated to improve postural control and coordination. While Weiss et al. (3) objective to check whether the functional resistance training has effects similar to conventional resistance training in the seven-week period, on strength and muscular endurance, flexibility, agility, balance and anthropometric measurements and concluded that both training are equally beneficial to increase strength, endurance and balance, however, for the other measures the alterations appear to be specific to each program.

Although the FRT is widely used in clinical practice and studies have shown results for several outcomes, were not found studies in the literature that have investigated the subjective report of musculoskeletal discomfort and the magnitude of gains muscle strength in young, considering the periodicity principle, in other words, respecting to frequency, progression of loads and recovery time; fact that representing a gap in the literature.

So, considering that this analysis can provide clinically relevant information to assist the understanding of influence of FRT in a healthy population, the objective of this study was to compare the effect of FRT and CRT in the musculoskeletal discomfort complaints and magnitude of gain muscle strength in healthy women. It is expected that the FRT has better effects on the organism in relation to clinical variables, such as the reduction of musculoskeletal complaints and increased muscle strength.

Methods

Population

To perform this study, we analyzed data of 52 female participants, apparently healthy, with a mean age of 22.04 ± 2.01 years, sedentary, who had not performed any regular physical exercise or resistance training in the six months prior to the study, and who made regular use of contraception.

Participants with at least one of the following were excluded: active tobacco use, alcohol abuse, taking drugs or medication except the contraceptive, the presence of inflammation and/or infection process, metabolic and respiratory disease, episode of musculotendinous or osteoarticular injury in the upper or lower limbs and/or spine.

All procedures were approved by the Ethics Committee in Research of the Faculty of Science and Technology (Protocol 2012/21892).

Study design

All protocols were carried out in the *Studio Salus*: *Physical Rehabilitation and Longevity* with temperature controlled between 21°C and 23°C, in the period between 12:00 and 15:00pm. The fifty-two participants were randomized randomly into 3 groups named: control group (CG; n = 13) which did not receive any training, functional resistance training group (FRT; n = 15) who performed an exercise program from models with complex lever systems and, conventional resistance training group (CRT; n = 14) which conducted an exercise program from conventional models. The FRT and CRT groups performed the same exercises for lower limbs, differing moving levers only in the exercises for the upper limbs.

Firstly, before the beginning of the training, participants were identified through name and age. All participants were oriented to maintain to your diet and daily activities normally during the study. The training program for both groups lasted for 12 weeks. The collections of anthropometric variables (height, body mass and subsequent calculation of body mass index [BMI]) occurred before the start of training, the muscle strength variable (1 Repetition Maximum test [1RM]) was collected in the moments before and after 12 weeks of training and musculoskeletal discomfort complaints (Nordic Musculoskeletal Questionnaire [NMQ]) were collected in every day of the training program.

Functional and Conventional Resistance Training

Training protocols were performed of periodized form and progressively and had lasted 12 weeks, with 10 weeks for realization of the proposed exercises and two weeks of absence of training with recovery goal, with three weekly sessions, lasting about 50 minutes, totaling 30 training sessions. The training for both training programs were carried out with a minimum interval of 24 hours and a maximum of 72 hours between them to also ensure the recuperative state of the participant. Initially, before the beginning of the 12 weeks of training was performed 1RM test for each exercise in both groups. After these tests, the participants started the training period.

At the beginning of each training session was performed five minutes warm up on a treadmill at a moderate and individual pace, followed by overall stretches for the upper and lower limbs. After this, the training was performed progressively, starting with the endurance training exercise program with loads between 30 to 40% of 1RM, in order to muscle adaptation to subsequent higher training loads applications, lasting three weeks. After this training period was performed one recovery week, which is characterized by the total pause of the sessions. From the fifth week the strength training phase was initiated, with loads progressing from 50 to 100% of 1RM over a period of seven weeks, wherein the ninth week was also considered recuperative week.

It is noteworthy that the periodization and, consequently, progression of loads, sets and repetitions were similar for the groups. The exercises for the lower limbs were the same for both training groups, while for the upper limbs the same muscle groups were worked; however, the FRT group performed the exercises in isometric positions and on unstable surfaces.

The training programs were composed of two sets of exercises (A and B), performed alternately between sessions. The exercises realized consisted in six exercises for lower limbs distributed in three by training (Training A: *legpress*, extension and flexor chair; and Training B: abductor chair, adductor and hip extension) and 10 types for upper limbs, distributed in two days with five exercise each consisting of the same muscle groups (pectoral, back, shoulder, biceps and triceps). The time interval adopted between sets of exercises ranged from 40 seconds to 1.5 minutes, respecting the proportionality between the time and the workload, and the recovery sensation of participant. The complete periodization of the dynamics of the exercises and sessions is presented in Table 1.

Table 1 - Training development according to the dynamics of the exercises and sessions

Weeks	Sessions	Dynamics of Work Volume – Series and Repetitions per exercise	Dynamics of Intensity of Effort (1RM) – Exercise load
1st	1st / 2nd / 3rd	2 series X 12 repetitions	30 to 40%
2nd	1st / 2nd / 3rd	2 series X 16 repetitions	30 to 40%
3rd	1st/ 2nd / 3rd	2 series X 20 repetitions	30 to 40%
4th	Recovery week	Recovery week	Recovery week
5th	1st / 2nd / 3rd	1 series X 16 / 12 / 9 repetitions	40 / 50 / 60%
6th	1st / 2nd / 3rd	1 series X 12 / 9 / 6 repetitions	50 / 60 / 70 %
7th	1st / 2nd / 3rd	1 series X 10 / 8 / 6 repetitions	60 / 70 / 80%
8th	1st / 2nd / 3rd	1 series X 8 / 6 / 4 repetitions	70 / 80 / 90%
9th	Recovery week	Recovery week	Recovery week
10th	1st / 2nd / 3rd	1 series X 6 / 4 / 2 / 4 / 6 repetitions	80 / 90 / 100 / 90 / 80 %
11th	1st / 2nd / 3rd	1 series X 6 / 4 / 2 / 2 / 4 / 6 repetitions	80 / 90 / 100 / 100 / 90 / 80%
12th	1st / 2nd / 3rd	1 series X 6 / 4 / 2 / 2 / 2 / 4 / 6 repetitions	80 / 90 / 100 / 100 / 100 / 90 / 80%

Analysis of anthropometric parameters

For determination of BMI was performed the measurement of height in the orthostatic position through a stadiometer (*Sanny*®, American Medical do Brasil, São Paulo, Brasil) and the body mass through on digital scale (*Tanita BC554*®*, Iron Man/Inner Scaner*). The calculation of BMI was performed according to the formula: BMI = weight [kg] / height^2 [m] (10).

1RM test and analysis of muscle strength

The 1RM test was performed to determination of maximal load, in kilograms, that each participant managed to accomplish during the movement required by the exercise to later be determined individual workloads. This test is the most resistance that can be performed by the participant during the execution of a given exercise, wherein the test was considered valid performed with total range of motion of controlled manner and with good posture.

The test was started with a load of 50% of the weight of the participant, receiving increments of 30% of this value and also, according to the perception of the participant, until be completed when it reached the maximum load, in which could perform the movement without mechanical failure. It was not allowed more than five attempts to establish the maximum load or else the test was considered invalid and the participant had to be submitted to the test on another day (11, 12). In this study, considering that the participants were young and because the logistics of collection, familiarization was considered the 1RM test itself.

The assessment of muscle strength in the three groups was obtained through this 1 RM test, being held a week before the start of training and after 12 weeks of training.

Analysis of musculoskeletal discomfort complaints

The NMQ is internationally recognized as standard for measuring investigation of musculoskeletal symptoms (13), in addition to has been validated and adapted to the Brazilian culture (14). The QNSO had as proposal standardize the mensuration of description of musculoskeletal symptoms of the participants during the training programs (15). The participant was questioned about the presence of some musculoskeletal discomfort in any anatomical site through NMQ in all training sessions, before starting it.

Statistical Analyses

For data analysis of the population profile, descriptive statistical methods were used, and the results were presented as mean values and standard deviation. Data normality was assessed using the *Kolmogorov-Smirnov* test. To compare the moments of analysis the *paired t test* was used and to compare the groups, *ANOVA Oneway* analysis of variance technique, complemented by the multiple comparison *Tukey* test for parametric data and the *Kruskall Wallis* test complemented by a *Dunn* multiple comparison test for nonparametric data. All results considered a 5% level of significance and were presented as mean and standard deviation values.

Results

The anthropometric characteristics of the participants, such as age, height, body mass and BMI were respectively: FRT – 22.0 ± 2.35 years, 1.63 ± 0.05 m, 59.99 ± 8.66 kg and 22.09 ± 2.91 kg.m^2; CRT – 22.5 ± 1.78 years, 1.61 ± 0.07 m, 53.81 ± 6.50 kg and 20.72 ± 2.87 kg.m^2; CG – 20.69 ± 1.10 years, 1.62 ± 0.27 m, 56.35 ± 7.51 kg and 21.47 ± 2.95 kg.m^2.

Table 2 shows the 1RM test values for each training group in the pre and post moments the 12 weeks of training. Significant increases were observed in all exercises between pre and post-training moments for both training groups. Furthermore, a statistical difference was also observed in CG for the exercises back, shoulder, flexor chair, extension chair, hip extensor, abductor chair and adductor chair.

The magnitude of gain in percentages for the upper and lower limbs in general is presented in Table 3, and separated by muscle groups worked during training in Table 4. There was no statistically significant difference between the training groups, however both trainings were different from CG.

Regarding the NMQ, the CRT group presented 27.3% more complaints of musculoskeletal discomfort than the FRT group (Figure 1).

Table 2 - Mean and standard deviation of the values in kilograms of the 1RM test for upper and lower limbs

Exercises	Group	Baseline	12 weeks
Biceps	FRT	10.33 ± 3.51	15.06 ± 3.28*
	CRT	10.00 ± 2.77	17.28 ± 3.04*
	CG	10.38 ±2.46	10.84 ± 2.54
Triceps	FRT	9.33 ± 3.20	14.66 ± 4.68*
	CRT	9.64 ± 3.07	14.64 ± 3.31*
	CG	8.84 ± 2.99	9.84 ± 1.67

(To be continued)

(Conclusion)

Table 2 - Mean and standard deviation of the values in kilograms of the 1RM test for upper and lower limbs

Exercises	Group	Baseline	12 weeks
Pectoral	FRT	18.33 ± 6.98	23.20 ± 8.67*
	CRT	21.07 ± 6.84	26.28 ± 7.66*
	CG	22.30 ± 10.33	22.00 ± 10.12
Back	FRT	21.33 ± 7.18	31.60 ± 8.18*
	CRT	21.42 ± 6.63	37.07 ± 8.07*
	CG	23.46 ± 4.73	27.23 ± 4.81*
Shoulder	FRT	6.93 ± 2.08	11.20 ± 2.78*
	CRT	7.07 ± 1.68	12.00 ± 2.93*
	CG	7.38 ± 2.29	8.61 ± 2.50*
Flexor Chair	FRT	47.66 ± 9.97	61.66 ± 11.75*
	CRT	50.00 ± 11.26	64.28 ± 9.37*
	CG	42.30 ± 13.48	52.69 ± 10.49*
Extension Chair	FRT	58.66 ±10.43	87.66 ± 13.07*
	CRT	58.57 ± 15.37	84.28 ± 11.57*
	CG	49.23 ± 10.17	61.69 ± 15.73*
Hip Extensor	FRT	50.66 ±14.86	72.73 ±14.97*
	CRT	45.35 ± 12.47	69.14 ± 8.42*
	CG	50.38 ± 11.98	58.53 ± 8.26*
Leg press	FRT	54.13 ± 12.29	81.93 ± 14.87*
	CRT	54.00 ± 11.60	81.50 ± 15.15*
	CG	65.38 ± 11.83	60.92 ± 25.06
Abductor Chair	FRT	35.66 ± 8.20	45.00 ± 10.84*
	CRT	35.00 ± 8.32	43.21 ± 6.68*
	CG	30.76 ± 9.75	35.07 ± 9.42*
Adductor Chair	FRT	31.33 ± 9.72	37.80 ± 9.01*
	CRT	32.14 ± 8.70	38.71 ±7.84*
	CG	28.46 ± 8.75	31.30 ± 6.62*

*The comparison of results between moments of collecting respected statistical significance of $p < 0.05$.

Note: 1RM: 1 maximum repetition; FRT: Functional Resistance Training; CRT: Conventional Resistance Training; CG: Control Group.

Table 3 - Mean, standard deviation, median and minimum and maximum values of percentage gain (Kg) in the 1RM test according to groups

Segment	Groups		
	FRT	CRT	CG
UL	47.10 ± 41.93* 38.48 (-25.0; 300.0)	52.43 ± 38.94* 43.91 (-7.69; 200.0)	5.57 ± 22.67 0.0 (-45.65; 100.0)
LL	39.46 ± 25.80* 35.80 (0.0; 131.43)	40.95 ± 27.57* 35.41 (0.0; 140.0)	17.38 ± 29.29 14.28 (-86.48; 135.0)

* Statistical difference compared to the CG ($p < 0.05$).

Note: Kg: kilogram; 1RM: 1 repetition maximum; FRT: Functional Resistance Training; CRT: Conventional Resistance Training; CG: Control group; UL: Upper limbs; LL: lower limbs.

Table 4 - Percentage gain in the 1RM test of the exercises for the upper and lower limbs

Exercises	FRT	CRT	CG
Flexor Chair	31.01± 19.75	31.95 ±22.03	31.55 ± 34.58
Extension Chair	51.57± 19.91*	49.53 ± 25.91*	26.34 ± 23.42
Hip Extensor	48.95 ± 29.80*	60.87 ± 36.78*	19.01 ± 18.68
Adductor Chair	23.48 ± 15.02	22.62 ± 12.01	14.03 ± 21.10
Abductor Chair	26.69 ± 19.0	28.14 ± 24.68	15.67 ± 14.30
Leg press	55.07 ± 30.50*	52.57 ± 17.65*	-2.32 ± 44.94
Biceps	63.11± 74.58*	82.14 ± 46.01*	6.15 ± 21.80
Triceps	70.22± 64.81*	61.90 ± 51.61*	22.82 ± 42.46
Pectoral	30.33± 35.84*	31.73 ± 34.16*	0.25 ± 20.23
Back	53.32± 30.94*	79.68 ± 34.84*	18.71 ± 22.17
Shoulder	67.46± 35.41*	70.43 ± 18.53*	19.90 ± 23.07

* Statistical difference compared to the CG ($p < 0.05$).

Note: 1RM: 1 repetition maximum; FRT: Functional Resistance Training; CRT: Conventional Resistance Training; CG: Control group.

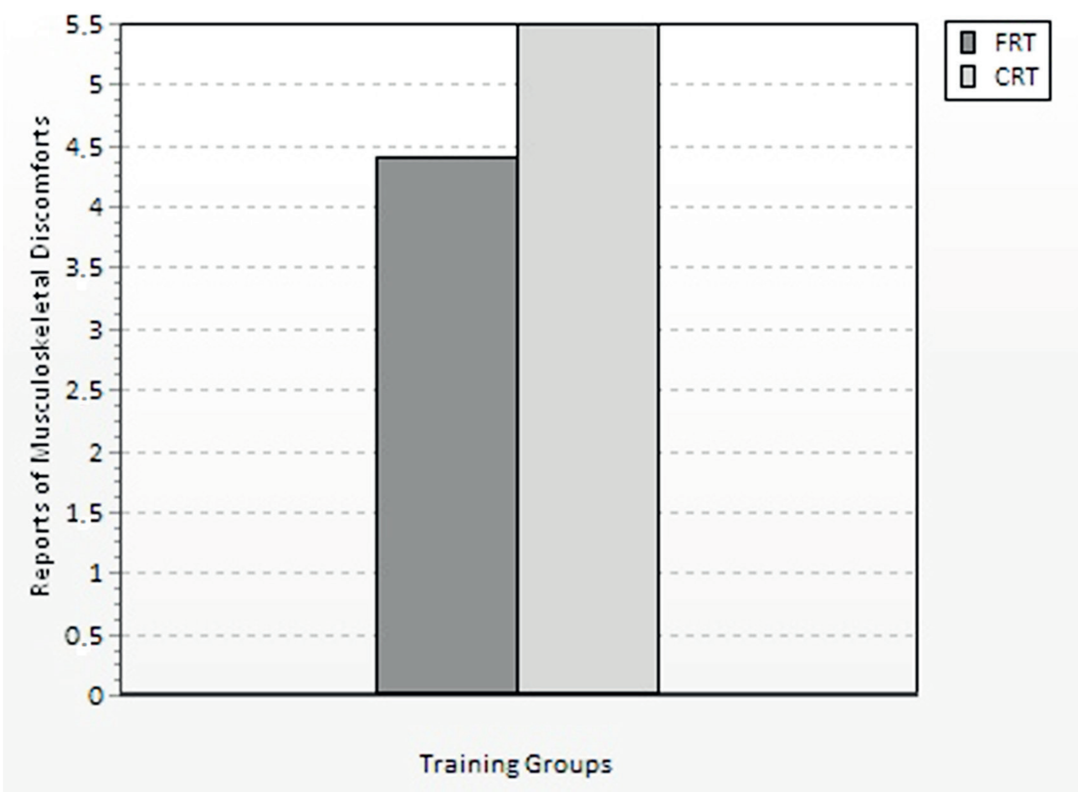

Figure 1 - Mean values of reports of musculoskeletal discomforts per participant according NMQ

Discussion

The objective of this study was to investigate the effects that FRT has on the musculoskeletal discomfort complaints and the magnitude of gain muscle strength compared to the CRT. The results demonstrated similarity in the magnitude of strength gains between the two training methods. However, regarding to musculoskeletal discomfort reports, the FRT group presented around 27% less complaints, according to the NMQ.

Our hypothesis that FRT would be most effectively increase muscle strength compared to CRT was not sustained. The FRT group presented gains of 39% in the lower limbs and 47% in the upper limbs, while the CRT group presented gains of approximately 40% and 52% for the upper and lower limbs respectively. However, when the gains in each exercise were examined in isolation observed that in the adductor, abductor and flexor chair exercises there was no statistical difference between the groups in the magnitude of strength gains.

The three study groups, including the control group, obtained a gain of around 31% in the flexor chair. For the adductor and abductor exercises these values were 20% and 23%, respectively. Futhermore, gains of muscle strength in hip extensor exercises, extension chair, shoulder and back were also observed. This fact demonstrates that the performance of these three exercises for 12 weeks was not sufficient to promote changes in the respective 1RM tests, compared to the CG. One hypothesis that could explain the lower strength gain for these muscle groups compared to others; is the fact of the number of exercises that worked these muscle groups are smaller, which consequently collaborates with a lower strength gain. In addition, the fact that the CG also has presented muscle strength gain can be explained by the daily activities of participants, since these were not controlled.

For the leg press exercise, the results were significant for both training groups. The FRT group presented a 55% gain, and the CRT group 52.5%. The results in this case are in agreement with the literature, which points to gains ranging from 23% (16) to 100% (17) depending on the periodization model applied. For exercises in the lower limbs, the leg extension improved by 51.5% and 49.5% for the FRT and CRT groups, respectively. These values were higher than those found in previous studies, which reported 19% (18) and 21% (19) increases in the strength test for extensor muscles of the knee after 12 weeks of resistance training. It is also important to mention that for the hip extensor exercise, the magnitude of gain was 49% for the FRT group and 60% for the CRT.

In relation to the upper limbs, studies show strength gains ranging from 13% (20) to 24.5 % (17) for the bench press exercise, in addition to other studies which also found significant improvements in this exercise (16, 21-24). In the present study, the FRT and CRT training groups presented gains of 30% and 31%, respectively. For the biceps, the FRT and CRT groups obtained gains of 63% and 82%, respectively, exceeding the findings of Baker et al. (22) who achieved up to 20%. For the triceps, the values reached 70% for the FRT group and 62% for the CRT group.

For the shoulder muscles Kraemer et al. (23) found a significant increase in 1 RM and, similarly, the current study found gains for the FRT and CRT groups of 67% and 70%, respectively, exceeding again the study of Baker et al. (22) who found up to 27% for the same segment. Although the percentage for the CRT group was higher, both groups demonstrated significance compared to the CG. This clinical trial also presented gains in the back exercise, where the FRT group obtained 53% and the CRT 79%, due to the higher values, the CRT stands out in this exercise. The position of execution of these two exercises for the FRT group consisted of isometric contractions of the muscles in the lower limbs and trunk, thus, we hypothesized that because of this difficulty the participants this group have not been able to execute the movement with ideal muscle recruitment.

In summary, yet there was not a consensus in relation the alteration of muscle strength through the FRT. Studies shows that the periodized resistance training provides mucular strength gains (25 - 27). Other studies show that the addition of an unstable surface at an exercise can decrease the production of muscle strength and thus could potentially decrease the training stimulus and muscle adaptations over time (28 - 30) and Behm et al. (31) suggest that the challenge of instability introduced at an exercise does not alter the production of muscle strength and the adaptations to training.

This study shows that for a population of sedentary young women, both the TRF as the TRC provide similar effects in relation to muscle strength. Kibele e Behm (32) found similar results in seven weeks of a functional exercise program in which muscle strength, and functional variables such as dynamic balance and shutlle run test were not considered different compared to a traditional exercise program. Weiss et al. (3) concluded that the FRT can be a training alternative more creative to improve performance in young adult as compared to traditional exercise, since the results indicate a similarity between the two methods to increase the strength, endurance and balance.

Although no studies were found which addressed musculoskeletal discomfort caused by RT using the

NMQ, this study found fewer complaints from the FRT group, which seems to be an important aspect as both groups had similar gains in relation to muscle strength.

When considering concerns related to physical activity, it is noted that the greatest onus of this practice is the occurrence of sports injuries. In this context, this clinical trial demonstrated that there were fewer complaints of musculoskeletal discomfort in the FRT group, indicating that it is possible to obtain substantial gains through RT with less musculoskeletal damage. We believe that this aspect may have occurred as a result of position of the body when performing the exercises, there is greater muscle activation using the complex system of levers during FRT, thus minimizing joint and segmental impacts such as those which occur in the CRT. Therefore, individuals seeking training aimed at gaining strength with the minimal discomfort possible should perform FRT; fact this that is an important clinical application of the study.

Some limitations of the study should be identified. In the present study were not evaluated the abdominal muscles and the stabilizing muscles of the trunk, either by clinical tests such as the trunk flexion test or through devices that can capture the electromyographic activity of the muscles. This fact prevented further discussion about the magnitude of muscle strength gains, considering that FRT requires the action of these muscles to stabilize the body during the execution of movements with the upper and lower limbs on unstable surfaces. Furthermore, although be a standardized test, 1RM test may have influenced the results, since variations in administration and motivation for the achievement of test may have been different among participants, and also has to consider the large number of tests realized which may have led a muscle fatigue, in addition not have been made a familiarization with the participants. Finally, the subjectivity of NMQ questionnaire should be considered in assessing the results obtained.

As future studies, we suggest evaluate different specific muscle groups, and perform the FRT with different forms of periodization, duration and cover diverse populations that can benefit from the method.

Conclusion

It was concluded that there was no difference in the magnitude of gains muscle strength between FRT and CRT models, however there was a trend of lower occurrence of musculoskeletal discomfort in the FRT in healthy women.

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