Inter and intradays reproducibility of power control in test of muscle power

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ABSTRACT

The aim of this study was to determine the reproducibility of an instrument of measurement of muscular power (MP), the *Power Control Technogym@*, through a simple test of MP. Fifteen women (26.2 ± 1.9 years) experienced in strength training in two exercises - the low row and the front lat pull down, were evaluated through a test of 1RM. The maximum load and the load that generated the MP in each exercise were determined. After obtaining the load that generated the MP, the individuals carried out three days of testing with the purpose to analyze inter and intradays reproducibility of the generated power. The comparison between the results of the MP was made through the ANOVA for repeated measures and Bonferroni *post-hoc* to specify which measures differ from each other, being adopted a level of significance of 5%. No significant differences were found at inter and intradays measurements respectively in the low row (p = 0.991; p = 1.000) and front lat pull down (p = 0.607; p = 1.000). This data can suggest that, for a simple test of MP, the *Power Control TechnoGym@* seems to be a useful and trustworthy instrument in the use of loads in the MP.

Keywords: 1RM. Maximum muscular power. Maximum loads. Strength training.

INTRODUCTION

The training for muscular strength up to the 1980's was little accepted by the population in the fitness and wellness centers. However, in 1990, when the American College of Sports Medicine exposed its position *"The Recommended Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory and Muscular Fitness and Healthy Adults"*[1], the strength training became part of the exercises prescription, aiming health.

After this publishing, scientific articles came out reporting the benefits of the strength and muscular power training (MP), not only for health individuals, but also for those with diseases. Nowadays, opinions on the muscular strength exercises practice; aerobic work and flexibility are inserted in the context of some organizations such as: The American Heart Association and The American Association of Cardiovascular and Pulmonary Rehabilitation[2].

Within this context, the MP has generated scientific interest[3-4], however, there is still practical and methodological controversy, especially when confronting attitudes not very scientifically based. One of the aspects frequently neglected in this kind of training is the issue on the ideal load and velocity for the MP training, which may be defined as the ability to produce strength rapidly, and which is measured through the product of the load by the velocity[3,5]. Such issue was practically raised in the study by Coelho *et al.*[6], where it was demonstrated that different exercise protocols conducted in the maximum MP led to distinct cardiac rate, lactic acid and exertion perception indices.

The MP is muscular strength-dependent and necessary in several sports, as well as in routine ordinary activities[7-8]. It is necessary hence, the power measurement in strength training locations, so that the prescription of exercises is conducted in ideal loads to the maximal MP.

Thus, the aim of this study refers to verify the inter and intradays reproducibility in a MP test, through a power measurement device, the Power Control TechnoGym@, in the seated row and front open movement in the high pulley exercises.

MATERIALS AND METHODS

The study used 15 volunteer trained women with age range of 25 and 30 years (26,2 ± 1,9), body weight between 52 and 70 Kg (59,6 ± 5,1) and height between 151 and 169 cm (161,9 ± 5,02). The volunteers should fulfill these characteristics for the inclusion in the experiment: a) be trained for at least 12 months; b) do not present any problem that would influence in the data obtaining and interpretation. After clarifying all doubts about the experimental protocol, the volunteers signed a consent form, according to the resolution 196/96 resolution norms of the National Health Board on research involving humans. The study was approved by the Ethics Committee of the Institution.

The selected exercises for the study were the seated row and the front open movement in the high pulley, conducted in *TechnoGym@* selection apparel and followed the following recommendations for the tests application: For the seated row, the seated individual with the sternum touching the board, with flexed shoulders and hands in semi-prone grip holding two front handles in a distance in which they were able to keep their elbows completely extended (figure 1). For the concentric phase, a shoulder extension performed with a flexion lower than 90° from the ante arm with the arm was adopted as breadth (figure 2). The sternum was

Figure 1 *– Initial position – seated row*

Figure 2 *– Final position (concentric phase)*

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Figure 3 *– Initial position – front pull*

Figure 4 *– Final position (concentric phase)*

touching the board during the movement, isolating hence the muscle group to be worked, being considered invalid the trial in which the sternum was removed from the board.

In the front open movement in the high pulley, the individual is seated with shoulders abducted and raised above head and elbows completely extended, with hands holding two handles to a distance wider than the shoulders width (figure 3). The concentric phase consists of a complete shoulders adduction with a flexion of the elbows. The sternum is always touching the board avoiding thus the chest movement, which would invalidate the trial (figure 4).

The MP was obtained through the *Power Control TechnoGym®* (figure 5), an electronic machine which consists of a timer with a cord attached to the base of the plaques (overload of the machine), that measures the average velocity of the movement in m/s^{-1}. This velocity is multiplied by the exercise load in kilograms and the generated MP may be seen in an electronic board which is placed in front of the individual.

The volunteers visited the test site five times, and performed the sequence that had as first exercise the seated row, followed by the front open movement in the high pulley. The height, body weight measurement and the 1RM test of the proposed exercises were conducted in the first session. The 1RM test consisted of trials for maximum loads and the maximum MP. A mild specific warm up, with two series of six repetitions, was performed prior to the test. Load increase of 2,5, 5 and 10 kg was used accordingly to the individual's perceived exertion until the maximum MP and the maximum load in the 1RM test were determined. Three minute-intervals between the trials and 10 minutes between the exercises were used. The initial load was randomly chosen and the individual received clear information that the movement should be performed with the highest velocity intention as possible in the concentric phase of the movement. A 1RM re-test was performed in the second session in order to verify the reproducibility of the obtained loads in the previous day.

Once the load that generated the maximum MP was obtained, the individuals were submitted to the third and fourth data collection sessions, where they performed tests that consisted of a previous articulatory warm up, with two series of six repetitions with 40% of the 1RM load. The volunteer was instructed to perform a single movement with the highest velocity as possible in the maximum MP generated in the 1RM test. The same warm up was used in the fifth session, and afterwards 10 repetitions were performed in the maximum MP, adopting one minute-interval between them. The generated power was written down at the end of each movement. The Latin square technique was adopted in the ordination of the three sessions in order to decrease the familiarization effect, and the proposed the initial order proposed for the exercises, that is, the row first and the pull later, keeping a five minute-interval between the exercises.

Figure 5 – Power Control

The comparison between the maximum MP results for the individualized load in the different days (interdays) and in the 10 series of the same day (intradays) was performed through the ANOVA for repeated measures and through the multiple comparisons test by Bonferroni in order to specify which measurements differ between each other, being adopted a significance index of 5%.

RESULTS

The descriptive analysis of the anthropometrical data of the 15 volunteers can be found in table 1. The maximum load percentages that generated the maximum power and the average of the power (Watts) found in the tests days of the proposed exercises can be seen in table 2. The inter and intradays inferential analysis is found in table 3.

The MP measurements found on the third day of test in the ten repetitions in the evaluated exercises can be seen in graphic 1.

Concerning the interdays reproducibility in the analysis of the measurements generated by the *Power Control TechnoGym®* for

TABLE 1
Descriptive analysis of the anthropometrical variables

Variables	Average	Standard deviation	Minimum	Maximum
Age	26	± 1.9	23	28
Weight	59	± 5.1	52	70
Height	163	± 5.02	151	167

TABLE 2
Power averages (Watts) and % max. load in 1RM in the three days of testing

Exercises	Seated row				Front pull			
Tests	1st	2nd	3rd	%CM	1st	2nd	3rd	%CM
Average	215	213	213	75	195	198	183	77
Standard deviation	56.6	51.2	54.1	9.2	43.7	46	45.4	6.9
Minimum	158	152	121	58.3	138	128	104	66.6
Maximum	372	348	379	89.4	291	298	289	89.5

TABLE 3
Inter and intradays inferential analysis

Exercises	Row		Pull	
Tests	Interdays	Intradays	Interdays	Intradays
F	0.01	0.10	0.51	0.03
p	0.991	1.00	0.607	1.00

F = variance analysis; p < 0.05.

the three days of test in the seated row exercise, no significant differences were observed in the individual power (p = 0,991), nor for the front pull exercise in the high pulley (p = 0,607). Significant differences were not observed in the row and pull exercise, respectively (p = 1000; p = 1,000), for the intradays reproducibility analysis.

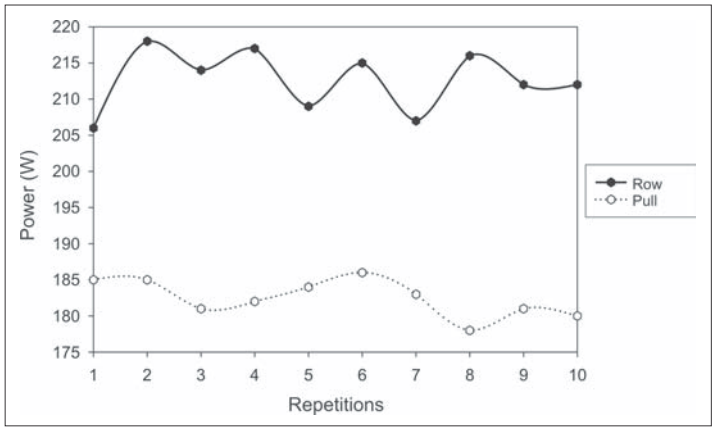
DISCUSSION

The development of a new measurement instrument should follow several criteria, among them, we can consider that the reproducibility is one of the first and most important, and therefore, should be tested in the validation process[9-10]. Concerning reliability, the greatest positive aspect of the developed methodological approach relies on the high reproducibility of the obtained data on the same day as well as on different days. Thus, in the present study, the approach of the inter and intradays reproducibility of a MP test in two distinct exercises was chosen.

Concerning the training prescription for the MP, the ideal relation between load and velocity of the movement performance is a difficult aspect to be controlled, and studies[3-4,6] demonstrate that this relation is casually connected. Moreover, the instruments for the movement's velocity measurement usually involve sophisticated apparatus, such as isokinetic equipment[11-12], the ideal velocity which tends to generate the highest power in an isokinetic dynamometer, cannot be controlled outside it. Such fact makes the data application in field situations impossible, besides the equipment's high cost. The relevance of the maximum MP measurement, performed through the *Power Control*, relies on the easiness of obtaining this relation in a short time period.

It may be found in the literature suggested loads between 30 and 60% of 1RM as ideal loads for the MP development[13-14]. On the other hand, Hoeger *et al.*[15] demonstrated the possibility of these loads reach 80% of 1RM in weight lifters. These authors believe that the muscular mass involved in the exercise seems to influence the percentage differences in the work load for the MP[13,15]. Such fact has been already mentioned in another study by Simão *et al.*[3], where maximum power developed with loads of 72,7 to 88,8% of 1RM were used in the standing row exercise. These values were above the ones found in the literature.

It is possible that the difficulty in determining the loads is due to high velocity of movement[8,16-17], and that for this purpose, lower loads should be used and work with low velocity and high loads exclusively for strength improvement should be related. The fact that the power association is generated in low loads exposes the idea that in high loads there is no need to perform higher velocities



Graphic 1 *– Behavior of the averages of the 10 repetitions on the 3rd day of testing*

than the ones chosen for the strength improvement. This fact makes it possible hence, the use of loads directed to the power training presented in lower values than the ones determined to strength training programs.

The data presented in this study corroborate with Simão *et al.*[3] concerning the load percentages in the generated maximum power. The MP average was 74,4% (65 to 86%) for the row and 77% (66 to 88%) in the front pull for 1RM, being these values much higher than the ones presented in the literature[14,16]. Such information seems to be suitable to the prescription practice for the MP training, since through it one may observe that the velocity in which the movement is performed is not an essential factor in the generated power. What seems to be essential is the relation between the load and the highest velocity intention possible with the presented load, since even without the velocity measurement, the tested individuals were instructed to perform the exercise as fast as possible in the concentric phase independently of the load.

Although the velocity has not been controlled, it did not cause problems in the trustfulness of the presented data, since one may observe that no disparity in the averages between the power generated in the three days of tests and in the power generated intradays in the 10 repetitions was found. The recovery time adopted between the 10 repetitions did not influence the power production for the muscular group analyzed, demonstrating through the verifying by Bonferroni that it did not present significant differences between the power intradays generated from the first with the other nine repetitions.

When analyzing the reproducibility of a test, one should consider that its coefficients may be influenced by several variables, such as the size and the used sample heterogeneity[10]. The inter and intradays reproducibility in a sample consisted of individuals of different conditioning levels, body weight, height and muscular strength was determined in order to evaluate the influence of this aspect in a MP test. In this study, the reproducibility in the three days of tests did not negatively influence in the results, which allows us to infer that probably there was no effect of the learning or familiarization with the evaluation procedure. The MP evaluation did not present intra and interdays significant difference, showing that the *Power Control* presents reproducibility, besides being a simple and practical means of measuring muscular power.

Considering the importance of the MP development in ordinary activities[18], one may consider that the use of this equipment in a body building environment becomes a very accessible and practical means, and the test here applied very secure, once none incidents or late muscular discomfort were reported during the tests days for the prescription of optimum loads for the evaluated population.

Due to the verified results in the study, it was possible to come to the conclusion that in the used sample, the MP measured by

the *Power Control Technogym®* presents high inter and intradays reproducibility and can be used as an interesting strategy in the muscular function evaluation, especially when the aim is the training prescription based on the results of the maximum muscular power.

Application perspective

The use of optimal loads for training prescription for the MP development has been one of the problems faced by several coaches, especially in body building rooms. The instruments used in the measurement of this physical ability do not present good data reproducibility in these training centers. The *Power Control Techno-Gym®* through a simple MP test can extract relevant information about the load responsible for generating the highest power in a specific movement. The fact of being trustworthy in this information reproduction, as demonstrated in this study, enables its use in different populations and different exercises inside body building rooms. Moreover, it is less costly when compared to other instruments such as the isokinetic ones. Thus, in a body building room, the *Power Control Technogym®* becomes a useful instrument in the prescription of work loads that aim the maximum power production, instead of the importance of this physical value in the routine activities and in the sports performance.

All the authors declared there is not any potential conflict of interests regarding this article.

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