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ORIGINAL

INDICATORS OF STRENGTH IN YOUNG WOMEN WITH DIFFERENT RELATIVE STRENGTH RATIO

INDICADORES DE FUERZA EN MUJERES JÓVENES CON DIFERENTE TASA DE FUERZA RELATIVA

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ABSTRACT

Objective: The research presented below aimed to compare the rate of relative strength (RSR) and other strength indicators among young women. Methods: 146 women were evaluated. They were distributed in three groups according to the results of the RSR obtained in the squat exercise. The results obtained in the tests of prehensile strength of the right and left hand (PSRH-PSLH), Isometric strength lower limbs (ISLL), maximum chest strength (MCS), maximum squat strength (MSS), velocity over thirty meters (V30), jump height in (CMJ), pedaling power (PP) and mean propulsive velocity of upper and lower limbs (MPVUL-MPVLL) obtained at 50%, 60%, 70% and 80% of a maximum squat repetition were compared. Results: Significant differences ($p \leq 0.01$) were observed between the groups in the MCS, CMJ, V30, MPV and PP, and most of the variables presented the difference between G1 and G3 ($p \leq 0.01$).

KEYWORDS: Relative strength ratio, mean propulsive velocity, maximal strength.

RESUMEN

La investigación que se presenta a continuación tuvo como objetivo comparar la tasa de fuerza relativa (TFR) con distintos indicadores de fuerza en mujeres jóvenes. Para esto, se evaluaron a 146 mujeres que fueron distribuidas en tres grupos, de acuerdo con los resultados de la TFR obtenida en el ejercicio de sentadilla. Se compararon los resultados obtenidos en las pruebas de fuerza prensil de la mano derecha e izquierda (FPMD- FPMI), fuerza isométrica miembros inferiores (FIMI), fuerza máxima de pecho (FMP), fuerza máxima en sentadilla (FMS) velocidad de desplazamiento sobre treinta metros (V30), altura del salto en contramovimiento (CMJ), potencia de pedaleo (PP) y la velocidad media propulsiva de miembros superiores e inferiores (VMPMS-VMPMI) obtenida al 50 %, 60 %, 70 % y 80 % de una repetición máxima en sentadilla. Como resultado, se observaron diferencias significativas ($p \leq 0,01$) entre los grupos en la FMS, CMJ, V30, VMP y PP, y la mayoría de las variables presentaban la diferencia entre el G1 y G3 ($p \leq 0,01$).

PALABRAS CLAVE: tasa de fuerza relativa, velocidad media propulsiva, fuerza máxima muscular, potencia muscular.

INTRODUCTION

The rise of team sports in the female field has led to an emphasis on evaluations in this genre since the values or trends observed in men are not generalizable to women (Montoye & Lamphiear, 1977). Factors such as the stage of the menstrual cycle and its consequent hormonal change are correlated with injuries to the anterior cruciate ligament (Ahmad et al., 2006; Wild et al., 2013), although they do not seem to affect physical performance in vertical jump and aerobic endurance tests (Aburto-Corona et al. 2020). In addition, different indicators of strength (more specifically knee extension) have been evaluated to observe their clinical implication in the development of frailty processes in women older than 75 years (Barbat-Artigas et al., 2013). Along the same lines, age (González-De Los Reyes et al., 2019) and socioeconomic level (De los Reyes et al., 2020) can determine important changes between successive categories in young female athletes. Thus, to program training loads, it is necessary to stock up on reliable indicators to achieve the best possible performance and avoid injuries according to the specific conditions of each gender.

Lower values in the percentage of relative strength ratio (RSR) are correlated with high values in execution speed in the trained population (González-Badillo & Sánchez-Medina, 2010) so that training with low loads favors specific speed by increases in muscle activation in electromyography (EMG) (McBride et al., 2002). Even loads related to the relative strength rate (RSR) vary more in their mean propulsive speed (MPV), when comparing men with women, than between women with different levels of absolute force (Torrejón et al., 2019). In the case of men, higher total values are observed both in MPV (García-Ramos et al., 2019) and in RSR in bench press and squat (Monteiro et al., 2016) although values in maximum torque for flexion of elbow appear to be similar between genders after 10 weeks of training (Gentil et al., 2016). In this regard, when MPV is measured in men in different groups according to RSR, higher values are observed in execution speed as the percentage value of maximum repetition (1MR) decreases. Likewise, when the groups are divided according to RSR (0-1.30; 1.30-1.50; greater than 1.50), more differences are found in MPV than if they are compared by% 1MR (Sánchez-Medina et al., 2017); that is, RSR values are closer indicators of explosive strength than absolute values.

Thus, when programmed workouts are performed with different percentages in loss of speed (40% vs. 20%), an equivalence is observed in the absolute strength gain, but with a favorable increase in countermovement jump (CMJ) for the second group associated with myosin IIX heavy chain preservation (Pareja-Blanco et al., 2017). Similarly, strength training at low repetitions with moderate intensity and high execution speed shows better values in explosive strength indicators in soccer players (González-Badillo et al., 2015), which may indicate a better performance in tests that require the handling of one's own body weight in terms of explosive strength. In this sense, it can be observed that said indicator is sensitive and quite stable in relation to gender and physical condition, when it is intended to observe power or speed values. Therefore, it is important to evaluate it in different populations to determine the specific estimating equations of each group.

Strength development is manifested in such a way that RSR is an important indicator when highlighting factors directly related to explosive strength, since it necessarily refers to the distribution of body weight, that is, to the efficiency of movement. Due to the above, different sports use body weight as a selection filter to determine the categories where said variable manifests the force expressed from S = m * a. Thus, the strength expressed will depend in a correlational way on both the mass and the acceleration, that is, we can increase the applied force (power) either by increasing the weight or in the acceleration. When the values are normalized per kilogram of body weight, it is more likely to find changes more related to the speed of execution. In this case, in most sports and for health purposes, absolute strength is not so important as the ability to move one's body weight with the greatest possible acceleration (Balsalobre-Fernández et al., 2017), which allows to say that low workloads with high speeds. For this reason, indicators such as the speed that one is able to execute per kilogram of weight are more efficient than the absolute force in the transfer to real life.

The RSR indicator is more sensitive to changes or gains in terms of speed, as it uses the strength applied to one's own body weight. Therefore, the objective of the present work is to compare the different components of strength with the relative strength in female university students.

MATERIALS AND METHODS

A descriptive, cross-sectional observational study was carried out. One hundred forty-six women (age 21 ± 3 years, height 163.2 ± 8.1, weight 59.9 ± 10.1) students from academic programs related to physical education, sports or recreation who agreed to participate voluntarily in the study and met the inclusion criteria such as not having physical limitations, health problems or musculoskeletal injuries that could affect the tests. The study was designed following the deontological standards recognized by the Declaration of Helsinki (worldwide) and Resolution 8430 of 1993 of the Colombian Ministry of Health. The participants were informed of the details and objectives of the study, of the confidentiality of the information and of its exclusive use for scientific purposes, and they signed the informed consent. The project was approved by the research ethics committee of the Universidad Pedagógica Nacional.

PROCEDURES

The study variables were evaluated in three sessions separated by 72 hours of recovery, during which time those evaluated could not perform any type of training. The organization and sequence of the tests was carried out as presented in Table 1. The tests were always carried out at the same time (2-4 p.m.) to avoid the effects that circadian rhythms have on neuromuscular performance (Mora-Rodríguez et al., 2012; Pallarés et al., 2015). An introductory session was used to assess body composition, medical examination and familiarization with tests, with emphasis on performance technique.

Before evaluating each test, a general warm-up was carried out with a total duration of 10 minutes, distributed as follows: 5 minutes of band jogging at a speed of 8 km/h and 5 minutes of active stretching and joint mobility.

Table 1. *Organization of the tests*

Tests of day 1	Tests of day 2	Tests of day 3
1. Grip strength 2. Isometric lower limb strength 3. Maximum chest strength 4. Maximum squat strength	1.Speed in 30 meters 2.CMJ 3.Wingate	1.MPV of upper limbs 2.MPV of lower limbs

Height was measured with a precision of 0.5 cm during maximum inhalation, using a stadiometer (seca 202, Seca Ltd., Hamburg, Germany). Body weight was measured with an electronic scale (Health Metter 599 KL IL., USA) with 0.50 g precision.

Maximum strength. Maximum upper body and lower body strength were assessed using the 1MR method on a Smith machine, which allows vertical displacement of the bar along a fixed path, with very low frictional force between the bar and support rails. The Smith machine did not have any kind of counterweight mechanism, so that it acts identically to free weights, that is, isoinertial charge (Sánchez-Medina et al., 2014). A specific warm-up was carried out using only the weight of the bar, three series of eight repetitions were carried out and after three minutes of recovery the maximum strength was estimated. During the execution of the tests, the participants observed on a screen the results of the speed obtained in each repetition and were motivated by the evaluators to do their best.

The upper limbs were assessed using the bench press test, based on the protocol proposed by Sánchez-Medina et al. (2010), that is, lying on a flat bench in a supine position and with the feet resting on it, and the hands placed on the bar in a slightly more open position than the width of the shoulders (5-7 cm). This way, the amplitude of the grip was measured so that it could be reproduced in each series. The participants were instructed to lower the bar in a slow and controlled manner until they reached 1 centimeter from the top of the xiphoid process and to wait in a state of alert, until they heard the order of the evaluator to carry out the extension of the arms to maximum speed without raising the torso and the shoulders off the bench. The pauses had a duration of approximately 1.5 s (González-Badillo et al., 2014) in order to avoid the rebound effect and allow more reproducible and consistent measurements.

The test began with a load of 10 kg, four repetitions were performed with it. Then, progressive increases of 5 kg were made, and, with them, three repetitions were executed with each weight, until the achieved MPV was less than 0.50 m / s^{-1} (Pallarés et al., 2014). From that moment on, the increases were 1 to 2 kg and two repetitions were performed with each weight, to the point where the participants were unable to perform the 180° extension and the MPV was less than or equal to 0.20 m/s. The last load that each subject was able to perform correctly to full extension was considered their 1MR.

The maximum strength of the lower limbs was assessed by means of a deep squat, for which the same protocol as that described above was used. However, the test started with a 20 kg load, in 10 kg increments, until the achieved MPV was less than 0.60 m/s-1. From then on, the increases were 3-5 kg. Subjects began in an upright position with their knees and hips fully extended, and their feet shoulder-width apart, while the bar rested on the traps at the acromion level. This position was carefully verified so that it could be reproduced in each series. For standardization and safety reasons, the participants descended in a controlled manner at an average speed of ~0.50 - 0.60 m/s^{-1} until they reached a flexion that led to a tibiofemoral angle of 35-40° in the sagittal plane, which was measured with a goniometer (Nexgen Ergonomics, Point Claire, Quebec, Canada) to achieve a deep squat (Hartmann et al., 2013). In this position, a 1.5 s pause was made, and at the order of the evaluator the participants performed an extension at maximum speed.

For the record and the control of the speed of movement of the bar, a linear speed transducer (T-FORCE Dynamic Measurement System-2, ErgotechConsulting SL, Murcia, Spain) was used, which provided auditory and visual feedback in real time, with a sampling rate of 1000 Hz. From this, the eccentric and concentric phases of each repetition were automatically determined, as well as the driving phase of the concentric phase, during which the acceleration of the bar is greater than the acceleration due to the gravity (Pallarés et al., 2014).

The breaks between series were three minutes for loads less than 80% of the estimated MR and 5 minutes for loads greater than 80% of the estimated MR (Fernández-Ortega et al., 2017; González-Badillo et al., 2014).

MPV y power. With the results obtained in the 1MR test, in chest press and squat, the participants had to execute, at 50%, 60%, 70% and 80% of 1MR, two repetitions in each movement on the Smith machine, under the protocols described above for each test (Pallarés et al., 2014). First, the tests were carried out in the chest press and later in the deep squat, after 10 minutes of recovery. For the calculation of the MPV and peak power, a linear speed transducer (T-FORCE Dynamic Measurement System-2, ErgotechConsulting S.L., Murcia, Spain) was used.

Vertical jump. It was valued through the CMJ. The jump height was calculated to the nearest 0.1 cm of the measured flight time, using an infrared timer system (Optojump, Microgate®, Italy, with a precision of 1/1000 seconds), which, over the time used in the displacement of the center of gravity during the flight phase, estimates the jump height (h) as follows: $h= (g*t^2_f)/8$, where g represents the acceleration of gravity (9.81 m/s^{-2}) (Bosco et al., 1983). Because takeoff and landing position can affect jump flight, strict instructions were given to all participants to keep their legs extended during flight time. They started from a standing position and performed a downward knee flexion movement until they approached a 90° angle, and immediately a full speed thrust, keeping their hands on their hips at all times. (González-Badillo et al., 2015). All the participants received feedback on the results obtained in each of their attempts. Five attempts separated by 3 minutes of recovery were made between each one, the highest and the lowest value were discarded; in addition, the average was made with the remainder, which was kept for the analysis.

Maximum power of lower limbs. It was evaluated on a Monark 834 E brand cycle ergometer (Monark Exercise, Varberg, Sweden) adjusting the saddle at the height of the iliac spine and with a load equivalent to 6.7% of body weight (Driss & Vandewalle, 2013). The participants had to pedal at the highest possible speed and remain seated without getting up from the chair. A specific five-minute warm-up was performed on the cycle ergometer with a pedaling frequency of 40 RPM and a resistance of 2% of body weight, and they performed 5-second sprints at the end of each minute. After three minutes of rest, the test was carried out (Colantonio et al., 2003).

Running speed. Two accelerations were carried out over a distance of 30 meters on athletics track and the time used was recorded using the infrared light photocell system model WL34-R240 (Sick®, Germany), which were located at 0 and 30 m (Yeadon et al., 1999). Five minutes of recovery were allowed between each acceleration and, for analysis purposes, the best record was taken. The start was high with the start foot located behind the first photocell. A specific warm-up was performed where an acceleration of 10 m, 15 m and 20 meters was carried out. At the end, the participants walked slowly back to the starting line. After three minutes of recovery the test was carried out.

Isometric upper limb strength. The grip strength of both hands was assessed with the dynamometry method, so a Takei dynamometer (Scientific Instruments Co. Ltd., Tokyo, Japan) was used. Two attempts were made with each hand, and in recovery periods of three minutes, and the best result was recorded.

Isometric maximum strength of lower limbs. It was assessed using the Takei 5002 dynamometer (Scientific Instruments Co. Ltd., Tokyo, Japan). Participants performed a five-minute warm-up on a cycle ergometer at 70 RPM. After three minutes of recovery, they were positioned on the platform of the dynamometer adjusting the height of the grip to achieve a bend of the knees at an angle of 90 degrees, measured with a goniometer. The participants performed the greatest strength trying to extend their knees and keep their back straight, in order to focus the effort on the quadriceps muscles. Each one made three attempts lasting 3 seconds, the recovery time between each attempt was 3 minutes and the best of the three attempts was taken.

The relative strength ratio (RSR) was calculated taking into account the maximum strength achieved in the squat exercise by each of the participants divided by body weight.

DATA ANALYSIS

The information is presented through averages and standard deviations, according to organized groups. An analysis of variance, one-way Anova, was carried out to compare the means between the three groups for each applied strength test. Levene's statistical analysis was taken into account to evaluate the homogeneity of variances and, in the case of not passing this test, the Anova with the Brown-Forsythe adjustment was taken into account. *Post hoc* analyzes were carried out using the Gabriel or Games-Howell test, depending on the result of the homogeneity of variances test. The level of significance was set at a value of $p < 0.05$. Heta squared (η^2) and heta (η) were calculated from the following formula: (η^2) = SSG / SST sum of squares between groups / sum of squares of the total and was provided as a measure of effect size in the Anova. Up to a value of 0.2 was taken into account for a small effect size, 0.5 for a medium one, 0.8 for a large one, and 1.3 for a very large one.

RESULTS

146 young women with a mean age of 21 ± 3 were evaluated; weight 59.88 kg ± 10.24 kg; height 163.46 cm ± 8.32 cm and a body mass index of 22.35 kg/m^2 ± 3.01 kg/m^2.

The descriptive results of the strength variables obtained by the entire group are presented in Table 2.

Table 2 Isometric strength values, maximum force, running speed, average propulsive speed and power

Variable	Mean
Right dynamometry (kg)	28,7 ± 6,6
Left dynamometry (kg)	27,4 ± 6,3
Isometry mi (kg)	77,3 ± 19,5
Bench press (kg)	41,5 ± 14,4
Squat (kg)	46,5 ± 15,4
Race 30 m (s)	5,0 ± 0,46
PMS ms 50 (m,s-1)	0,8 ± 0,25
PMS ms 60 (m,s-1)	0,7 ± 0,11
PMS ms 70 (m,s-1)	0,6 ± 0,10
PMS ms 80 (m/s^{-1})	0,4 ± 0,90
PMS mi 50 (m/s^{-1})	0,7 ± 0,22
PMS mi 60 (m/s^{-1})	0,7 ± 0,11
PMS mi 70 (m/$^{s-1}$)	0,6 ± 0,10
PMS mi 80 (m/$^{s-1}$)	0,5 ± 0,12
Absolute power peak (kg)	387,3 ± 126,5
Relative power peak (kg)	6,3 ± 1,5

Note: mean values ± standard deviation

For the purposes of the analysis, the group was divided into three subgroups according to the results of RSR evaluated in the deep squat exercise and selecting the terciles as cut-off points as follows: group 1 (G1) RSR ≤ 0.6502; group 2 (G2) 0.6502> RSR ≤ 0.8404 and group 3 (G3) RSR> 0.8404. The characteristics of the sample divided into these three groups are presented in Table 3.

Table 3. Characteristics of the sample according to the relative strength ratio in the squat exercise. Groups organized by terciles

Variables	G1(n = 48)	G2 G1(n = 49)	G3 G1(n =49)
Age (years)	21 ± 3	21 ± 3	20 ± 3
Size (cm)	162,4 ± 8,6	163,04 ± 8,7	164,91 ± 7,4
Weight (kg)	59,9 ± 10,6	60,63 ± 10,2	59,12 ± 10,0
BMI (kg/m^2)	22,6 ± 3,2	22,73 ± 2,8	21,67 ± 2,9

Note: mean values ± standard deviation.

The one-factor analysis of variance (Anova) does not show significant differences (p > 0.05) in the general characteristics of the sample in the three groups according to the RSR.

The results of the different strength tests obtained by each of the groups are presented in Table 4. The results of the Anova of the maximum strength tests MPLL, MCS, MSS, MPVUL at 50% and absolute PP did not comply with the assumption of homogeneity of variances, so the significance value is reported with the Brown-Forsythe adjustment.

Table 4. Comparative values of the different strength tests grouped by relative squat strength values.

Variables	G1(n = 48)	G2 G1(n = 49)	G3 G1(n = 49)	Size of the effect (η)
Jump height (cm)	25,95 ± 25,2	25,5 ± 6,2	31,04 ± 14,2	0,148
Right dynamometry (kg)	26,42 ± 5,2 **	28,19 ± 6,3 **	31,62 ± 7,09 **	0,328
Left dynamometry (kg)	24,87 ± 5,3 *	26,97 ± 6,2	30,34 ± 6,2 *	0,357
ISLL (kg)	68,63 ± 13,3 &	76,82 ± 20,2 &	86,5 ± 20,1	0,375
Maximum chest press strength (kg)	32,4 ± 8,7 &&	40,6 ± 14,1 &&	51,5 ± 12,8 &&	0,547
Squat Max Strength (kg)	32,9 ± 8,3 &&	44,3 ± 7,4 &&	62,3 ± 12,3 &&	0,785
RSR	0,53 ± 0,09 &&	0,73 ± 0,05 &&	1,05 ± 0,15 &&	0,896
Speed 30 m (m/s)	5,70 ± 0,36 **	6,06 ± 0,52 **	6,47 ± 0,52 **	0,555
MPVUL 50 % 1MR (m/s^{-1})	0,70 ± 0,27 &	0,76 ± 0,26	0,85 ± 0,17 &	0,259
MPVUL 60 % 1MR (m/s^{-1})	0,63 ± 0,09	0,67 ± 0,11	0,67 ± 0,11	0,179
MPVUL 70 % 1MR (m/s^{-1})	0,52 ± 0,09	0,5 ± 0,11	0,54 ± 0,11	0,119
MPVUL 80 % 1MR (m/s^{-1})	0,37 ± 0,09	0,39 ± 0,09	0,4 ± 0,1	0,168
MPVULL 50 % 1MR (m/s^{-1})	0,70 ± 0,25 *	0,72 ± 0,21	0,8 ± 0,18 *	0,212

MPVULL 60 % 1MR (m/s^{-1})	0,64 ± 0,11 *	0,66 ± 0,11	0,72 ± 0,08 *	0,308
MPVULL 70 % 1MR (m/s^{-1})	0,54 ± 0,1 *	0,58 ± 0,09	0,61 ± 0,09 *	0,266
MPVULL 80 % 1MR (m/s^{-1})	0,41 ± 0,11 **	0,48 ± **0,12	0,48 ± 0,13 **	0,271
Absolute peak power (kg)	314,7 ± 89,4 &&	393,9 ± 124,3 &&	453,3 ± 123,5 &&	0,449
Relative peak power (kg)	5,4 ± 1,2 **	6,3 ± 1,32 **	7,1 ± 1,5 **	0,448

Note: ISLL: isometric strength lower limb; RSR: relative strength ratio; MPVUL: mean propulsive velocity in upper limbs; MPVLL: mean propulsive velocity in lower limbs.
* Significant differences post hoc Gabriel between G1 and G3.
** Significant differences between post hoc Gabriel G1, G2 and G3.
& Significant differences post hoc Games-Howell between G1 and G3.
&& Significant differences post hoc Games-Howell from G1, G2 and G3.

Height in the CMJ did not show differences between the groups. The grip strength of the right hand showed significant differences ($p < 0.001$) among the three groups. In the left hand, despite observing differences between the three groups, it was only significant between G1 and G3. Significant differences ($p < 0.001$) were found among the three groups in the maximum strength in the bench press, and only a significant difference ($p < 0.001$) between G1 and G3 was found in the ISLL.

The MPV variables analyzed in relation to the percentage of 1MR were obtained from a total of 1168 datasets. Significant differences were observed in the upper limb MPV between G1 and G3 (post hoc Games-Howell; $p = 0.003$), only when the movement was executed at 50% 1MR. In the lower limb MPV, there were significant differences ($p < 0.05$) between G1 and G3 at 50%, 60% and 70% of 1MR, while at 80% of 1MR the difference was significant ($p = 0.004$) between the three groups.

Finally, regarding the peak power and relative power obtained by the Wingate test, there were significant differences ($p < 0.001$) between the three groups.

DISCUSSION

The main finding of this study was to identify the incidence that RSR has on various manifestations of strength. To do this, the total sample was divided into three subgroups according to the RSR values in the deep squat in order to study whether it influences various manifestations of strength. The results indicate that in a group of young non-athletic women with similar body characteristics, the differences that occur in various manifestations of strength could depend on the RSR except in the height of the jump. The literature review did not identify previous studies that addressed this issue.

Sánchez-Medina et al. (2010), with a total sample of 100 men with experience of 1.5 to 4 years in weight training, researched whether the maximum power load depends on the individual strength levels. The population was divided into three subgroups, according to the RSR in chest press of each subject: group 1 (G1), n = 34, 0.95 ≤ RSR ≤ 1.14; group 2 (G2), n = 36, 1.16 ≤ RSR ≤ 1.31; and group 3 (G3), n = 30, 1.34 ≤ RSR ≤ 2.09. This study did not identify significant differences between the groups for any of the three parameters examined (maximum power, mean propulsive power and peak power), although it did identify some trend towards slightly lower P_{max} loads for the stronger group (G3). In a later study, Sánchez-Medina et al. (2017), conducted also with male athletes, verified whether the speed reached in each percentage of 1MR in deep squat depended on the levels of the RSR, the subjects were classified into three subgroups according to their RSR group 1 (G1), n = 24, RSR ≤ 1.30; group 2 (G2), n = 29, 1.30 <RSR ≤ 1.50; and group 3 (G3), n = 27, RSR> 1.50, did not find significant differences for the MPV achieved in each percentage of 1MR, or in the mean speed of 1MR between groups, there was no correlation between V1MR and RSR. González-Badillo et al. (Gonzalez-Badillo & Sanchez-Medina, 2010) (Conceicao, Fernandes, Lewis, Gonzalez-Badillo, & Jimenez-Reyes, 2016) indicate that the load-velocity profile does not appear to differ between participants matched by age and with different RSRs.

These results differ from those reported in the present study, where significant differences ($p < 0.001$ and 0.05) were observed between the three groups in various manifestations of strength such as grip strength, the 30-meter run, and MPV deep for each percentage of the 1MR (50-60-70-80%), and the absolute and relative peak power in pedaling. Even in the chest press MPV, despite not presenting significant differences among the three groups, a trend of a higher MPV is observed in all the 1MR percentages in the higher strength groups. The results of the present study also indicate significant differences in the load-velocity profile in deep squat associated with RSR.

Studies such as that of Torrejon and Balsalobre-Fernandez (2019), where the groups were also classified according to their RSR, observed weak differences in the speed of 1MR between the group of strong and weak men (ES = 0.18) and moderate between strong women compared to their weak counterparts (ES = 0.78). They also identified small differences in the slope of the loading speed profile between strong and weak women (ES = -0.39)

These differences between the studies could be due to the fact that the participants in the studies by Sánchez-Medina et al. (2017) were athletes, men with a deep squat RSR greater than 1.0, while in the present study the participants were women, non-athletes and with a RSR of 0.65 for the weak group and 0.84 for the strong group. One of the main drawbacks of these studies, as stated by Torrejón et al. (2019), is that the loading speed profile has been analyzed almost exclusively in men. Therefore, there is a need to replicate this type of research with women to determine the possible effects of RSR on the different manifestations of strength, considering the large differences in strength between men and women.

This observation is confirmed by the study by Balsalobre et al. (2017), in which they indicate that the velocity associated with each 1MR percentage during the military press exercise is higher in men than in women, and that individual loading speed profiles can be markedly different from the general loading speed profile obtained from the entire data set. This confirms the existence of individual loading rate profiles (i.e., the same absolute value of MPV may represent a different 1-MR percentage for each participant).

The mean MPV values obtained at 50% (0.74 m/s^{-1}), 60% (0.67 m/s^{-1}), 70% (0.58 m/s^{-1}), 80% (0,46 m/s^{-1}) of 1MR squat in the present study confirm these postulates and differ from those observed by Conceicao et al. (2016) that for the same percentages of 1MR presents values of 0.93 m/s^{-1}, 0.81 m/s^{-1}, 0.69 m/s^{-1} and 0.57 $m/^{-1}$ respectively, or those of Sánchez-Medina (2017), 1,14 m/s^{-1},1,0 m/s^{-1}, 0,84 m/s^{-1} and 0,68 m/s^{-1}.

These differences are also observed when comparing speed values for each percentage of 1MR between youth and middle-aged adults. (Fernandes et al., 2018).

This could indicate that both sex and age may have implications for RSR and that, in women, it is lower than in men. In addition, it can indicate, in that case, what its minimum value would be to establish it as an inclusion criterion as in previous studies.

It could then be assumed that the results of the different manifestations of strength evaluated here depend on the RSR in untrained women. This is confirmed by observing that the group with the highest RSR is the one that presents the best results in all the manifestations of strength evaluated in the present study, even in those in which no significant differences were identified between the groups, as is the case of MPV on the bench press.

Therefore, it is imperative that the mass of the individual is incorporated in the calculation of the strength used (Cormie et al, 2007) in order to really know their level of strength.

To our knowledge, this is the first study that has explored the differences that can occur in different manifestations of strength in a group of women when they are distributed into groups according to their RSR obtained in 1MR deep squat.

CONCLUSIONS

The results of the present study would indicate that the RSR in a population of young, non-athletic women has a great impact on the results of a wide range of manifestations of strength such as grip, isometric strength, maximum strength of upper and lower limbs , the power of upper and lower limbs and the speed of movement. Likewise, maximum squat strength is a good predictor of other manifestations of strength.

The results would suppose that the MPV, unlike other studies, presented significant differences between the RSR groups, which may suggest that the MPV is an indicator that behaves more reliably in groups with greater experience in strength training.

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