The efficacy of push-up test corrected by the body mass index, to determine the absolute muscular endurance in women of the brazilian army


ABSTRACT: The present study it had as objective to evaluate the effectiveness of the push up test, corrected for the body mass index, in the determination of the absolute endurance muscular for women in the brazilian army. The sample was constituted by 37 military, women, with ages understood between 18 and 32 years old, incorporated in the School of Management of the Army and in the Military Institute of Engineering in the year of 2001. These had been submitted to push up test, to 1RM bench press test and to 40% of 1RM bench press test, and had measured their height and their weight. The evaluated women had presented age of 25.2 ± 4.84 years, weight of 59.2 ± 7.33 Kg and height of 1.64 ± 0.05m. For the verification of the hypothesis used the defined techniques of the inferential statistics in the test of correlation of Pearson in the direction for verify the degree of proportionality between the two analyzed methods: The push up test with and without the body mass index, when related with the standard test (40% of 1RM bench press test). The considered level of significance was of p< 0.05, that is, 95% of certainty for the affirmations and/or refusals that the present study comes to denote. The push up test, when compared with the 1RM bench press test, as one expected, it did not present significant correlation (r>0.70), denoting that the two methods of evaluation present discord when of the real quantification of the performance of the individual. In the matching of the same test, now corrected for the body mass index, the correlation coefficient in equal 0.79674 ≈ 0.80 > 0.70, that is significant; it denotes thus with strong significance that the considered model, that obeys a “cubical curve, justifies to the values of the number of replications of push up test to the values of the number of 1RM in the bench press test, improving the evaluation process.

Keywords: Push up, endurance muscular, military, women

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RESUMO

Eficácia do teste de flexão e extensão de braços, corrigida pelo índice de massa corporal, na determinação da resistência muscular localizada absoluta em mulheres do exército brasileiro

O presente estudo teve como objetivo avaliar a eficácia do teste de flexão e extensão de braços, corrigida pelo índice de massa corporal, na determinação da resistência muscular absoluta para mulheres no exército brasileiro. A amostra foi constituída por 37 (trinta e sete) militares, do sexo feminino, com idades compreendidas entre 18 e 32 anos, incorporadas na Escola de Administração do Exército no Instituto Militar de Engenharia, do ano de 2001. Estas foram submetidas ao teste de flexão e extensão de braços, ao teste de 1RM no supino, ao teste de repetições máximas a 40% de 1RM no supino e tiveram medidas sua estatura e seu peso corporal. As mulheres avaliadas apresentaram idade de 25,2 ± 4,84 anos, peso de 59,2 ± 7,33 Kg e estatura de 1,64 ± 0,05m. Para o teste das hipóteses, foram utilizadas as técnicas da estatística inferencial definidas na teste de correlação de Pearson no sentido de comprovar a grau de proporcionalidade entre os dois métodos analisados, o teste de flexão e extensão de braços com e sem o índice de massa corporal, quando cruzados com o test padrão (teste de repetições máximas a 40% de 1RM no supino) entendendo que a normalização dos resultados observados pela massa corporal seja o processo de melhora na sintonia final do teste. O nível de significância considerado foi de p< 0,05, isto é, 95% de segurança para as afirmativas e/ou negativas que o presente estudo vinga denotar. O teste de flexão e extensão de braços quando é comparado ao teste de repetições máximas no supino, como se esperava, não apresentou correlação significativa (r > 0,70), denotando que os dois métodos de avaliação apresentam discordância na quantificação total do desempenho do indivíduo. Na comparação do mesmo teste, agora corrigido pelo índice de massa corporal, o coeficiente de correlação é igual 0,79674 = 0,80 > 0,70, isto é, significativo, denota com forte significância que o modelo proposto, que obedece uma curva cúbica, ajusta os valores do número de repetições do teste flexão e extensão de braços aos valores do número de repetições máximos no supino e assim melhorando o processo de avaliação. Então fica comprovado que o referido modelo ajusta de modo satisfatório e significativo a eficácia do teste de flexão e extensão.

Palavras-chave: Teste de flexão e extensão de braços, RML, militares, mulheres

INTRODUCTION

The physical evaluation test is a simple way to measure the ability of the military to move his body efficiently, using his greatest muscular groups and the cardio-respiratory system, whose results are strongly linked to his physical capacity level and his ability to perform military duty. (KNAPIK, 1989)

Every military, including women, apt to the military physical training (MPT) in the Brazilian army (BA) performs three times a year the physical evaluation test, that consists of cardio-pulmonary and neuromuscular tests (Brazil, 1990). According to the index the military achieves he receives an indication as insufficient, regular, good, very good or excellent. This indication grants the military points which are going to have influence on his promotion.

According to the Ministerial Regulation number 739 (Brazil, 1997), in the physical evaluation test, women perform the following exercises: 12 min. Run, sit-ups and push-ups.

The push-up exercises that consists of a sequence of push-ups leaning on the ground, is used aiming to evaluate the force and the muscular endurance of the push-ups (biceps, chest and triceps).

In military area, the muscular force of the superior limbs is necessary to the several tasks of the military training program. In many situations, it is required that the military lifts and stands his own body weight. These demands, military tasks, are only performed by male military. Women don’t need to be apt for fight, but to administration, as their work in the Brazilian army are mainly administrative. Then, why are women and men evaluated under the same requirements if women don’t need to lift or stand their body weight within their duty.

According to POLLOCK and WILMORE (1993), the muscular endurance has been measured by many ways, including the greater number of push-ups performed within an indefinite time. Many of these tests penalize the ones who have long arms and/ or legs, or the overweighted ones. In order to eliminate this effect, it was carried out a concept that uses an established percentage of his body weight as the boundary resistance; the person lifts this weight as much as possible or until he is dropped with fatigue.

Solid general lines, related to the real pattern percentage of the muscular weight for each tested group, weren’t established yet.
Actually, it is called in question if the weight to be used must really represent a body weight percentage or a settled percentage of the person’s 1-RM, or the absolute force.

What is observed in the superior muscular endurance evaluation, is that women within the same age, the same function and that differs from the others according to her body weight and height, realize the same number of repetitions, in the push-ups, achieving the same indication or grade. This is unfair to those ones who are higher or weighs more, as they need to make use of more force to perform the exercises. In this test, the evaluation isn’t observing what is necessary for their work to be done.

This problem does not only exist in the barracks. Media shows every day information about how important it is to preserve health and weave-being. This positive advertisement lead people to work out in gyms, clubs, parks, on the streets, leisure areas, cycle track, etc. searching for an improvement, not only physical, but also in health, even if it isn’t the main purpose. About this fitness movement, NOVAES & SILVEIRA NETO (1996) mention that:

“...the great number of people that reaches an improvement in life quality, health, esthetics and social and inner well-being, through the systematic practice of the supervised activities, does not allow this movement to stop developing.” (p.3)

Some people looks for a professional support, but some don’t. Those who want to be under an organized physical fitness program, based on scientifically concepts, must go through an evaluation in the beginning that includes the physical fitness aimed according to that person’s intent.

Following what FLECK & KRAEMER (1999) mentioned, there is a great level force variation between men and women when comparing the absolute muscular force. On the other hand, when we compare the relative muscular force of the superior part of the body, the difference between them decreases vertiginously. In the last decades, it can be observed that the researches amount in measure and evaluation area has been increasing a lot, however, there is a great lack of it about the differences between men and women push-ups.

When the amount of qualities and characteristics of human beings are evaluated, the development of a value measure technique is a problem (BEUNEN & BORNS, 1990). The obstacle for the authentication of a test is, mainly, to measure exactly what is aimed and its capacity to be useful with other people. FARINATTI and MONTEIRO (1996) states that the perfect test does not exist, in other words, every technique may provide mistakes.

Recently, RUTHERFORD & CORBIN (1993) compared the tests that evaluate force and muscular endurance of the superior limbs and that presented more trustful results than the other field tests. The disadvantages found in the lab tests are that they require special equipment, making it hard to be used in great populations. So, the authors selected the field tests as authentic evaluation tests when a great number of people needs to be evaluated.

RICCI e col.(1998) claimed that in superior limbs force and muscular endurance tests, it is more common to use for men the pull-up test, which is not performed by women due to morphological, myological and also cultural reasons.

According to DANTAS (1998), when it is intended to evaluate muscular endurance found in a specific muscular group, it can be used the maximum repetition test (MRT), which consists of performing the greatest repetition amount with a pre-established weight from 1 RM percentage.

From a pre-comprehension of the methods used to evaluate muscular endurance found in the superior limbs, the study suggests an introduction of a new evaluation factor. Observing the aspects of the phenomenological and axiomatic comprehension, aiming a phenomenological explanation creating then a hermeneutic and dialectical cycle of the scientific knowledge.

MATERIALS AND METHODS

Sample selection

This study’s sample was chosen intentionally, under medical evaluation to verify any significant orthopedic problem together with the arms and trunk, or any other contraindication against hard exercises whose characteristics are used in this present study. Those ones who presented muscular-skeletal harm incompatible or who used substances to improve force and muscular endurance were left out of the research. Every one was informed about this researches’ nature and signed the participation agreement statement, according to the rules to realize Human being researches, from the National Health Organization.

Sample

The theoretical and formal sample of this study was focused on military women, physically active, within thirty-seven women n=37, evaluated in two military organizations: Army Business School and Military Institute of Engineering. It is important to mention that the Brazilian Army holds around 3000 women. The evaluated women observed all the presented procedures, being within the age of 25.2 ± 4.84 years, weight 59.2 ± 7.33 kg and height of 1.64 ± 0.05 m. The general age, weight and height absolute values are presented in chart 1.

Protocols

The body weight (Kg) and height (cm) were measured in the 37 people of this study to characterize a sample. ROSS & MARFELL-JONES (1991)’s technique was used to measure these anthropometric variables.

An experimental study was carried out, aiming to verify which is the 1 RM bench press test percentage that presents a more significant correlation with the push-up test. Ten volunteers military women from the Brazilian Army, physically active, working in the Military Institute of Engineering, in Rio de Janeiro, within the age of 18.4 ± 0.5 years old, body weight of
51.7 ± 3.4 kg and height of 160.1 ± 4.5 cm, were submitted to TFEF, and, two days later, to the 40, 50, 60 and 70%-1RM bench press test (BPT). Pearson’s correlation coefficient (F) between TFEF and the 40, 50, 60 and 70%-1RM ST equaled 0.43 (p=0.016), 0.34 (p=0.029), 0.35 (p=0.019) and 0.35 (p=0.034), respectively. (LAPORTA JUNIOR & FERNANDES FILHO, 2001).

Due to the obtained results, it can be inferred that the 40% of 1RM is the one presenting the most suitable correlation with TFEF, being for this reason, it was chosen percentage to be used in this data acquisition.

Measurements

The data was collected in two steps:

1st ) In the Army Business School – Salvador (BA), in the pre-established days.

2nd ) In the Army Physical Education School – Rio de Janeiro, in the Military Institute of Engineering.

The military women were under the following procedures:

1) An anamnesis and a medical evaluation that collected the following information: age, physical activity level, arm and trunk orthopedic problems, or any other contraindication for hard exercises, considering the parameters set in this research.

2) Right performance training for every test presented in this research. The 1RM test and the maximum repetition bench press test were performed with barbell and weight, what required a more intensive training, as the evaluated were not used to the test. The ones into this study had to learn how to make the biggest force possible in the exercises. The push-up test was easier, as the samples are used to it in the military physical training, in which they are submitted to.

3) No special equipment was used by the evaluated ones and each one had been informed not to eat an hour before any test, but they all had a substantial meal at least five hours before each test.

4) The author promoted a specific warm-up for each activity, which consisted of bench press repetitions (very low weight), followed by limber.

5) In the first day, weight, height and the 1RM bench press test were applied.

6) In the second day, a push-up test was performed.

7) In the third day, a bench press test in 40% took place.

8) The procedures were carried out every other day, in each collect step and, in the tests’ days, the evaluated didn’t perform any activity that requires intensive work of the neuromuscular system.

9) During each of the three days of research, the conditions (hour, clothing and place) were reproduced and the performance sequence was properly repeated.

Statistical Analysis

Descriptive Statistical techniques were employed, aiming to characterize the study sample according to the selected variables. For the continuous nature ones that followed a well-defined metric system, were employed mean, pattern deflection, variation, total amplitude and curtose, in order to understand sample homogeneity and dispersion index for symmetry analysis of the frequency distribution under a normal curve. For the discreet nature variables, the frequency distributions were employed, considering the absolute values and their relative values.

In order to test hypothesis, statistic techniques of inference were employed, explained in Pearson’s correlation test, through the pairing method, in order to verify proportion degree between the two analyzed methods, when compared with the pattern test (supine), inferring that the results normalization observed in body mass are the test improvement process.

This research has observed the basic considerations in the statistical view, to keep the research’s scientific characteristics. The importance level verified was p<0.05, in other words, 95% sure for the statements this study provides. The estimation’s mistake observed the bi-caudal limits of the mean distribution, corresponding to the calculated pattern mistake to an amplitude of 99% according to the Z score (standardized distribution).

RESULTS AND DISCUSSION

Mean values and their derivatives for the body mass index

The mean values and their derivatives regarding BMI are shown in Chart 2.

It is interesting to notice that the mean value of the body mass index was considered normal, as the sample was composed of physically active women. According to ACSM (2000), values from 25kg m² increase the decease risk, related to the cardio-vascular system. After observing the sample, only one woman presented a higher value. It is due to the fact that all women, taking part in this study, are military students and, because of that they are under an intensive and extremely controlled military physical training.

Mean values and their derivatives for the tests

The mean values and their derivatives, regarding the 40% of 1RM test (supine), maximum repetition test (supine) and the push-ups are in CHART 3.

<table>
<thead>
<tr>
<th>Chart 1 – Mean values for age, weight and height</th>
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<tr>
<td><strong>Description</strong></td>
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<tr>
<td>N</td>
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<tr>
<td>Mean</td>
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<td>PD</td>
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The push-up test presented 23 repetitions. The sample’s homogeneity was assured through the curtose test, presenting a central aspect, whose mean values are within a 95% interval, that show what was previously exposed, when from 23.33 to 29.24 repetitions are observed, as the interval within the mean.

The 1RM bench press test was 36.8kg. The sample’s homogeneity was assured through the curtose test, presenting a central aspect, whose mean values are within a 95% interval, that show what was previously exposed, when from 37.47 to 42.92kg are observed, as the interval within the mean.

The maximum repetition bench press test presented 25 repetitions. The sample’s homogeneity was assured through the curtose test, presenting a central aspect, whose mean values are within a 95% interval, that show what was previously exposed, when from 25.08 to 27.84 repetitions are observed, as the interval within the mean.

**Discussion and correlation between the tests**

This study’s statistical purpose, is to establish a regression curve, in order to suit the push-up test, once it is the one utilized to evaluate force and physical endurance of the superior limbs. This need is taken into consideration, once this author understands that when push-ups frequency are observed, points like body weight and height are not taken into consideration, and for this reason, they are not used as differential tools. So, even if the evaluated presented differences in these orthopedic details, they need to perform the same number of repetitions to achieve the same score.

Once this problem is reasoned out, a physical and bio-mechanical concepts approach is developed, realizing that the full work matches the best parameter for the comparative analysis between the utilized method (Push-up test) and the alternative chosen test (Maximum repetition in the bench press).

Observing that the full work (W) tallies with:

\[ W = \text{Force} \times \text{Displacement}, \text{being Force (F) directly proportional to Body weight (P), where F = f(P) and the full displacement is directly proportional to the double (up and down) of the full frequency times (number of repetitions) the full arm length. Then, we conclude that:} \]

\[ W (\text{push-up}) = f(P) \times \text{number of repetitions} \times \text{arm length} \]
\[ W (\text{bench press}) = f(40\% \text{ 1RM}) \times \text{number of BP repetitions} \times \text{arm length} \]

Considering also that in the bench press bio-mechanic execution, we will obtain the full displacement corresponding to the arm length, making it possible to eliminate the comparative relation, once it is a constant inside the system.

In order to analyze the correlation, three initial factors are obtained as follows:

- **Factor 1** - corresponds to the proportional element of the full work performed in the push-up test:
  \[ \text{Factor 1} = f(P) \times \text{number of push-ups} \]

- **Factor 2** - corresponds to the proportional element of the full work performed in the maximum repetition bench press test:
  \[ \text{Factor 2} = f(40\% \text{ 1RM}) \times \text{number of bench press repetitions} \]

- **Factor 3** - corresponds to the quantitative element, related to the number of repetitions in the push-up sequence, that is the beginning point for the evaluation concept creation.

\[ \text{Factor 3} = \text{number of push-ups} \]

The mean values and their derivatives for the striped factors above are presented in **CHART4**:

Pearson’s correlation test will be employed, in order to analyze this.

When Pearson’s correlation test is employed between these three factors, the following results on **CHART 5** are obtained:

First, it is observed that there are significant differences between factor1 and factor2, understood here as the lacking of significant
correlation \((r < 0.70)\) between the respective data, and then, the lacking of direct proportion relation between both factors.

\[ f(P) \times \text{number of push-ups} = f(\text{Max.force}) \times \text{number of bench press} \]

From the three crossing, the first one (factor1 x factor2), as it was expected, didn’t present a significant correlation \((r > 0.70)\), indicating that the two evaluation methods present a disagreement, according to the evaluator’s real perform quantification. This fact is corroborated by the fact that the correlation between factor 1 and factor2 are significant \((r = 0.80 > 0.70)\), according to what was also expected and, unlike it, the non-correlation between factor2 and factor3.

These results are analyzed together, leading to the conclusion that there is a real disarrangement in the force of the superior limbs quantification and scoring if they are analyzed directly through the push-ups number of repetitions.

According to the current inferential statistics, the multiple regression method will be employed (Stepwise Selection Correlation), in order to build a better curve that can adjust the full frequency (number of repetitions), observed in both evaluation methods, push-up and bench press, taking into consideration the lack of a direct proportion relation between them, obtaining as a variable to interface these frequencies, the BMI, body mass index, derivative from the ratio between weight and height.

During the second moment of inferential statistics approach, using as a dependent variable the bench press number of repetitions, called factor4 and as an independent variable the ratio between the push-up number of repetitions and the body mass index, called factor5. The acquired results follows below:

- Factor 4 = Bench press number of repetitions
- Factor 5 = Push-up number of repetitions / BMI

Considering that the correlation coefficient equals 0.79674 = 0.80 > 0.70, in other words, significant, denoting with strong significance that the aimed model, that follows the cubic curve, adjusts the values of factor5 (push-up number of repetitions) with the values of factor4 (bench press number of repetitions) and, then improving the evaluation process, according what is shown in the graphic.

| Chart 4 - Mean values and their derivatives for the factors 1, 2, 3 and 4 |
|---|---|---|---|---|
|  | Factor 1 | Factor 2 | Factor 3 | Factor 4 |
| n | 37 | 37 | 37 | 37 |
| Mean | 1646.27 | 420.66 | 27.78 | 26.46 |
| P.D. | 355.26 | 96.10 | 4.52 | 4.27 |

| Chart 5 - Pearson's coefficient and correlation |
|---|---|---|
| Crossing | Pearson's r | Result |
| Factor1 and factor2 | 0.339811 | Not significant |
| Factor1 and factor3 | 0.808483 | Significant |
| Factor2 and factor3 | 0.393679 | Not significant |

Taking into consideration that the main purpose of this dissertation is focused on the efficacy of the push-up test, corrected by the body mass index, in order to determine the muscular endurance in Brazilian military women, corroborating that the referred model adjusts satisfactorily and significantly the push-up test efficacy.

**CONCLUSION**

The most important from this work is that the most common evaluation test to measure women’s muscular endurance located in the superior limbs, the push-up test did not present a significant correlation with the bench press maximum number of repetitions. It means that the examined test is not authentic to measure muscular endurance located in the superior limbs.

The results obtained in this study indicates that the body weight and height are the most influent factors in the performance in the investigated field. Inversely, these same tests present a significant correlation when the body mass index is employed to correct the push-up test.

It is important to emphasize that in the Brazilian Army, women are facing the administrative area, while men the operational area. Then, the evaluation may and must be different. Men need to be evaluated according to his body weight, in other words, he has to be able to stand his own body; on the other hand, women are not used in combat situations, and for this reason, they do not need to stand their own body weight.

According to the previous thought, the Brazilian Army need the absolute muscular endurance in men, what may be checked, precisely, through the push-up test. In women, the object of this study, the same test corrected by the body mass index, presents a more real result, and eliminates, in part, the mistake caused by body weight and height, providing a more fair evaluation.

This study represented only a step, when comparing to what is needed in the study of physical evaluation in Army, Gyms, Clubs, etc.

In the context of this work, other qualities investigation, such as, force, aerobics resistance, anaerobic resistance and flexibility,
great importance items as physical ability component. The investigation about this kind of study for men is equally important.

The Brazilian Army has successfully taken part into peace missions, guided by the United Nations Organization. Among the many factors for the Brazilian military success in this kind of mission, is the worry about physical capacity. The great number of studies, national and international, related to military physical training, possibly has been demonstrating the importance given to the physical care, and it reflects directly in the society, as the Army Force is part of it.

REFERENCES


