Performance analysis of women over 55 years on abdominal tests: impact of anthropometry and flexibility

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Summary

The objective of the present study was to evaluate the effect of anthropometric variables and flexibility on the performance of women aged 55+ years on abdominal test protocols. The sample was composed by 20 physically active volunteers, aged 55 years (median 61), who were participants in gymnastic activities program. Each volunteer performed two abdominal tests: partial trunk flexion with a 7.6 cm sliding of the hands (P1) and partial flexion of the trunk with the hands on the thighs (P2), both executed with the feet resting on the ground. For analysis, the number of correct executions (final position) was considered in each test, as recommended by the authors. Measurements of body mass, flexibility, height, waist and hip perimeters, subjective perception of exertion, and calculations of body mass index and waist-hip ratio were performed. The perception of abdominal effort, and discomfort or pain in the cervical and lumbar region were also evaluated. The results showed that there were no statistically significant associations between the analyzed indicators (Age: P1: rs = -0.024, p = 0.916; P2: rs = -0.194, p = 0.407; BMI: P1: rs =-0.064, p = 0.792; P2: rs = -0.235, p= 0.327; Waist Circumference: P1: rs = -0.143, p = 0.563; P2: rs = 0.027, p = 0.908; Flexibility: r s= -0.327, p = 0.169; P2: rs = 0.0009, p = 0.991; Hip waist ratio: P1: rs = -0.209, p = 0.371; P2: rs = 0.217, p = 0.353) and the performance on the tests. In addition, 35% of the participants made valid attempts on P1 while 45% produced at least one valid attempt on P2. It was concluded that both abdominal tests were adequate for the studied sample and they can be applied to adult and elderly women to assess their abdominal musculature.

Key words:
Abdominal muscles. Exercise test. Elderly. Anthropometry.

Análisis del desempeño de mujeres mayores de 55 años en test abdominales: impacto de la antropometría y flexibilidad

Resumen

El objetivo del presente estudio fue evaluar el efecto de las variables las antropométricas y la flexibilidad sobre el desempeño de mujeres mayores de 55 años en protocolos de testes abdominales. La muestra, seleccionada por criterio de accesibilidad, estuvo formada por 20 voluntarias físicamente activas, mayores de 55 años (mediana 61), que participaban en actividades gimnásticas para personas mayores. Cada voluntaria realizó dos pruebas abdominales: flexión parcial del tronco con deslizamiento de las manos de 7,6 cm (P1) y flexión parcial del tronco con las manos en los muslos (P2), ambas ejecutadas con los pies apoyados en el suelo. Para el análisis, se consideró el número de ejecuciones correctas (posición final) en cada prueba, según lo recomendado por los autores. Se realizaron mediciones de masa corporal, flexibilidad, altura, perímetro de cintura y cadera, percepción subjetiva del esfuerzo y cálculos del índice de masa corporal y la relación cintura-cadera. También se evaluó la percepción de esfuerzo abdominal y de malestar o dolor en la región cervical y lumbar. Los resultados mostraron que no hubo asociaciones estadísticamente significativas entre las variables analizadas (Edad: P1: rs = -0,024, p = 0,916; P2: rs = -0,194, p = 0,407; IMC: P1: rs =-0,064, p = 0,792; P2: rs = -0,235, p = 0,327; Perímetro de cintura: P1: rs = -0,143, p = 0,563; P2: rs = 0,027, p = 0,908; Flexibilidad: rs = -0,327, p = 0,169; P2: rs = 0,0009, p = 0,991; Relación cintura/cadera: P1: rs = -0,209, p = 0,371; P2: rs = 0,217, p = 0,353) y el desempeño en las pruebas, y el 35% de las participantes hicieron intentos válidos en P1 mientras que el 45% produjo al menos un intento válido en P2. Se concluyó que ambas pruebas abdominales fueron adecuadas para la muestra estudiada y se pueden aplicar a mujeres adultas y mayores para evaluar su musculatura abdominal.

Palabras clave:
Músculos abdominales. Prueba de esfuerzo. Anciano. Antropometría.

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Introduction

Studies on musculoskeletal fitness in people 55+ years old have shown that its components (especially strength, flexibility, and muscular endurance) are positively associated with health status, i.e., they have a predictive relationship with mortality[1-3]. In order to evaluate these aspects, fitness tests are generally used to evaluate functional capacity through the assessment of balance, upper and lower limb strength and resistance, displacement velocity, distance traveled, and flexibility[4]. However, the evaluation of abdominal resistance is not usually studied.

The preservation of abdominal strength during the aging process is fundamental for the support and containment of the abdominal contents, for the maintenance of the normal posture of the pelvis, and for the production and control of the movement of the trunk during flexion and rotation of the trunk[5]. Moreover, abdominal strength is indirectly responsible for the curvature of the lumbar spine and essential for maintaining body posture[6,7]. Furthermore, weakness of the abdominal muscles is associated with disorders such as ptosis or anterior projection of the abdominal region; difficulty raising the head while supine; impairments in breathing and in performing certain movements such as coughing, vomiting, and sneezing. Also, accentuation of lumbar lordosis, the latter being due to the disproportionate strengthening of the psoas major muscle in relation to the abdominal muscles, which causes low back pain[2].

Anthropometrics variables and flexibility undergoes significant physiological changes during the aging process[8,9]. We hypothesized that this change can affect the performance of people 55+ years old on abdominal tests. However, the relationship between anthropometrics variables, flexibility, and performance is not adequately clarified in the literature.

It is also unclear what factors can interfere with the performance of abdominal exercises, being a problem to be answered. All modifications resulting from the aging process should be considered in the evaluation of the performance of the abdominal muscles of women 55+ years old. Mainly because they can be a source of errors, especially if the performance of this test is evaluated against the protocols for abdominal tests proposed for young people and adults.

In view of the above, the present study aimed to evaluate the effect of anthropometric variables and flexibility on the performance of women aged 55+ years on two abdominal test protocols. Our hypothesis is that anthropometric variables and flexibility will be directly associated with the performance of women aged 55+ years in the proposed abdominal tests.

Materials and method

Participants

The sample of the present study was composed of physically active women. The following inclusion criteria were adopted: participants were required to be 55+ years old; be women; be clinically fit for regular physical exercise; be physically active, practicing physical exercises for at least 1 year with a frequency of 3 times a week; not have any acute or chronic illness that could be affected by the exercise; have experience in performing abdominal exercises; and consenting freely and voluntarily to perform all study procedures. The exclusion criteria were: presenting bone or joint limitation during the intervention, which prevented the performance of the abdominal exercises; and having used pharmacological drugs, which could affect the result of anthropometrics and functional assessments.

Those who agreed to participate signed an informed consent form. All procedures were approved by the Ethics Committee on Human Research of the Federal University of Viçosa, according to Resolution 466/2012 of the National Ethics Committee (CONEP), the National Health Council, in accordance with the ethical principles expressed in the Declaration of Helsinki.

The present study is observational and prospective research, with crossover design, being carried out in its entirety, in the Morphophysiology Laboratory of the Physical Education course of the Federal University of Viçosa (UFV).

Interventions

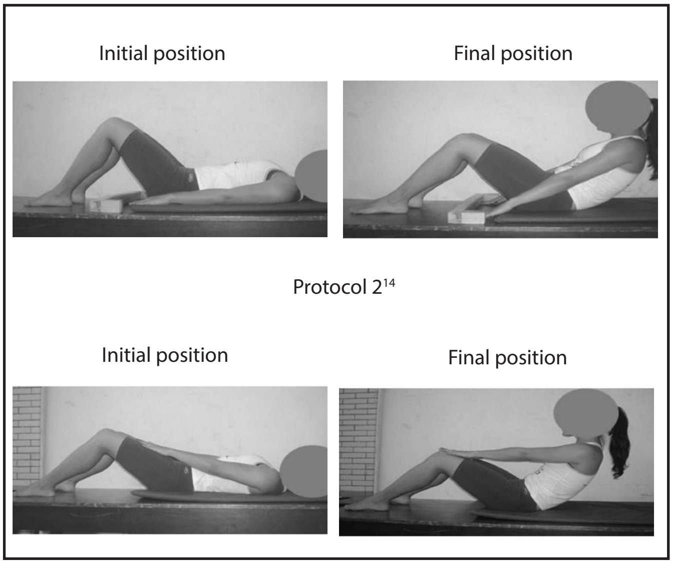
The data collection was performed on alternate days by two fully trained kinesiologists. The participants were individually evaluated by the same evaluator in a private setting and the order of execution of the tests was determined at random. A warm-up was not allowed before each test was conducted.

Two abdominal tests were used to evaluate abdominal muscle strength, both of which were chosen based on an earlier study[10]. This choice was made because the participants reported a low rate of discomfort or pain in the cervical and/or lumbar spine. The characteristics of the two protocols are described in Table 1 and Figure 1.

Table 1. Abdominal test protocols with respective duration, feet position, form of execution and number of repetitions.

Tests	Duration (min)	Feet Position	Execution	Number of repetitions
Protocol 1 (P1) - partial flexion of the trunk and sliding hands 7.6 cm (13)	1	On the ground	From the extremity of the middle fingers, set 7.6 cm on the ground; in the initial position, flex the trunk and slide hands on the ground trying to reach the 7.6 cm mark.	Higher number of repetitions
Protocol 2 (P2) - partial flexion of the trunk and hands on thighs (14)	6	On the ground	With knees bent between 120-140°; set a mark on the top edge of the patella. From the initial position, flex the trunk and slide hands on thighs until they touch the mark held on the knees.	Cadenced test; 20 repetitions/min; maximum 120 repetitions

Figure 1. Illustrative pictures of initial and final positions of the five abdominal test protocols used.



Outcomes

On the first day, before the abdominal tests execution, anthropometric measures were taken, in each volunteer, (body mass [kg] and height [cm]) to calculate the BMI and also the waist-to-hip ratio[11]. Flexibility was also assessed through the sit-and-reach test (cm)[12].

For analysis of performance in the abdominal protocols, the number of correct executions (reaching the correct final position) was considered in each test, as recommended by the developers of these tests[13,14]. All volunteers complied with the timeframes of the test protocols, regardless of whether they performed them correctly or not. In the paced test (P2), a mechanical metronome was used, with a frequency capacity of 40 to 208 beats per minute. The instrument was presented to the participants on the day before the test, to familiarize them with the rhythm to be followed.

At the end of each test, the 20 point Borg scale[15] was used to indicate the subjective perception of effort (RPE) and a scale of 0 to 4 points was used to verify the perception of discomfort or pain in the cervical and lumbar spine, effort of the abdominal muscles (0 = no discomfort/effort, 1 = very little, 2 = moderate, 3 = intense, 4 = very intense).

Sample size calculation

Considering Wilcoxon test, a priori calculation, an effect size f of 0.8 for abdominal performance[10], an α of 5% and a power of 95%. The sample size calculation performed by the G-Power® program at the University of Dusseldorf, indicated that a total sample size of 20 individuals. Thus, the total sample size was of 20 physically active women 55+ years old.

Statistical methods

The data were described as median, minimum and maximum values. The normality was verified by the Shapiro Wilk test. Comparisons between the abdominal tests were made by the Wilcoxon test and the relations among the variables were evaluated by the Spearman correlation. Interpretation of the Spearman correlation was assessed according to the following criteria: 0–0.30 negligible, 0.30–0.50 weak, 0.50–0.70 moderate, 0.70–0.90 strong, and 0.90–1.00 very strong[16]. The effect size was calculated using "r" test for Wilcoxon test. Values were classified as insignificant (<0.20), small (0.20-0.49), medium (0.50-0.79) and large (> 0.79)[17]. For all analyses, the significance level was set at $p < 0.05$.

Results

The data of the anthropometric characterization of the participants is shown in Table 2 and the results of the correct execution, the RPE, the perception of discomfort or pain in the cervical and lumbar spine and abdominal muscle effort, and the comparison of the medians of the variables studied in the two tests can be seen in Table 3.

Table 2. Mean, minimum and maximum values of the variables of anthropometric characterization of the sample.

	Median	Minimum	Maximum
Age (years)	61	55	73
Body mass (kg)	60.8	49.8	80
Height (cm)	153.5	143	160
Body Mass Index (Kg/m²)	26.32	22.56	35.32
Waist circumference (cm)	84.65	71	108
Waist-hip ratio	0.862	0.742	1.023
Flexibility (cm)	31	16	44.3

Table 3. Results (median, minimum and maximum value) of correct performances, rating of perceived exertion (RPE), perception of abdominal muscle effort, perception of discomfort or pain in the cervical and lumbar spine and comparison of medians of the P1 test[13] and P2[14].

	P1				P2			
	Med	Min	Max	Med	Min	Max	p*	ES
Correct Executions	0	0	48	0	0	23	0,497	0
RPE	12	9	15	13	7	17	0,083	0,07
Perceived abdominal effort	3	1	4	1	0	3	0,320	0,5
Pain in the cervical region	1	1	4	0	0	2	0,147	0,25
Pain in the lower back	1	1	3	0	0	1	0,375	0,33

*p-value obtained through the Wilcoxon test; ES: effect size; RPE: Rating of perceived exertion; Med: Median; Min: Minimum; Max: Maximum.

Table 4. Performance ratio in the two abdominal tests with age, body mass index, waist circumference, flexibility and waist/hip ratio.

	P1		P2	
	rs	P	rs	P
Age (years)	-0.024	0.916	-0.194	0.407
BMI (Kg/m²)	-0.064	0.792	-0.235	0.327
Waist Circumference (cm)	-0.143	0.563	0.027	0.908
Flexibility (cm)	-0.327	0.169	0.0009	0.991
Hip waist ratio	-0.209	0.371	0.217	0.353

BMI: Body Mass Index; rs: Spearman correlation.

Comparing the BMI values obtained with the values recommended by WHO[18], the participants were in general overweight and also classified as "high risk" for cardiovascular diseases by waist circumference (WC) and waist-to-hip ratio[18]. The flexibility result, when compared to the reference values[18], ranked the group as "good."

The results did not identify any statistically significant differences for all variables measured. Although a greater number of correct executions were obtained for P1, during the tests it was observed that the number of women who achieved at least one correct execution was higher for P2. The associations between test performance and anthropometric parameters are shown in Table 4, and there were no significant correlations.

Discussion

The present study aimed to evaluate the effect of anthropometric variables and flexibility on the performance of women aged 55+ years on two abdominal test protocols. The main results founded were: 1) there no significant differences in performance between the two protocols; 2) the two tests did not present significant differences for RPE, perception of abdominal effort, or perception of pain in the cervical and lumbar region; 3) there no associations between tests performance and anthropometric indicators or flexibility.

The difference in performance between the two tests was not significant (p = 0,497), noting that the median values for both were zero, indicating the difficulty the women had in their performance. This high degree of difficulty can also be verified by the median value of RPE (Table 3), indicating that both constitute exercises that require moderate to intense muscular effort, depending on individual physical fitness. However, they are abdominal tests that do not seem to impose excessive stress on the cervical and lumbar spine, as reported by the participants.

The individual performances for P1, when classified according to MacFarlane[19], showed three volunteers with weak performance, one below average and 16 unrated (below "weak"). For P2, the norm proposed by Jetté, Quenneville and Sidney[20] shows that three evaluated could not be classified because there were no parameters for the age group in question, eight had poor performance, five were below average, two average, and one above average. Therefore, if we consider individual performance only on the basis of the number of correct runs by strictly observing the test protocols, it can be inferred that, although the elderly women regularly participated in physical activities, their usual exercise program may not develop a compatible abdominal strength level with that required to achieve an expected average result for sex and age group. The physical fitness level of the patients evaluated the stage of aging they are in and the physiological changes resulting from this process, the characteristics of the population used to construct the reference values and tests, and the different physical requirements for performing these abdominal tests can also be related to performance.

Another important aspect is that each test requires distinct physical abilities that also manifest in different ways in the various phases of life. P1 is characterized by being a test where the speed of execution is an important prerequisite, because one must execute the greatest possible number of repetitions in a minute, which quickly leads to muscular fatigue. Logic indicates that 1 minute tests reflect much more than just muscular strength and instead also require muscular endurance[21]. P1 presented a higher number of correct replicates, but only by four of the women. Another important aspect with respect to P1 is the requirement for increased spine flexion to slip the hands on the ground and reach the 7.6 cm mark, which could result in pain in the cervical and lumbar region. This requirement, coupled with the speed required to perform the test, imposed a significant stress on the spine, possibly making the test uncomfortable for some people.

P2 was a cadenced test, lasting six minutes, and more women were able to perform at least one correct repetition than for P1. However, its slow execution requires more time required to support the trunk in relation to P1 and, because of this, requires good conditioning of the abdominal musculature. It has also been shown that P2 is easier to perform than P1 because of the more comfortable position of the arms and greater hip stability, which together do not interfere with the distance traveled by the hands during the exercise[22]. It also allows for a number of people to be evaluated simultaneously due to the use of the metronome. On the other hand, by controlling the number of repetitions through the metronome (20 per minute), P2 can become long, exhausting, and demotivating, and this should be considered as a possible limiting factor for the application of this test in the elderly. Despite the advantages of P2, another drawback noted was the lack of coordination and rhythm regarding the use of the metronome. The maintenance of the rhythm of movement depends on the integration of the central commands and neuromuscular coordination, particularly of muscle strength and the reaction time[23]. With aging, there is an increase in motor response time resulting from structural and functional modifications of the organism, altering the integrity of the central nervous system, contributing to slower reactions as the person ages. This decline in sensory functions along with the lack of an adequate time of practice with the instrument (metronome) were probably factors that interfered with the results.

In this study, a higher performance was expected on P2 than on P1, but this was not observed. The explanation for this may be the duration of the test, as mentioned earlier. In comparison to younger people, the elderly need to activate a higher percentage of their reduced muscle mass to generate the same force that allows them to perform and sustain exercises that must be performed with a certain intensity and time[24]. By requiring higher percentages of maximal exercise capacity, muscle fatigue can occur early in response to increased metabolic stress and decreased ability of the neuromuscular system to generate strength, work, or power during repeated muscle contractions[25]. In addition, localized muscle endurance work requires that a specific muscle group maintain the same strength level for a longer period of time, and in that case, the motivation factor may influence performance on tests aimed at assessing physical aspects. Motivation is an important factor in activities and sports that require high muscular and metabolic activity[26].

In addition to the characteristics of each test mentioned above, other aspects that could interfere with the results relate to the degree of prior engagement in physical activity and level of physical fitness of the participants, their lack of familiarity with the tests, difficulties in coordination of movements, and difficulty following the test rhythm dictated by the metronome, among others.

When compared to each other, the two tests did not present statistically significant differences for RPE, perception of abdominal effort, or perception of pain in the cervical and lumbar region (Table 3), suggesting that despite some inadequate performances, with some adaptations they could be used in women 55+ years for the purpose of abdominal muscle testing. Regarding pains in the cervical and lumbar region, it can be said that both tests are satisfactory, since the frequency at which these symptoms appeared was low, in spite of greater reports of discomfort in P1.

In regard to effort, evaluated through RPE, both tests are applicable, since values between 12 and 13 correspond to a low level of difficulty and cardiorespiratory overload[15]. The low level of perception of reported abdominal effort may be related to the low activation of the abdominal musculature; however, it is important to mention that each test implies a different perception of effort, because the SPE reflects exercise fatigue in a different way[27,28], that is, being more sensitive in the active muscles during the performance of power exercises than in central fatigue during the performance of resistance exercises[29].

Regarding the relationship between performance on the tests with anthropometric parameters and flexibility, there was also no significant difference between them (Table 4). For BMI and waist-to-hip ratio, there was a tendency for an inverse correlation. This trend indicates that overweight women may be at risk of poor performance[30], as well as limiting their involvement in structured physical activities, with a consequent reduction in muscle strength. Similarly, body weight was another variable that did not demonstrate a significant correlation with performance in both protocols. This finding suggests that, for the evaluated group, body weight does not present as a mechanical barrier to the performance of women 55+ years of age on the tests evaluated.

In this study, excess body weight may also be one of the determining factors for the low abdominal exercise performance and, even though the BMI did not present statistical significance (Table 4), it was inversely proportional to the performance of the participants. Even so, it is assumed that the increase in body mass, represented by the fat component, tends to restrict engagement in physical exercises, especially those that require strength and thus reduces muscular fitness and coordination for more complex exercises.

Flexibility did not demonstrate a statistically significant correlation with performance in the abdominal tests used, suggesting that it did not influence performance. In relation to flexibility, the range of motion of the joint decreases considerably with age, limiting the motion and function of the elderly. A decrease in flexibility along with shortening of the hip flexor muscle and extensor muscles of the back may result in additional mechanical stress on the joints and soft tissues of the lumbar spine and may cause lordosis. Thus, the deep abdominal muscles are essential to support the lumbar spine and strengthening these muscles can reduce back pain[31].

Weakening of the abdominal muscles, along with ptosis of the abdomen and shortening of the anteversory muscles of the pelvis, are factors directly related to the degree of flexibility of the lumbar spine and, consequently, directly related to low back pain. This imbalance may limit spinal movements due to impaired levels of adequate flexibility or pain caused by postural deviations. In people with reduced mobility in the articulations of the spine or with shortening of the extensors of the spine, contraction of the abdominal muscles will exert a greater compression force on the intervertebral discs than in individuals with good spine flexibility[31]. This limitation may interfere with the performance of certain exercises, such as performing trunk flexion during abdominal exercises.

Thus, based on the main findings of this study, we concluded that both abdominal tests evaluated seem to be adequate for women 55+ years, despite the difficulty most of the participants had in performing correct executions, and that anthropometric variables and flexibility did not seem to directly influence the performance.

However, despite the relevance of the results, the present study has some limitations: 1) the use of the same volunteers to carry out the two assessment protocols was a potential limitation. However, this option minimized inter-subject variability; 2) The use of only trained women 55+ years old, which prevents the generalization of the results found here for other populations (for example, men, untrained women, older adults); 3) The use of simple anthropometric measures can also be considered a limitation of the study, since anthropometry has low sensitivity and high variation[32]. Nonetheless, the use of simple anthropometric measures can increase the ecological validity, and to be applied for different professionals involved with exercise prescription.

Conclusion

Based on the results obtained, it was possible to conclude that both abdominal test protocols were adequate for the sample studied, since they did not present statistically significant differences for performance or perception of pain in the cervical and lumbar region.

Variables such as BMI, body weight, hip waist ratio, and flexibility do not seem to interfere with their performance, at least for the population investigated. In addition, the internal load imposed by the abdominal test protocols, evaluated through SPE, remained within physiological limits, showing that both are safe from the point of view of perceived exertion. On the other hand, the abdominal musculature, evaluated by a perception scale constructed for this study, also did not show any statistically significant results.

Finally, the results indicated that the use of the abdominal test as part of the assessment of musculoskeletal fitness in women 55+ years old proved to be safe, easy to apply, and suitable for this subjects.

Conflict of interest

The authors do not declare a conflict of interest.

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