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DO POSITION, TIME OF DAY, AND VERBAL ENCOURAGEMENT INFLUENCE HANDGRIP STRENGTH MEASUREMENT?

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Abstract

Introduction: *the use of grip strength measurement in research studies and clinical practice has gained relevance due to its close relationship with health events. The European Working Group on Sarcopenia (EWGSOP) introduced the measurement of muscle function (muscle strength and physical performance) as an essential criterion for the diagnosis of sarcopenia. For this reason, the primary objective of our study was to evaluate three different methods for determining handgrip strength measurements.*

Methods: *a quasi-experimental study was conducted in three bone health centers in Argentina. Healthy male and female volunteers, aged between 18 and 40 years were included. We assessed the impact of limb dominance, posture (sitting vs standing), time of day (morning vs afternoon), and verbal encouragement (yes/no) on handgrip strength measurements.*

Results: *a total of 117 participants were analyzed with males comprising 41% of the sample. The mean age of men was 27.7 years and mean age of women was 28.7 years. Men exhibited greater handgrip strength compared to women (46.5 ± 11.7 kg vs. 27.0 ± 6.8, $p<0.001$). Handgrip strength was consistently greater in the dominant limb across all tests ($p<0.05$). No variations were observed in handgrip strength with respect to posture or time of day ($p>0.05$). However, a significant difference was noted before and after verbal encouragement (29.81 ± 12.14 kg vs. 33.50 ± 11.40 $p<0.001$).*

Conclusions: *according to our results, handgrip strength should be measured using the dominant limb and evaluators should use verbal encouragement to obtain maximum grip strength.*

Ethics approval information: *National University of Rosario (resolution N°5596/2023)*

Keywords: *handgrip strength, muscle function, sarcopenia*

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¿INFLUYEN LA POSICIÓN, LA HORA DEL DÍA Y EL ESTÍMULO VERBAL EN LA MEDICIÓN DE LA FUERZA DE PRENSIÓN DE LA MANO?

Resumen

Introducción: la utilización de la medición de fuerza de puño en la práctica clínica y en el ámbito de la investigación ha ganado relevancia por su íntima relación con eventos en salud. El Grupo de Trabajo Europeo sobre Sarcopenia (EWGSOP2) introdujo la medición de la función muscular (fuerza y rendimiento físico) como un criterio fundamental para el diagnóstico de sarcopenia. El objetivo principal de nuestro estudio fue analizar tres diferentes métodos para evaluar la fuerza de puño.

Materiales y métodos: un estudio cuasiexperimental fue conducido en tres centros de referencia en Argentina. Hombres y mujeres voluntarias entre 18 y 40 años fueron incluidos en el estudio. Se evaluó el impacto de la dominancia, postura (parado vs sentado), tiempo de día (mañana y tarde) y estímulo verbal sobre las mediciones de fuerza de puño.

Resultados: un total de 117 participantes fueron analizados, de los cuales el 41 % fueron masculinos. La media de edad fue de 27.7 años en hombres y 28.7 años en mujeres. Los hombres presentaron mayor fuerza de puño en comparación con mujeres (46.5 ± 11.7 kg vs. 27.0 ± 6.8, $p<0.001$). Además, la fuerza en el miembro dominante fue mayor en todas las pruebas realizadas ($p<0.05$). No se observaron variaciones con respecto a la postura y el tiempo del día. Sin embargo, se observaron incrementos significativos posterior al estímulo verbal (29.81 ± 12.14 kg vs. 33.50 ± 11.40 $p<0.001$).

Conclusión: de acuerdo a nuestras observaciones, la medición de la fuerza de puño debería ser medida usando el miembro dominante y con estímulos verbales para obtener la máxima prensión.

Información sobre la aprobación ética: Universidad Nacional de Rosario (resolución N°5596/2023)

Palabras claves: fuerza de puño, función muscular, sarcopenia

Introduction

In recent years, the use of grip strength measurement in research studies and clinical practice has gained relevance due to its close relationship with health events.[1,2] Several studies have found a higher risk of mortality among individuals with lower grip strength.[3-6] Moreover, research has emphasized its utility in evaluating cognitive functions and longevity, with its assessment considered a fundamental criterion for diagnosing frailty.[7,8] All these findings suggest that grip strength assessment holds significant value across different clinical settings.[9-12]

On the other hand, the European Working Group on Sarcopenia (EWGSOP) introduced the measurement of muscle function (muscle strength and physical performance) as an essential criterion for diagnosing sarcopenia, which refers to the loss of muscle mass that accompanies the aging process.[13] This EWGSOP position statement recognizes handgrip strength as an interchangeable tool with leg strength measurement.[13,14] The 2019 guidelines recommend the assessment of handgrip as the initial step in the screening algorithm for patients at risk of sarcopenia given its greater standardization and wider availability compared to assessing leg strength.[15]

Grip strength usually increases in men and women similarly until adolescence and then reaches its peak between the second and third decade of life, with men generally

exhibiting greater strength.[16] After this peak, grip strength tends to gradually decrease with aging. While grip strength measurements are generally reliable and repeatable, in certain pathologies such as rheumatoid arthritis and carpal tunnel syndrome, their accuracy could be compromised.[17] Hydraulic hand dynamometers are widely used in research studies due to their versatility, allowing the hand to be placed in 5 positions for better handling. Previous calibration protocols have contributed to achieving more reliable results.[18,19] However, there remains no consensus on the optimal hand position, device type or limb dominance for grip strength assessment. The Society of Hand Therapists (ASHT) recommends the use of a hydraulic dynamometer positioned in the second configuration.[20] Conversely, the Southampton protocol suggests beginning measurements with the participant seated, using the right extremity and positioning the hand in any of the 5 configurations.[18] Additionally, variations in strength according to circadian rhythm and the operator's instructions have been observed.[21,22]

Therefore, our study aimed to assess the effect of limb dominance, position (sitting vs. standing), time of day (morning vs. afternoon) and verbal encouragement (yes/no) on the determination of handgrip strength measurement.

Methods

A quasi-experimental study was conducted in three bone health centers in Argentina. A convenience sample of healthy male and female participating volunteers, aged between 18 and 40 years, was recruited for this study. Invitations to participate were made in public spaces, such as universities, libraries, and to administrative employees.

Participants with motor or nerve injuries involving the upper extremities, recent trauma or surgery, arthritis or tendon injuries were excluded.

All participants were weighed and heighted and subsequently the body mass index (BMI kg/m^2) was calculated. Grip strength measurements were carried out by a single evaluator at each research center. A total of 3 tests (test 1 or Effect of Posture, test 2 or Effect of Time and test 3 or Effect of Verbal Encouragement) were carried out to find the most suitable technique. Both upper limbs (dominant and non-dominant) were examined 3 times in each test using hydraulic hand dynamometers (JAMAR o Baseline Hydraulic Hand Dynamometer, USA). The highest value recorded from each limb was used for the analysis. The instruments were calibrated before the beginning of the evaluations with a known weight of 10 and 20 kg and afterward, a cross-calibration of the instruments was carried out between the centers using an unknown weight.

The protocol was approved by the ethics committee of the National University of Rosario (resolution N°5596/2023) following the principles of the Declaration of Helsinki. Prior to their participation, all volunteers provided a written informed consent.

Test 1: Effect of Posture (standing vs. sitting) on maximum grip strength measurements

The standing position measurements were performed with the forearm supinated and the elbow flexed at 90 degrees, with the hand located in the second position of the dynamometer. The forearm was not rested on any surface. Three consecutive measurements were taken in each limb, with a one-minute interval between the measurements. Participants were instructed to exert maximum force and maintain it for 3 seconds (moment A).

Following a rest interval of 10 minutes, grip strength measurements in the sitting position were assessed without forearm support, using the same instructions as in the standing position (moment B). A total of 53 subjects were evaluated in this test.

Test 2: Effect of Time (morning vs. afternoon) on maximum grip strength measurements

The first measurements were carried out in a sitting position between 8:00 a.m. and 9:00 a.m., following the circadian rhythm of hormonal release (moment A). The afternoon assessments were conducted in the afternoon, between 2:00 and 4:00 p.m. on the same day, using the same population (moment B). Subjects underwent the study in a sitting position following the instructions outlined in test 1 with a one-minute interval between measurements. A total of 37 subjects were evaluated in this test.

Test 3: Effect of Verbal Encouragement on Maximum Grip Strength Measurements

The measurement technique was the same as that used in test 2. Following an explanation of the procedure, participants were asked to exert maximum force (moment A). After three determinations in each limb, a 10-minute break was taken, and a new measurement session began with the addition of verbal encouragement for maximum force (moment B). The phrase "¡Harder! ¡Harder! ¡Harder!" was used to provide instructions followed by a "stop" command. A total of 27 participants were evaluated in this test.

Statistical analysis

Continuous variables were expressed as mean ± standard deviation (SD) or as median and interquartile range [IQR], depending on their parametric or non-parametric distribution. Variables with a normal distribution were analyzed with the t-test for paired samples and the alternative non-parametric Wilcoxon signed-rank test was used when the variables did not follow the assumption of normality. Statistical significance was described as $p<0.05$.

Statistical analysis was performed with STATISTIX 7.0 software Copyright©1995, 2000.

Results

A total of 117 subjects were assessed for their eligibility to participate in the study. The mean age of men was 27.7 years and the mean age of women was 28.7 years. The baseline clinical characteristics for each group are shown in Table 1. As expected, the grip strength measurements in the dominant hand were statistically significant compared to the non-dominant hand in the three performed tests ($p<0.05$) (Table 2). On the other hand, men exhibited 72% greater handgrip strength compared to women (46.5 ± 11.7 kg vs. 27.0 ± 6.8, $p<0.001$).

There were no significant differences in position (standing vs. sitting) and time (morning vs. afternoon). However, grip strength was significantly higher when the test was performed with verbal encouragement ($p<0.001$, Table 3).

For all tests, the best grip strength measurement was obtained between the second and third determinations in 84% of the evaluations.

Table 1. Baseline clinical characteristics

	Test 1 (n=53)	Test 2 (n=37)	Test 3 (n=27)
Age (y)	24.13±4.75	31.03±2.95	31.88±5.75
Weight (Kg)	62.35±11.76	68.91±15.12	73.93±16.44
Height (m)	1.69±0.09	1.66±0.07	1.65± 0.12
BMI (Kg/m²)	22.89±2.59	24.87±4.89	26.88±5.12
Men (%)	42% (n=22)	27% (n=10)	41% (n=11)
Female (%)	58% (n=31)	73% (n=27)	59% (n=16)

BMI: Body Mass Index

Discussion

After analyzing handgrip strength according to dominance, we observed greater strength in the dominant hand regardless of the moment of execution. Bohannon R summarized a total of 10 studies where the laterality of handgrip strength was evaluated according to dominance.[22] Similar to our results, the author concludes that its importance lies in dominance. Furthermore, it stands out that this difference is especially accentuated in right-handed individuals.[22] These results are consistent with the findings by Crosby et al. in a study with 214 volunteers of both sexes, reporting a 10% difference in favor of the dominant hand in right-handed people.[23] Conversely, they found that only 50% of left-handed individuals had greater strength in their dominant limb.[23] As a result, some therapists utilize this 10% difference as a critical value in the recovery of injured hands.[18]

Furthermore, when we evaluated the effect of posture (standing vs. sitting) on maximum grip strength measurements no differences were observed. The results are consistent with those reported previously by El-sais et al.[24]

Circadian rhythm and strength oscillations have been proposed as variables to consider when determining muscle strength.[25-26] Some studies have shown an increase in skeletal muscle strength between 4:00 p.m. and 8:30 p.m.[21] However, in our study, no discrepancies were observed between morning and afternoon assessments.

It has been observed that different volume levels of verbal encouragement during instruction generate variations in handgrip strength, increasing it.[17] Similarly, in this study, we report the effect of verbal encouragement, showing a significant increase after its implementation.[27] Belkhiria C et al. reported an increase in muscle strength and maximum

Table 2. Dominant vs non-dominant limb in moment A

	Dominant (kg)	Non-dominant (kg)	P
Test 1 standing vs. sitting (n=53)	33.30±12.97	31.79±12.56	**0.017**
Test 2 morning vs. afternoon (n=37)	38.92±12.33	34.92±12.75	**<0.001**
Test 3 verbal encouragement (n=27)	35.50±11.40	34.16±12.57	**0.034**

Table 3. All tests (position, time and verbal encouragement)

	Grip strength Moment A (kg)	Grip Strength Moment B (kg)	P
Test 1 standing vs. sitting (n=53)	33.30±12.97	33.49±12.35	0.709
Test 2 morning vs. afternoon (n=37)	38.92±12.33	38.88±12.87	0.942
Test 3 with or without verbal encouragement (n=27)	29.81±12.14	33.50±11.40	**<0.001**

voluntary force (MVF) and maximum rate of force development (MRFD) during verbal encouragement.[28]

Among the limitations we found in this work, we highlight the small number of participants, the imbalance between the sample sizes, BMI and sexes, as well as the use of two different brands of dynamometers. Nevertheless, cross-calibration was performed before starting the study.

Additionally, this research only included healthy and young people, limiting the extrapolation of our results to the aging population.

In summary, according to the results of this study, handgrip strength should be measured using the dominant limb, and evaluators should provide verbal encouragement to obtain maximum grip strength. Furthermore, position (sitting or standing) and time of day (morning vs. afternoon) do not seem to affect grip strength measurements.

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