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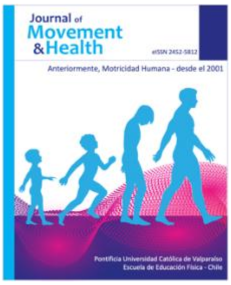


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## Original article

# Association between flexibility measurements obtained by two different methods in extreme conditioning practitioners

Asociación entre las mediciones de flexibilidad obtenidas por dos métodos diferentes en practicantes de entrenamiento extremo

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**Abstract**

**Objective:** The aim of this study was to investigate the association between flexibility measurements obtained using angular and quantitative methods in practitioners of extreme conditioning programs. **Methods:** This observational, cross-sectional study included 40 participants (17 men and 23 women), with a mean age of 31.02 ± 4.82 years, training experience of 11.65 ± 9.98 months, and a weekly training frequency of 4.17 ± 1.22 days. Flexibility was assessed using an angular method (Fleximeter) and a quantitative method (Flexitest). Comparisons were performed using Student's t-test, and the relationship between methods was examined using Pearson's correlation. **Results:** Positive and significant associations were observed for the following movements: medial rotation ($r = 0.44$, $p = 0.003$), shoulder extension ($r = 0.34$, $p = 0.03$), elbow extension ($r = 0.41$, $p = 0.007$), wrist flexion ($r = 0.35$, $p = 0.02$), spinal flexion ($r = 0.42$, $p = 0.005$), dorsiflexion ($r = 0.40$, $p = 0.009$), and ankle plantar flexion ($r = 0.44$, $p = 0.003$). **Conclusion:** The findings indicate that flexibility measurements show moderate associations when the movements assessed are more similar between tests, suggesting that, for these specific movements, both assessment tools may be used interchangeably.

**Keywords:** physical assessment; biomechanics; physical exercise; flexibility; test validity

**Resumen**

**Objetivo:** El objetivo de este estudio fue investigar la asociación entre las mediciones de flexibilidad obtenidas mediante métodos angulares y cuantitativos en practicantes de programas de acondicionamiento extremo. **Métodos:** Este estudio observacional y transversal incluyó a 40 participantes (17 hombres y 23 mujeres), con una edad media de 31,02 ± 4,82 años, una experiencia de entrenamiento de 11,65 ± 9,98 meses y una frecuencia semanal de entrenamiento de 4,17 ± 1,22 días. La flexibilidad se evaluó mediante un método angular (flexímetro) y un método cuantitativo (flexitest). Las comparaciones se realizaron mediante la prueba t de Student y la relación entre los métodos se analizó mediante la correlación de Pearson. **Resultados:** Se observaron asociaciones positivas y significativas en los siguientes movimientos: rotación medial ($r = 0,44$; $p = 0,003$), extensión de hombro ($r = 0,34$; $p = 0,03$), extensión de codo ($r = 0,41$; $p = 0,007$), flexión de muñeca ($r = 0,35$; $p = 0,02$), flexión de columna ($r = 0,42$; $p = 0,005$), dorsiflexión ($r = 0,40$; $p = 0,009$) y flexión plantar del tobillo ($r = 0,44$; $p = 0,003$). **Conclusión:** Los resultados sugieren que las mediciones de flexibilidad están moderadamente asociadas cuando los movimientos evaluados son más similares entre sí, lo que indica que, para estos movimientos específicos, ambos instrumentos pueden utilizarse de manera intercambiable.

**Palabras clave:** evaluación física; biomecánica; ejercicio físico; flexibilidad; validez del test

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**Key points**

- The study identified moderate and significant correlations between flexibility measurements obtained using the Fleximeter and the Flexitest in specific movements.
- Women demonstrated higher flexibility levels than men in most of the assessed movements.
- The findings indicate that both methods can be used complementarily, especially for movements with simpler biomechanical patterns.

## Introduction

Flexibility is a physical capacity related to the maximum range of motion (ROM) that a joint or a set of joints can achieve, limited by the individual's muscular, articular, and neuromuscular properties[1]. In sports practice and high-intensity physical activities, such as functional training programs, cross-training, and other models of extreme conditioning programs (ECP), flexibility plays an essential role in optimizing performance, improving the biomechanical efficiency of movements, and preventing injuries[2–5].

Changes in flexibility levels, whether due to deficits or excesses, may cause overload on musculoskeletal structures. Muscle shortening restricts the range of motion, impairing proper exercise execution, while hypermobility can compromise joint stability, increasing the risk of injury, especially in activities involving repetitive movements under high load[4–6].

In this context, accurate assessment of flexibility is an essential step both for training prescription and for monitoring practitioners' physical progress. Various instruments are employed for this purpose, with direct methods—based on angular measurements such as goniometers and fleximeters—and indirect methods—based on qualitative scales, such as the flexitest[1,7]—standing out. Each method presents advantages and limitations related to sensitivity, ease of application, cost, and the evaluator's technical expertise required[8,9].

Despite the widespread use of these instruments in clinical and sports settings, literature still lacks studies specifically investigating the correlation between angular and qualitative methods, particularly in physically active adults engaged in ECPs[4,5,10]. This methodological gap limits professionals' ability to make informed decisions regarding the most appropriate instrument for different assessment contexts[11–13].

Therefore, understanding whether a significant correlation exists between flexibility assessment methods—one based on angular measurements and the other on qualitative scores—is fundamental to supporting both clinical practice and training prescription. Such understanding ensures that assessments are not only practical but also scientifically valid and reliable.

Given this scenario, the present study aim of this study was to investigate the association between flexibility measurements obtained using the angular and quantitative flexibility in practitioners of ECPs, seeking to contribute to the careful selection of assessment instruments, expand the practical applicability of the tests, and strengthen their scientific foundation.

## Methods

### *Study Design*

This is an observational, cross-sectional, and analytical study conducted with the objective of analyzing the correlation between angular and qualitative flexibility measurements in practitioners of an ECP, specifically CrossFit®.

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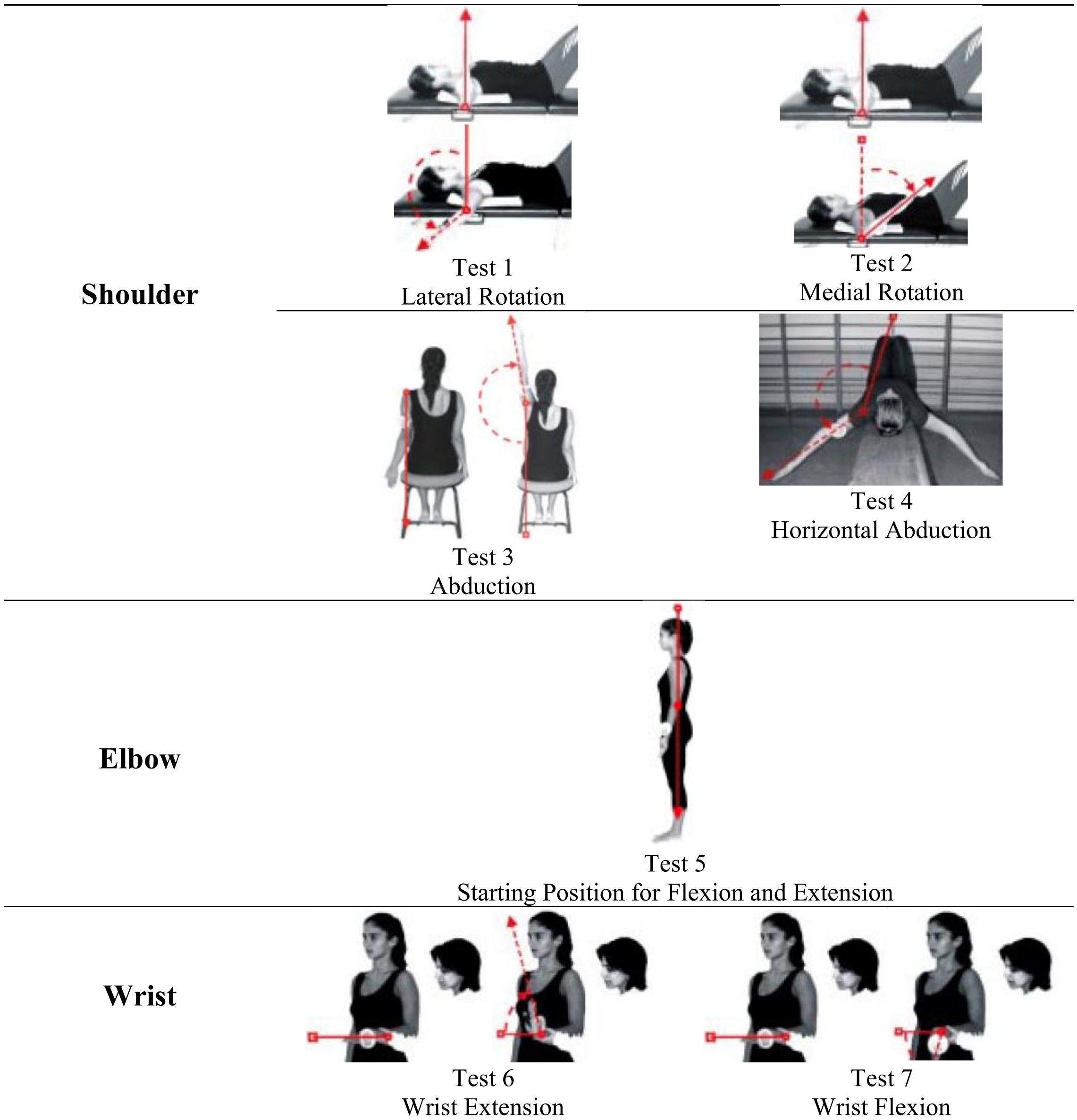
*Participants*

The sample consisted of 40 individuals, including 17 men and 23 women, 31.02 ± 4.82 years and regular practitioners of an ECP. Participants were selected by convenience sampling from the same CrossFit box affiliated with the brand. Eligible participants were required to have been practicing the modality for at least one month, to be in adequate physical condition, and to have no active musculoskeletal injuries. Individuals presenting recent joint pain or discomfort, as well as those who did not agree to sign the Informed Consent Form, were excluded. The study was approved by the Ethics Committee of the Federal University of Triângulo Mineiro (protocol no. 3.290.661).

*Instruments*

Two instruments were used to measure flexibility: the universal Fleximeter (Sanny®, Brazil) and the Flexitest, following the protocol proposed by Araújo[14]. The Fleximeter is validated for measuring angular range of motion and demonstrates high reliability, while the Flexitest provides a qualitative score (Flexindex) composed of the sum of scores from 20 specific movements (Figures 1 and 2).



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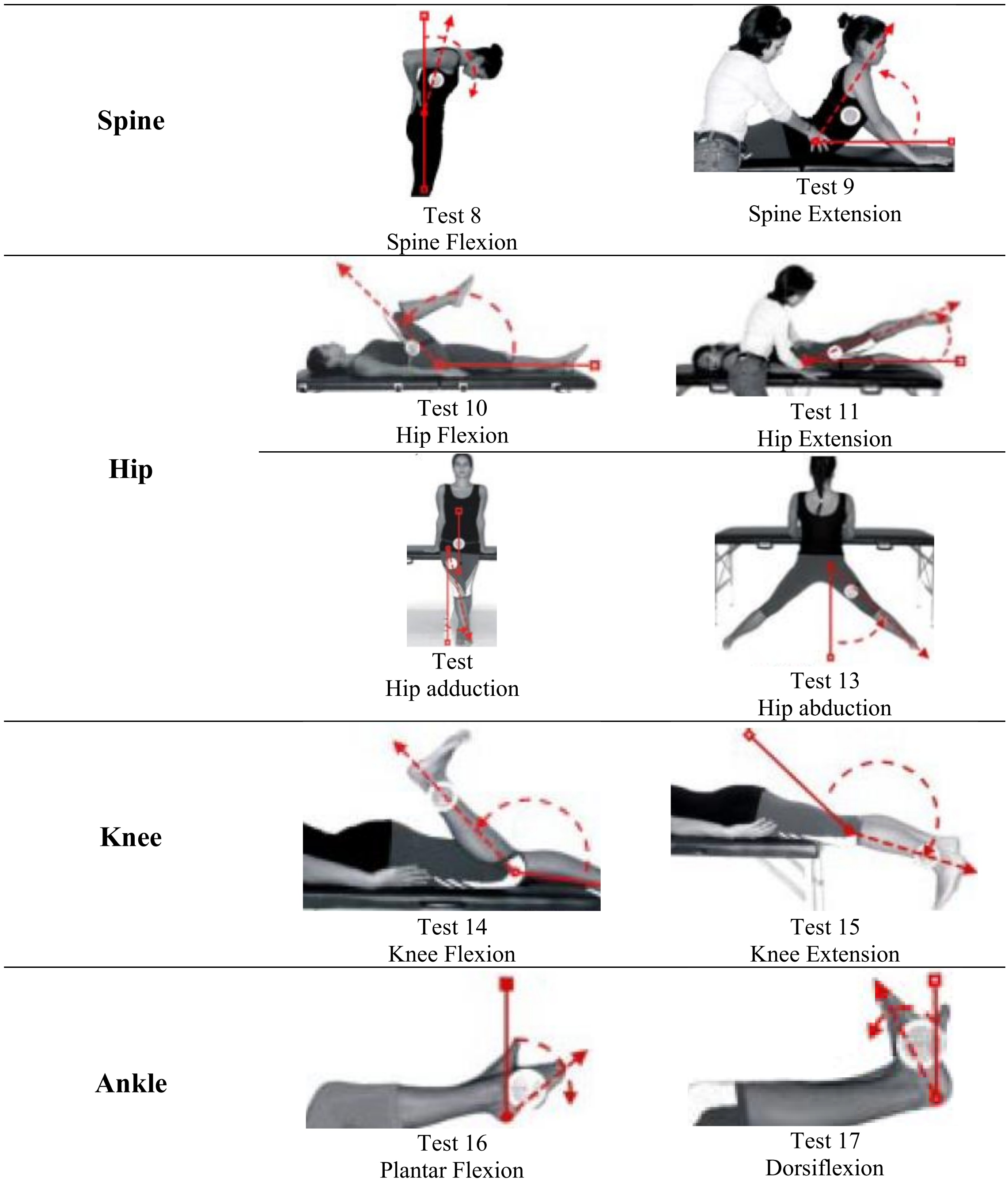


**Figure 1.** Positioning for flexibility tests using the Fleximeter.
**Source:** Adapted from Fleximeter (Sanny®, Brazil)

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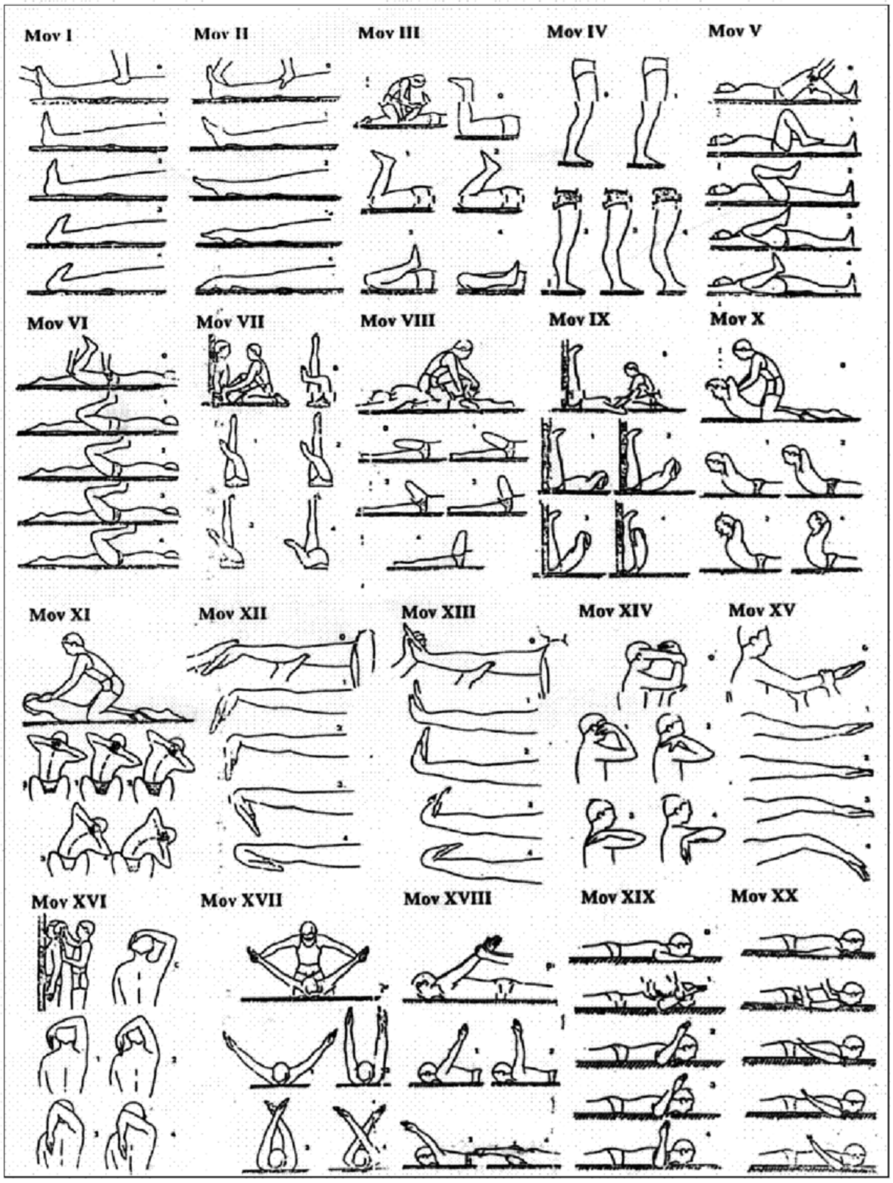


**Figure 2.** Evaluation map of the exercises comprising the Flexitest.
**Source:** Adapted from Araújo[14,15].

*Procedures*

At the beginning of the session, body mass (kg) and height (m) were measured. For these assessments, a WELMY mechanical scale with a precision of 100 g, equipped with a stadiometer, was used. Body mass index (BMI) was calculated by dividing weight (kg) by the square of height (m).

Assessments were conducted in a controlled environment, always at the same time of day. Participants were instructed to avoid intense physical activity in the 48 hours prior to testing. The sequence of tests followed a standardized order: first the Fleximeter, followed by the Flexitest. Evaluations were performed without prior warm-up, with movements executed actively. Two repetitions were performed for each movement, and the highest measurement was recorded.

Considering the diversity of tests, some Flexitest movements were selected, based on joint movement similarity, to be compared with the corresponding Fleximeter measurements (Figure 1). In this regard, the pairs used for correlation between measurements and results are presented in Table 1.

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**Table 1.** Correspondence Between Flexibility Tests of the Two Instruments.

| Region | Joint Movement | Flexitest | Fleximeter |
|---|---|---|---|
| Shoulder | Medial Rotation | Mov XX | Test 2 |
| | Lateral Rotation | Mov XIX | Test 1 |
| | Horizontal Abduction | Mov XVII | Test 4 |
| | Abduction | Mov XVI | Test 3 |
| Elbow | Extension | Mov XV | Test 5 |
| | Flexion | Mov XIV | Test 5 |
| Wrist | Extension | Mov XIII | Test 6 |
| | Flexion | Mov XII | Test 7 |
| Spine | Flexion | Mov IX | Test 8 |
| | Extension | Mov X | Test 9 |
| Hip | Extension | Mov VI | Test 11 |
| | Flexion | Mov V | Test 10 |
| | Adduction | Mov VII | Test 12 |
| | Abduction | Mov VIII | Test 13 |
| Knee | Extension | Mov IV | Test 15 |
| | Flexion | Mov III | Test 14 |
| Ankle | Dorsiflexion | Mov I | Test 16 |
| | Plantar Flexion | Mov II | Test 17 |

*Statistical Analysis*

Data were analyzed descriptively (mean, standard deviation, minimum, and maximum values). The Shapiro-Wilk test was used to assess normality. Comparisons between sexes were performed using Student's T-test. Correlation between methods was analyzed using Pearson's correlation coefficient, with significance set at $p<0.05$. Correlation values were classified as follows: very low (0–0.1), low (0.1–0.3), moderate (0.3–0.5), high (0.5–0.7), very high (0.7–0.9), and almost perfect (0.9–1.0)[16]. Analyses were conducted using IBM SPSS Statistics software, version 23.

## Results

The sample consisted of 40 participants, including 23 women (31.1 ± 5 years; 68.2 ± 10.36 kg; 1.70 ± 0.05 m; body mass index 23.9 ± 3) and 17 men (30.8 ± 4.7 years; 85.1 ± 8.4 kg; 1.80 ± 0.07 m; body mass index 27 ± 2.7), with a mean age of 31.02 ± 4.82 years. The mean BMI as 25.38 ± 3.03 kg/m², with an average weekly training frequency of 4.17 ± 1.22 days and an average training experience of 11.65 ± 9.98 months (table 2).

**Table 2.** Descriptive analysis of the sample (means and standard deviations).

| Variables | Total | Women | Men | t-test | *p* |
|---|---|---|---|---|---|
| Age (years) | 31.02 (4.82) | 31.17 (5) | 30.82 (4.71) | 0.22 | 0.82 |
| Body Mass Index | 25.38 (3.03) | 23.99 (3) | 27.27 (1.83) | -4.27 | 0.00* |
| Training frequency (weekly) | 4.17 (1.22) | 4.09 (1.31) | 4.29 (1.10) | -0.53 | 0.60 |
| Training experience (months) | 11.65 (9.98) | 10.78 (10.22) | 12.82 (9.82) | -0.63 | 0.53 |

*p<0.05

Regarding sex differences, the t-test showed that women demonstrated better flexibility scores in the flexibility index. They had higher scores in all tests except hip abduction, knee hyperextension, and knee flexion. Significant differences were found in the following

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measures: ankle dorsiflexion ($p = 0.02$), hip extension ($p = 0.03$), lateral spinal flexion ($p = 0.002$), elbow flexion ($p = 0.01$), horizontal shoulder abduction ($p = 0.005$), shoulder extension ($p = 0.01$), shoulder external rotation ($p < 0.001$), and shoulder internal rotation ($p = 0.02$).

For angular measurements, the t-test showed higher scores for women, except for spinal flexion and ankle dorsiflexion. These differences were significant for horizontal shoulder abduction ($p = 0.01$), shoulder lateral rotation ($p = 0.001$), elbow extension and flexion ($p = 0.01$ and $p < 0.001$), wrist extension and flexion ($p = 0.006$ and $p = 0.004$), hip flexion ($p < 0.001$), ankle plantar flexion ($p < 0.001$), and foot inversion ($p = 0.04$).

Table 3 presents the angular correlations between the measurements obtained using the Fleximeter and the classifications from the Flexitest for each body segment and its respective movements individually. Regarding age, a positive and moderate correlation was found only for foot inversion in the angular measurement ($r = 0.35$; $p = 0.02$) and for knee hyperextension in the non-dimensional measurement ($r = 0.41$; $p = 0.009$).

**Table 3.** Angular correlations between the Fleximeter and Flexitest.

| Segment | Movement (°) | *r* | *p* |
|---|---|---|---|
| Shoulder | Medial Rotation | 0.44 | 0.003** |
| | Lateral Rotation | 0.30 | 0.052 |
| | Horizontal Abduction | 0.04 | 0.81 |
| | Abduction | 0.21 | 0.17 |
| | Extension | 0.34 | 0.03* |
| Elbow | Flexion | 0.14 | 0.38 |
| | Extension | 0.41 | 0.007** |
| Wrist | Flexion | 0.35 | 0.02* |
| | Extension | 0.21 | 0.17 |
| Hip | Flexion | 0.42 | 0.005** |
| | Extension | 0.22 | 0.16 |
| | Adduction | 0.22 | 0.15 |
| Knee | Flexion | 0.13 | 0.40 |
| | Extension | 0.13 | 0.40 |
| Ankle | Dorsiflexion | 0.40 | 0.009** |
| | Plantar Flexion | 0.44 | 0.003** |

*p<0.05. **p<0.001.

## Discussion

The results of this study indicated a positive and moderate correlation between the angular measurements obtained using the Fleximeter and the qualitative measurements obtained using the Flexitest in specific movements, such as medial rotation and shoulder extension, elbow extension, wrist flexion, spinal flexion, dorsiflexion, and ankle plantar flexion. These findings suggest that, for movements with simpler biomechanics or whose execution patterns are less influenced by adjacent kinetic chains, both methods can be used complementarily.

This pattern of partial agreement between methods has been previously reported in the literature, especially in studies assessing the concurrent validity of range of motion measurement instruments. Keogh et al.[8] highlights that the correlation between different methods tends to be stronger in joints that move within isolated planes, with less influence from

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postural compensation. Schlager et al.[9] confirmed this behavior in their analysis on hyperflexibility.

In contrast, in movements of greater biomechanical complexity—such as hip abduction, trunk extension, or shoulder abduction—no significant correlations were identified between the methods. This outcome likely reflects the intrinsic limitations of qualitative tests, which, although easy to administer and low-cost, are more susceptible to the influence of positioning, the evaluator's subjective interpretation, and the interaction among different musculoskeletal chains[12,13]. Additionally, the findings confirmed that women exhibited higher flexibility scores compared to men, supporting the literature, which attributes this difference to hormonal, morphological, and tissue composition factors[6,17,18].

From a practical standpoint, the results of this study offer a relevant contribution to professionals involved in exercise prescription, health and fitness evaluations (HFEs), and rehabilitation. For movements in which a strong correlation between methods was observed, both the Fleximeter and the Flexitest can be used interchangeably, considering factors such as cost, time, and available resources. However, for more complex movements, angular measurement methods are recommended.

*Limitations and Strengths*

Among the limitations of this study are the sample size and the heterogeneity in participants' training experience, which may have introduced variability in the results. Additionally, possible engagement in complementary physical activities outside the HFE was not controlled by, which could have influenced flexibility levels. Another limitation concerns the biomechanical differences between some of the movement pairings used for correlation. For shoulder assessment, Mov XVI of the Flexitest involves posterior adduction with internal rotation, whereas Fleximeter Test 3 assesses pure abduction. Although these procedures are not equivalent, the correlation was interpreted as an approximation of global shoulder flexibility. Similarly, for trunk flexion, the Flexitest is performed in the supine position, while the Fleximeter protocol is carried out in standing—a posture that introduces hamstring tension and alters the biomechanical demands of the movement. Because these tests are not fully comparable, the results should be interpreted as reflecting general posterior chain flexibility rather than direct equivalence between the methods. Moreover, the adoption of a fixed sequence of assessments (Fleximeter followed by the Flexitest), which may have influenced flexibility measurements due to an order effect. Because active repetitions were performed during the first test (Fleximeter), they may have acted as a specific warm-up, promoting acute mobilization and potentially increasing the range of motion in the subsequent Flexitest. Since the assessment sequences were not randomized to control for a carryover effect[19], this factor may have influenced participants' performance in the Flexitest.

A key strength of this study is the comparison of two flexibility assessment methods that are easy to apply, low-cost, and widely used in clinical and sports settings. Considering that ECPs may increase injury risk due to changes in movement patterns during workouts of the day[20], flexibility assessment becomes particularly relevant. By identifying movements with agreement between methods, the study highlights the importance of flexibility evaluation as a tool for injury prevention in high-intensity training contexts. It is suggested that future research increase the sample size, stratify participants according to experience level, and include additional analyses of intra- and inter-rater reliability, as well as the use of technological methods such as motion capture systems or inertial sensors.

## Conclusions

The analyses conducted in this study indicate a positive and moderate correlation between angular and qualitative flexibility measurements in specific joint movements,

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particularly those involving simpler biomechanical patterns. Thus, both the fleximeter and the Flexitest prove to be viable tools for assessing flexibility in individuals engaged in health and fitness evaluations, provided their use is directed toward movements whose biomechanics support this equivalence. For joints or movements of greater complexity, the results suggest that angular methods offer greater precision and reliability. These findings contribute directly to clinical practice and the sports context, providing support for professionals to choose flexibility assessment tools based on the specificity of the movements and the operational conditions available. Finally, it is recommended that future studies explore larger samples, include different experience levels among participants, and incorporate complementary biomechanical analysis methods to deepen the understanding of the applicability and validity of different flexibility measurement techniques.

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**Conflict of Interest**

The authors declare no conflicts of interest related to the published article.

**Declaration of generative AI and AI-assisted technologies in the writing process**

The authors declare that no generative AI or AI-assisted technologies were used in the writing

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