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Analysis of agreement of assessment tools of range of motion in the elderly

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ABSTRACT

Background: Considering the growth of the elderly population and the typical declines in the aging process on physical capacities such as flexibility, it is necessary to understand how different assessment instruments are able to measure joint range of motion. **Objective:** To verify the agreement between the goniometer and fleximeter instruments in the evaluation of the range of motion of the hip, knee and ankle joints of elderly women. **Methods:** The study evaluated a total of 138 elderly women, mean age of 70 years (± 5.49). The goniometer and the fleximeter were used to verify the range of motion of the hip flexion, knee flexion and ankle dorsi- and plantar-flexion. For the analysis were used the Intraclass Correlation Coefficient (ICC) and Bland-Altman plot, with confidence intervals of 95%. **Results:** The ICC values showed excellent agreement between the instruments, while the Bland-Altman plots presented a low risk of bias for all the regions evaluated (hip flexion: ICC= 0.99, bias= 1.19; knee flexion: ICC= 0.99, bias= -0.16; ankle dorsiflexion: ICC= 0.91, bias= -0.60; ankle plantar-flexion: ICC= 0.96; bias= -0.81). **Conclusion:** The results showed an excellent agreement between the data provided by the goniometer and fleximeter instruments on the evaluation of the range of motion of the hip flexion, knee flexion and ankle dorsi- and plantar-flexion, indicating that both provide similar results in the elderly.

Keywords: Joint; Range of Motion; Assessment; Elderly.

INTRODUCTION

The elderly population is increasing in Brazil and in the world. It is estimated that by the year 2025, the number of elderly people reaches approximately 32 million in Brazil[1]. With the growth of this population, the concern of health professionals increases, contributing to the improvement of physical capacities, such as flexibility, muscular strength, postural balance, among others, which are fundamental for the accomplishment of activities of daily living[2-5]. One of the most compromised physical abilities during the aging process is flexibility[6-8]. The main physiological change regarding flexibility is the decrease of the extensibility capacity of the muscular fibers, leading to a smaller range of motion[9-11]. Another factor that compromises the flexibility of the elderly is the commitment of the joints, due to wear by pressure, dehydration or friction with the bones, becoming more rigid and, consequently, causing a decrease in the joint range of motion[12,13].

Thus, it is essential to use instruments that measure this variable, as a way of contributing to intervention actions for the elderly population. Different instruments can be used to evaluate flexibility, among them are the fleximeter and the goniometer[14-17]. Both evaluate the range of motion in degrees (º), of the most diverse joints of the body, however, the evaluation procedures and the way of fixing them occur in a different way[15,18]. Another fact that should be considered is the cost of each equipment, since the goniometer is more accessible[19,20]; on the other hand, the use of the fleximeter instrument is simpler, since it does not depend on pre-established anatomical markings. The evaluation occurs with the fixation of the instrument in the desired segments through tape Velcro® (Velcro Companies Brazil, São Paulo, Brazil) and the achieved range of movement is obtained by the use of force of gravity on the pointer of the equipment[15,21].

Some studies[15,16,18,21,22] verified that both instruments present good levels of validity and reliability in different populations, however, there is a gap in the literature regarding agreement studies of the measurements offered by the fleximeter and the goniometer. Thus, taking into account the importance of monitoring the maintenance or progression of flexibility levels in elderly and noting the lack of information regarding the agreement data of these two instruments, the aim of this study was to verify the agreement between the

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goniometer and the fleximeter on the range of motion of the hip, knee and ankle joints of elderly women.

METHODS

Sample

The sample was composed by 138 elderly women physically active, with mean age of 70 years old (± 5.49) and Body Mass Index (BMI) of 27.6 (± 4.39), living in the city of Londrina, Paraná, Brazil. The inclusion criteria were: a) 60 years or older; b) walk without support device (canes, walkers, crutches); c) not be institutionalized; d) have no history of injury or surgical procedure in the hip, knee and ankle joints; e) present no cognitive deficit according to the score related to their schooling, in the Mini Mental State Examination (MMSE)[23]. Recruitment occurred through telephone contact, or home visits to the elderly women who participated in physical exercise programs in the city of Londrina, so that the inclusion criteria were confirmed. All participants, after being informed about the study proposal and the procedures to which they would be submitted, signed an Informed Consent Form, according to Resolution 466/12 of the National Health Council. The study was approved by the Ethics Committee on Research Involving Human Beings of the Universidade Norte do Paraná (276.702).

Instruments

To analyze the range of motion of the joints (hip, knee and ankle) was used a Carci Universal Goniometer (Carci Indústria e Comércio de Aparelhos Cirúrgicos e Ortopédicos Ltda., São Paulo, Brazil) and a Sanny Fleximeter (American Medical do Brasil Ltda., São Paulo, Brazil). The goniometer is an equipment composed of two stems interconnected by an axis of rotation, with one of the rods remaining immobile (fixed arm), while the other is aligned to a specific anatomical point of the body during the evaluation[15,21]. The fleximeter is a device with a gravitational action mechanism, used to measure the joint range of motion through an angular scale. Because it is an instrument that contains a tape Velcro (Velcro Companies Brazil, São Paulo, Brazil) that is fixed in the joint of interest, it allows isolating the various joint movements of the body[21].

Data collection

The data collection was performed in the Laboratory of Functional Evaluation and Human Motor Performance (LAFUP), of the Universidade Norte do Paraná. All the elderly women attended the laboratory, where the evaluations were performed, always in the afternoon period at controlled temperature (23º C). It was performed evaluations of hip flexion, knee flexion and ankle dorsi- and plantar-flexion. The positioning of the volunteers was identical for each of the evaluated follow-up when using each instrument (the measurements were performed at the same time, using the goniometer and fleximeter instrument) and followed the recommendations in the literature[24]. To evaluate the hip flexion movement, the volunteer remained in the supine position on a stretcher, with the lower limbs in extension, keeping the arms extended alongside the body. The fleximeter was positioned laterally on the thigh region, taking into account the midpoint between the major trochanter and the lateral epicondyle of the femur; whereas the goniometer was positioned keeping the axis in the greater trochanter region of the femur, the fixed arm on the side of the trunk and the movable arm on the lateral region of the femur. The volunteer started from a neutral position of the hip, with the knees extended and performed the flexion of the hip in an active way (the evaluator oriented the importance of knee extension while followed the movement with the movable arm of the Goniometer), seeking maximum flexion of the hip joint.

Regarding the evaluation of the knee flexion movement, the volunteer remained in a supine position on the stretcher, with the lower limbs in extension, keeping the arms extended alongside the body. The fleximeter was positioned in the region near the lateral malleolus of the ankle; whereas the goniometer was positioned maintaining the axis near the lateral epicondyle of the femur, the fixed arm in the lateral region of the femur and the movable arm in the lateral region of the fibula. The volunteer started from a neutral position of the knee, with the lower limbs extended on the stretcher and performed knee flexion in an active way (the evaluator advised the importance of knee support on the stretcher while followed the movement with the movable arm of the goniometer), seeking maximum flexion of the knee joint. To evaluate the movements of ankle dorsi- and plantar-flexion, the volunteer remained sitting on the stretcher, with the lower limbs without touching it or the ground and knees bent at 90 degrees. The fleximeter was positioned laterally on the midfoot region; whereas the goniometer was positioned keeping the axis near the lateral malleolus of the ankle, the fixed arm in the fibula region and the movable arm in the lateral region of the foot. The volunteer was instructed to keep the foot in a neutral position to begin the test. Therefore, the evaluator requested that the volunteer perform the ankle dorsiflexion to the maximum limit and followed the movement with the goniometer movable arm. Then evaluated the movement of ankle plantar-flexion. For reasons of standardization of the test, it was evaluated only the right lower limb movements. Three trials were performed for each test, and the first one was used for familiarization. Of the other two attempts, only the one with greater joint range of motion was used. All procedures were performed by the same evaluator, with previous experience in this type of evaluation and the angulation results of both instruments were noted by a second evaluator.

Statistical Analysis

Descriptive data were presented as mean and standard deviation. In order to verify the agreement between the measurements provided by the two methods (goniometer and fleximeter), was used the Intraclass Correlation Coefficient

(ICC). The classification of the agreement degree between the instruments was established using the criteria described by Fleiss[13] (in relation of the ICC values): poor (< 0.4); moderate (between 0.4 and 0.75); and excellent (> 0.75). It was also used Bland-Altman analysis, that allowed us to visualize the presence or absence of systematic bias in the assessments, in which determines how clinically important the discrepancies between the two instruments are and what limits of agreement determine the differences between the two instruments. Analysis was performed using the GraphPad Prism 6 and Bioestat 5, with confidence interval of 95% ($p < 0.05$).

RESULTS

The ICC values showed excellent agreement between the goniometer and fleximeter instruments for all regions evaluated (hip flexion= 0.99, knee flexion= 0.99, ankle dorsiflexion= 0.91, ankle plantar-flexion= 0.96) (Table 1). The Bland-Altman plots for hip flexion range (Figure 1), knee flexion (Figure 2), ankle dorsiflexion (Figure 3) and plantar-flexion (Figure 4), demonstrated that there was no systematic bias in the agreement of the measurements between the goniometer and fleximeter instruments. In addition, the measurements of all movements performed were distributed within acceptable limits of variation.

Table 1. Comparison of the range of motion between the goniometer and fleximeter instruments in the elderly.

Motion	Goniometer	Fleximeter	Accuracy			Bland-Altman	
	Mean (SD)	Mean (SD)	ICC	P	Error	Bias	SD
HFM	84.43 (14.25)	83.23 (14.86)	0.99	0.001	0.0006	1.19	2.49
KFM	113.1 (11.46)	113.3 (11.81)	0.99	0.001	0.0002	-0.16	2.13
ADF	17.11 (3.86)	17.72 (3.70)	0.91	0.001	0.01	-0.60	2.76
APF	27.27 (5.91)	28.08 (6.66)	0.96	0.001	0.009	-0.81	3.84

Note: HFM = hip flexion movement; KFM = knee flexion movement; ADF = ankle dorsiflexion; APF = ankle plantar-flexion.

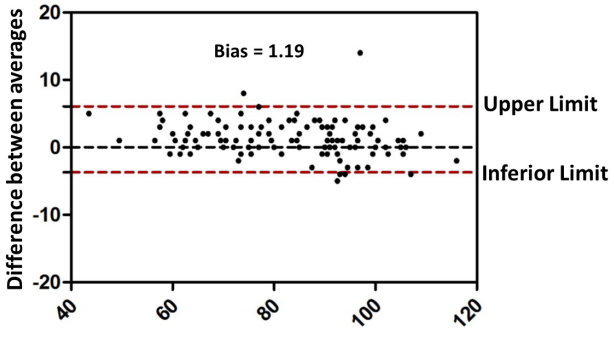

Figure 1. Bland-Altman diagram showing the risk of bias and the confidence interval between the measurements of goniometer and fleximeter instrument in the hip flexion range of motion.

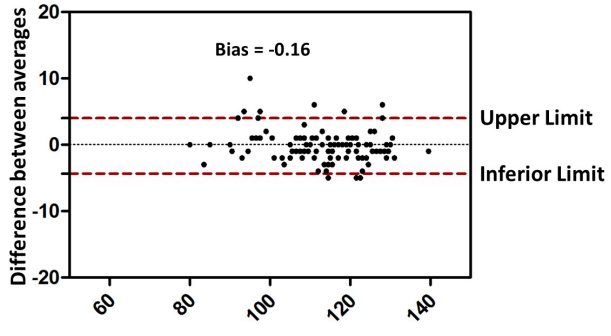

Figure 2. Bland-Altman diagram showing the risk of bias and the confidence interval between the measurements of goniometer and fleximeter instrument in the knee flexion range of motion.

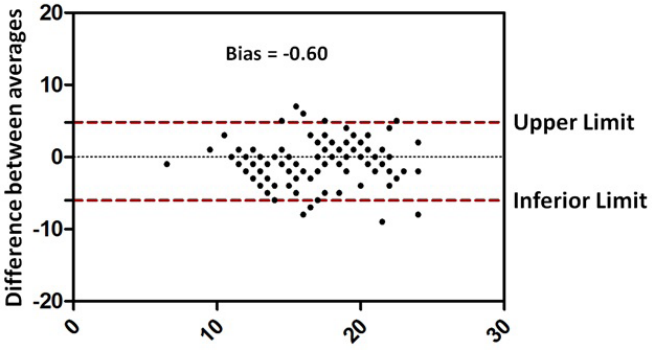

Figure 3. Bland-Altman diagram showing the risk of bias and the confidence interval between the measurements of goniometer and fleximeter instrument in the ankle dorsiflexion range of motion.

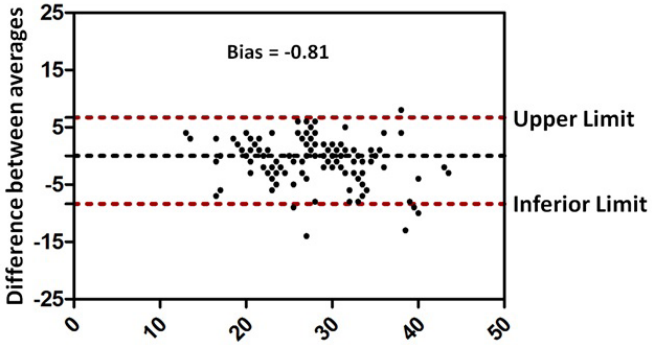

Figure 4. Bland-Altman diagram showing the risk of bias and the confidence interval between the measurements of goniometer and fleximeter instrument in the ankle plantar-flexion range of motion.

DISCUSSION

In view of the importance of monitoring the maintenance and progression of the flexibility of the elderly and noting a gap in the literature on concordance data between the fleximeter and the goniometer, the objective of this study was to verify the agreement between these two instruments in the elderly population. The results showed that there is an excellent concordance between the instruments, after evaluation of hip and knee flexion, ankle dorsi- and plantar-flexion range of motion in the elderly, with a low risk of bias. Taking these two instruments into consideration. Few studies compared their measurements for the most diverse body regions and none had as reference the elderly population. A research performed by Barbosa Filgueira and Santana[25] with the objective of comparing the performance of goniometer and fleximeter instruments in the evaluation of the elbow flexion of young women. There was a positive and strong correlation between the instruments but with significant differences between the mean values presented by each device. In another study. Batista Meira and Santana[26] compared the measurements of both instruments, measuring the knee joint in the young adult population. The results found converge with the findings of the previous study in which correlations were found between the instruments however. with significant differences between their values. Differently of these studies which evaluated the correlation (linear association between two variables) and comparison between means this study sought to verify the agreement between the instruments (which allowed us to find out if the measures are equivalent i.e. if one is able to replace the other) obtained by ICC analysis and Bland-Altman plots. The results indicated that the measures of range of motion found through the goniometer and fleximeter instruments tend to reproduce similar results. The values of risk of bias presented results close to zero and the confidence intervals did not show great variations which leads us to infer that there is a concordance between the two instruments analyzed. Other studies have also verified the agreement between different instruments for the flexibility assessment. Achour Júnior et al.[27] conducted a study that aimed to compare and analyze the agreement between two types of fleximeters and a inclinometer and to evaluate the range of motion of the cervical spine in the young adult population. The authors observed the existence of agreement between the three instruments.

Florêncio et al.[17] observed concordance and reliability between the fleximeter and the cervical range of motion instruments to assess the flexibility of the cervical spine of young adults. The results showed that the instruments tested have good agreement and both can be used to evaluate the movements of the cervical region of this population. Although review studies. such as the one of Williams et al.[22] have demonstrated that the goniometer and fleximeter instruments are valid and reliable it draws attention for the lack of studies involving the elderly population in relation to the verification of the agreement between the different instruments used to verify the range of motion. Since the limitations presented in this age group, regarding the decrease of flexibility, reflect in an important way in the accomplishment of activities of the daily living[5], it is important to identify the possible concordances/disagreements between the different instruments that can be used in clinical practice. In addition. the professionals will be able to choose the equipment that most corresponds to their needs, taking into account. for example. the cost or their affinity for the handling[19.20].

Another important factor is the possibility of comparing the data presented by the different studies that use different equipment, such as the goniometer and the fleximeter. This study showed that the results of the measurements obtained in the evaluation of the three joints were concordant for both instruments suggesting that the results of these tests provide the same information and can be compared. It is suggested for future studies that other segments can be evaluated as well as with the use of other instruments so that different factors can be established in relation to the measurement of range of motion in the elderly.

CONCLUSION

There is an excellent agreement between the data when using the goniometer and fleximeter instruments to evaluate the range of motion of the hip flexion knee flexion and ankle dorsi- and plantar-flexion indicating that both provide similar results in the elderly population.

AUTHORS CONTRIBUTIONS

DAAPO: study design and development, data analysis and acquisition, critical review, approved final version; RQF: study design and development, data analysis and acquisition; AAJ: study design and development, data analysis and acquisition, critical review; RFO, LCO, IOS, VS, RGO: study development, data acquisition, approved final version.

CONFLICT OF INTERESTS

The authors declare that there was no conflict of interests.

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