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The preponderance of decreased joint mobility or muscular elasticity in the loss of flexibility in the aging process

Original Article

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ABSTRACT: In healthy people it's possible to admit that the capacity and the freedom of executing movements generate comfort, taking to the well-being. With the aging; an increase of the density appears in the cartilage and in the surround tissues, besides the tendency to the loss of the elasticity of the muscles, to the development of the arthritis and of other pathologies of the locomotor's system, that intensify the restriction of the movement and reduce the flexibility. The main objective of that study is to verify if the loss of the flexibility carted by the aging happens, preponderantly, in function of the decrease of the mobility, or of the loss of the muscular elasticity. Two sample groups were set up, including the age groups between 31 to 45 years (age ripens), and among 61 to 75 years (senior-young). In the first stage of the research it was made the selection of the movements that are limited for the muscular elasticity and of those restricted ones for the mobility to articulate. In the second stage, the profile of flexibility of the two sample groups was verified. Collected the results, it was ended that the loss of flexibility during the aging process obtained an index of 45.9% for the mobility, while the muscular elasticity was responsible for 54.1%, on the total of the variation.

Keywords: Flexibility, mobility, muscular elasticity, aging.

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RESUMO

A preponderância da diminuição da mobilidade articular ou da elasticidade muscular na perda da flexibilidade no envelhecimento

Em pessoas saudáveis se admite que a capacidade e a liberdade de executar movimentos geram conforto, levando ao bem-estar. Com o envelhecimento, surge um aumento da densidade na cartilagem e nos tecidos ao seu redor, além da tendência à perda da elasticidade dos músculos, ao desenvolvimento da artrite e de outras patologias do aparelho locomotor, que intensificam a restrição do movimento articular, reduzindo a flexibilidade. O principal objetivo desse estudo é verificar se a perda da flexibilidade acarretada pelo envelhecimento ocorre, preponderantemente, em função da diminuição da mobilidade, ou da perda da elasticidade muscular. Montaram-se dois grupos amostrais, abrangendo as faixas etárias entre 31 e 45 anos (idade madura) e entre 61 e 75 anos (idoso-jovem). Na primeira etapa da pesquisa, fez-se a seleção dos movimentos que são limitados pela elasticidade muscular e daqueles restritos pela mobilidade articular. Na segunda etapa, verificou-se o perfil de flexibilidade dos dois grupos amostrais. Coletados os resultados, concluiu-se que a perda de flexibilidade durante o processo de envelhecimento obteve um índice de 45,9% para a mobilidade articular, enquanto que a elasticidade muscular foi responsável por 54,1%, sobre o total da variação.

Palavras-chave: Flexibilidade, mobilidade articular, elasticidade muscular, envelhecimento.

RESUMEN

La preponderancia de la disminución de la movilidad articular de la elasticidad muscular en la pérdida de la flexibilidad en el envejecimiento

En las personas saludables es posible admitir que la capacidad y la libertad de ejecutar los movimientos generan el conforto, mientras llevando al bienestar. Con el envejecimiento un aumento de la densidad aparece en el cartílago y en el tejidos cercanos, además de la tendencia a la pérdida de la elasticidad de los músculos, al desarrollo de la artritis y de otras patologías del sistema locomotor que intensifica la restricción del movimiento y reduce la flexibilidad. El objetivo principal de ese estudio es verificar si la pérdida de la flexibilidad por el envejecimiento pasa, preponderantemente, en la función de la disminución de la movilidad, o de la pérdida de la elasticidad muscular. El estudio fue hecho con dos grupos: un de ellos con edad entre 31 y 45 años (la edad madura), y entre 61 a 75 años (mayor-joven). En la primera fase de la investigación fue hecho la selección de los movimientos que están limitado para la elasticidad muscular y de aquellos restringidos para la movilidad articular. En la segunda fase, se verificó el perfil de flexibilidad de los dos grupos de la muestra. Obtenidos los resultados, fue constatado que la pérdida de flexibilidad durante el proceso de envejecimiento obtuvo un índice de 45,9% para la movilidad, mientras la elasticidad muscular fue responsable por 54,1%, en el total de la variación.

Palabras clave: Flexibilidad, movilidad, elasticidad muscular, envejecimiento.

INTRODUCTION

The absolute and relative numbers of elderly people are increasing in almost all countries in the world. The society has been facing, therefore, a growing segment of elderly population, which demands more and more specialized health services, showing at the same time, less responsive capacity to such services. Therefore, extraordinary responsibilities fall on the elderly's and/or programs and institutions aimed at the well being and a decent quality of life of the elderly individual.

The aging is a complex process involving many variables - genetic factors, lifestyle, chronic diseases, among other data. To state the obvious, aging affects every human being, since they do not die, in childhood or as young. However, what deserves serious attention is how you get older: it is urgent, therefore, demand and find effective means for the steps of the aging process to occur in the most satisfying way possible. Participation in physical activity will provide opportunities to a number of favorable factors contributing to healthy aging through an independent lifestyle, improving functional capacity and quality of life at this stage (ACSM, 1998).

Physical activity brings both preventive and therapeutic benefits for people weakened by the passage of time, these benefits which first goal is to make their days more pleasant, by improving the possibilities of everyday occupations and leisure activities.

The greatest impact on the functional capacity results from the physiological changes that affect the mobility of the elderly person. Walking programs, aiming at the development of flexibility, and strength training are able to prevent muscle weakness, because of a plausible restoration of balance. Muscle vulnerability and consequent lack of balance represent risk factors for falls in the elderly people.

Moreover, positive changes in functional capacity would result in a broader independence in daily life activities, (BARRY, RICH & CARLSON, 1993). This attitude provide benefits for bone health and thus reducing the dangers of osteoporosis, the correction and postural stability, reducing and avoiding possible accidents and adding flexibility and range of motion. It is thus increased, because the functional capacity of senescent men and women, thus contributing to a desirable and therefore worthy quality of life.

According to BUCKWATER, (1997), regular activity can often slow or reverse the decline of mobility, a decline that contributes to diseases and disabilities in elderly people.

The financial status and quality of life are negatively affected, simultaneously to the decline in the ability to work and participate in social activities and leisure.

The self-image and self-esteem tend to harm themselves; the quality of sleep deteriorates compromising often and the psychological state of mind of those who are aging or are elderly individuals already. The reduced capacity for exercise affects different organic systems, establishing favorable field for heart diseases, diabetes and colon cancer, among other problems.

The ability of an elderly person, in seeking to retain the daily life skills and mobility - such as walking, getting up and reaching some object above his/her head - indicates important aspects of a quality lifestyle (ALEXANDER, NICKEL, BORESKIE, & SEARLE, 2000).

A balanced motricity values the body, values the self-concept and self-esteem, creating at the same time, a productive and healthy interdependence with the environment - with friends, family, finally, with the social stratum to which the elderly person belongs. The

smooth capturing of movements marks the starting point from where the pleasurable existential possibilities of various stages of senescence.

In order to prescribe and program appropriate exercises for the elderly, it requires a careful and efficient planning, considering data such as age, life experience, the level of preparation, schooling, health conditions of each subject.

Such activities - enjoyable - will emphasize the joy, motivation, spontaneity, from each one and from the group, both in interaction in order to let the elderly individuals comfortable and relaxed. After the experience of a session of activity, it is expected that they feel more animated and relaxed, reducing the anxiety and depression and even disappearing both (DANTAS, 1999, p. 200).

It is recalled that the daily performance of physical activities is of utmost importance with regard to quality of life in old age. To exercise physically every day requires a certain level of physical fitness (physical ability); according to the WHO, physical fitness is "the ability to perform muscular work satisfactorily", (VANHEUVELEN, KEMPEN, ORMEL, & RISPENS, 1998,) including components such as located muscular endurance, strength, aerobic endurance, flexibility and body composition.

According to ACSM (1998), the term flexibility covers the range of motion of single or multiple joints, and the ability to perform specific tasks DANTAS, (1998, 173) completes this definition, adding that flexibility is the "physical quality responsible for the voluntary implementation of a movement of maximum angular range, by a joint or set of joints within the morphological limits without the risk of causing injury".

The prognosis of loss of mobility afflicts and seriously worries anyone, particularly the elderly ones: a progressive decrease in range of motion and increased joint stiffness characterize the aging process. The specific causes and the importance of these changes in old age are not clear enough. Decreased range of motion may involve the deterioration of cartilage, ligaments, tendons, synovial fluid and muscles. Collagen, one of the primary components of the connective tissue, becomes denser over the years, and would reveal, accordingly, a decrease of elastin. It is unknown which of these factors play more important role with respect to old age, however, as it is gaining force, the calcification of cartilage and connective tissues around them is increased; a trend appears to shortening the muscles, to the development of arthritis and other negative orthopedic conditions, which enhance the restriction of joint movement and reduce the elasticity and tolerance of compression of the spine (MISNER, MASSEY, BEMBEN, GOING & PATRICK, 1992).

People do not always end their lives in asylums due to acute illnesses, but often due to the fact of not properly developing their physical abilities and thus lose their biological resistance (ADAMS, O'SHEA, & O'SHEA, 1999). When they reach close to 50 years of age, if they have opted for a sedentary lifestyle, they begin to pay the price for that choice. Sedentary lifestyle not only expects but also causes serious consequences - changes in body composition, including loss of lean body mass, strength, flexibility and bone density. There is, moreover, the increased weight and body fat.

The inactivity, in senescence - is repeated - is the main factor of these changes: The levels of physical activity show one of the determinant aspects that affect body composition from childhood to old age.

An adequate flexibility helps the human being, both to find its functional balance in the different experiences, and to fully participate in numerous activities, whether for leisure, whether in the community. It was observed that the absence of reasonable flexibility leads the subject to greater chance of injuries and functional problems, especially when it comes to sedentary individuals in middle age or elderly ones.

Flexibility declines with age - stands out once again in this research. It seems that individuals suffer a loss of 20 to 30% between 30 and 70 years-old. The contributions of soft tissue, to the total resistance, found in articulation, list the following: joint capsules, 47%; muscle and its fascia, 41%; tendons and ligaments, 10%; and skin, 2%.

Limited evidences suggest that biological changes - stiffening of tendons, joint capsules, changes in muscle - are responsible for the decline of mobility related to age. With the advance of time, the increase in collagen solubility, making it thicker, not forgetting its extra content in the muscle: in contrast, leads to a reduced range of motion.

The detention or lack of activity enhances the turnover of collagen and deposition in the joints, reducing the muscle fiber as well as the muscle mass at the expense of flexibility.

When someone gets older, the range of motion during walking and the joints of the lower extremity become increasingly limited. The elderly makes shorter steps than the young person, refreshing, therefore, a contention in the range of hip flexion and extension and a reduced flexibility of the ankles. Among the daily duties, to crouch and to tie the shoe laces require a large range of motions, which is limited in old age.

Exercise can reduce the fibrosis related to senescence and help maintain flexibility in the elderly. The decline in flexibility among the elderly, caused by lack of exercise, is reversible through specific activities.

Flexibility is a key component of fitness, essential to the elderly people, flexibility that acts as a safety factor in preventing falls and domestic accidents in general. It is, however, often neglected by individuals in old age. The flexibility, combined with the strength, allows the subject to carry out its daily tasks, with reduced risk of injury.

MESSIER, LOESER, HOOVER, SEMBLE & WISE, (1992) found that the limited flexibility prevents the dynamic range of movements, leading to significant differences in measures of speed. According to results achieved on the issue, it appears that adults with osteoarthritis of the knee compensate such pathology by reducing the angular velocity of knee during walking, and also extending

STRUCTURES		PROPERTIES
Joints Ligaments	Joint Mobility	Joint Capsule Ligaments
Voluntary Muscles (and tendons)	Plasticity	Mitochondria, Sarcoplasmic Reticulum and Tubular System
	Muscular Elasticity	Endomysial, Perimysial and Epimysium; Sarcomere
Skin	Maleability	

Source: Dantas, 1997.

the range of motion in the legs affected and unaffected. So there is evidence that the therapy, through flexibility exercises, benefits patients with arthritis.

The measure from range of motion is routinely used in assessing both joint mobility and its role in the treatments and setting of realistic goals for the special case of each patient.

Researchers have suggested that joint ranges of motion selected vary with age. Regressive changes in all tissues of the joints begin to occur after 20 years of age, may succeed decreased range of motion. Pain, muscle weakness or spasm would indicate limitation of active joint movement.

The health status of an individual and any progress in its joint integrity associated with aging are able to affect selected ranges of motion. The relation between the range of motions and physical activity is not yet well established (WALKER, SUE, MILES-ELKOUSY, FORD & TREVELYAN, 1984).

It has been reported that participation in fitness or high levels of physical activity would increase the flexibility or offset its decline, this decline related to age. According to DANTAS (1999, p. 205), limiting the range of motion by increasing the number of years lived focuses more on specific joints.

The analysis of data, drawn here, will just focus on the morphological aspects, influenced by the factors described in the table below.

(1) Rotação da coluna cervical
(2) Extensão de joelho
(3) Flexão de ombro
(4) Abdução de ombro
(5) Extensão de cotovelo
(6) Flexão de quadril
(7) Flexão de joelho
(8) Adução de ombro
(9) Flexão de cotovelo
(10) Prono-supinação

Among the properties that influence the phenomenon of flexibility, the ones providing interest for this work are those, according to FOX, BOWER, & FOSS, (1991, p. 134), related to the factors of stronger resistance in achieving greater articulation arches: The joint mobility, (47%), and joint elasticity, (41%).

As already stated at the beginning of this introduction, the primary objective of this study is to verify if the loss of flexibility brought about by aging, occurs mainly due to the decrease in joint mobility, or loss of elasticity.

METHODS

Study Model

The study was developed in two phases, using for each one of them distinct models.

Initially it was employed a descriptive research model, (ARY, JACOB & RAZAVICH, 1972), from the survey type, (KERLINGER, 1964), in which it was used the Delphic Panel as method for obtaining data in research.

Subsequently, it was applied the pre-experimental design, through "Statistical Group Comparison", (CAMPBELL, 1979).

Selection of Subjects

It is pointed out once more, that two sample groups were made - one composed of individuals in middle age, (31 to 45 years-old, Group "A"), and another of young elderly individuals (61 to 75 years-old - Group "B"), according to the WHO classification, cited by WEINECK (1991 p.330). The number of people in each group was determined by the Power Experiment. All the studied subjects were healthy and non-athletes, exercising at least three times a week in the last three months of research.

Methodological Procedures

1st Step: Selection of limited movements by muscular elasticity and movements restricted by joint mobility

A jury of experts was selected through the Delphi Technique, in two rounds and then asked to position themselves about which most human movements typically limited by the elasticity of muscles, in their maximum range, (Set "I") and which ones have in the mobility their main limiting factor, (Set "II"). The researchers presented the instrument with the description of the 52 most important movements of the human body (excluding those held by the hands

Hampered by Joint Mobility	Hampered by Muscular Elasticity
Abduction of wrist art. (X = 0.89 ± 1.02) z = 4.5380	Abduction of shoulder girdle (X=-0.57 ±1.09) z=2.8934
Circumduction of wrist art. (X = 0.84 ± 0.87) z = 5.2966	Adduction of shoulder girdle (X=-0.68 ±0.97) z= 3.1207
Rotation of the lumbar spine (X=0.52 ± 1,09) z=2.8971	retraction of the clavicular sternum (X= -0.52 ±1.22) z=3.2105
Internal rotation of knee art. (X = 0.83 ± 1.21) z=3.7663	Rotation of the cervical spine (X = -0.63 ±1.03) z =2.9952
External rotation of knee art. (X= 0.82 ± 1.24) z=3.6546	Hip flexion (X = -0.52 ± 0.75) z =5.6712

and feet). Before each movement, a range of progressive value, based on the Likert scale, provided a quantitative opinion on the most important factor in limiting the flexibility: the move would be prominently prevented by the muscular elasticity in almost all the people, (-2), or the move would possibly be prevented in some people, by the muscular elasticity (-1); it could also be that the movement would be prevented by another factor - such as the volume of the agonist - or a combination of factors, not characterizing the predominance of either, (0); or even succeed in some subjects, that the movement would be prevented by joint mobility, (+ 1) or, finally, there would be the possibility that the movement to be clearly prevented by joint mobility in almost all individuals, (+ 2).

It was stressed that should not be considered pathological changes compared with the normality standards.

The instrument selected was validated by five members - doctors and Master's teachers - with at least five years of professional experience, and submitted subsequently to the trial of 63 experts in kinesiology, anatomy, orthopedics and human motricity.

RESULTS

The data were collected results in a Microsoft Excel 7.0 spreadsheet, through the Mystat software; the deviations were calculated using the "z" score for each item.

Were considered as being of undoubted preference from the panel of experts, the items that presented a "z" score ≥ 2.5, able to ensure a certainty of 99%. The moves more distinctly barred by one or the other factor were as follows, in the opinion of experts:

The results achieved in the research ratified the above explained, in a non-systematic way in the literature, allowing for the continuation of this study.

2nd Step: Verification of the profile of flexibility from the sample groups

The measure of flexibility from the movements of sets "I" and "II", group "A" and then the group "B".

Instrumentation

It was obtained a measure of flexibility by means of a Lafayette Goniometer Set, using the LABIFIE protocol, (DANTAS, 1993), with the subjects not warmed up in the afternoon and at STP.

STATISTICAL TREATMENT AND PRESENTATION OF DATA

The sample for this study corresponds to n = 62, subjects were divided according to age - elderly and mature - and regarding physical activity and gender.

For an initial analysis of data, the subjects were submitted to two distinct treatments: by means of a Descriptive Statistics tool to present the sample analyzed, and through the Statistical Inference, in which were performed the hypothesis tests, to be verified, by comparison, the components of the averages from the studied variables.

Seven variables were analyzed (M1 = wrist abduction; M2= wrist adduction; M3 = internal rotation of the knee; M4 = external rotation of the knee; M5 = abduction of the shoulder girdle; M6 = adduction of the shoulder girdle; M7 = hip flexion), then coming up the following averages and their respective standard deviations, as the table shows:

In the table below are visualized more distinctly the variables AGE, PHYSICAL ACTIVITY PRACTICE and SEX.

It is extremely important that it is previously clarified the subtitle used.

Study of Correlations

In order to verify the existence of functional relations between the analyzed variables, and reduce, therefore, the analytical redundancies, it was made an array of correlation between those variables, applying the Pearson's Correlation Test: it was observed, then a level of significance for the coefficient "r", from $p < 0.05$ and a degree of freedom = 61. Here are the results according to the table:

Such results demonstrated that there are significant correlations between the variables M1 and M6 ($r = 0.36$, $p = 0.0041 < 0.01$) and between M4 and M7 ($r = 0.31$, $p = 0.01145 < 0.02$).

The variable M7 appeared as a determinant factor in identifying differences between the studied groups, obtaining a significance level of $p > 0.05$ and positive frequency, when performed the testing of the null hypotheses.

In summary, in all comparisons of the researched groups, the variable M7 accused differences. It is fair to say, with 95% certainty

Group Code	n	Freq.	M1	M2	M3	M4	M5	M6	M7
G-A	62	100.0%	21.60 (5.94)	37.88 (15.02)	26.58 (7.84)	27.53 (6.09)	3.09 2.15)	4.58 (4.83)	87.60 (15.93)
I-B1	30	48.4%	21.51 (5.79)	37.55 (14.81)	24.66 (7.11)	24.62 (6.03)	3.25 (2.75)	3.13 (1.34)	83.34 (14.75)
M-B2	32	51.6%	21.68 (6.16)	38.19 (15.45)	28.37 (8.17)	30.25 (4.80)	2.93 (1.40)	5.94 (6.35)	91.60 (16.19)
Group Code	n	Freq.	M1	M2	M3	M4	M5	M6	M7
P-C1	31	50.0%	22.94 (6.47)	33.64 (15.46)	24.70 (8.02)	27.57 (6.02)	3.26 (2.69)	3.85 (2.36)	93.78 (15.96)
ñP-C2	31	50.0%	20.25 (5.10)	42.12 (13.51)	28.45 (7.31)	27.48 (6.26)	2.91 (1.44)	5.31 (6.39)	81.43 (13.52)
Fem-D1	46	74.2%	21.26 (5.76)	38.95 (14.15)	27.60 (7.65)	27.92 5.96)	3.30 (2.35)	5.00 (5.51)	91.33 (14.93)
Masc-D2	16	25.8%	22.57 (6.51)	34.80 (17.41)	23.64 (7.87)	26.41 (6.51)	2.48 (1.28)	3.36 (1.37)	76.89 (14.09)

that this variable is dominant over the ability of Muscular Elasticity or over Joint Mobility.

According to the results showed in this first statistical approach, it was concluded that:

1. The age group, physical activity and gender appear to be inference factors in the selection of sample universe from the sample itself, since they show a strong influence on the variables analyzed in this study;

2. In both age groups, referring to "mature" and "old", the variables that have updated most appropriate indicators to diagnose and quantify the reduction in **muscular elasticity** and **loss of joint mobility** were the significant smaller differences compared to the average group of mature individuals; regarding the M4, M6 and M7, in which the averages from the elderly group had a higher result;

3. The variable M7 demonstrated the ability to assess, with high significance, the stages of evolution of the reductions mentioned above: Differences were presented according to age group, physical activity and gender. Moreover, it presented to be functional when compared to the variable M4.

It was performed a second statistical approach, based on tests of analysis of variance and correlation coefficient by rank, of Spearman. As final considerations, it states the following:

- The angles of movements Mi (i = 1, 2,3... 7) quantified are directly proportional to the mobility and elasticity parameters, that is, the larger the angles, the greater the conditions of Mobility and Elasticity, and vice versa;

- Joint Mobility → (M1, M2, M3, M4);

- Muscular elasticity → (M5, M6, M7);

- Flexibility → joint mobility combined to muscular elasticity;

-Two Groups (mature {30< age < 46}) and (elderly {60< age < 75}), with the distribution specified below.

- Because of the angles appear directly proportional to the parameters studied and also conform to a continuous metric standard, were consisted in two other analytical variables, according to the table below:

It was applied the test of analysis of variance combined with Tukey's test to make sure whether there are significant differences ($p < 0.05$) between the averages of the studied groups according to the

Group Code	n	Freq.	m1	M2	M3	M4	M5	M6	M7
I.P.Fem-H1	8	12.9%	20.56 (6.23)	31.55 (16.20)	23.73 (6.15)	27.34 (7.43)	4.51 (4.63)	3.01 (1.42)	94.78 (14.18)
I.P. Masc-H2	7	11.3%	25.09 (6.03)	25.69 (9.24)	22.64 (8.95)	22.50 (5.98)	2.64 (1.49)	4.10 (1.53)	81.20 (12.69)
I. ñP. Fem-H3	13	21.0%	20.05 (5.44)	45.35 (7.70)	27.32 (6.00)	23.68 (4.96)	3.05 (1.62)	2.75 (1.09)	81.03 (11.95)
I. ñP.Masc-H4	2	3.2%	22.30 (1.84)	52.30 (28.28)	18.15 (8.70)	27.30 (6.65)	1.65 (1.91)	2.65 (0.92)	60.15 (0.64)
M.P. Fem-H5	13	21.0%	23.12 (6.74)	41.54 (15.00)	26.45 (9.37)	30.21 (3.96)	3.03 (1.73)	4.52 (3.19)	102.82 (14.33)
M.P. Masc-H6	3	4.8%	23.53 (8.41)	23.53 (16.29)	24.50 (5.15)	28.63 (3.51)	2.40 (0.17)	2.67 (0.58)	81.30 (8.89)
M. ñP. Fem-H7	12	19.4%	21.03 (4.79)	34.14 (14.87)	31.72 (7.01)	30.41 (5.65)	3.05 (1.26)	9.30 (9.01)	87.75 (10.03)
M. ñP. Masc-H8	4	6.5%	17.58 (6.49)	50.45 (7.02)	27.48 (8.00)	31.15 (6.79)	2.65 (1.40)	2.95 (1.38)	74.40 (18.97)

VARIABLE	M1	M2	M3	M4	M5	M6	M7
M1	-	r=-0.08 p>0.05	r=0.05 p>0.05	r=-0.11 p>0.05	r= .07 p>0.05	r=0.36 p<0.01	r=-0.13 p>0.05
M2	r=-0.08 p>0.05	-	r=0.23 p>0.05	r=0.22 p>0.05	r=-. 05 p>0.05	r=-0.23 p>0.05	r=-0.22 p>0.05
M3	r=0.05 p>0.05	r=0.23 p>0.05	-	r=0.20 p>0.05	r=0.02 p>0.05	r=0.09 p>0.05	r=0.04 p>0.05
M4	r=-0.11 p>0.05	r=0.22 p>0.05	r=0.20 p>0.05	-	r=0.01 p>0.05	r=-0.05 p>0.05	r=0.31 p<0.02
M5	r=0.07 p>0.05	r=-0.05 p>0.05	r=0.02 p>0.05	r=0.01 p>0.05	-	r=0.16 p>0.05	r=0.15 p>0.05
M6	r=0.36 p<0.01	r=-0.23 p>0.05	r=0.09 p>0.05	r=-0.05 p>0.05	r=0.16 p>0.05	-	r=-0.01 p>0.05
M7	r=-0.13 p>0.05	r=-0.22 p>0.05	r=0.04 p>0.05	r=0.31 p<0.02	r=0.15 p>0.05	r=-0.01 p>0.05	-

Code	Variable	Parameter	Scale
MA	M1+M2+M3+M4	Joint Mobility	continuous
EM	M5+M6+M7	Muscular Elasticity	continuous

Variables	F calculated	p	Tukey
MA	4.97	0.030	Mature>Elderly
EM	6.402	0.014	Mature>Elderly

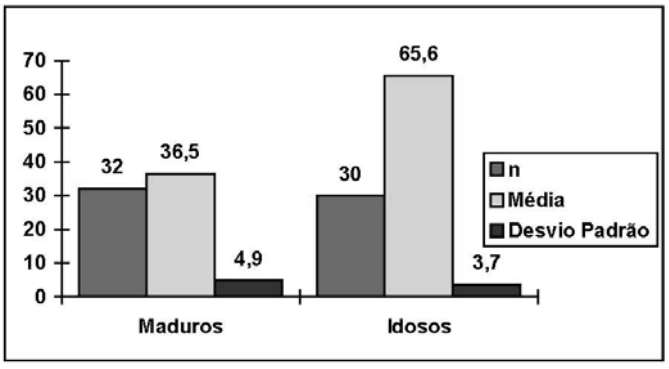
analytical variables MA, (**joint mobility**), and EM, (**muscular elasticity**). The following results were found:

In the table above, both $p < 0.05$ show that there are significant differences between groups in both parameters. In *joint mobility*, the group of mature (119.82), presents a result significantly greater than that of the elderly group, (108.34). This implies that, in mature, the *joint mobility* is considerably higher than that from the elderly, in the age ranges considered.

After this analysis, the hypothesis of differences in the parameters [MA and EM] is supported by the results achieved.

Continuing this analysis, it was developed a study of correlations between all researched variables: It was used the coefficient of Spearman (rank), since the data are continuous (angular data and age), and discrete (status of the group according to age range). Thus, it was decided to treat all data, using the nonparametric Spearman correlation tests for ranks, considering the variables Mi, as dependents, and age as independent.

The table below endorses the results:

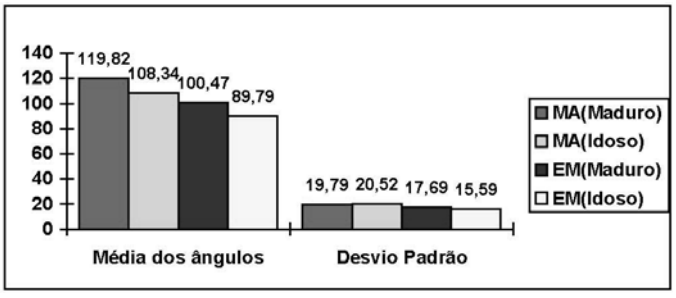


The results confirm that observed at the beginning of the study: They show that the variables M4, M7, MA and EM are the key to analysis of the behaviors and differentiation between the groups of mature and elderly. Definitely, are recognized significant correlations ($p < 0.05$) with age, being all negative - M4 (main variable of the *joint mobility* parameter), x age (-0.4930), M7 (main variable parameter of the *muscular elasticity* parameter), x age (-0.2557), MA x age (-0.2232) and EM x (-0.2767).

These findings mean that the variables are inversely proportional to age, that is, when the age range rises, decrease the angles corresponding to the capabilities of *joint mobility* and *muscular elasticity* and vice versa. This finding confirms the hypothesis that the parameters for flexibility are functional – in a vision of causality (cause and effect) - in relation to the respective age range.

When affirming the existence of significant correlation between the parameter variations joint mobility and muscular elasticity with the age factor, guided the present study to quantify the inferences, from each of these analyzed parameters, in the total variation of the capacity for flexibility, an ability that is captured as a combination of them.

It is understood, therefore, about the factors involved, being the joint mobility → (M1 + M2 + M3 + M4) and the muscular elasticity → (M5 + M6 + M7).



It was consulted the study of multiple correlation, just as an aid to quantify the weights, that is, the respective weights of the coefficients, related to their respective variables, according to the following model:

Delta (variation) Age = A x (Delta joint mobility) + B x (Delta muscular elasticity)

In this case, A and B are dimensionless constants and summed, result in [A + B] 100% of inferences, (weights). Consequently, the analytical coefficients correspond to the respective weights of inferences on the whole, [delta flexibility].

Here are the results, outlined in the tables below:

R = 0.878009, Degree of Freedom = 61

CONCLUSION

In summary, it is concluded that the variations in the ability of flexibility result from age variations, result from the proportions of functionally inferences of variations, (delta) of joint mobility weighing 45.9% on the total variation of flexibility, and muscular elasticity, the latter being responsible for 54.1% with a high significance: p (0.0001). It is revealed, therefore, that the loss of muscle flexibility, caused by age, occurs primarily by the decrease in muscular elasticity. Therefore, it has been an analytic coefficient - 0.256745 - for an R=0.87809, and a degree of freedom of 61.

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