Scale of perceived exertion in the flexibility (PERFLEX): a dimensionless tool to evaluate the intensity?

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\textbf{ABSTRACT}

\textbf{Introduction}: The difficulty of counting with evaluation tools capable to evaluate the labor physical stress, due to the accomplishing of movements arches of maximum amplitude in the activities of professional groups, mainly in the health area (nurses, physiotherapists and physicians, especially) was the preponderant motivator factor for the research execution. The objective of this study is to search the correlation by chance existent between the intensity and the amplitude of articular movement arches (evaluated through the Scale of Perceived Effort in the Flexibility - PERFLEX) - with an objective method of evaluation of the flexibility. \textbf{Materials and Methods}: The sample was composed by a group of 42 voluntary students, of both sexes, of the Superior School of Physical Education of Muzambinho (Escola Superior de Educação Física de Muzambinho), Minas Gerais, non-athletes, varying between 19 and 27 years. PERFLEX possesses five intensities levels, varying from 0 to 110, classified in five verbal descriptors, so that the evaluator can discern it, through the description of its perception, which the sensation corresponding to the amplitude of accomplished movement: from 0 to 30 - “Normality”; from 31 to 60 - “Forcing”; from 61 to 80 - “Discomfort”; from 81 to 90 - “Bearable Pain”; and from 91 to 110 - “Strong Pain.” Parallel to the evaluation of the subjective effort perception, during the accomplishing of the movement along the whole articular arch, was measured the angle of the same (through a goniometer) and the applied force to get the quoted arch (through a dynamometer). The goniometry was made, following the LABIFIE protocol. \textbf{Results}: The results of the statistically significant correlations (for p<0.05) between angular average (of the goniometry) and the applied tension in the body segment (dynamometry), for the levels of PERFLEX were: in the “Mobility” category, (indexes from 31 to 60) correlation was observed in the movements of Horizontal Shoulder Extension (r=0.62; p=0.029) and of Inferior Limbs Abduction (r=0.63; p=0.025); in the “Stretching” category, (indexes from 61 to 80) the correlation can be observed, also in the Horizontal Shoulder Extension (r=0.76; p=0.004). \textbf{Discussion}: The study indicates that PERFLEX can come to turn in a valid instrument, of evaluation of the intensity level demanded for the accomplishing of a movement of maximum angular amplitude.

\textbf{KEYWORDS}

Muscle Stretching Exercises, Articular Motion Range, Articular, Goniometry.

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Escala de esfuerzo percibido na flexibilidade (PERFLEX): ¿Un instrumento adimensional para se avaliar a intensidade?

RESUMEN

Introducción: La dificultad de contar con instrumentos de evaluación capaces de evaluar el estrés físico laboral, decorrente de la realización de arcos de movimientos de amplitud máxima en las actividades de grupos profesionales, sobre todo en el área de salud (enfermeros, fisioterapeutas y médicos, en especial) fue el factor motivador preponderante para la ejecución de la investigación. Objetivo: El objetivo de este estudio es buscar la correlación quizá existente entre la intensidad y la amplitud de arcos de movimientos articulares (evaluados por medio de la Escala de Esfuerzo Percibido en la Flexibilidad - PERFLEX) - con un método objetivo de evaluación de la flexibilidad. Materiales y Métodos: La muestra fue compuesta por un grupo de 42 alumnos voluntarios, de ambos los sexos, de la Escuela Superior de Educación Física de Muzambinho, Minas Gerais, no atletas, variando entre 19 y 27 años. La PERFLEX posee cinco niveles de intensidades, variando de 0 a 110, categorizados en cinco descriptores verbales, para que lo evaluando pueda discernir, a través de la descripción de su percepción, cual la sensación correspondiente a la amplitud de movimiento realizado: de 0 a 30 - “Normalidad”; de 31 a 60 - “Forzamento”; de 61 a 80 - “Desconforto”; de 81 a 90 - “Dolor soportable”; y de 91 a 110 - “Dolor fuerte”. Paralelamente a la evaluación de la percepción subjetiva de esfuerzo, durante la realización del movimiento a lo largo de todo el arco articular, se mensuraba el ángulo del mismo, por medio de un goniómetro, y a la fuerza aplicada para conseguir se citado arco, por medio de un dinamómetro. Los resultados de las correlaciones estadísticamente significativas (para $p<0,05$) entre las medias angulares y las de tensión aplicada en el segmento corporal, para los niveles de la PERFLEX, fueron: en la categoría “Mobilidad” (índices de 31 a 60), se observó correlación en los movimientos de extensión horizontal del hombro ($r=0,62$; $p=0,029$) y de abducción de miembros inferiores ($r=0,63$; $p=0,025$); en la categoría “Estiramiento” (índices de 61 a 80), la correlación puede ser observada, también en la Extensión Horizontal del Hombro ($r=0,76$; $p=0,004$). Discusión: El estudio indica que la PERFLEX puede venir a constituirse en un instrumento válido, de evaluación del nivel de la intensidad exigida para la realización de un movimiento de amplitud angular máxima.

PALABRAS CLAVE

Ejercicios de Estiramiento Muscular, Rango del Movimiento Articular, Goniometria Articular.

INTRODUCTION

The daily, labor and sports activities use, on several occasions, the maximum arches of autonomous movement. These arches of movement are limited by the flexibility conditions of muscle segments involved in the respective joints. Therefore, the muscle segments need to have good flexibility level, making possible like this the full utilization of these articular arches, but not reaching the region with high resistance to movement.

In labor practice, health professionals, especially nurses, physiotherapists and doctors, need to achieve...
maximum amplitude of joint movements, with levels of physical stress very difficult to be measured by formal methods of flexibility evaluation\(^2\). The inability to use the linear or angular methods in the on the job evaluation of labor physical stress, was an important motivating factor for this study.

The level of flexibility is directly related to the quality of life, being required minimum values of articular amplitude\(^2\), to permit the implementation of activities of daily living and working within the limits of low resistance to movement, because they do not produce early fatigue\(^2\).

Exercises for flexibility have been considered for a long time, as an essential part in the procedures of warming and indispensable in physical fitness, and a method to improve the efficiency of the movement, taking direct relationship with the muscle performance\(^4,5\), in addition to qualitative and quantitative benefits, whether in physical performances\(^5\), or in labor.

The obtaining of a good level of flexibility by carrying out regular exercises, whether carried out at maximum or submaximum way, positively influence the movement capacity, preventing restrictions on the necessary achievement of the motion arches for daily or labor activities\(^5,\).\(^5\)

Although the subjective perception of effort (PSE) was originally developed to control the intensity of predominantly aerobic exercises\(^9\), studies showed evidence that indicated their validity and reproducibility for other kinds of exercises\(^10,11\). This effort is closely linked to the exercise intensity, as a result of the integration of afferent signals, from muscle-skeletal, cardiovascular and pulmonary systems\(^9\).

The conceptual structure for the observation of perceived effort is derived from two converging lines of research: the behavior observation and visual perception. Through integration of central and peripheral signals, the perception of effort is given by numerical classification and/or verbal expressions, so the valuation of perceived effort is a powerful tool to monitor the intensity of the effort and is often used in tests of progressive effort\(^12\).

The standard tests to evaluate the subjective perception of effort typically detect several properties as: (a) the weight of an object that will be lifted and/or transported, (b) the movement and its direction, and (c) Expectations, modes, and skills that are background or consequential to an event\(^13\).

In the case of the amplitude of articular motion is essential to considers that to achieve the maximum motion range, will be necessary pass through submaximal level, until reach the maximum level. The ways of working that exploit these two levels are called in literature, respectively, stretching and overstretching\(^2,14,15\). A dimensionless toll to evaluate the subjective perception of effort, necessarily have to contemplate such categorization.

Thus, this study aims to search the correlation by chance existent between the intensity and amplitude of articular movement arches (evaluated through the Scale of Perceived Effort in the Flexibility - PERFLEX), with an objective method of evaluation of the flexibility (the goniometry), with control of the applied force (through dynamometry).

**MATERIALS AND METHODS**

**Approval of the study**

The study was submitted and approved by the Research Ethics Committee of Universidade Castelo Branco under number 0015/2008.

**Sample**

The sample comprised a group of 42 volunteers, students from the Superior School of Physical Education (Escola Superior de Educação Física) of Muzambinho city, state of Minas Gerais, Brazil, with 18 males and 24 females, all active, non-athletes, aged between 19 years and 27 years, which, according to the World Health Organization\(^16\), represents the adult age.

The volunteers were previously informed about the purpose and procedures of this study. Later, were excluded those who had a history of orthopedic, neurological and rheumatological diseases and then the selected individuals signed a free and informed consent, agreeing to the participation in the search, according to the resolution 196/96 of the National Council Health.

**Methodological procedures**

Conducted the preliminary procedures already described, started the measuring of the movements of the horizontal shoulder extension (HSE), shoulder joint abduction (SJA), lumbar spine flexion (LSF), the hip flexion (HF) and lower limbs abduction (LLA), through a test of progressive

**Figure 1 - Manual Muscle Test System**
effort, where every movement of flexibility is carried out in accordance with the protocol of LABIFIE of goniometry. The evaluation was performed by using, at the same time, three instruments:

1. To measure the movement amplitude was used a steel goniometer (Lafayette, USA), 14”, with scale of 180° and accuracy of 1°.

2. To quantify the effort tension, was used a dynamometer Manual Muscle Test System - Model 01.163 (Lafayette, USA), ranging from zero to 136kg and precision of 0.1kgf (Figure 1).

3. To assess the effort perception, was used a dimensionless method called: Scale of Perceived Effort in Flexibility (PERFLEX), which has five intensity levels, ranging from 0 to 110, categorized into five verbal descriptors, so that the person who evaluates can discern through the description of perception, what feeling correspond to the range of movement performed: 0 to 30 - “normality”, from 31 to 60 - “forcing” of 61 to 80 - “discomfort”, from 81 to 90 - “Bearable pain”, and 91 to 110 - “strong pain”. The PERFLEX shows, moreover, a “Specification” column, which are described the morphofunctional effects of different arches of movement in the motive system, as shown in previous studies (Figure 2).

At every sign made by the evaluated subject, according to the sensation description of the scale, the movement was stopped, and were collected and recorded the values presented in the goniometer, the dynamometer and in the PERFLEX (numerical grade of the “level”). After collection, the movement was resumed from where it stopped, until the individual reaches the next level of the scale, when he repeated the procedure that was described above. This process continued until they reached the maximum supported articular limit by the subject.

Place, time and temperature for data collection were similar for all volunteers. All verbal information informed during the data collection was standardized in order to avoid interference in the results.

Data analysis

The instrument used for statistical analysis was the software SPSS 14.0 for Windows. Were used the following methods of descriptive statistics, which permit to characterize the sample based on the selected variables: measures of central tendency (mean) and dispersion (standard deviation). The statistical inference was developed by the

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**Table 1 - Descriptive results of the PERFLEX scale levels, based on the results of goniometry (°) and dynamometry (kgf)**

<table>
<thead>
<tr>
<th></th>
<th>31-60 (mobility)</th>
<th>61-80 (stretching)</th>
<th>81-90 (overstretching)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean</td>
<td>sd</td>
<td>mean</td>
</tr>
<tr>
<td>HSE</td>
<td>dynamometry</td>
<td>2.3</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>goniometry</td>
<td>52.5</td>
<td>8.4</td>
</tr>
<tr>
<td>SJA</td>
<td>dynamometry</td>
<td>3.4</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>goniometry</td>
<td>172.5</td>
<td>15.7</td>
</tr>
<tr>
<td>LSF</td>
<td>dynamometry</td>
<td>7.4</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>goniometry</td>
<td>13.0</td>
<td>11.1</td>
</tr>
<tr>
<td>HF</td>
<td>dynamometry</td>
<td>4.3</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>goniometry</td>
<td>60.5</td>
<td>10.7</td>
</tr>
<tr>
<td>LLA</td>
<td>dynamometry</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>goniometry</td>
<td>30.0</td>
<td>6.0</td>
</tr>
</tbody>
</table>

sd: standard deviation; HSE: horizontal shoulder extension; SJA: shoulder joint abduction; LSF: lumbar spine flexion; HF: hip flexion; LLA: lower limbs abduction.
Shapiro-Wilk test to verify the normality of the sample of the correlation test of Pearson, to the verification of the level of association between the variables and the variance analysis (ANOVA), followed by post hoc test of Tukey.

As criteria of statistical significance, was adopted the value of $p<0.05$.

RESULTS

Was decided to start the presentation of results through descriptive statistics of the collected data, as shown in Table 1.

The values presented in Table 1, when compared to those obtained by Silva et al.$^{19}$, show that the mean amplitudes found are considered normal for all evaluated movements.

Then, as seen in Table 2, was tried to establish the possible correlation between the angular data, obtained through goniometry, and measuring of the applied force, obtained by dynamometry in each one of the levels of PERFLEX.

It appears that, in the movement of the horizontal shoulder extension (HSE), at the level corresponding to the "mobility", was found a correlation classified as high mean. The same occurring for the same movement, at the level corresponding to "stretching", for the same joint. To the lower limbs abduction (LLA) movement there is a correlation in the level corresponding to the "mobility"$^{20}$.

These results allow establishing the existence of significant valid correlation between the arch of articular movement, the tension applied and the perception of effort. Moreover, can be understood a proportionality between such measures, as are shown in Graphs 1 and 2.

Can be checked that did not occurred significant differences in the movements of the lumbar spine flexion (LSF), in comparisons of the sensations forcing vs. discomfort and forcing vs. bearable pain. And the same is true for the hip flexion (HF) in comparison to sensation discomfort vs. bearable pain.

According to Graph 2, can be verified that there was a significant difference in the forcing feeling compared to the bearable pain, and discomfort compared to bearable pain for all evaluated movements.

The comparison between forcing and discomfort showed significant difference only in the movement of the shoulder joint abduction (SJA).

DISCUSSION

The results found in this research corroborate with studies found in the bibliography$^{21}$, which describe the SPE as a powerful tool in the flexibility evaluation and can be

Graph 1 - Multiple comparisons between the amplitude of the articular movement, measured by goniometer, and the perceptions of effort, as the PERFLEX scale

Graph 2 - Multiple comparisons between the tensions applied to the body segments, measured by dynamometer, and the perceptions of effort, as the PERFLEX scale.

Table 2 - Correlation between the data obtained by goniometry and dynamometry in all articular movements, according to PERFLEX

<table>
<thead>
<tr>
<th></th>
<th>31-60 (mobility)</th>
<th>61-80 (stretching)</th>
<th>81-90 (overstretching)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$r$ value-p</td>
<td>$r$ value-p</td>
<td>$r$ value-p</td>
</tr>
<tr>
<td>HSE</td>
<td>0.62 * 0.029</td>
<td>0.76 ** 0.004</td>
<td>0.52 0.079</td>
</tr>
<tr>
<td>SJA</td>
<td>-0.12 0.694</td>
<td>0.22 0.49</td>
<td>0.31 0.311</td>
</tr>
<tr>
<td>LSF</td>
<td>0.27 0.396</td>
<td>0.51 0.087</td>
<td>0.36 0.246</td>
</tr>
<tr>
<td>HF</td>
<td>-0.12 0.695</td>
<td>-0.03 0.914</td>
<td>0.51 0.084</td>
</tr>
<tr>
<td>LLA</td>
<td>0.63 * 0.025</td>
<td>0.16 0.618</td>
<td>0.54 0.068</td>
</tr>
</tbody>
</table>

HSE: horizontal shoulder extension; SJA: shoulder joint abduction; LSF: lumbar spine flexion; HF: hip flexion; LLA: lower limbs abduction

* $p<0.05$

** $p<0.01$
changed by training, when provoking the increase of the original articular arches.

In studies with military, it was concluded that physically active individuals were able to be accurately classified through SPE, in some types of flexibility, which corroborates the results of this study, which found significant correlation between the SPE and the objective measures in some flexibility movement.

Another study found a positive correlation between the categorization established for the performance of certain skills by teachers and self-categorization of these, proposed by the students. This finding supports the possibility of self-evaluation by the SPE intensity needed to obtain arches of growing movements, as well as was presented in work that states that a mechanism known as increase of the tolerance capacity to tension in stretching, transforming it into overstretching.

In a review conducted about the discomfort perception to the stretching tension, can be understood that, in any contractile reflex activity, flexibility is mostly influenced by muscular component than neural component, turning evident like this that the perception of exerted effort will be determinant in the evaluation of flexibility.

The results of this study indicate that the Scale of Perceived Effort in Flexibility (PERFLEX) shows great potential for evaluating the intensity necessary in order to achieve the large arches of movement that characterize the flexibility, as demonstrated by the correlations reached between the used methods, mainly in the goniometry.

After the validation of the method, can be evaluated that the effort spent on the labor and in daily activities, by many professionals, especially the group that motivated this study, the nurses.

It should be emphasized that flexibility is an indispensable component of physical fitness, and have a validated instrument with these characteristics will be of great importance.

From the results found in this study, the recommendations are: increase the sample, with the aim of giving greater statistical significance for the generalization of the results; the accomplishing of studies in other populations to verify the behavior and the applicability of the scale; and scientific validation of the Scale of Perceived Effort in Flexibility - PERFLEX.

REFERENCES

APPLICATION OF A JUMP TEST WITH INCREASING WEIGHTS TO EVALUATE THE RELATION BETWEEN STRENGTH-SPEED AND POTENCY

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ABSTRACT

Introduction: The objective of this study was to analyze the differences between heights or potencies produced in a jump test using different percentages of a Maximum Repetition (1RM), as well as identifying weight zones where the high potencies and those where it is not possible to jump are reached. Materials and Methods: 14 athletes of different specialties accomplished a jump test with increasing weights, determining the overload level based on the value of 1RM, previously measured in the squat exercise with free bar. Results: The obtained results indicated that, when jumping with percentages under 40%, highest heights and potencies can be reached, being them significantly different (p<0.05) from the ones produced with percentages over 60% of 1RM. Moreover, when jumping with weights between 41% -50% and 51%-60% of 1RM, even if they do not observe significant differences, losses of potency superior to 10% and 20%, respectively are determined. Discussion: In accordance with these results, when accomplishing explosive exercises with different weight percentages, it is possible to distinguish three zones of work: Zone one or explosive strength (40% to 60%), Zone 2 or high average strength (60% to 90%) and Zone 3 or of maximum strength (greater than 90%).

KEYWORDS

Muscle Strength, Physical Education and Training.

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