ABSTRACT: The goal of this study was to measure flexibility levels and relationships of the results with the muscle fiber types. The sample group was comprised of 66 individuals, bodybuilding users, aged 20-30 years. The method used for evaluating flexibility was the goniometry, using the LABIFE protocol. The method used to classify fiber types was the dermatoglyphic method by Cummins & Midlo. The statistical treatment of data used was descriptive and inferential statistics with reliability level of p<0.05. The results showed significant differences (p=0.02<0.05) between flexibility levels when crossed with fiber classes. We concluded that there is a correlation between the dermatoglyphic parameters and their classification regarding the muscular fiber types and flexibility; individuals with predominant glycolytic fibers prove to be more flexible.

Keywords: Flexibility; Muscle; Oxidative; Glycolytic.
INTRODUCTION

Muscles form a fundamental component of flexibility for their joint elastic properties (Dantas, 1999), what is in accordance with Fox et al. (1986) in the following quotation: “it is, however, the muscular fiber that will present the greatest potential for flexibility development.” According to McArdle, Katch, F. and Katch, V. (1998), the skeletal muscle is not only a homogenous fiber group with similar metabolic and functional properties. Each muscle contains a combination of different fiber types. We differentiate these muscular fibers in those of slow twitch, or tonic fiber, or still fiber type I; and those of fast twitch, or phasic fiber, or phasic type II, which, in turn, fell into specific functional subcategories, according to Howald (1984 apud Weineck, 1991:43).

According to the American College of Sports Medicine (1998), the term flexibility ranges the amplitude of movements of simple or multiple articulations and the ability to develop specific tasks. Dantas (1999:57) also highlights that flexibility is a “physical quality in charge of the voluntary performance of movement of maximum angular amplitude, by an articulation or group of articulations, within the morphological limits, without the risk of causing injury.”

The same aforementioned journal quoted by Rodrigues & Dantas (2002) places the terms strength and flexibility altogether with the aerobic capacity and body composition, as the four most import components of physical fitness.

Dantas (1999) reports that the flexibility presents a great relation to life quality and human being welfare, what explains Dantas et al. (2002): “an adequate flexibility helps the human being, so much to find their functional balance in several experiences, as to participate completely in innumerous activities, be it for leisure, be it in community.” Alter (1999) quoting Garhammer (1989) explains that flexibility is recognized as an essential factor in the skillful movement, consequently playing a significant role in the determination of the final result of several movements or competitive situations. This corroborates Wiemann & Klee (2000) in the quotation: “There are several sports and sports subjects as sporting rhythmic gymnastics and hurdling, in which the capacity of performance is considered the key to a very high level of flexibility.”

As regards the biological individuality, Dantas (1999:62) describes that “people of the same sex and age may possess totally dissimilar flexibility levels among one another [...] the flexibility level of a movement depends upon the osseous structure, the accumulation of fibrous adjacent tissue and muscular elasticity whose tendons cross the articulation. Complementing the subject on the biological individuality, Jabbour (1998) affirms that genetics dictates our competitive potential, and there are genetic markers which are in charge of this determination which we cannot change: sex, stature, body symmetry and proportion of fast or slow twitch fibers.

A survey conducted by Achour Junior (1996), in innumerous scientific articles and books, demonstrated that the majority of these studies aims at assessing the differences between sex, race, time persistence, temperature, relevance in the warming-up, injury prevention, athletic performance and different methods to develop flexibility. However, we noticed that there is a considerable lack of publications about muscular fiber types and flexibility levels.

If flexibility is so important, turning into one of the physical qualities, and if the muscular fiber is a limitative factor of flexibility and determining of physical fitness, therefore the study referring to the influence of the muscular fiber type in the flexibility cannot be put in the background.

And thus, the aim of this present study was mensurate the flexibility levels and relate the results to the type of muscular fiber.

Dermatoglyphy

Dermatoglyphic patterns, considered as genetic marks, have intrigued the human beings since the primeval times. In the course of time, they have been studied by anatomists, physiologists, geneticians, anthropologists and doctors among others (Penrose,
1968 apud Fernandes Filho, 1997). The word dermatoglyphy comes from the Latin term dermo, and it means skin, and the term glypha means to register, record. This term had already been proposed by Cummins & Midlo, it was introduced in the 42nd Annual Session of the American Association of Anatomists held in April of 1926.

Cummins & Midlo (1942) distinguish three groups of patterns: arch (A), loop (L) and whorl (W). The form of patterns composes a qualitative characteristic, whereas the quantity of lines (QL), summation of the total quantity of lines (STQL), and the quantity of cutaneous crests, also known as minutiae inside the pattern represents the quantitative characteristic. The evaluation of the pattern intensity is carried out coming from the presence of deltas, and so it is calculated the so-called delta index (D10), which is the number of probable deltas in all fingers, having the minimum of 0 and the maximum of 20. The arch (A) does not represent delta; the loop (L) represents a delta; and the whorl (W) represents two deltas (Gladkova, 1996).

There are some expressive studies developed between 1996 and 1997 by the Laboratory of Anthropology, Morphology and Sports Genetics of VNIIFK in Moscow. In the dermatoglyphic patterns, the physical qualities are studied aiming at the type of sports activity and the muscular fiber type.

Nikichuk, Abramova and Ozolin (apud Fernandes Filho, 2003) researched a scheme of principles of the association of fingerprints with physical qualities: velocity and explosive force were characterized by the loop increase (L) (>7), whorl decrease (<3), the presence and arch increase, and a reduction of STQL; whereas the aerobic capacity, endurance and activities of complex motor combinations were characterized by the decrease of arches (up to 0) and loops (>6), and the increase of whorls (>4) and the STQL increase (cf. Table 1).

**MATERIALS AND METHODS**

The study complies with the norms for the completion of research on human being, according to the norms of the National Health Council, abiding by the Guidelines and Regulating Norms of Research involving human beings, going into fact as of 10th October, 1996 in Brazil.

**Sample**

Sixty-six individuals (n=66), all freely and voluntarily, were selected, aged 20-30 years. The sample for study development was selected in the universe of a Fitness Center called Winner Fitness, from the town Muzambinho / MG (state of Minas Gerais – Brazil). It was characterized as intentional: “[…] when the aims of the study need that guinea pigs had specific physical features (Flegner; Dias, 1995:48).” As an inclusion prerequisite: only bodybuilding users with 3-month-old activity at this Fitness Center were considered and belonged to the age group indicated.

**Procedures**

It was used the protocol of goniometry proposed by LABIFIE (1997 apud Dantas, 1999:132) for the verification of maximum capacity of articular amplitude in degrees in the movement of horizontal length of the shoulder articulation and flexion of hip articulation, both of the right side. The selected protocol for the determination of the muscular fiber type was the dermatoglyphic method of digital dermatoglyphy by Cummins & Midlo (1942 apud Fernandes Filho, 1997).

**Instruments**

For the measure of flexibility, it was used a Lafayette goniometer, manufactured in USA. For the fingerprints, it was used a digital pad, brand Impress, model 250, manufactured in Brazil.

**Protocol**

In the test of shoulder flexibility was carried out the measure of the horizontal length of the shoulder articulation, positioning the individual in sitting position, the knee spread and upright spine, with the abducted arm at 90° with the trunk, elbow in extension and palm backwards (Fernandes Filho, 1999). The goniometer was placed with its central axis over the acromial point, and one of the handles was kept over an imaginary line between the acromial points, and the other one in outer arm part, following

**Table 1** – Group classification of dermatoglyphic indices and somatic-functional – indices – among highly qualified college oarsmen (N=101)

<table>
<thead>
<tr>
<th>Class</th>
<th>Fingerprints</th>
<th>Digital Summation</th>
<th>Functional</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>5.5</td>
<td>26.5</td>
<td>Maximum</td>
</tr>
<tr>
<td>II</td>
<td>9.0</td>
<td>47.7</td>
<td>Strength</td>
</tr>
<tr>
<td>III</td>
<td>11.6</td>
<td>126.4</td>
<td>Stature strength (absolute)</td>
</tr>
<tr>
<td>IV</td>
<td>13.1</td>
<td>134.2</td>
<td>Endurance Coordination</td>
</tr>
<tr>
<td>V</td>
<td>17.5</td>
<td>162.8</td>
<td>Coordination</td>
</tr>
</tbody>
</table>

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a drawn line from the acromial point to the radial point. Then, it was carried the measure of the horizontal extension of the shoulder articulation (Fernandes Filho, 1999).

In order to measure the flexion of the hip articulation, the individual was placed in decubitous dorsal position, with the hip in abduction, abduction and rotation of 0° and knees in extension. The goniometer was placed with its central axis over the trochanteric point, with one of the fixed handles in the lateral part of the trunk over the extension of the axilar line, and the other one, on the outer part of the thigh with its medium line. Afterwards, it was carried out the flexion of the hip articulation (Dantas et al., 1997).

The process and the following fingerprint collection take part of method used in the study. After the fingerprint collection, it was carried a preliminary reading processing, whose standard method follows:

The types of patterns of distal phalanxes are the following: Arch (A) – pattern without deltas. It is characterized by the absence of triradia or deltas and is composed of crests which cross transversally the digital pad; the loop (L) – pattern of a delta possesses a delta. This is about a slightly closed pattern in which the skin crests begin in one end of the finger and curve distally in relation to the another one, however, if they are near that one where they begin; Whorl (W) – patterns of two deltas. It contains two deltas. This is about a closed pattern, in which the central lines concentrate along the pattern nucleus. For this study, whose aim is merely determine the type of muscular fiber of each individual, the delta index was (D10): this is obtained by using the summation of deltas of all patterns, so that the evaluation of Arch (A) is always 0 – this is the absence of delta; of each Loop (L) – 1 (one delta); of each Whorl (W) e S pattern – 2 (two deltas), i.e., SL + 2SW.

### Table 2 - Minimum, maximum, mean and standard deviation for the variables which comprise the dermatoglyphic classification

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>66</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>L</td>
<td>66</td>
<td>0</td>
<td>10</td>
<td>6.14</td>
<td>3.12</td>
</tr>
<tr>
<td>W</td>
<td>66</td>
<td>0</td>
<td>10</td>
<td>3.86</td>
<td>3.12</td>
</tr>
<tr>
<td>D10</td>
<td>66</td>
<td>10</td>
<td>20</td>
<td>13.86</td>
<td>3.12</td>
</tr>
</tbody>
</table>

### Table 3 – Fiber type frequency (glycolitic and oxidative) presented in the sample Fiber_C

<table>
<thead>
<tr>
<th>Fiber Type</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>39</td>
<td>59.1</td>
</tr>
<tr>
<td>O</td>
<td>27</td>
<td>40.9</td>
</tr>
<tr>
<td>TOTAL</td>
<td>66</td>
<td>100.00</td>
</tr>
</tbody>
</table>

### Table 4 - Frequency of the variable A (ARCH) presented in the sample A * fiber_C

<table>
<thead>
<tr>
<th>Fibra_C</th>
<th>G</th>
<th>O</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>39</td>
<td>27</td>
<td>66</td>
</tr>
</tbody>
</table>

### Figure 2 – Glycolitic fiber x oxidative

**Statistical treatment of data**

The present treatment observed the basic norms for the maintenance of the scientificity of it, i.e., a level of significance \( p < 0.05 \). This was composed of two parts. The former was relative to descriptive statistics, in which were presented the mean and derived values for the value of continuous nature, as well as the Tables of Frequency Distributions for data of discrete nature. The latter was that of relative to inferential statistics, through which it was carried out the application of hypothetical tests, Student’s t-test, as well as the qui-square test for variables of nominal discrete contents which comprised the basis of the comparative process of calculated mean values and frequency distributions, respectively, according to the discretionary variable considered (type of fiber).

**Results**

The descriptive statistic for the variables which compose the dermatoglyphic classification and basis for the classification as for the fiber type (cf. Tables 2, 3 and 4 and Figure 2).

All the \((G + O)\) observed did not present Arch \((A = 0)\) (cf. Table 5.)

It is noticed greater concentrations of L in the elements belonging to the fiber type Glycolitic comparatively to the fiber type Oxidative (cf. Table 6).

Contrary to the expectations of what had been observed for the L frequency, in the case of W, we had greater frequencies that are registered in the fiber type oxidative comparatively to the one of glycolitic.

Following the statistic analysis, it was carried the cross tabulation of the respective classifications, aiming at examining the possible correlations between them. For it, it was made use of the non-parametric test for the variables of nominal nature, Pearson’s Correlation by qui-square test. It was used rejection base of the null hypothesis (inexistence of correlation) the significance index \( p < 0.05 \) (cf. Charts 1, 2, 3 and 4 and Figures 3 and 4).
For the flexibility classifications of shoulder and hip, when crossed with the classification per fiber type, there are significant differences between the respective distributions.

For the shoulder flexibility, it is noticed that for the Oxidative fiber (74.1%), the greater concentrations take place in the classes A and B (quartile below the mean), if compared to the Glycolitic fibers (33.3%). This fact denotes that these present greater flexibility than the oxidative fiber corroborated by the Pearson Chi-Square coefficient equal to 19.238, degree of liberty equal to 3 and significance level $p = 0.002 < 0.05$ (cf. Figure 5).

For the hip flexibility, it is noticed that for the Oxidative fiber (81.4%), the greater concentrations take place in the classes A and B (quartile below the mean), if compared to the Glycolitic fibers (33.3%). This fact denotes that these present greater flexibility than the oxidative fiber corroborated by the Pearson Chi-Square coefficient equal to 19.238, degree of liberty equal to 3 and significance level $p = 0.002 < 0.05$.

For both cases, we should reject the null hypothesis (Equality between the distributions of fiber type x flexibility levels) and accept them in alternative form, i.e., significant differences ($p > 0.05$) between the distributions and consequent direct relation between the fiber type and flexibility level (cf. Figure 6).

It was then conducted the Test T de Student for the mean comparison of shoulder extension and hip flexion, according to the two fiber types O and G (cf. Tables 9 and 10; Figures 7 and 8). The shoulder and hip, significantly inferior ($p < 0.05$) to the ones calculated for the Glycolitic fibers.
By means of the result analysis, we could observe that the patterns L and W presented as variables of dermatoglyphic are directly related to the typology of muscular fibers. It is observed greater concentrations of L in the elements belonging to type fiber glycolitic comparatively to the fiber type oxidative. In the case of W, there are greater frequencies are observed in the fiber type oxidative comparatively to the fiber type glycolitic. These results are according to the following quotation of Nikichuk, Abramova and Ozolian (apud Fernandes Filho, 2003), when they report that an increase of loops (L) and decrease of Whorls (W) are associated to the physical qualities, velocity and rapid strength. This fact is corroborated by Fox. Mathews refers to the velocists which predominantly possess fibers of rapid contracture, and to endurance athletes which predominantly present slow-twitch fiber. These data have also been demonstrated by Mero, Luhtanen and Komi (1983) who described that velocity runners were intimately related according to the percentual of fast-twitch muscular fiber.

For the classifications of flexibility of shoulder horizontal extension (SHE) and hip flexion (HFL), when crossed with the classification...
per fiber type, for the SHE, the glycolitic fibers present greater flexibility than the oxidative fibers. For the HFL, the glycolitic fibers also presented greater flexibility than the oxidative fibers.

These results come to meet some principles of the literature, as related in the quotation of Achour Junior (1998), referring to Kor- naven (1984) about the fast-twitch fiber which mentions that these have smaller density of endomysium. However, the perimysium of red fibers (slow-twitch fiber) is denser, according to Achour Junior quoting Vailas & Vailas (1994). The perimysium is probably more resistant to tissue deformation than the endomysium during stretching exercises. In another study, it was studied the relation between the muscular flexibility shortening ad long distance runners, individual that, according to McArdle, Katch, F. and Katch, V. (1998), in general have predominantly slow-twitch fibers. It was noticed that such runners present reduced muscular extremities.

If we take in consideration the quotation of Dantas (1999:90): “[...] simplifying, only appropriate for pedagogical purposes, the mechanical properties of the skeletal muscle, this can compare it (due to its elastic components) to a rubber tube. The thicker was the walls of the tube, the bigger the length that it might achieve, if stretched. By analogy, it can be understood why hypertrophied muscle is liable to reach an excellent level of flexibility.” When facing it which the following pieces of information of Katch, F. and Katch, V. (1980), and McArdle, Katch, F. and Katch, V. (1998), who report, in the first reference, that weightlifters present an extraordinary muscular hypertrophy, and the second reference that the weightlifters, referring to the muscular volume, increased unquestionably the fast-twitch fibers and that these can be up to 45% bigger that those of endurance athletes. We supposed that these individuals with fast-twitch fibers have greater capacity of muscle hypertrophy and also of achieving high flexibility indices.

Soares, Dantas and Fernandes Filho (2003) affirm that ballerinas have a high degree of flexibility and a greater evidence of the L dermatoglyphic pattern type. This fact corroborates this study, once the individuals who presented a higher level of flexibility were glycolytic which have a greater occurrence of fingerprint of the L type. As the flexibility is a physical quality which does not develop uniformly in all body joints, it is advisable that in a further study it is used articular movements different than the ones gauge in it.

CONCLUSION

The obtained results in this study allowed concluding that there is some correlation between the dermatoglyphic parameters and classification as regards the muscular fiber type (glycolitic fibers or oxidative fibers) with the flexibility of shoulder and hip joints, in the movements of extension and flexion, respectively, in this sample, composed by 66 individuals aged 20-30 years, bodybuilders for at least three months. The individuals with predominance of glycolitic fibers presented a higher degree of flexibility than the individuals with oxidative fibers.

REFERENCES

