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ISOMETRIC BACK FUNCTION TESTS

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ABSTRACT
In this work we have shown a very simple method of measuring the back function, since it is still unclear what the back function tests actually measure. Back lifting and extension tests (isometric back extension endurance) are commonly used methods in value judgment of work ability and rehabilitation. Isometric measurements that we have done, were reffered to the measuring of lumbal moments which depended on pulling forces, and inclination of the torso, as well as the age of subjects and gender. Using this method we found out, that is possible, to get out results which performance is mainly influenced on hereditary and behavioral factors i.e. it assesses the physical capacity for lifting, which means that it may prove difficult to alter isokinetic lifting capacity by interventions, what indicates that behavioral factors may play more influential roles.
Keywords: Back function, paravertebral muscle, muscle cross-sectional area, lifting force, isometric tests.

1. INTRODUCTION
In the literature that performed the questions on human work analysis, we can very often see, presented postures in work postures, then in sitting positions, even in lying positions. Sometimes, there are drawn down the lines of «correct» appearance of the spine. Now, we put the question, how we can know, is it really correct?
There are two typical postures of the standing up human:

1. erected like solider (e.g. in anatomical atlases)
2. physiological erect human.

The shapes of these two postures have different curvature parameters, so they are not, as we say, congruent curves. We have the same thing if we compare upright sitting to the relaxed or working sitting postures. Sometimes the shape changes are expressed by angles.

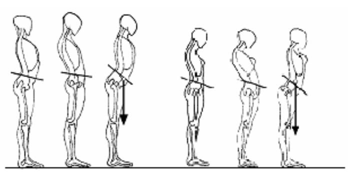

Figure 1. Possible planar standing postures of female and male with different slopes of the pelvis, while resultant forces cross the stability area (8).

If we consider, let's say, "neutral line" of the spine as a space curve, then mentioned planar measuring of the curvature or angles are incorrect. In kinematic analysis of the spine segments, we can see this mistake very often. In mentioned sense, we did not see a full anthropometric analysis of the human spine divided into groups by sex and percentile groups, in literature sources. We would say there is no dimensional analysis of the whole and segmental spine.

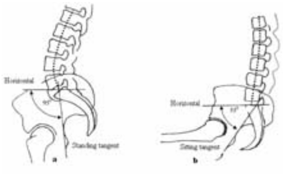

Figure 2. Anatomy of the lumbar region when standing (a) and sitting (b), lumbar lordosis traversing into kyphosis (8)

In this conformation there is complete balance between the muscles at the front and back of the pelvis. When standing (Fig. a and b), the muscles in front become more tense and at the back they become more relaxed. This increases lordosis in the lumbar region. When sitting (Fig. d and e) the muscles at the back are tenser and those in front are more relaxed.
If there is any relative movement between two vertebral segments, there is no evidence what the allowed value of this distortion is! Is it 2, 3 or 4 millimeters?

2. THE STABILITY OF THE WHOLE BODY

Standing stable posture of the human body is defined as the mechanical state of equilibrium between gravity weight and other outside forces acting on the body. According to the biomechanical model as it is shown in the Fig. 3. The body will stay in equilibrium if the resultant force F_R pass through the stability area on the floor.
As it is well known "A repetitive strain injury" (RSI) is a syndrome that affects muscles, tendons and nerves in the hands, arms and upper back. The medically accepted condition in which it occurs is when muscles in these areas of the body are kept tense for very long periods of time, due to poor posture and/or repetitive motions.
The abdominal muscles are the main focus of attention as they act like a corset, taking the pressure off the back and pulling all the other abdominal muscles into place. The corset muscles are those that contract as you bellow. They include the muscles of your "six pack" (it is there, even if you can't see it) and the muscles that run up and down your back.
Training exercises of these core muscles aim to improve body posture and body alignment. Core stability is also needed in everyday life: helping to keep you fit and to prevent injury when you are loaded with physical activities.

3. ISOMETRIC MEASUREMENTS

Previous isometric measurements that have been done eariler (Morris, Davis, Stubbs, Troup, Bartelink, Labar [4], Muftić [6], Veljović (2007) etc; Davis, 1956; Morris at al., 1961, Mairiaux, Ph., at coll. 1978. are here presented as control group of data, but they were reffered to the measuring of lumbal moments which depended on pulling forces, and inclination of the torso, as well as the age of subjects and their statistical distribution [8].

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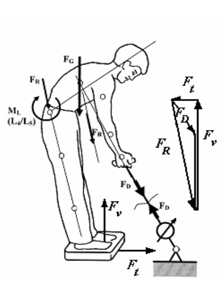

These results were impetus for very wide experiments that measured the different values of safe forces, at three different body postures (rect, half bent and bent posture) for males and females in the range of age from 18 to 70 years. Figure 3. shows the general principle of pulling force measurement that was measured by means of a dynamometer. From knowing the segmental weights and measured force on the weighing machine, we put the forces in figure 12. made out from photographs which we did for each measuring. Safe force has been limited with the force of friction F_t .

Figure 3. Experimental posture of half bent examinee [8]

These results were impetus for very wide experiments that measured the different values of safe forces, at three different body postures (erect, half bent and bent posture) for 50 males and 35 females in the range of age from 18 to 70 years. Figure 11. shows the general principle of lumbal moments measurements measured by means of a dynamometer.

4. METHODS

Measurements have been done in "statical" conditions, each measuring in duration of four seconds. Also, each measurement has been repeated for three times after one minute of relaxation of the examinee. Final measurement values are mean values of these triple results.

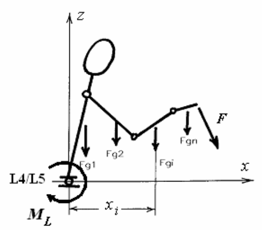

Figure 4. Planar biomechanical model

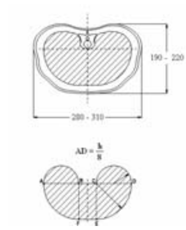

Figure 5. Cross – section of abdomen

$$A = (69,44 - 104,72)\,10^{-4}\ h^2,\quad m^2 \qquad (1)$$

On such a way IAP measurements may be used as an index of spinal stress in real life tasks. It was reason that the measurements of IAP were repeated for known lumbar level L4/L5 where it was performed for 50 males in a series of 150 pulling the rope tasks, and 35 females in series of 105 pulling rope tests. The lumbar moment was determined through a biomechanical model deriving data from the subject anthropometry and photographically recorded postures. Using the regression formula of Donskij and Zatscijorskij [1] the elements of the biomechanical model were determined.
The lumbar moment is determined through a biomechanical model deriving data from the subject anthropometry and photographically recorded postures. From these measurements the 3-D diagram on the Fig. 7. i

$$M_L = \sum_{i=1}^{n} F_i \cdot x_i \qquad (2)$$

$$F_{abd} = \frac{16 M_L}{h},\quad N \qquad (3)$$

$$p_{abd} = IAP = (0{,}2 \div 0{,}3)\frac{F_L}{A} = \frac{(0{,}2 \div 0{,}3)\frac{16 M_L}{h}}{(90 \div 105)\cdot 10^{-4} h^2} \qquad (4)$$

$$IAT = (350 \div 450)\frac{M_L}{h^3},\quad Pa \qquad (5)$$

5. RESULTS OF MEASUREMENTS

Determination of intra-abdominal forces for all other ages could be settled decreasing the respective force for the value of 212 N for persons who are 32 years old, multiplication by means of the factor makes it possible to calculate dividing respective values of abdominal force for a person (Fig. 6.) that we analyzed, who is of same age and belongs to determined percentile number.

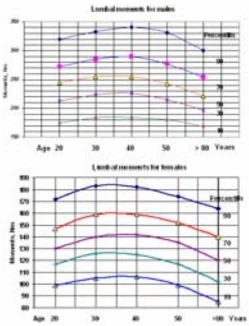

Figure 6. Graphical presentation of the relations between pulling lumbal moment depending on age and sex.

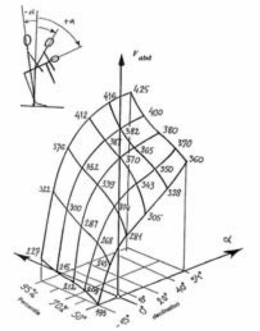

Figure 7. The values of intra-abdominal equilibrium force for males of 32 years that change the torso inclination from -15^o to + 54^o, and for statistical distribution of the standing height's from 50 to 90 % percentiles.

6. DISCUSSIONS AND CONCLUSIONS

Determination of intra-abdominal forces for all other ages could be settled decreasing the respective force for the value of 212 N for persons of 32 years, multiplication by means of the factor makes it possible to calculate dividing respective values of abdominal force for a person (Fig. 6.) that we analyzed, who has his age and belongs to determined percentile number. For example a person of 50 years in the group of 70% has the intra-abdominal force of 183 N in the diagram. Then the decreasing factor we mentioned above is k = 183 / 212 = 0,863. So, if we now would like to know the intra-abdominal force of this 50 years old subject when he declines his torso for, lets say +20^0, then it is (for 70% and +20^o the force value of 370 N) from the diagram, so the calculated value of force is 370 x 0,863 = 319,3 N.

In the case of female subjects, calculated intra-abdominal force should decreased for the next reduction of about 30%. That is present in the case of 50 years old females which belong to the group of 70% with the same inclination of the torso, the intra-abdominal force of 319,3 x 0,70 = 223,5 N.

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