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Abstract

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DIAGNOSTICAL INFORMATIVITY OF THE MYOMETRICAL METHOD IN THE MEDICAL RESEARCH OF OCCUPATIONAL HEALTH CARE

One of the unsolved problems for the medical research in the occupational health service is the objective examination of the condition of the skeletal muscles. Current methods: palpation, anamnesis, etc. give us subjective estimations and therefore forming the diagnosis is complicated and, in many cases, disputable.

The aim of this study was to clarify the application possibilities of the myometrical method in studies for skeletal muscles in occupational health service.

During the study anthropometrical values were collected from 1976 employees of Estonian companies and simultaneously with, but independently from the traditional health study the data about the tone, elasticity and stiffness of skeletal muscle were collected also, using myometrical method. Characteristics of the skeletal muscles' parameters (tone, elasticity and stiffness values) were measured in the person's state of relaxation, for both right and left side of the body at the centre of the muscle belly from the following muscles: m.tibialis anterior, m.extensor digitorum, m.adductor pollicis, m.abductor pollicis brevis, m.flexor carpi radialis, m.gastrocnemius c.m., m.trapezius from two regions – (upper region, middle region) and m.erector spinae.

The employees participating in the study were divided into eight groups by sex (men and women), by age (up to 35 years and older than 35) and the body mass index (BMI) (up to 25 and over 25). When comparing the groups with each other it was found that for majority of cases there exists a statistically significant difference ($p < 0,05$). Thus the normal values for the examined muscles must be calculated for eight groups, taking into account sex, age and BMI values.

In conclusion, we can say that myometrical method gives complementary information for the occupational health medical research that simplify the formulation of the diagnosis and monitoring the changes in skeletal muscles induced by a work process and preventing overuse trauma. The existence of normal values facilitates the assessments and specifies in what danger zone the examined muscle is.

Keywords: skeletal muscle, Cumulative Trauma Disorder, Study of occupational health, myometry, Normal values.

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Резюме

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ДІАГНОСТИЧНА ІНФОРМАТИВНІСТЬ МІОМЕТРИЧНОГО МЕТОДУ В МЕДИЧНИХ ДОСЛІДЖЕННЯХ ОХОРОНИ ПРАЦІ

Однією з невирішених проблем медичних досліджень у сфері охорони праці залишається об’єктивність оцінювання стану скелетних м'язів. В основі класичних методів (пальпація, анамнез і т.п.), лежать суб'єктивні оцінки, тому, як правило, постановка діагнозу складна і в багатьох випадках спірна.

Мета цього дослідження: з’ясувати можливості застосування міометричного методу дослідження скелетних м'язів в охороні праці.

Антропометричні показники збиралися з 1976 року фахівцями естонських компаній одночасно, але незалежно, з традиційним медичним оглядом стану здоров'я працівників. За допомогою міометричного методу були зібрані дані про тонус, еластичність і жорсткість скелетних м'язів. Характеристики скелетних м'язів (тонус, еластичність і жорсткість) вимірювалися в стані розслаблення, як правої, так і лівої частини тіла, в центрі таких м'язів: m.tibialis anterior, m.extensor digitorum, m.adductor pollicis, m. abductor pollicis brevis, m.flexor carpi radialis, m.gastrocnemius cm, m.trapezius (дві ділянки – верхня область, середня область) і m.erector spinae.

Працівники, які брали участь в дослідженні, були поділені на вісім груп за статтю (чоловіки і жінки), за віком (до 35 років і старше 35 років) та за індексом маси тіла (ІМТ) (до 25 і більше 25). Порівняльний аналіз дозволив виявити, в більшості випадків, статистично значущу різницю ($p < 0,05$) між досліджуваними показниками м'язів в цих групах. Отже, значення норми показників тонусу, еластичності і жорсткості досліджуваних м'язів мають розраховуватися з урахуванням статі, віку і значень ІМТ.

Уважаємо, що міометричний метод дає додаткову інформацію для медичних досліджень у сфері охорони праці, полегшує встановлення діагнозу та проведення моніторингу за станом скелетних м'язів, який змінюється внаслідок виконання роботи, тим самим зменшується ризик кумулятивного травмування на виробництві. Розроблення нормативних показників для скелетних м’язів сприяє виявленню м’язів, що знаходяться в небезпечній зоні кумулятивного травмування.

Ключові слова: скелетний м'яз, кумулятивний травматичний розлад, дослідження в охороні праці, міометрія, нормативні показники.

Резюме

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ДИАГНОСТИЧЕСКАЯ ИНФОРМАТИВНОСТЬ МИОМЕТРИЧЕСКОГО МЕТОДА В МЕДИЦИНСКИХ ИССЛЕДОВАНИЯХ В ОХРАНЕ ТРУДА

Одной из нерешенных проблем медицинских исследований в сфере охраны труда является объективность оценки состояния скелетных мышц. В основе классических методов (пальпация, анамнез и т.п.), лежат субъективные оценки, поэтому, как правило, постановка диагноза усложняется и во многих случаях является неоднозначной.

Цель этого исследования: выяснить возможности применения миометрического метода исследования скелетных мышц в охране труда.

Антропометрические показатели собирались с 1976 года специа-

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листами эстонских компаний одновременно, но независимо, с традиционным медицинским осмотром состояния здоровья работников. С помощью миометрического метода были собраны данные о тонусе, эластичности и жесткости скелетных мышц. Характеристики скелетных мышц (тонус, эластичность и жесткость) измерялись в состоянии расслабления, как правой, так и левой части тела, в центре таких мышц: m.tibialis anterior, m.extensor digitorum, m.adductor pollicis, m. abductor pollicis brevis, m.flexor carpi radialis, m.gastrocnemius cm, m.trapezius (два участка – верхняя область, средняя область) и m.erector spinae.

Работники, участвовавшие в исследовании, были разделены на восемь групп по полу (мужчины и женщины), по возрасту (до 35 лет и старше 35 лет) и по индексу массы тела (ИМТ) (до 25 и более 25). Сравнительный анализ позволил выявить, в большинстве случаев, статистически значимую разницу ($p < 0,05$) между исследуемыми показателями мышц в этих группах. Следовательно, значение нормы показателей тонуса, эластичности и жесткости исследуемых мышц должны рассчитываться с учетом пола, возраста и значений ИМТ.

Считаем, что миометрический метод дает дополнительную информацию для медицинских исследований в сфере охраны труда, облегчает установление диагноза и проведения мониторинга за состоянием скелетных мышц, которое изменяется в результате выполнения работы, тем самым уменьшается риск кумулятивного травматического расстройства на производстве. Разработка нормативных показателей для скелетных мышц способствует выявлению мышц, находящихся в опасной зоне.

Ключевые слова: скелетная мышца, кумулятивное травматическое расстройство, исследования в области охраны труда, миометрия, нормативные показатели.

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Introduction

One of the unsolved problems for the occupational health survey is the lack of objectivity in examining the condition of the skeletal muscles. Current methods: palpation, anamnesis, etc. give us subjective estimations and therefore formation of the diagnosis is complicated and, in many cases, disputable.

According to the definition of work health service, adopted in 1950 by International Labour Organisation (ILO) and World Health Organisation (WHO), it is a discipline with the main objective to maintain and improve employees' health and ability to work, making the working environment and process safer, and developing work culture in such way that it would contribute to safety at workplaces, improve positive social climate and would help to raise the productivity of the companies [3].

It is known that when working and engaging oneself in continuous physical or intensive activity, fatigue appears at a certain moment, characterised by the feeling of fatigue and the inability to continue activity at the required level of intensity. When people are tired their working ability decreases and it can manifest itself in the decrease of work amount and the quality of action. At that state changes in the functions of the central nervous system occur and the co-operational activity of functions can be disturbed. Fatigue is a sign that the intensity of the effort must be decreased or that the activity must be stopped altogether. When comparing fatigue between dynamic and static work, in the first case the restoration of the energy supplies during the contraction and relaxation phase of the muscle and removal of decay products during the muscle relaxation takes place while working. But when dynamic work is exercised beyond the limits of capability, the relaxation time may not be sufficient and restoration of energy and removal of decay products is not so effective anymore and fatigue accumulates. In case of static work, fatigue evolves

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because the continuous maintenance of body posture exceeds the physical capability.

On the basis of physiological effort, criteria of physically tiresome and non-tiring work can be distinguished. When the organism is not allowed a sufficient rest period after strenuous work, functionality disorders and illnesses occur, revealing itself as cumulative trauma disorder or repetitive strain disorder. In conformity with the intensity and duration of the effort, different units of energetic processes in the organism limit physical work ability for strenuous work and hence the work accomplished. Here a law applies: the shorter the length of the work the higher the intensity of the work can be and the smaller is the relative importance of the aerobic energy production. This applies to both dynamic and static work.

The unfavourable influence of workload is exhibited foremost as a feeling of discomfort in the muscles; then follow moderate non-specific complaints, manifesting themselves mostly as pains. Work ability drops, because it is uncomfortable to fulfil one's work assignments with aching muscles-joints. When the workload is not reduced the irritation threshold of the nerve endings of fascias surrounding muscle bundles drops and release points (or trigger points) are formed that cause radiating pain and functionality disorders. Myofacial pains syndrome is formed, the ability to work is significantly disturbed. Further development of the process can lead to permanent decrease in work ability and, for worse cases, disablement. The damages of physical overuse can be in the neck and shoulder area, lumbar region, elbow joints, forearms, wrists, hands, hips and knees [7].

The invention and elaboration [8; 9] of the myometrical method to measure and assess the biomechanical parameters of muscles (stiffness and elasticity)and tone, in skeletal muscles presents new opportunities for improving the quality of medical checkups in occupational health service. The measurement repeatability of the myometrical method and the device are good [1; 6; 10]; thus it is possible to discover early changes in the stiffness and elasticity of the skeletal muscle and to assess the effectiveness of the applied treatments. The method gives objective results irrespective of the measurer [10] and is informative with other research methods for skeletal muscles (EMG, measurements of intramuscular pressure [4].

When evaluating the condition of the nerve muscle apparatus it is important to base on normal values. Similarly, to electrocardiogram or blood pressure assessments [5], there are no strict normal values for assessing the parameters of the skeletal muscle. Here the following should be considered. There are qualitative and quantitative norms. Qualitative or biological norm for species that includes individual norm has in turn been formed by evolution conditions and it contains a certain reaction norm that is determined by the range of the muscle's biomechanical characteristics.

Quantitative or phenotypic norm is expressed by statistical numbers and reflects the variability of the given parameter depending on the ontogenesis cycle, physiological variability due to the influence of physical and emotional load or the 24-hour cycle.

Thus, in our case, we can operate with the definitions of adaptive norm that is related to ontogenesis and the person's quality of life; and reaction norm that reflects the person's health. Therefore, when making evaluations we have to proceed from the definition of the norm, but the criterion has to be the parameter trends or changes in time.

PURPOSE OF THE PAPER

To clarify the application possibilities of the myometrical method in studies for skeletal muscles in occupational health service.

THE METHODS AND SUBJECTS OF THE SURVEY

In the course of the field study, anthropometrical values were collected from the employees of Estonian companies and simultaneously with, but independently from the traditional health survey the data about the parameters of skeletal muscle was also collected, using myometrical method.

1. Health Survey

Occupational health physician and neurologist examined employees within the capacity of their specialty. The values for arterial blood pressure were measured by standard method on a. cubitalis over fossa cubitalis for all of the employees. The doctors used OMRON M4-1 blood pressure-pulsimeter and YAMASU sphygmomanometer for supplementary control of high blood pressure values. When interpreting the blood pressure values they proceeded from the criterion given by the World Health Organisation (WHO): the limits for the systolic and diastolic pressure were 140/90 mmHg respectively; hypertension was diagnosed when systolic pressure was ≥ 160 mmHg and diastolic pressure ≥ 95 mmHg.

2. Anthropometry

Anthropometrical values - body mass (on the medical scale by SOEHNLE) and body length (with metallic anthropometer) were determined.

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Anamnesis

3. Myometrical survey

The parameters measured by myometer are: 1) oscillation frequency of the skeletal muscle that characterises the tension of a muscle or tone and is shown as $\nu = \frac{1}{T}$; where ν is frequency [Hz], and T is the oscillation period [s]; 2) logarithmic decrement that characterises the elasticity of the muscle i.e. muscle's ability to restore its original shape after contraction and the logarithmic decrement of ratio amplitude of the natural oscillation is shown as $\Theta = \ln \frac{A_2}{A_4}$; where Θ is the logarithmic decrement of natural oscillation, A_2 is the second amplitude and A_4 is the fourth amplitude; 3) stiffness that characterises muscle's quality to resist the force that change the shape of muscle it and is shown as $C = \frac{m \cdot a_{max}}{\Delta l}$; where m is the mass of the myometer's testing end [kg], a_{max} is acceleration at the moment when the testing end has compressed the examined muscle the most [m/s^2] and Δl is deformation [m].

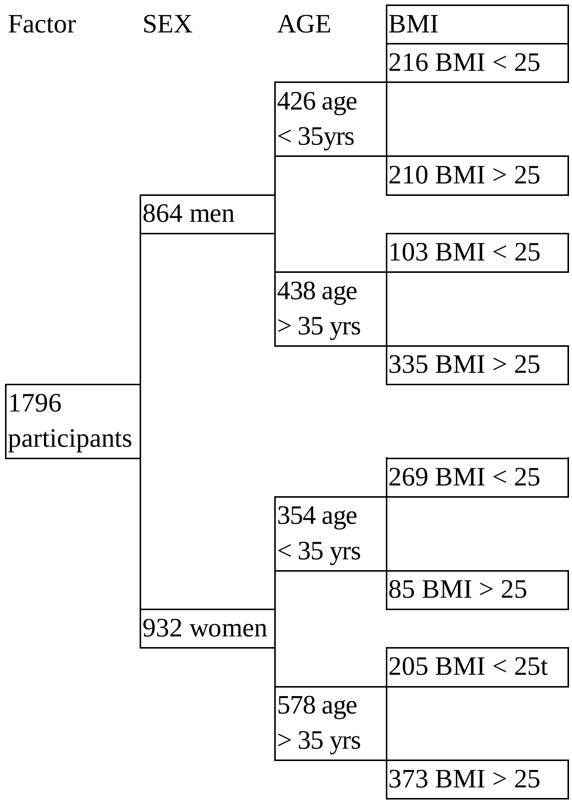
Measuring the characteristics of the skeletal muscles' (tone, elasticity and stiffness values) was performed while the person was lying on the portative treatment table Apollo Nova (Finland) in the state of tranquillity, for both right and left side of the body from the muscle belly for the following muscles: m.tibialis anterior, m.extensor digitorum, m.adductor pollicis, m.abductor pollicis brevis, m.flexor carpi radialis, m.gastrocnemius c.m., m.trapezius from two regions - (upper and middle region) and m.erector spinae. These muscles were chosen, because they are the most commonly used muscles when working and doctors of occupational health service have most often received complaints about them.

4. Subjects

1796 employees between the ages of 19–74 and with the body mass index of 16–46 were examined. The survey participants were divided into eight groups by sex (men and women), by age (up to 35 years and older than 35) and the body mass index (BMI) (up to 25 and over 25) as follows:

5.Statistics

MS Excel was used in the statistical data processing to calculate Student criterion and the distribution functions were evaluated with the STATISTICA programme.



Body mass index was calculated in the following way: $KMI = \frac{N}{h^2}$; where N is the weight of the body [kg] and h is the height of the body [m].

RESULTS

The comparison of oscillation frequency (F), decrement (D), and stiffness (C) of the right body side, divided into groups characterised by sex, age, and body mass index is shown in the Tables 1–7. The examined muscles were: m.tibialis anterior (TIB), m.extensor digitorum (EXD), m.adductor pollicis (ADD), m.abductor pollicis brevis (ADP), m.flexor carpi radialis (FLC), m.gastrocnemius c.m. (GAS), m.trapezius (upper region) (TRS), m.trapezius (middle region) (TRC) and m.erector spinae (ERE). As there were no significant differences between the muscles of the right and left body side, the tables exhibit only the results for the right side. The sign "+" in the tables denotes higher muscle parameter value for the compared groups, the sign "-" denotes lower value and the coloured square denotes significant statistical difference $p < 0.05$.

Table 1 **–** The comparison of oscillation frequency, decrement, and stiffness on the right side for men (M) and women (W)

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Right side		ADP			ERE			EXD			FLC			GAS			ADD			TIB			TRC			TRS		
		F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C
Sex	M	-	-	-	+	-	+	+	-	+	+	-	+	+	-	+	+	-	+	-	-	+	+	-	+	+	-	+
	W	+	+	+	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	+	+	-	-	+	-	-	+	-

Table 2 **–** The comparison of oscillation frequency, decrement, and stiffness on the right side for men, age < 35 yrs and age > 35 yrs

Right side		ADP			ERE			EXD			FLC			GAS			ADD			TIB			TRC			TRS		
		F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C
Age	< 35 yrs	-	-	-	-	-	-	-	-	+	-	-	+	+	-	+	-	-	-	+	-	+	-	-	-	-	-	-
	> 35 yrs	+	+	+	+	+	+	+	+	-	+	+	-	-	+	-	+	+	+	-	+	-	+	+	+	+	+	+

Table 3 **–** The comparison of oscillation frequency, decrement, and stiffness on the right side for women, age < 35 yrs and age > 35 yrs

Right side		ADP			ERE			EXD			FLC			GAS			ADD			TIB			TRC			TRS		
		F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C
Age	< 35 yrs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-
	> 35 yrs	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	-	+	+	+	+	+	+

Table 4 **–** The comparison of oscillation frequency, decrement, and stiffness on the right side for BMI < 25 and BMI > 25; men, age < 35 yrs

Right side		ADP			ERE			EXD			FLC			GAS			ADD			TIB			TRC			TRS		
		F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C
BMI	< 25	-	+	-	+	+	+	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	+	-	+	+	-	-
	> 25	+	-	+	-	-	-	+	+	+	+	+	+	+	+	+	-	-	+	+	+	+	-	+	-	-	+	+

Table 5 **–** The comparison of oscillation frequency, decrement, and stiffness on the right side for BMI < 25 and BMI > 25; men, age > 35 yrs

Right side		ADP			ERE			EXD			FLC			GAS			ADD			TIB			TRC			TRS		
		F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C
BMI	< 25	+	+	-	+	+	+	-	-	-	-	-	-	-	-	-	+	+	-	-	+	-	+	-	+	-	-	-
	> 25	-	-	+	-	-	-	+	+	+	+	+	+	+	+	+	-	-	+	+	-	+	-	+	-	+	+	+

Table 6 **–** The comparison of oscillation frequency, decrement, and stiffness on the right side for BMI < 25 and BMI > 25; women, age < 35 yrs

Right side		ADP			ERE			EXD			FLC			GAS			ADD			TIB			TRC			TRS		
		F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C
BMI	< 25	+	+	+	+	-	+	-	-	-	+	-	+	-	-	-	-	-	-	+	-	+	+	-	+	+	+	+
	> 25	-	-	-	-	+	-	+	+	+	-	+	-	+	+	+	+	+	+	-	+	-	-	+	-	-	-	-

Table 7 **–** The comparison of oscillation frequency, decrement, and stiffness on the right side for BMI < 25 and BMI > 25; women, age > 35 yrs

Right side		ADP			ERE			EXD			FLC			GAS			ADD			TIB			TRC			TRS		
		F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C	F	D	C
BMI	< 25	-	-	-	+	-	+	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	+	-	+	+	-	-
	> 25	+	+	+	-	+	-	+	+	+	-	+	-	+	+	+	+	+	+	+	+	+	-	+	-	-	+	+

When the groups are compared to each other it can be seen that a statistically significant difference occurs for majority of cases. It was taken into consideration when developing the normal values. For

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every group distribution function of the measuring results was determined and the symmetry of the distribution was assessed. For logarithmic decrement logarithmic variation was used [2]. The obtained result explains that the parameters of skeletal muscle tone are higher for older people and that normal values must be created separately for men and women. It also appears from the analysis of the above tables that if a person has higher BMI, the parameters of tone for the examined muscle are statistically significantly higher.

The normal values can be calculated from the data collected from the field study in case when the distribution function of the parameters of the examined muscles for the abovementioned eight groups corresponds to the standard distribution.

Next we will exhibit the histograms of myometrical parameters for one muscle. As the below figures show, the given bar graphs have distribution close to the standard distribution.

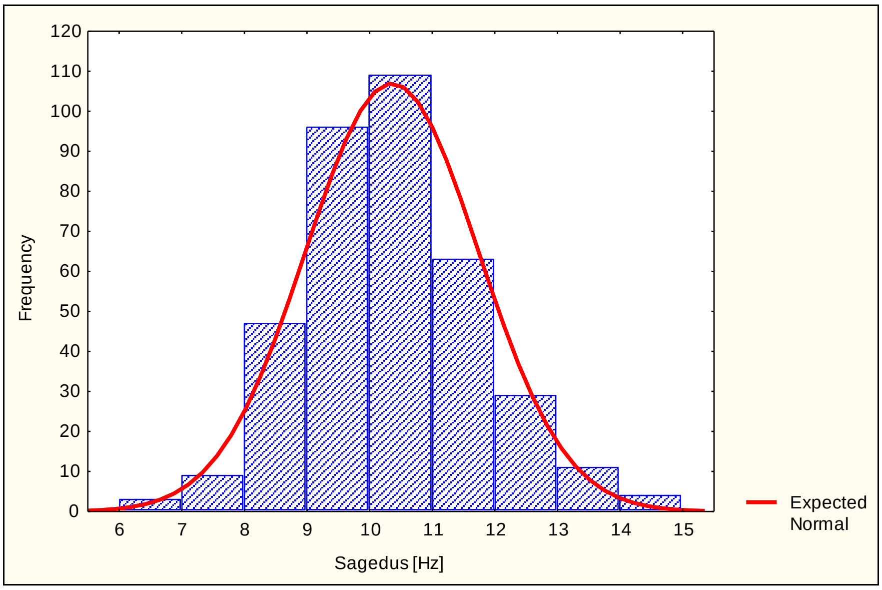

Figure 1 – Histogram, m.trapezius (upper region), right side, women, age > 35 yrs, BMI > 25, frequency [Hz]

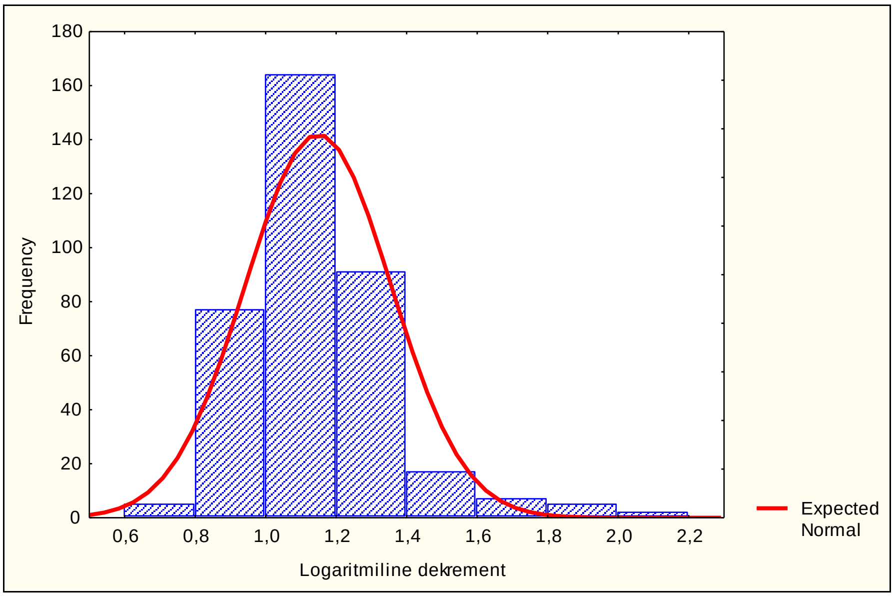

Figure 2 – Histogram, m.trapezius (upper region), right side, women, age > 35 yrs, BMI > 25, logarithmic decrement

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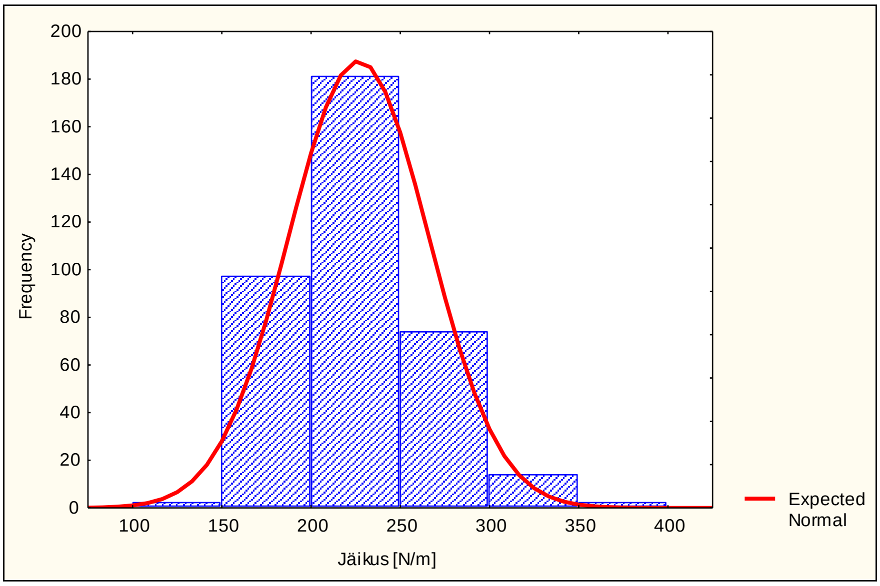

Figure 3 – Histogram, m.trapezius (upper region), right side, women, age > 35 yrs, BMI > 25, stiffness [N/m]

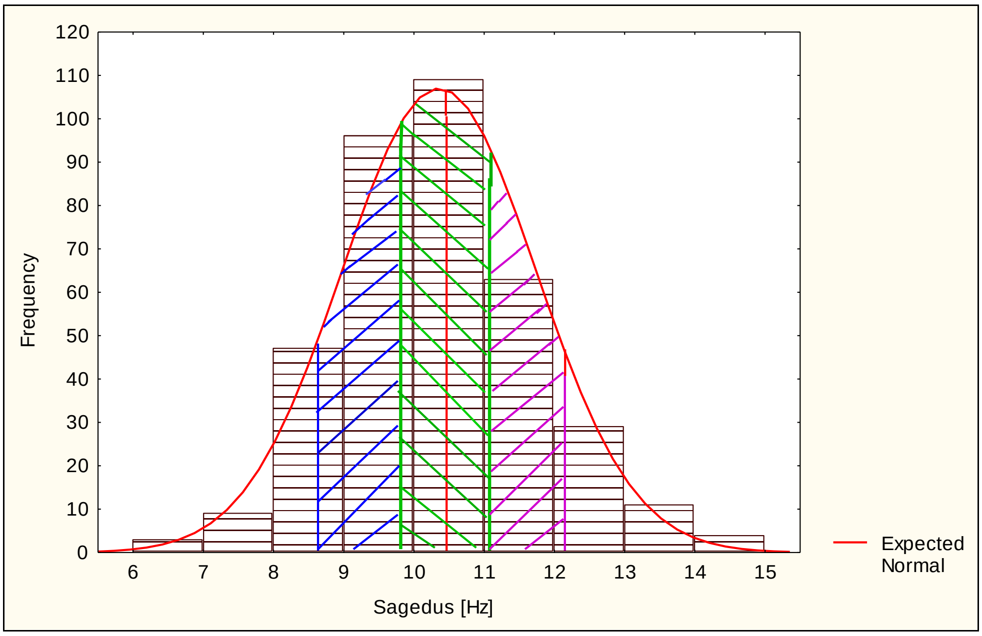

Figure 4 – Histogram, m.trapezius (upper region), right side, women, age > 35 yrs, BMI > 25, frequency [Hz]

The streaked green area corresponds to average norm values, streaked blue area to the left shows low norm values, purple area to the right shows high norm values; area to further right is the very high value area and the area left of the blue area is the very low values area.

The average range of the normal values means that if muscle values fall there, the muscle is in a good state, but if the muscle values fall to the higher range of normal values, it means that the examined muscle is endangered by cumulative trauma disorder and when they fall to the lower range of the normal values the muscle is in a very good condition.

Normal values are shown as the aforementioned ranges (see Table 8).

DISCUSSION

So far, health study has been subjective with regard to muscle assessment. Diagnosis is usually developed mainly based on anamnesis (patient has a complaint) and via palpation. Now there is a new alternative – objectifying myometrical method and a device that has been designed to monitor changes in the tone and biomechanical properties of the

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skeletal muscles and to compare the condition of symmetrical muscle groups for giving assessments about the economy or condition of the skeletal muscles. Every myometrical measurement results in a numerical parameter that characterises the condition of the muscle. Based upon these parameters it is possible to detect very small changes in the functional condition of the muscle. The existence of normal values also facilitates assessments.

Table 8 – Norm values, m.trapezius (upper region), right side, women, age > 35 yrs, BMI > 25

	mean. - 1.5*SD	avg. - 0.5*SD	avg.	avg. + 0.5*SD	avg. + 1.5*SD
Frequency [Hz]	8,75	9,89	10,46	11,03	12,17
Decrement	0,776	0,888	0,950	1,016	1,163
Stiffness [N/m]	162,99	202,17	221,76	241,35	280,53

To calculate normal values the differences of skeletal muscle parameters depending on sex, age and BMI values were determined. It appeared that the parameter is dependent on the person's sex, the difference is statistically relevant $p < 0.05$ (Table 1). Generally, when comparing men and women, for men the values for muscle tone parameters of frequency and stiffness were higher, but the logarithmic decrement values were lower than the respective muscle tone parameters for women (Table 1). When comparing the men and women age groups - younger than 35 and older than 35 years - it appeared that for vast majority of cases the difference is statistically relevant $p < 0.05$ (Table 1) and it can be said that for people older than 35 the muscle tone parameters are higher than for people younger than 35 years (Tables 2 and 3). When comparing the BMI values (< 25 and > 25) for the above groups then again, for the majority of cases the difference was statistically relevant $p < 0.05$ and we can say that in case of higher BMI values the parameters for examined muscles' tone are higher than for the lower BMI values (Tables 4–7). Thus the normal values for the examined muscles must be calculated for eight groups, taking into account sex, age and BMI values.

Next we will examine the placement of myometrical parameter values of one person's one muscle – m.trapezius (upper region) in the range of the normal values given in the table starting from left: low, average and high.

The above figure 5 shows that for this specific muscle the frequency and logarithmic decrement are placed high on the scale of the normal values and stiffness is placed on the very high zone.

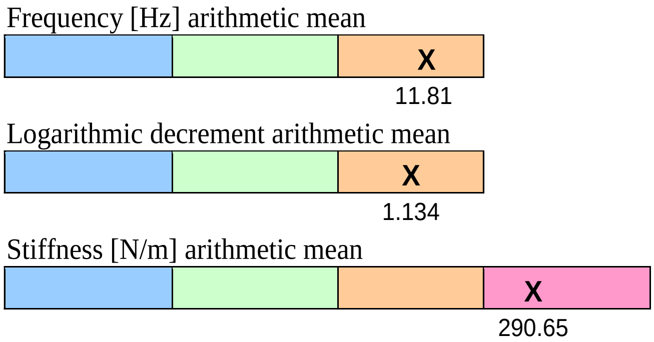

Figure 5 – The placement of measuring results on the scale of normal values for a woman: age > 35 yrs, BMI > 25, m.trapezius (upper region), right side parameters (frequency, logarithmic decrement and stiffness)

It means that the examined muscle has a heightened risk for cumulative trauma disorder. As the result of the medical assessment myofascial pains and channel syndrome were diagnosed in her case. By carrying out further myometrical measurements it is possible to monitor, via such assessments, the changes occurring in the skeletal muscles. If the next survey took place the following year, we could establish whether the changes in the examined muscle show the improvement or further detoriation of the employee's health condition. If the person was sent to rehabilitation, we could assess its effectiveness. If the changes are not favourable, other rehabilitation devices should be applied, etc. As the result of such surveys we get objective confirmation to the medical findings.

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Conclusion

Myometrical method gives complementary information for the occupational health medical research that enables specifying the formulation of the diagnosis and to monitor the changes in skeletal muscles induced by a work process and to prevent cumulative trauma disorder. The existence of normal values facilitates the assessments and specifies in what danger zone the examined muscle is.

References

1. Bizzini M, Mannion AF. Reliability of a new, hand-held device for assessing skeletal muscle stiffness. *Clinical Biomechanics*. 2003;18(5):459-461.
2. Bland M. An Introduction to Medical Statistics. Oxford: Oxford University Press, 2004. 410 p.
3. International Labour Organisation. Technical and ethical guidelines for workers` health surveillance. Geneva: International Labour Office, 1998. 54 p.
4. Korhonen RK, Vain A, Vanninen E, Viir R, Jurvelin JS. Can mechanical myotonometry or electromyography by used for the prediction of intramuscular pressure? *Physiol Meas.* 2005;26:1-13.
5. Mancia G. Ambulatory Blood Pressure Monitoring: Rresearch and Clinical Applications, *Journal of Hypertension*. 1990;8(7):1-13.
6. Pruyn EC, Watsford ML, Murphy AJ. Validity and reliability of three methods of stiffness assessment. *J. of Sport and Health Science*. 2015; 5(4):476-483. doi.org/10.1016/j.jshs.2015.12.001
7. Travell JG, Simons DG, Myofascial Pain and Dysfunction. Baltimore: Williams&Wilkins, 1983. 1044 p.
8. Vain A, inventor. A device for investigating viscoelastic properties of the skeletal muscles, USSR patent nr.790397, 1977.
9. Vain A, inventor. Method and a device for recording mechanical oscillations in soft biological tissue – myometer. Estonia patent nr. 033740, 1996.
10. Viir R, Laiho K, Kramarenko J, Mikkelsson M. Repeatability of trapezius muscle tone assessment by a myometric method. *J Mech Med Biol*. 2006;6:215-228.

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