Introduction. Functional disorders of the knee joint have major influence on the level of physical activity and working capability of elderly people [14]. The functional integrity of the knee joint and its structural elements influences not only physical capability and physical activity but also the quality of human life on the whole. One of the main factors of well-being of elderly people is the capability to lead a healthy life. The majority of experts share the view that the main component of such a life is maintaining the optimal level of physical activity in all forms of its expression [8, 11]. The capability of a person to maintain the necessary level of functional independence is becoming lower with age, essential blood supply and oxygenation of skeletal muscles decrease, the strength and the speed of their contraction decrease [2], brittleness of the bones increases, joint mobility increases leading to the change of a rational stereotype of limb movement on the whole. Thus, there are changes of a movement stereotype, which affect physical qualities and recovery of complex movements [7].

Interest to the question of maintaining physical activity is affirmed by the results of many studies conducted in Russia [10] and abroad [1]. It is known that elderly people spend up to 86% of their time sitting, and about 57% of elderly people cannot return to the previous level of physical activity [9]. Functional and degenerative disorders of the knee joint concern up to 10% of people over 60 years old [4]. Women are more in danger of functional and degenerative disorders in the knee joints than men [6], especially in extreme conditions of the Russian north [5]. The functional correction of the locomotion system in elderly people is a complicated and multi-faceted problem, which cannot be solved without searching the functional features of its separate elements, especially against the increase in the number of elderly people [16] and their incapacitation [13].

Materials and methods. Relatively healthy elderly women aged from 60 to 74 years participated in the study. All participants were selected according to the inclusion and exclusion criteria (Table 1).

Using these criteria, we divided the participants into three research groups: group 1 – 60–64 years (n = 34), group 2 – 65–69 years (n = 31) and group 3 – 70–74 years (n = 18) (Table 2). All participants (n = 83) did not have contraindications to the exercise stress at the moment of the research and gave voluntary written informed consent approved by the Ethics Committee of the Surgut State University.
The functional status of the knee joint was assessed using WOMAC index [15] (Nicholas Bellamy, Queensland, Australia). This index contains 24 criteria, which are divided into 3 subscales – joint pain (5 criteria), stiffness (2 criteria) and physical function (17 criteria). Low values of the criteria characterize a lower intensity of pain and stiffness in the joint during exercise and a higher level of functional performance.

Three physical performance tests were conducted, the timed up and go test (TUG), the 6-minute walk (6MW) and sit to stand test (STS). The TUG identifies the level of functional mobility and is considered as reliable and valid in community-dwelling older adults. It is a timed measure of a person’s ability to stand from a chair, walk three meters, turn 180 degrees, return to the chair and sit down. The 6MW defines the capability of a person to move independently when during a definite time it is necessary to walk at the greatest possible distance. The STS test requires the participant to stand up from the chair, the height of which is regulated at the level of 110% from knee height, with hands crossed at the level of the chest. Before and after the tests the intensity of knee joint pain was measured. Pain was estimated with the help of Numeric Pain Rating Scale (NPRS) with a 10-point scale, where 10 = exquisite pain, 0 = no pain. The participants of the research were asked to choose a number on the scale to describe the intensity of pain feeling at the moment.

Statistical analysis was performed using Statistica 10 (StatSoft Ink, USA) and IBM SPSS 22 (IBM, USA). The normality of distribution was tested by the Shapiro-Wilk and Kolmogorov-Smirnov tests. To estimate the confidence level between groups, we used the Wilcoxon signed-rank test. Independent samples t-tests were used to analyze differences between groups for the TUG, 6MW and STS tests. The level of statistical significance was established at p < 0.05.

Results. Table 3 shows the results of analysis on the effect of age on the functional indices of the knee joint in elderly women.

It was established that pain and stiffness in the knee joint in elderly women increased significantly with age while physical functionality decreased.
decreased (p < 0.01). Most often correlation is established between the age and physical function subscale (r = 0.666; p < 0.01) (Fig. 1).

Correlation between age-pain (Fig. 2) and age-stiffness (Fig. 3) indices had a less pronounced character of r = 0.581 and r = 0.565 respectively (p < 0.01). However, the dependence of these characteristics shows an essential influence of age on the functional condition of the knee in elderly women. The data obtained provide a strong evidence that the age of elderly women is one of the main factors influencing the progression of functional disorders in the knee joint.
Knee pain severity, pretest-posttest change, Numeric Pain Rating Scale (NPRS), points (M, 95% CI)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Knee Pain Severity, M, 95% CI</th>
<th>p</th>
<th>Minimum pain for the last 24 hours</th>
<th>Maximum pain for the last 24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1: 60–64 years (n = 34)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest TUG</td>
<td>1.35 (1.12; 1.57)</td>
<td>0.0005</td>
<td>0.53 (0.21; 0.85)</td>
<td>2.18 (1.87; 2.48)</td>
</tr>
<tr>
<td>Post-test TUG</td>
<td>1.91 (1.63; 2.18)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest 6MW</td>
<td>1.38 (1.15; 1.60)</td>
<td>0.0003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-test 6MW</td>
<td>0.82 (0.50; 1.13)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest STS</td>
<td>1.41 (1.16; 1.65)</td>
<td>0.0037</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-test STS</td>
<td>1.85 (1.48; 2.21)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2: 65–69 years (n = 31)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest TUG</td>
<td>1.54 (1.26; 1.82)</td>
<td>0.2924</td>
<td>0.68 (0.35; 1.02)</td>
<td>2.57 (2.14; 2.97)*</td>
</tr>
<tr>
<td>Post-test TUG</td>
<td>1.58 (1.22; 1.93)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest 6MW</td>
<td>1.45 (1.15; 1.74)</td>
<td>0.0009</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-test 6MW</td>
<td>0.96 (0.63; 1.30)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest STS</td>
<td>1.29 (1.01; 1.56)</td>
<td>0.0002</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-test STS</td>
<td>1.93 (1.60; 2.26)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 3: 70–74 years (n = 18)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest TUG</td>
<td>1.88 (1.25; 2.52)</td>
<td>0.5785</td>
<td>1.02 (0.74; 1.41)^</td>
<td>4.26 (3.83; 4.75)^</td>
</tr>
<tr>
<td>Post-test TUG</td>
<td>1.94 (1.21; 2.67)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest 6MW</td>
<td>2.16 (1.74; 2.59)</td>
<td>0.0008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-test 6MW</td>
<td>1.11 (0.54; 1.67)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest STS</td>
<td>2.05 (1.65; 2.45)</td>
<td>0.0204</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-test STS</td>
<td>2.61 (1.99; 3.22)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. Numeric pain rating scale (NPRS) – possible score for all tests = 0–10 points; × – average value of pain for the last 24 hours; * – significant difference between G1 and G2, ^ – significant difference between G2 and G3; p < 0.05.

While studying the effect of the age on pain intensity during physical activity we received the following results. Statistical analysis showed a significant upward and downward change in indicators of knee joint pain before and after physical exertion (Table 4).
Возрастные особенности функционального состояния коленного сустава...

Table 5

<table>
<thead>
<tr>
<th>Test</th>
<th>G1, n = 34</th>
<th>G2, n = 31</th>
<th>G3, n = 18</th>
</tr>
</thead>
<tbody>
<tr>
<td>TUG, s</td>
<td>6.83 (6.63; 7.04)</td>
<td>7.56 (7.29; 7.82)</td>
<td>8.73 (8.26; 9.21)</td>
</tr>
<tr>
<td>6MW, m</td>
<td>588.1 (576.3; 599.9)</td>
<td>548.6 (539.5; 557.6)</td>
<td>526.6 (517.2; 536.1)</td>
</tr>
<tr>
<td>STS, s</td>
<td>1.71 (1.69; 1.74)</td>
<td>1.84 (1.80; 1.87)</td>
<td>2.01 (1.94; 2.08)</td>
</tr>
</tbody>
</table>

In group 1 (60–64 years), significant changes were recorded after each test (p < 0.01). However, if in TUG and STS tests indices of pain intensity demonstrated an increase (p < 0.01), after 6MW test pain decrease was recorded (p < 0.01). In G1 and G2 significant changes were recorded in 6MW and STS tests (p < 0.01), where the same tendency as in G1 was found – pain increase after STS test and pain decrease after 6MW test. However, it is worth noting that the TUG test did not change significantly the index of pain in G2 and G3 – p = 0.29 and p = 0.57 respectively. However, in G1, its significant increase was recorded (p < 0.01).

The data obtained show that the most expressive growth of pain in the knee joint was recorded after the STS test. The difference in expression of pain in TUG and 6MW test compared to the STS test can be explained by the differences in their procedures. During the TUG test, we allowed the participants to use hands in order to help themselves to stand up, while during the STS test, hands of the participants were strictly in the crossed position at the level of the chest. The angles of the knee joint when transiting from the sitting to standing position are the least beneficial. The compression load on the joint arising from standing and squatting movements occurs at angles less than 60 degrees [12], which makes it much more difficult to cope with the load on the joint, and the resulting compression causes pain.

We believe that walking in this situation is not so much a factor affecting the occurrence of pain in the joint as a factor due to which a number of albeit short-term but positive changes occur – the work of the respiratory and cardiovascular systems improves blood circulation and nutrient delivery to the bone and cartilage of the joint; the tone of muscles increases as well as the total range of motion in the joint [3].

Table 5 shows the indices of physical performance tests. The results clearly demonstrate that the “age” factor has a significant impact on the level of physical performance of the tested women. According to the indicators of the three studied groups, the dynamics of a decrease in the functional indicators of the subjects can be traced, and if there are no significant differences between adjacent groups (G1-G2 and G2-G3 (p > 0.05)), then between G1-G3 groups statistically significant differences were recorded in relation to all functional tests - TUG (p = 0.015), 6MW (p = 0.013), STS (p = 0.002). Correlation analysis (Fig. 4A, B, C) also showed a pronounced dependence between women's physical performance and their age (6MW, r = –0.667; TUG, r = 0.734; STS, r = 0.781).

Conclusion. Knee joint impairments are mainly represented by changes that appear at the beginning with minimal signs, but eventually progress to more complex pathological conditions. The main functional degenerative disorders include joint pain, limitation of its mobility, decreased trophism of soft periarticular tissues and their diseases.

Capability of a person to maintain optimal level of physical activity depends largely on the functional status of the locomotor system and its separate structural elements. The malfunction of the knee joint leads to a change in a balanced stereotype of movement thereby the position of a person becomes less stable. The increase of the number of movements in the knee joint aimed at its stabilization results in a compressive stress of the kneecap that becomes the reason of pain and decline of motions in the joint.

Estimation of the knee pain severity, decline of motions and level of physical performance in elderly women allow obtaining new data about the age dynamics of functional and degenerative disorders in the knee joint. The data obtained confirm that the age of elderly women is one of the main factors influencing their functional status.
Fig. 4. Correlation between the age and physical performance tests (M, 95% CI)
It was established that the age is also one of the key factors influencing the progression of functional and degenerative disorders in the knee joint, which are not only accompanied by the increase of pain and stiffness but also have a great impact on functional capabilities in elderly women.

The functional assessment of the knee joint and level of physical performance will contribute to preparing and implementing the programs of physical activity enhancement and correction of the knee joint function in elderly women.

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References
7. Kryvinia E.N., Mosunov D.F. [Aging and Objectives of Physical Culture in Old Age]. *Adaptivnaya fizicheskaya kul’tura* [Adapted Physical Education], 2015, vol. 61, no. 1, pp. 46–49. (in Russ.)
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ВОЗРАСТНЫЕ ОСОБЕННОСТИ ФУНКЦИОНАЛЬНОГО СОСТОЯНИЯ КОЛЕННОГО СУСТАВА И УРОВНЯ ФИЗИЧЕСКОЙ РАБОТОСПОСОБНОСТИ ПОЖИЛЫХ ЖЕНЩИН

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Цель. Изучить возрастную динамику развития функциональных и дегенеративных нарушений коленного сустава и уровня физической работоспособности женщин пожилого возраста. Материалы и методы. В исследовании приняли участие три группы относительно здоровых женщин пожилого возраста (Г1 – 60–64 лет (n = 34), Г2 – 65–69 лет (n = 31) и Г3 – 70–74 лет (n = 18)). С помощью индекса WOMAC оценили функциональное состояние коленного сустава (боли, ограничение подвижности, физическую функциональность). При помощи трех функциональных тестов провели оценку уровня физической работоспособности женщин. До и после проведения тестов с помощью цифровой рейтинговой шкалы биологи проводили оценку боли в коленном суставе. Результаты. Показатели интенсивности боли и тугоподвижности в коленном суставе у пожилых женщин с возрастом достоверно увеличивались, в то время как уровень физической функциональности падал (p < 0,01). Установлены корреляционные зависимости между показателями «возраст – боль» (r = 0,581), «возраст – тугоподвижность» (r = 0,565) и «возраст – физическая функциональность» (r = 0,666), p < 0,01. Установлены достоверные изменения показателя боли в коленном суставе при выполнении физической нагрузки. Корреляционный анализ показал четко выраженную зависимость уровня физической работоспособности женщин от их возраста. Заключение. Полученные данные свидетельствуют, что возраст у пожилых женщин является одним из факторов, влияющих на прогрессирование функционально-дегенеративных нарушений в коленном суставе. Подтверждён факт того, что возраст оказывает непосредственное влияние на функциональные возможности пожилых женщин. Ключевые слова: пожилые женщины, коленный сустав, физическая работоспособность.

Литература


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