Evaluation of the relationship between muscle stiffness in the lower limbs and dynamic stability of the knee in adults with different levels of physical activity

INTRODUCTION: The knee joint plays a very important role in the human locomotion. Its location and functions make it subject to very high loads, especially during activities that include running, jumping or dynamic changes of movement direction. The ability of the knee to resist forces acting on it in rapidly and suddenly changing conditions is referred to as the dynamic stabilization. One of the properties of tissues, that play an important role in stabilization processes, is passive stiffness, defined as the resistance of tissues against stretching, which is not the result of nerve impulsation.

AIM OF THE STUDY: To assess the relationship between muscle stiffness in the lower limb and the dynamic stability of the knee joint in groups of young adults with different levels of physical activity. In addition, it was decided to determine the correlation between the results of stiffness measurements using two different research tools: modified „lacking-angle" tests and myotometry.

MATERIAL: The willingness to participate in the project was reported by 130 people, of whom 71 were qualified to participate in the study and underwent the full measurement procedure. The qualification process had a two-stage character. In the first stage, volunteers were assessed in terms of meeting the inclusion criteria: age 18-30; BMI in the range of 18.5-24.99; no pain in the musculoskeletal system. The exclusion criteria were: history of surgery or fractures in the lower limbs; history of injury of ligament-capsular apparatus of the knee joint; the occurrence of other injuries or ailments in the period of 3 months before the study, which forced at least a weekly limitation of the routine level of physical activity; in the case of athletes - having a higher sports class than the second class at any stage of their career. The second stage of selection included an analysis of the level of physical activity of the participants. Based on

the author's questionnaire and the IPAQ, two groups of people were qualified for the next phase of the study: moderate (UA, n=35) and high level of physical activity (WA, n=36).

METHODS: The research procedure included: measurement of passive stiffness of the rectus femoris and hamstrings muscles using modified „lacking-angle" tests; myotometric measurements in fascial points AN-GE, IR-GE, AN-TA, RE-GE, ER-GE, RE-TA; assessment of the dynamic stability of the knee joint using the battery of single-leg hop tests. Then, the correlation coefficients (r) between the stiffness measurement results and the hop tests results were calculated; the results in both groups were compared and correlations between both stiffness measurement tools were calculated.

RESULTS: The obtained results indicated the existence of a correlation between stiffness and the results of single-leg hop tests. With regard to myotonometry, in the UA large and moderate correlations were shown in the RE-GE and ER-GE. Whereas, in the WA the greatest values of the r coefficient were obtained in the IR-GE; AN-GE and AN-TA in triple hop for distance; and RE-GE, but at a lower level than in the UA. In the context of stiffness measurements using modified „lacking-angle" tests, the largest correlations were shown for hamstrings in the UA. Comparing both groups, people with a high level of physical activity obtained significantly better ($p \leq 0,05$), or being at the border of significance, results in hop tests. There were no differences between the groups in the level of stiffness. Flexibility test results correlated moderately with myotonometry in hamstrings; in rectus femoris small correlations were shown.

CONCLUSIONS: Passive stiffness is an important component of stabilization mechanisms, also in the context of the knee joint. That property, in the context to the muscles of lower limb, positively correlates with the level of stabilization of the knee, assessed using a battery of single-leg hop tests. The stabilizing ability of the knee joint is conditioned by different "stiffness patterns" depending on the level of physical activity.

Keywords: passive stiffness; dynamic stabilization; knee joint; myotometry; single leg hop tests