‘Mathematical model of prediction of health consequences in musculoskeletal system as a result of sedentary lifestyle’ – Abstract

Remarkably intensive progress made by the civilisation has led to the adoption of a sedentary lifestyle by humans. The research conducted by the International Journal of Behavioral and Physical Activity has revealed that people spend as many as 64h per week on sitting, 28h per week on standing and only 11h per week on walking. Statistical data published by Eurobarometer in 2014 only confirm the tendency to decrease physical activity among Polish people – only 5% of them regularly do physical activities, 23% do that with some regularity, 18% sometimes and 52% do not do any physical activities at all. Alas, further statistical data, compiled this time by the World Health Organisation (WHO) for the year 2004, confirm that a sedentary lifestyle is becoming a norm and is the 4th reason for human mortality all over the world, just after hypertension, tobacco smoking and an increased level of glucose in blood. According to the data obtained from literature, a sedentary lifestyle is connected with as many as 35 diseases or chronic conditions, including: pains in the lower sections of the backbone, cardiovascular diseases, decrease in bone density (osteoporosis), depression, diabetes, obesity and impairment of intellectual functions.

Increasing awareness of the problem leads to more frequent discussions about the elimination of the consequences of a sedentary lifestyle. The only tools that enable a quantitative evaluation of the functioning of the human motor system are biomechanical investigations and mathematical modelling. The latter, which is becoming more and more popular, models the human motor system using optimisation techniques enabling a non-invasive determination of both reaction forces and muscular forces. In view of alarming statistics, the increasing popularity of a sedentary lifestyle and the lack of literature data, which would directly define the dependence between a long-term sedentary lifestyle and functioning of the motor system, this project aims to develop a mathematical model for the prognosis of health consequences within the musculoskeletal system resulting from a sedentary lifestyle.

The mathematical model will be developed on the basis of data found in literature, experimental and model biomechanical investigations conducted within the framework of this project. In the first phase of the project a model for the prognosis of the BMI changes and a model of changes in the muscles morphology will be developed on the basis of the literature data. The next studies will focus on surveys, anthropometric measurements and biomechanical such as: evaluation of the body position, stabilographic tests, gait studies, investigations of the biomechanics of sitting during typical office work and typical after-work activities (e.g. while watching TV), the examination of bone density – densimetric tests and tests of anterior abdominal wall and spine muscle morphology. Then, it is planned to carry our longitudinal monitoring of physical activity and at least monthly biomechanical tests conducted in a period of one year. Data obtained from the experimental tests will make it possible to devise a mathematical model of a sitting position model in the AnyBody Modeling System environment. They will also allow the determination of changes in this position as a result of a more and more widespread sedentary lifestyle. The model of a sitting position will enable the determination and then the evaluation of loads generated in the human musculoskeletal system. Subsequently, the results of the simulations and two models: a model for the prognosis of the BMI changes and a model of changes in the muscles morphology will constitute the basis for the development of a mathematical model for the prognosis of health consequences resulting from a sedentary lifestyle. The above-mentioned models will be verified on the basis of data obtained in the longitudinal experimental studies.

A resultant algorithm will make it possible to assess the effects of a given lifestyle on the changes of loads and the activity of muscles occurring in the motor system. The model to be developed is to become an instrument enabling the determination which life parameters of a human being should be changed, and in what way, to prevent future consequences resulting from an increasing sedentary lifestyle.