

## **SUMMARY**

### **BLOOD PROOXIDANT AND ANTIOXIDANT BALANCE OVER THE CERTAIN STAGES OF HANDBALL PLAYERS TRAINING CYCLE**

The primary objective of the thesis was to evaluate how the efficiency of blood antioxidant defence system of handball players was changing over a half-year macrocycle training. For the purpose of the objective, blood was tested before and after a multistage shuttle run test (the so called beep test) performed during the preparation, competition and transition stage to determine the activity of selected antioxidant enzymes, the concentration of non-enzymatic antioxidants and oxidative stress markers and the activity of selected markers of muscle cell membrane damage. Bearing in mind that oxidative stress induced by a physical exercise may have an effect on the host immune response, it was also observed how some selected indicators of immune system were changing. For this purpose, the following research questions were stated:

1. Does a multistage running test have an impact on the blood antioxidant defence system of handball players? How does it change over the particular stages of the training cycle?
2. Does the physical exercise test used in the research induce oxidative stress in the tested men's blood? How does it change over the particular stages of the training cycle?
3. Does the change in the prooxidant and antioxidant balance that occurred over the half-year training macrocycle have an effect on the muscle cell membrane activity, which is to be determined upon the activity of cell enzymes in blood?
4. Does the running test used in the research have an impact on the tested players immune response? Is it different at the particular stages of the training cycle?

The following research hypotheses were formulated:

1. A multistage running test has an impact on the blood antioxidant defence system of handball players at each of the particular stages of the training cycle. The most favourable changes are to be observed at the end of the preparation stage.
2. The used physical exercise test induces oxidative stress in the tested men's blood. A significant prooxidant and antioxidant balance disorder is to be observed at the end of the competition stage.

3. Changes in the prooxidant and antioxidant balance in the handball players blood that occurred over the half-year training macrocycle have an effect on the muscle cell membrane activity. A significant drop in the escape of the cell enzymes to the bloodstream is to be observed especially at the end of the transition stage due to a higher blood antioxidant capacity.
4. A running test has an impact on the tested players immune response. The most significant change is to be observed at the end of the competition stage.

The research programme was approved by the Bioethics Committee for Scientific Research of the Jerzy Kukuczka Academy of Physical Education in Katowice (Resolution no 4/ 2013). The research was carried out as a part of the statutory research studies of the Academy of Physical Education in Katowice targeted at the conduct of research projects by the young scientists and PhD students. The research was carried out during the matches of Silesian and Opole Third Men's Regional League between January and June 2015. The participants were the players of the UKS Imperium Katowice who were informed about the purpose of the research and agreed to participate. Initially, twenty one handball players participated; the number of participants changed over the particular stages of the training cycle due to the injuries that occurred during the league matches. Finally, only fourteen players participated in all of the planned research tests.

The participants performed a multistage running test (the so called beep test), recommended by the Polish Handball Federation, at the beginning and at the end of the preparation stage and at the end of both the competition and the transition stage. The multistage running test took place on the handball pitch. The participants ran 20-meter sections keeping time with the beeps on the soundtrack. Blood from the antecubital vein collected before the beep test, immediately after having it completed and over the first hour of post-workout recovery was a biological material used for the biochemical tests.

The following parameters were determined in blood: hemoglobin (Hb), haematocrit (Ht), lactate concentration (LA), leukocytes (WBC), antioxidant enzymes: the activity of superoxide dismutase (SOD), glutathione peroxidase (GPx), catalase (CAT), glutathione reductase (GR), non-enzymatic antioxidants: the concentration of reduced glutathione (GSH), uric acid (KM), total antioxidant status (TAS), oxidative stress markers: the concentration of lipid peroxidation metabolites with thiobarbituric acid (MDA), advanced oxidation protein

products AOPP, total oxidative status in PerOx plasma, muscle cell membrane damage markers: creatine kinase (CK), lactate dehydrogenase (LDH), aspartate aminotransferase (ASPART) and alanine transaminase (ALAT) and the markers of the immune system: C-reactive protein (CRP), TNF- $\alpha$  , hs-IL-6.

Referring to the test results, the following conclusions were made:

1. Regardless of the stage of the training macrocycle, a one-off physical exercise stimulus, which was the beep test, resulted in a moderate favourable change in the blood antioxidant defence system of the handball players. It was shown in blood by a higher activity of the antioxidant enzymes (SOD, CAT and GPx) and a higher concentration of non-enzymatic antioxidants (GSH and KM) and the total antioxidant status (TAS).
2. There is a correlation between the antioxidant status parameters and the training stage. A significant positive change was observed at the end of the preparation stage, indicating that training might result in favourable adaptive changes.
3. It is likely that the participation of the tested players in many league matches was the reason for the statistically significant prooxidant and antioxidant balance disorder towards oxidation observed after having performed the physical exercise test at the end of the competition stage. A lower skeletal muscle cell membrane activity was a consequence of the imbalance. In this respect, no considerable changes were observed over the other stages of the training cycle.
4. A typical immune response to the physical exercise stimulus at each of the stages of the training cycle was a statistically significant increase in the number of leucocytes and lymphocytes in blood. Additionally, a post-workout increase trend of IL-6, TNF- $\alpha$  and CRP was recognised during the preparation and transition stage. At the end of the league season, the values of the rest and post-exercise inflammatory parameters were the highest, which might indicate a lower efficiency of the immune system