

9. SUMMARY

Long-distance running are included in the group of endurance sports. Athletes practicing endurance sports often strive to significantly reduce body weight, especially body fat, to increase exercise capacity, improve speed, motor ability and overall fitness. Physical performance is affected by properly planned training, genetic factors, psyche (motivation) and the external environment. A balanced nutrition plan and appropriate supplementation also play an extremely important role. Physical activity, despite many health benefits exerted on the human body, can also cause adverse effects. The risk of nausea, vomiting, stomach aches or diarrhea may increase. In endurance sports, these problems may affect up to 70% of competitors.

The aim of the study was to assess the impact of diet and applied probiotic therapy on reducing the incidence of gastrointestinal disorders and selected parameters determining the inflammation of the body, body composition, cardiopulmonary efficiency and selected biochemical parameters in the serum of long-distance runners.

70 people meeting the inclusion criteria were included in the intervention and observational study. The research was carried out at the Department of Dietetics and Clinical Nutrition at the Faculty of Health Sciences of the Medical University of Białystok, Fitness Maniac Gym Club in Białystok and at the Department of Hematological Diagnostics and the Department of Biochemical Diagnostics of the University Clinical Hospital in Białystok. The study was randomized using a double-blind trial. A simple draw without returning was used to divide the players into groups G1 and G2. Every second person from the sampling frame was group G1 (n=35) and the remaining group G2 (n=35). The intervention factor was the SANPROBI BARIERR multi-graft probiotic from Sanprobi Sp. z o.o. or placebo. Competitors used probiotic / placebo for three months at a dose of 2x2 capsules daily (2.5 x 10⁹ CFU / g (1 capsule)). Group G1 was given the preparation marked with the letter A, while group G2 was given the preparation marked with the letter B. Both players and researchers were not informed about the type of capsule taken (probiotic or placebo). The consent of the Bioethics Committee of the Medical University, no. RI-002/81/2017, was obtained for the study.

The study consisted of two stages, and each stage was associated with three visits by the participants. The first of these included qualification for the study, issue of an original survey to be completed, and 3-day nutrition diaries. At the second visit, body composition analysis and test determining cardiopulmonary efficiency on a medical treadmill were performed. Every second person was given Formulation A, the remaining Form B. During the

third visit, each athlete received blood from the vein in the amount of 10 ml for morphological tests (blood counts with smear, lipid profile, fasting glucose, C-reactive protein concentration) and ionogram). The final stage (W2) included similar three visits, where the first visit was made after 3 months of taking A or B preparation by competitors and 66 competitors took part in it.

In the studied groups of women and men, the type and frequency of gastrointestinal disorders (feelings of heartburn, constipation and diarrhea) were analyzed. 50% of women from the G1 group, 67% of women from the G2 group, 55% of men from the G1 group and 85% of men from the G2 group declared that preventing them from taking part in the competition due to gastrointestinal disorders. After three months of research, 100% of the G1 women, 83% of the G2 women, 95% of the G1 men and 96% of the G2 men reported that they could enter the competition without gastrointestinal disorders. The differences in the groups were not statistically significant. 43% of the G1 women, 50% of the G2 women, 45% of the G1 men and 31% of the G2 men declared heartburn occurring mainly during training and competition. After three months of research, the heartburn feeling decreased in the majority of respondents, i.e. 57% of the G1 group women, 50% of the G2 group women, 45% of the G1 group men and 46% of the G2 group men, and none of the competitors observed an increase in the frequency of this type of symptoms (differences in groups not statistically significant). The vast majority of people (79% of women in the G1 group, 67% of women in the G2 group and 60% of men in the G1 group and 81% of men in the G2 group) reported diarrhea, most often during training sessions, they were less frequent during the competition. After 3 months of research, these symptoms decreased in the majority of respondents, i.e. 57% of the G1 women, 67% of the G2 women, 40% of the G1 men and 65% of the G2 men (differences in groups not statistically significant). The occurrence of constipation was declared by 64% of the G1 women and 67% of the G2 women. After three months of using probiotic / placebo, a reduction in constipation was found in 57% of the G1 women as well as 33% of the G2 women (no statistically significant differences were found). On the other hand, constipation with diarrhea was observed among women in the G1 group (43%) as well as in the G2 group (50%), the least frequently among men in the G1 group (25%) and in the G2 group (8%). It was found that three-month probiotic / placebo intervention reduced these symptoms in 93% of the G1 women, 100% of the G2 women, 90% of the G1 men and 88% of the G2 men (statistically insignificant differences).

After three months of testing, both groups (G1 and G2) decreased in C-reactive protein. The differences were not statistically significant. TNF-alpha serum concentration

after three months of the study decreased both among men and women, both groups studied and these differences showed high statistical significance (in the group of women G1 $p=0.003$, men in the group G1 $p=0.001$, and men from the group G2 where $p=0.016$). However, the decrease in TNF-alpha concentration in the G2 group of women was close to statistical significance ($p=0.074$). After three months of research, IL-6 levels were also reduced in 14% of the G1 women, 17% of the G2 women, and 20% of the G1 men and 23% of the G2 men. The increase of IL-6 concentration in relation to the initial examination was found in 10% of the G1 men and 12% of the G2 men. The differences in the groups were not statistically significant.

Selected parameters assessing the cardiopulmonary capacity of the studied men and women were analyzed. After three months of research in the G1 group of women, an increase in all parameters assessing cardiopulmonary efficiency was noted, except for the respiratory reserve and the anaerobic threshold (AT). In the G2 group of women, however, an unfavorable reduction in the concentration of maximum oxygen uptake, minute ventilation, exercise capacity, respiratory reserve and anaerobic threshold was demonstrated. After 3 months of study in the G1 male group, a statistically significant increase in VO_{2max} ($p=0.017$), V_e ($p=0.013$), FC ($p=0.036$), respiratory reserve ($p=0.020$) and exercise capacity ($p=0.036$). No such beneficial changes were observed in the control group.

Anthropometric parameters were analyzed. A decrease in BFM (kg), PBF (%) and VAT (cm^2) was observed in the group of women using probiotic G1. In the group of women using placebo G2, a slight increase in total body fat and a decrease in visceral fat were observed. After three months of observation (with probiotic intervention), a statistically significant reduction was found in the G1 male group: TBW (kg) ($p=0.019$), FFM (kg) ($p=0.019$) and SMM (kg) ($p=0.022$). In the G2 men group, after three months, no statistically significant changes in body composition parameters were noted.

After 3 months of research, an increase in sodium, potassium and iron levels (statistically insignificant) was observed in the group of women using probiotics (G1). Iron levels decreased significantly in the placebo group. In both examined groups of men, a decrease in serum calcium was demonstrated, but a statistically significant result was observed only in the G1 group ($p=0.011$). Magnesium concentration after 3 months of study decreased insignificantly in the G1 men group and significantly increased in the G2 group ($p=0.034$).

After three months of observation, a significant, favorable increase in HDL cholesterol ($p=0.035$) was observed in the G1 female group, which was not demonstrated in the G2

group, where HDL cholesterol had a negative decrease. An improvement in the lipid profile in terms of LDL cholesterol and triglycerides (statistically insignificant) was also demonstrated in the G1 group of women. An insignificant increase in total cholesterol and triglycerides as well as a statistically significant LDL fraction were noted in the G1 male group ($p=0.038$). In the G2 group, on the other hand, an insignificant increase in LDL cholesterol, as well as a decrease in total cholesterol and triglycerides were noted.

At the final visit, the participants subjectively assessed a change in their overall health after a 3-month probiotic / placebo intervention. 71% of the G1 women, 50% of the G2 women, 60% of the G1 men and 50% of the G2 men improved health. Only 5% of men in the G1 group said their health had worsened. The observed differences in the groups were not statistically significant.

To sum up, after a three-month follow-up, long-distance runners showed a tendency to reduce the occurrence of heartburn and diarrhea in both groups studied, and constipation especially in the group taking the probiotic Sanprobi Barierr. Probiotic therapy showed an additional improvement in health in the subjective assessment of players. A decrease in TNF-alpha serum concentration was found in both men and women taking the probiotic as well as in men from the G2 group, while the decrease in IL-6 and CRP protein levels was similar in both groups studied and did not differ statistically. Probiotic therapy had a positive effect on improving the parameters assessing the players' body composition (a statistically significant increase in lean body mass and skeletal muscle mass in men, and a statistically insignificant reduction in the content of total and visceral fat in women).

The beneficial effect of probiotic therapy on improving the parameters assessing cardio-pulmonary fitness in endurance sports athletes was also observed. A statistically significant increase in serum HDL cholesterol as well as a favorable trend in increasing iron concentration and lowering LDL cholesterol and triglycerides were found in the group of women using probiotic therapy. This was not seen in the group of men using probiotics. It seems that the observed insignificant differences in the diet of the competitors did not significantly affect the tested parameters of body composition, circulatory and respiratory efficiency and selected biochemical parameters in serum. A larger number of similar randomized studies on large groups of athletes would perhaps allow to learn the mechanisms of the beneficial effect of probiotic strains on the body of endurance sports athletes.