SELECTED CIRCADIAN DETERMINANTS OF PERFORMANCE IN SUPER LEAGUE FLOORBALL PLAYERS

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Abstract

In the paper are presented results of a part of the international research project W/VSP/161/I researched the impact of lifestyle, circadian typology, sleep and eating habits on the performance of athletes in cooperation of the College of PE and Sport PALESTRA in Czech Republic and the University of Kochi in Japan. The main aim of the presented study was to investigate selected circadian determinants of super league male players on their sport performance. The second aim was to develop and objective an educational material focused on floorball players. 12 males, super league players of AC Sparta Praha, in the age 17 – 27 participated in the study. The survey was carried out in the timeline of four weeks within four educational units when players got the necessary information. Anthropometric measurements, Battery of 3 Questionnaires, Sleep Diary, Intervention program "What can get me to level up?!" and Statistical methods were used for monitoring, analyse, evaluation and prediction during the investigation. The hypotheses were confirmed. In participants were analysed the improving of psychological condition in 10.29 %, in physical fitness in 12.75 %, in sleep quality in 3.65 % and in improving of the selected playing activities even in 48 %. The results declare that the applied intervention program can effectively support the performance and health of young super league floorball players.

Keywords

Sport performance, sleep and circadian rhythms, floorball, super league players.

1 INTRODUCTION

Chronobiological determinants and their influence on performance in sports are still unknown for athletes in the Czech Republic. However, athletes, especially players, encounter them, and these determinants are very important to them. Athletes at the semi-professional and professional level solve many details of their life, but completely forget the crucial and important factors related to performance in terms of their circadian preferences.

Circadian rhythms last 24 hours and belong to biorhythms that are related to most biochemical and physiological functions of the organism. Biorhythms are also subject to psychological processes - remembering, concentration of attention and reaction time. Daily biorhythm is a period of the human body, it includes energetic maxima, minima and also time for rest (Liba, 2016). Being a morning type man is not only much better in the sport and an athlete would be heading to this lifestyle. If an athlete goes to sleep soon, he has a good hormone levels, has good

sleep that helps him recover and prepare for the next stage of training. The reasons for keeping the regime and being rather the morning type are many. Of the many intervention studies by Harada and Krejčí, it is evident that a person with the right biorhythms is better focused, demonstrably increasing his responses, better regenerating the body and being resistant to injuries. The higher concentration of serotonin in the brain means the better concentration during the training. Bad sleep mode causes athletes suffering from depression and heart or vascular disease. In better cases they have only a bad mood and are tired. Sleep is the building block of the right human biorhythm, and we must attach great weight to it. (Harada, Krejčí, et al., 2016)

In the context of circadian rhythms, we know three important hormones that, if they have the right level in the body, help achieve the right circadian rhythms. Important hormones for the proper functioning of circadian rhythms:

- Melatonin
- Serotonin
- Tryptophan

Serotonin belongs to a group of mediators, from a chemical point of view belongs to the group of biogenic amines. Serotonin affects mood regulation, like noradrenaline, and helps regulate sleep. A lower serotonin value in the body is often associated with depression. Serotonin is also closely related to the tryptophan hormone, which is best formed in the morning if the correct breakfast composition is chosen. People should eat good quality proteins, such as soy, peas, fresh eggs, high quality cheese, white yoghurt, or tuna or salmon. The right breakfast made up of proteins and, for example, a very nutritionally balanced banana, will increase the level of tryptophan. Tryptophan is further converted to serotonin. The conversion takes place when the above-mentioned breakfast and sunshine are combined. Everyone should go out after breakfast and expose themselves to sunlight. For example, a 15-minute walk, a morning run, or just a public transport journey. The effect of sunlight converts tryptophan to serotonin. This transformation is very beneficial to us. We feel better then, we have fewer tendencies to depression, work better and we are more efficient. For athletes, this process is very important in the match. Athletes make big mistakes in the form of breakfast and do not even know they should go out.

Melatonin is a hormone that is formed in the shingles and is essential for sleep. Melatonin originates from serotonin. His work increases the darkness. On the contrary, light diminishes its production. Cells of pineal cells create intense secretions called melatonin. Melatonin is then transported to the wall of the capillaries through which the protrusions are brought into the bloodstream. According to impulses that come from one hypothalamic nucleus, pynealocytes produce a fluctuating amount of melatonin. This fluctuating amount is related to the maintenance of circadian rhythms and physiological changes of the organism. (Dylevsky, 2009)

The higher amount of melatonin in the evening is stimulator of the better quality of sleep in the body. Under an artificial yellow incandescent lamp of 2300 to 2700 K, we should read a book in the evenings. This power of illumination is positive for melatonin formation. It is important to have absolute darkness during sleep. Any minimal light makes our body break during

rest (Harada, Krejčí, Wakamura, et al., 2016). On the contrary, the artificial blue light which reduces melatonin in the body is very damaging. Artificial blue light is omnipresent in today's world. A young student or top athlete, according to Takeuchi and colleagues, spends an average of several hours each night playing computer games, watching TV, or making a tablet or cell phone. These factors cause very low melatonin levels, and people are tired the next day and worse focus on any job. (Takeuchi et al., 2015). For a clearer understanding of the relationship of hormones to circadian rhythms, the following diagram was created, see Figure 1.

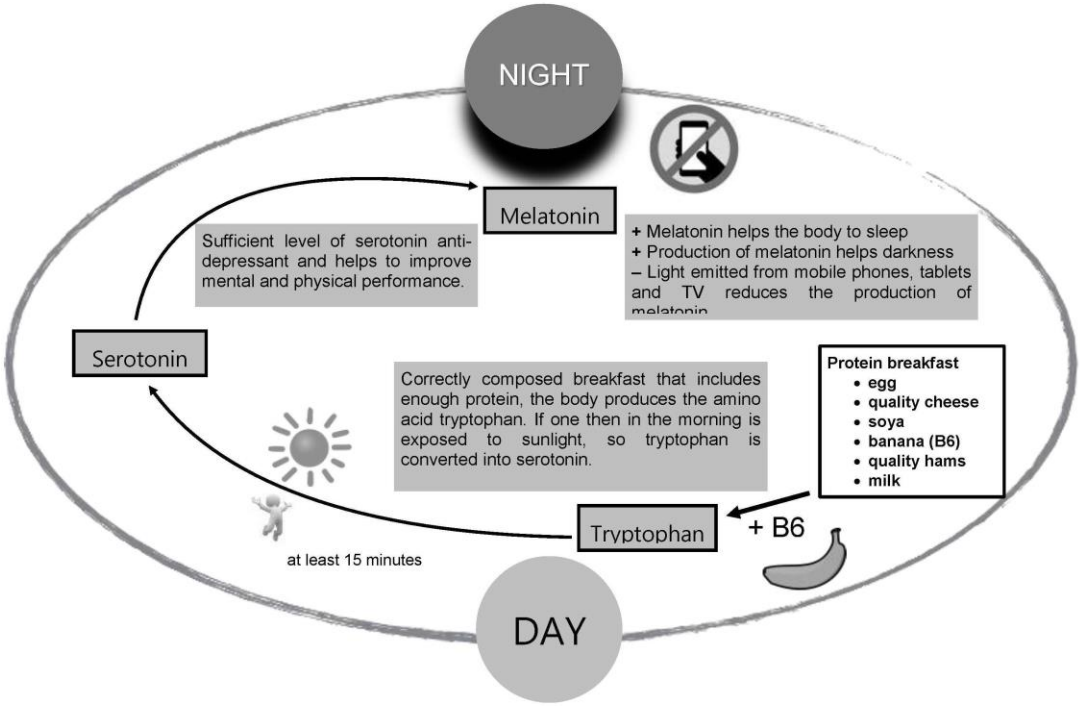


Figure 1 Diagram declared the relationship of circadian rhythms to tryptophan, serotonin and melatonin formation (Mandelbaum, 2016)

According to the published outputs of Harada et al. it is essential to follow the three principles: walk in time to sleep, get up early and eat regularly. These scientists have developed educational material dealing with the subject: "Three Benefits of Early Saving to Sleep, Earlier Rising and Regular Breakfast" (Harada, Wada et al., 2013). Also the research study of Nakade, Takeuchi, et al. has shown that tested university students - athletes have lower performance on training and are also very vulnerable to injuries due to evening lifestyle typology (Nakade, Takeuchi, Krejčí, et al., 2015).

Breakfast diet in relation to circadian rhythms

Linking nutrition, sleep, and the influence of light on humans is important for proper function of circadian rhythms. It is essential that these determinants are linked to each other and athletes have learned to manage them all, not just their parts. If an

athlete wants his biorhythm to work, he must also be concerned about proper nutrition. Japanese Intervention: A questionnaire survey of comparisons of circadian typology, physical and mental health and nutritional habits of Japanese university students at university students who are sporting, has shown that students have psychological and social problems. The relationship with nutrition is not negligible at all. The results of the research showed that students with far more energy-consuming typology consumed carbohydrates. Even in the evening, the morning breakfast is disturbed in addition to sleep. Hormone formation is not as good as we would need. (Nakade, Takeuchi, Krejčí, et al., 2015).

Influence of light on athlete biorhythm

Both types of artificial and natural light are important for the production of melatonin and serotonin hormones. Sunshine is the daylight that helps athletes to wake up and to feel fresh and full of energy. On the contrary, the moonlight creates the athlete for sleep. We also encounter classic light bulbs, fluorescent blue and fluorescent white lights, LED lights and candlelight or fireplace lighting. The proper circadian rhythm has these lights mainly due to the time in which the human body acts. Daylight, a sun-like light, is a fluorescent white light found in fluorescent lamps. These lights are in offices, shops and many other public places. This light, if it has a minimum luminous intensity of 4200 K, positively affects the brain. If a fluorescent light with a minimum luminous intensity of 4200 K is applied to the athlete, this will partially replace the sunlight that is important for serotonin production. But the sunshine can not be completely replaced. Research at the University of Kochi recommends that the athlete be exposed to sunlight for at least 15 minutes every day after breakfast. Thereafter, the tryptophan hormone is better converted to serotonin. A large dose of serotonin that the athlete gets because of sunlight can maintain a solid phase of circadian rhythms.

Sport professiography of floorball

Floorball is a goal game that is considered one of the fastest sports in the world. In this victory game, it decides which of the two teams will score more goals. Non-hockey goalkeepers have a shot at speeds up to 200 km / h. It is a physically demanding sport, but less demanding than hockey. With its dynamism it does not lose its attractiveness at any stage of the game. The anticipatory nature of the game brings great demands on the cognitive and sensomotoric processes of the players. Game situations run in time and players are exposed to great emotions. At the top level floorball requires physically-quality players. In particular, it must be advanced in repeated high-intensity short-term activities. The main requirement is the combination of speed and fitness capabilities. Each player is both an executive and a psychological point of view, an important member of the team, and helps the overall strategic and operational performance of the entire group of players as a whole. We understand the profession as a characteristic of sport in terms of the requirements of selective rules, psyche, methods and requirements. In this heuristic collective game, it is important to overtake the opponent, apply unexpected procedures, anticipate how the opponent reacts and direct contact that is common in the floorball to overcome the opponent. For these aspects of

floorball it is important to be mentally well balanced and physically ready.

2 OBJECTIVES AND HYPOTHESES

The main goal of the study was research of selected chronobiological determinants of performance of extralig players AC Sparta Praha - floorball and research monitoring of effects of the intervention program on the performance of players in the category of men from 17 years of age. A partial goal was to create educational material for players and floorball trainers.

Hypotheses:

H1: After completing the intervention program "What can get me to level up?!" a subjective improvement of the physical fitness assessment will take place.

H2: After completing the intervention program "What can get me to level up?!" subjective improvement of the psychological condition will be improved.

H3: After completing the "What can get me to level up?!" intervention program, participants will improve sleep quality.

H4: After graduating from the "What can get me to level up?!" intervention program, the game activity will improve by at least 40%.

3 METHODS

Material and procedure

The research team consisted of 12 superligo floorball players in the age range 17-27 years of age, who were at the time of research at the beginning of the competition period. The player's average age was 22.5 years, median 22 years. The players were involved in the AC Sparta Prague training process and are entering the top Czech floorball league - Tipsport Superlize.

Before the start of the intervention program, players were introduced to the course of the research and participated voluntarily. Of the participating players there were 8% of the workers, 42% of the university students or secondary schools, 50% of the university students and of the working people. The students are selected by 80% of university students and 20% of secondary schools. All players lived in Prague or near Prague and were still single.

Before the intervention was launched, questionnaires and record sheets were prepared in cooperation with the Japanese Department of the University of Kochi (Harada, Tsuji). Then an informative flyer "What can get me to level up?!" (Mandelbaum, Harada, Krejci, 2015) was created to describe the purpose and objectives of the intervention. Prior to the start of the research, a selection of suitable players was consulted with the club's coaches and supervisors. Appropriate players have chosen the team coach to decide which players are willing to undergo the test and also who have a long-term interest in improving their sporting skills in detail. The intervention program was conducted continuously for 14 days, with four educational units being implemented.

The presented research study was elaborated in the framework of the International research Project of VŠTVS PALESTRA W/VSP/131/I "Research of the influence of lifestyle, circadian typology, sleep and eating habits on the mental health of sports and non-sports children and students in the Czech

Republic and Japan" in collaboration with the Laboratory of Environmental Physiology, Kochi University, Japan.

The research was conducted over a four-week timeline. In the first week it was prior to start the intervention and to give to players first information about sleep, breakfast, and light intervention program "What can get me to level up?!". Data editing, statistical analysis and consultation of scientific solutions of the research solution took place at the Japanese laboratories of the University of Kochi, see the Figure 2.

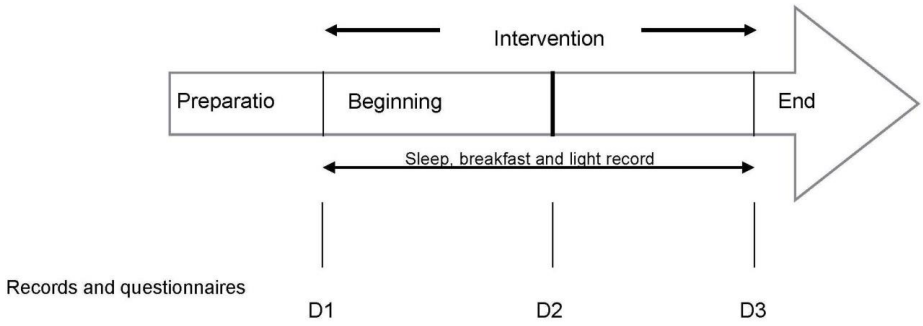


Figure 2 Timeline of the investigation procedure

Diagnostics

Anthropometric measurements

- *Weight Measurement*: Weights of participants of the intervention program were determined on a personal scale of Microlife WSD80Ds. Dear participants took part in lingerie. • Body height measurement: Vertical distance from point to pad. The participant stood back to the wall (without lining on the floor), his heels and toes together. The walls touched the heel, his buttocks and his head. The head was in a position in the so-called Frankfurt Horizontal, which provided the correct position for measuring the highest point on the top of the head. (Kornatovska and Bláha, 2015).
- *InBody* - Measurement took place at least two hours after the last meal intake of the participant, before the shower and after calming the heart rate from the exercise load. An example of the results of a test participant from the AC Sparta Praha Team, see http://www.inbody.cz/pro-presne-mereni-na-inbody.php)

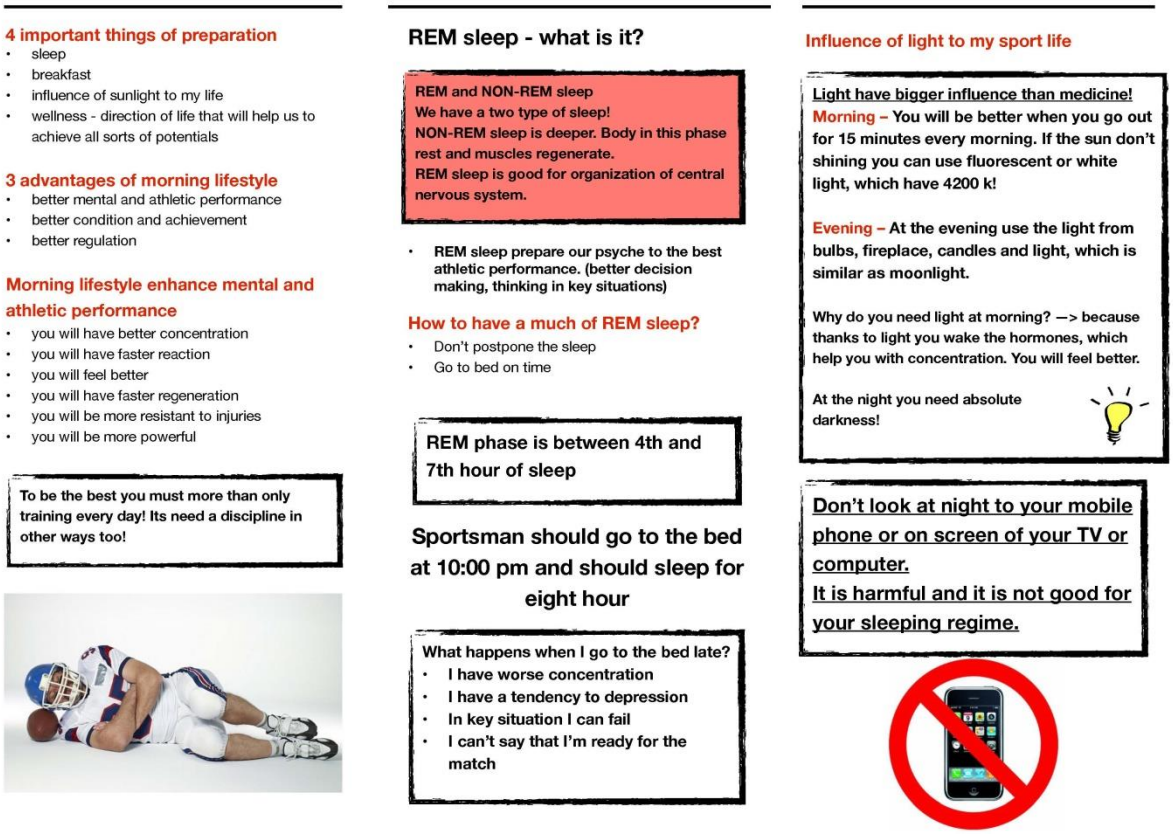
Tests "Pencil - paper"

- *Questionnaire CIT* „Ciircadian typology and preferences“ (Harada, Krejčí, 2015)
- *Questionnaire „Assessment of floorball skills“*. This questionnaire consisted of 17 items that subjectively players evaluated (Mandelbaum, 2016)

- *Sleep diary* (Harada, Krejci, Tsuji and Mandelbaum, 2015)
- *Breakfast diary* - with using of the web application (http://www.kalorickatabulky.cz)

Intervention "What can get me to level up?!"

The intervention was created thanks to inspiration from Tetsuo Harada, who created educational material for Japanese athletes - under this inspiration was created a flyer "What can get me to level up?!", see the Picture 1, divided into five sections. The first section contains basic milestones of training in terms of circadian rhythms and wellness lifestyle. The second part of the flyer describes the basic characteristics of REM and NON - REM sleep. The third section informs participants about the influence of natural and artificial light on sports performance. In the fourth section, players will learn why they should have breakfast and what composition should have breakfast with a good effect on circadian rhythms. The last 5th section of the flyer contains information about the wellness lifestyle, regeneration, and a summary of what an athlete should improve to improve his biorhythms and lifestyle. This flyer was received by each participant before the start of the intervention. It was a continuous two-day program with regular recording of sleep rhythms, the time the body is exposed to, the time the body is exposed to artificial light "blue light", the food the participant consume for breakfast and mental and physical feelings. At the beginning, in the middle and at the end, four educational units were made. Each training unit lasted for a total of 30 to 90 minutes.



Picture 1 Flyer "What can get me to level up?!"used in the intervention by floorball players (Mandelbaum, 2016)

Statistics

Statistical analysis was provided in the Japanese workplace, in the Laboratory of Environmental Physiology of Kochi University, based on the SPSS program, using Wilcoxon test, Kruscal-Wallis test, Pearson correlation coefficient and Mann-Whitney U-test.

4 RESULTS AND DISCUSSION

Results of anthropometric examinations

Players had taken measurements on the InBody before the intervention began. By measuring, their mean value of idle consumption of metabolism was 1874.6 calories (Table 8). The minimum value is 1566 calories. The calorie consumption of floorball players is 0.1 kcal per kilogram of player per minute. A player with an average weight of 68.3 kg would use 409.8 calories per hour of intense floorball training. The AC Sparta Prague players were very low. Eleven participating players out of twelve had less body fat than 12%. Four players had only 3-6% of the fat in the body. The total average of AC Sparta Praha's participants was 7.53% of body fat. The InBody was the daily calorie consumption values in sleep mode. According to the histogram, 3 of the most participants (4) ranged between 1800 and 1900 calories per day. With an hour of workload, but the calorie requirement increases by up to 500 calories.

Results of the tests "Pencil - Paper"

The results of the test of physical and mental condition evaluated from the sleep

journal were evaluated by the Mann - Whitney U - test. Of the subjective sensory scores recorded in Table 10 of the first 3 days and the last 3 days of the 12-day intervention program, there was statistically proven significant improvement in the physical condition of the players. The bold Z and P values show a statistically significant improvement for the participants. Physical condition improved during the intervention program by 12.75%. These results verify the hypothesis H1.

Of the recorded values in the sleep preferences, statistically significant improvement in the psychological condition of the participants was statistically demonstrated. The improvement in mental health was 10.85%. These results verify the hypothesis H2.

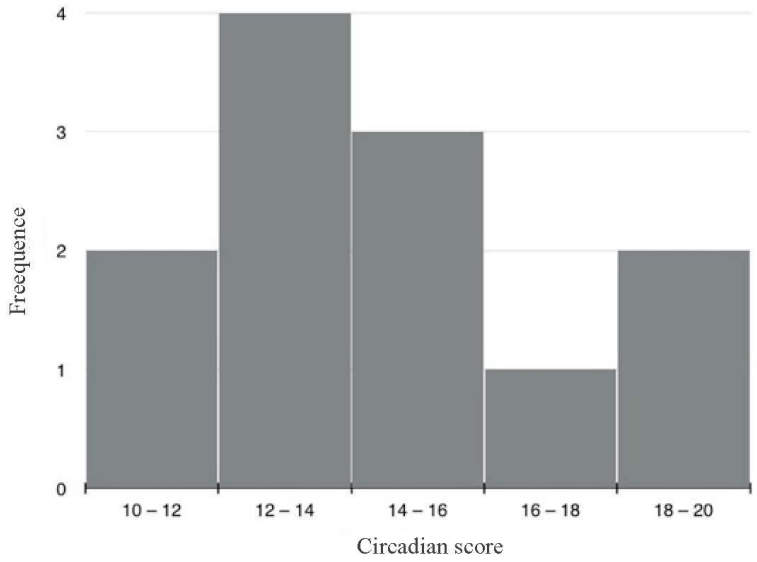


Figure 3 Circadian score values of participants (n = 12, male)

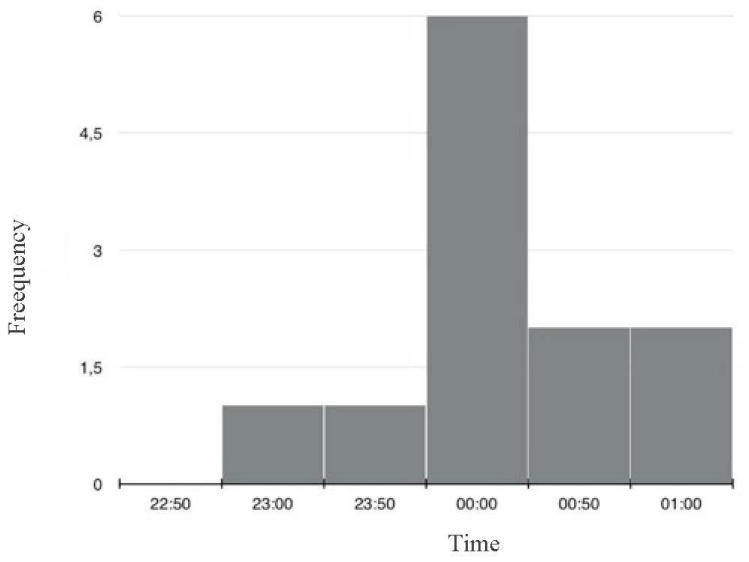


Figure 4 Time when participants went to sleep in weekend days (n = 12, men)

Figure 3 shows values of very high circadian score. All participants had a score higher than 10. Participants were evening types due to biorhythms. Figure 4 shows the average times in which 12 participants were put on sleep on weekdays. Most participants were put to sleep at 23:00 and 24:00. The results of the analysis also showed that participants went to sleep on days off rather than on working days.

According to the records, most participants woke up in the days of the holidays very late and differently from business days.

On average, participants were put on sleep for up to 90 minutes later on days off than on working days. Due to circadian rhythms, participants should be asleep at the same time each day.

Also, during the times when participants woke up on days off and working days, it was a significant difference. One participant woke up on days off until 6 hours later than on business days. Participants should wake up every day as well, no matter what the day is.

On weekdays, each participant should ideally sleep for 8 hours. But only 8 - 8.5 hours slept only 5 participants. Analysis of weekend sleep results showed that the participants slept a few hours longer than on weekdays. Each participant would ideally sleep for 8 hours. Some slept for up to 12 hours.

We really do consider the fact that most of the participants slept for up to 6 hours longer on working days than on working days. Only two participants slept at the same time on weekdays and on working days.

Results of time records evaluated from the sleep log. Mann - Whitney U - test and the Wilcoxon test show that the difference between the first and last 3 days of the interventions was statistically proven. Participants experienced a change in waking and waking hours. At the end of the intervention the participants got up later. Significant improvement occurred in the quality of sleep, which improved at the end of the intervention. The quality of sleep quality improved on average by 3.65%. These results verify the hypothesis H3.

The evaluation of the sleep determinants and the anthropometric measurements was made using the Pearson coefficient. The Pearson coefficient revealed significant relationships in the relationship between sleep determinants and the amount of fat in the body. Statistical evaluation shows that participants with higher fat content in the body later rose on days off. Over the weekend, participants with higher fat content also slept longer than those with lower body fat.

In addition, positive changes were analyzed for the 16 components important in the game. Positive changes in the impact of the intervention program have been analyzed. Frequency analysis found that a positive change occurred in 48% of response records, with the most common positive changes for the components of the "field of view in the game", "score accuracy" and "tactics understanding" were well chosen in the intervention program. The results verify the H4 hypothesis.

Table 1 Evaluation of the comparison of the sleep determinants with quantity of bdy fat (n = 12, males)

Monitored sleep determinants	Pearson coefficient	Quantity of body fat [%]	Quantity of body fat [kg]
Time to go in bed on weekdays	Pearson'sr p	–.343 .230	–.359 .208
Get up time on weekdays	Pearson'sr p	.018 .952	–.014 .961
Time to go in bed on weekend days	Pearson'sr p	–.299 .299	–.398 .159
Get up time on weekend days	Pearson'sr p	**–.788 **** .001	**–.806 **** .000
Cirkadián type - score	Pearson'sr p	.351 .219	.432 .123
Participants used to go sleep very late	Pearson'sr p	.042 .886	–.052 .860
Participants used to awake very late	Pearson'sr p	**–.763 **** .002	**–.771**** .001

DISCUSSION

Analyses of the subjective physical fitness assessments has shown that even such a short intervention program can improve players' feelings and improve one of the most important sports determinants. Improving subjective physical fitness ratings by 12.75% is not negligible. This is a sign that information on this issue has been well-handed to players before the start of the intervention program. Based on the correct program concept, players have followed Circadian recommendations in their daily schedule. We were very surprised that such a short intervention program could improve the subjective feeling of physical fitness by more than 10%. This improvement can have a strategic impact on the mental health of floorball players. The knowledge and skills of players leading to the elimination of excessive physical and psychological stress bring athletes knowledge of their self. (Krejci, Harada, 2016). The subjective assessment of the players' psychological condition during the 14-day program improved by 10.29%, indicating the effectiveness of the intervention program aimed at improving the mental balance of the players. The mental aspects of the athlete are associated with other floorball skills. Psychic properties do not manifest in every athlete in the same way and with the same clarity, but for each individual, his psychological qualities are reflected in his skills. For this reason, psychological balance and comfort for sporting performance is extremely important, as mentioned by Dovalil (2010), Hošek (in Slepička, Hošek, Hátlová, 2006). As Harad et al. (2015), the interdependence of the psyche and circadian rhythms, the player's performance in the game is unforgettable. Psychotropic balance and a good subjective sensation are mainly due to the hormone serotonin, which is synthesized from the tryptophan hormone. The process of physiological transformation is complex, but it is sufficient for the athlete to understand the main context, and in particular to follow the intervention principles (Harada et al., 2015). The results

show that if the players observe these determinants, their psychic status will be demonstrably improved. In order to improve the psyche of players, it is important to follow all the recommendations in relation to circadian rhythms in this intervention program. For this reason, a flyer "What can get me to level up?!"Has been created for extralig players of floorball, so players have been properly and effectively informed. The psychological state of the individual also has a positive effect on the hormone melatonin, which on the contrary helps sleep athletes, which is almost the most important determinant for the regeneration and psychic properties of the players. For proper melatonin production, it's important to sleep about 22 hours, keep the same sleep mode every day, and restrict work on electronic devices that emit light-blue light. This artificial light has a very negative effect on melatonin production. In view of improving players in psychological condition, it is obvious that players have followed a well-defined intervention program.

Prior to the start of the intervention, during the first meeting with the players in EJ 2, the selected participants gained detailed information about the circadian rhythms in pairs. They also gained information about the breakfast diet they were supposed to follow. The goal was to increase the protein content of their breakfast, which is involved in the formation of tryptophane and then, thanks to the sunshine, synthesize it to serotonin, which helps to correctly adjust the circadian rhythms. Players learned how to work with the mobile application www.kaloricketabulky.cz during the training unit, which proved to be good for evaluating eating habits. A detailed online overview of the breakfast composition of all participants has helped to greatly improve the effectiveness of the intervention program. Players have shown interest in gaining additional knowledge about the breakfast issues on which they have worked very well. The results of the breakfast composition show that the dishes contained good quality protein and the protein content increased by 39% on average at the end of the intervention, which is a significant improvement.

Another recommendation for participants was to go for a minimum of 15 minutes each morning after breakfast. They can walk on public transport or go to work. Most participants spent 15 minutes in front of the intervention program in the morning in the morning light. After receiving information that their mood is positive for their mental and physical fitness, players have increased their average time to 37.6 minutes. According to Harady and Krejci (2013), vitamin B6 with daylight contact is positive for the synthesis of tryptophane to serotonin. It is very interesting that players, after only fourteen days of extending the time spent in daylight in the morning, improved all the components examined, which are associated with light determinants. The players apparently received the information well because they fulfilled the recommendations.

The results also showed that players had problems with their sleeping rhythms. In the pre-intervention questionnaire, players reported difficulty getting up and falling asleep, but also during the intervention it was found that the participants were going to sleep at different times on weekdays and on working days. Also, the length of sleep extended to players on days off to 6 hours. It is likely

that players have time, psychologically and physically demanding weekdays in which, unlike other top athletes, they must also work, school or work and school at the same time. This schedule of performance floorball players is very demanding, and it is almost impossible to observe all the principles of circadian rhythms. As long as this sport does not go on a professional level, it will be very difficult to adhere, for example, to the principle of walking around 22 hours and sleeping 8 hours each day. Superligbalbalbalist training often ends only around 22 hours. These players can be included in the evening typology, which, according to the Japanese study, is negative in terms of psychological and social performance. Players should therefore have this information about the circadian rhythms and their influence on sports performance. (Harada, Nakade and Krejci, 2015)

The study found that the intervention program that we created for the needs of AC Sparta Praha's super league team - floorball is feasible. The program has positively and unconditionally fallen into the training process of floorball players. There were no major problems during the program. I have shown willingness and interest to implement the intervention in full. From players, I have a great approach and a responsible approach to this program. The players responsibly filled in the questionnaires and recorded the values in the diaries. The program was tailored for male floorball players, and players just recorded and retrieved information.

5 CONCLUSIONS

The four verified hypotheses indicate a valuable methodological preparation of the research. The conclusions of the study can be crucial in the two directions: First - players of the super league floorball team are able to make great progress in fourteen days and improve the values of their circadian determinants in a short time. Second - obtained information about the circadian rhythms and player biorhythms can improve players' performance within fourteen days of the intervention. Therefore we can conclude that this practice if very effective and beneficial and therefore can be recommended for the training of floorball players in general.

Research has shown that floorball players in hard-to-do-now computers hardly give up staying at a computer or working on mobile devices, which is very negative for the proper functioning of Circadian rhythms. Players also go to sleep late and have different sleep schedules that harm circadian determinants.

Based on results analysis, floorball trainers can recommend that floorball players should follow several determinants to improve their circadian rhythms. Players should go to sleep within 22 hours, sleeping about 8 hours. In addition, they should also be asleep for as long as workdays and days off. Floorball players should go to sleep at the same time each day and at the same time should also get up. Breakfast should include foods rich in proteins to have enough tryptophan and then go to 15 minutes out in the sunshine to tryptophan to synthesize the hormone serotonin. In the evening, players should restrict the time spent under the influence

of "light light" that adversely affects melatonin production.

A strategic perspective for further research in the area seems to be the need to add motor testing of players before the intervention by selected tests aimed at coordination, reaction speed and player's memory. It would also be good to study sleep and a breakfast regime for players for two weeks prior to the intervention intervention so that the results are as obvious as possible. Definitely it is possible to recommend the presented study to inspirations for practice of coaches as well for wellness specialist in the field of sports.

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7 CONTACTS

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