THE EFFECT OF YEARLY BIORHYTHMS ON MOTOR PERFORMANCE IN ELITE BIATHLETES

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- Biathlon.

Abstract:

The knowledge related to sports chronobiology underlies the effectiveness of sports training in both elite and competitive sport. The rhythm of the change in the functional state of man is one of the most important biological rhythms that affect the level of motor abilities and skills. Biathlon is a demanding sport, where sports success determined by high level of endurance capacity together with efficient skiing technique with maximum shooting efficiency. The paper presents the findings of ex post facto research aimed to determine the effect of lunar rhythms on motor performance in elite biathletes throughout the 2008/2009 and 2009/2010 seasons.

INTRODUCTION

Kašper (1985), Loužecký et al. (1985), Nitzsche (1988, 1998) and Paugschová (2000, 2008) characterize biathlon as an endurance sport with specific emphasis on shooting. The shooting using a small-caliber rifle significantly affects the official final standings at the end of a biathlon race. Motor performance is also influenced by external environment as exogenous factors markedly affect biathlon performance.

According to Suchomel (2006) external environment is a summation of exogenous factors that have formed mankind throughout phylogeny. The crucial part of the phenotypical variability of traits of motor abilities parameters is determined by the effect of factors termed external environment. The exogenous effects of external environment are according to Měkota (2005) considered to be the so-called modifiers.

Biological rhythms have been investigated by an array of authors such as Jančoková (2000, 2011), Mojžiš (2011), Halberg (1986, 2004), Roenneberg et al. (2003), Švorc et al. (2008), Pivovarníček (2009). They may be characterized according to internal and external factors. Generally, it is distinguished between endogenous and exogenous factors.

Exogenous factors (rhythmical inputs from the organism's external environment) are to certain extent able to change the intensity, duration and frequency of activity and can act as the timing device for the onset and termination of activity (Švorc et al., 2008). The analysis of Jančoková (2000, 1998) showed that the effect of exogenous factors is to a great extent present in speed-strength sports.

The purpose of sports chronobiology is to investigate the optimal time periods and cycles for the development of motor abilities and corresponding physiological and mental functions. They affect not only the level of both conditioning and coordination abilities and sports performance, but also actual state of performance, which is dependent on the exogenous factors as well (Jančoková, 2000).

The classification of biological rhythms has been investigated by Berger (1995), Malachov (2006), Sedliak (2001), Jančoková (2000) and others. We refer to the classification

by Halberg (1969) who distinguishes between rhythms of high frequency with the period lasting up to 30 minutes, rhythms of medium frequency with the time period ranging from 30 minutes to 6 days and rhythms of low frequency 7 – 14 – 30-day rhythms and seasonal rhythms – yearly, multiyear rhythms. With regard to the low-frequency rhythms, we aimed to investigate the lunar and seasonal rhythms.

The alternation of lunar phases is induced by the sunlight exposure of the moon by the sun. During the phase of the new moon the dark side of the moon is faces Earth and the moon is not visible from Earth. In the first quarter only one half of the visible disk of the moon is visible (similar to the letter D). The moon is waxing towards full. In the full moon the disk is fully illuminated. The side of the moon toward the sun illuminates all night. After that the moon is waning. During the the third quarter the moon "reverses" towards the last quarter similar in shape to the letter C visible in the morning sky. This phase continues to the new moon, which is the beginning of the new cycle of moon phases (Jančoková et al., 2011).

Synodic month is the period of the complete cycle of the phases of the moon. Its length is 29.53 days relative to the sun (as a reference point) and the whole cycle between two new moons is referred to as lunation. One week equals approximately one quarter of the synodic period of the moon's rotation period. The length of the lunar day is 24 hours and 50 minutes. In the phase of the new moon and the full moon the gravitational forces of both celestial bodies coact and high tides, or low tides are highest and lowest in the quarter phases (Ahlers, 1984; Jančoková, 2000; Foster & Roenneberg, 2008; Jančoková et al., 2011).

Lunar rhythms are also a factor that affects living organisms and plants (Becker, 1975 In Jančoková et. al., 2011). The atmospheric ionization and the Earth's magnetism change due to the phases of the moon. The exactly set rhythms that correspond with the synodic month achieve its minimum and maximum during the full moon. The research showed that moon depending of the phase it is in, can affect the magnitude of the beam of solar radiation (Čiževskij, 1976 In Jančoková et. al., 2011).

The changes in the physiological functions of living organisms are investigated depending on the period of the year. The changes during the season of the year coincide with the yearly cycle (Štulajter, 2004). Švorc et al. (2008) and Jančoková (2000) have agreed that the changes to a large extent bear the character of exogenous rhythms and are the result of adaptation to the environment.

The months of February and August are characterized by most maximums and minimums that are crucial in connection with the yearly biological rhythms. We may speak about the "biological year," which is divided into two phases. The first is referred to as the biological spring and summer, which lasts from 16/2 to 15/8 and the second one is referred to as the biological autumn and winter lasting from 16/8 to 15/2. The phase of the biological spring is characterized by the greatest increases in body height, faster development, muscle and strength gains. In the second phase the growth decelerates similarly to the development and the level of fitness and adaptability decrease especially during the winter. The main causes lie in the insuffficiency of light, electromagnetism and ultraviolet radiation. The tension in the autonomic functions and overall activity is changed by the light (Štulajter, 2004; Jančoková, 2000; Zelenka, 1976).

Training effect during biological autumn and winter is decreased. Kopanev (1985) considers yearly rhythms of performance as highly stable. According to Jančoková (2000) the speed-strength athletes show absolute maximum in June and others occasionally in September. The endurance athletes demonstrate absolute maximum until late September or October.

From the aspect of the training process, the crucial role in the competition period is to develop the components of sports performance that underlie performance capacity. However,

fundamental changes in this period are out of question due to the rhythmic nature of the exercise stimuli (Kokinda, 2010).

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PURPOSE OF THE THESIS

The purpose of the study was to determine the effect of low-frequency biorhythms on the changes in running performance in selected elite biathletes throughout the yearly training cycles 2008/2009 and 2009/2010 in the World Cup sprint races.

MATERIAL AND METHOD

The research sample consisted of subjects H.P. and Š.D. (see Table 1), who were the members of the biathlon national team during the yearly training cycles (YTC) 2008/2009 and 2009/2010.

Table 1. Basic data about research participants

	H.P.	**Š.D.**
Club	Biathlon club Military Sports Center Dukla Banská Bystrica	Biathlon club Military Sports Center Dukla Banská Bystrica
Winter Olympics	*Torino 2006*: 4x7.5km- 14th place Pursuit race – 24th place 20 km – 29th place 10 km – 29th place	*Torino 2006*: 4x7.5km – 14th place 20 km – 56th place
Year of birth	1978	1983
Body mass	68 kg	70 kg
Body height	172 cm	174 cm

Legend: km - kilometer; kg - kilogram; cm - centimeter

The conducted research may be classified as ex post facto research. In the monitored seasons, the biathletes participated in the World Cup races and Winter Olympic Games. To acquire data for the analysis, we have summarized the results of both biathletes from the sprint races during the yearly training cycles 2008/2009 and 2009/2010.

Table 2. Phases of the moon and the list of races in the yearly training cycle 2008/2009

2008/2009		**Phases of the moon**
1.SP Östersund SWE	6/12/2008	First quarter (2nd phase)
2.SP Hochfilzen AUT	12/12/2008	Full moon (3rd phase)
3.SP Hochfilzen AUT	20/12/2008	Last quarter (4th phase)
4.SP Oberhof GER	10/1/2009	First quarter (2nd phase)
5.SP Ruhpolding GER	17/1/2009	Full moon (3rd phase)
6.SP Pokljuka SLO	23/1/2009	Last quarter (4th phase)
MS Pyeong Chang KOR	14/2/2009	Full moon (3rd phase)
7.SP Vancouver CAN	13/3/2009	Last quarter (4th phase)
8.SP Trondheim NOR	19/3/2009	Last quarter (4th phase)
9.SP Khanty-Mansyisk RUS	26/3/2009	New moon (1st phase)

The World Cup series during each of the seasons consisted of 9 races. These races were analyzed together with the peak races of the season (see Tables 2 and 3), which were the World Championships in the YTC 2008/2009 and Winter Olympic Games during the YTC 2009/2010. The terms of the World Cup were almost identical in both seasons.

Table 3. Phases of the moon and the list of sprint races in YTC 2009/2010

2009/2010		**Phases of the moon**
1.SP Östersund SWE	5/12/2009	Full moon (3rd phase)
2.SP Hochfilzen AUT	11/12/2009	Last quarter (4th phase)
3.SP Pokljuka SLO	20/12/2009	New moon (1st phase)
4.SP Oberhof GER	9/1/2010	Last quarter (4th phase)
5.SP Ruhpolding GER	14/1/2010	Last quarter (4th phase)
6.SP Anterselva ITA	23/1/2010	First quarter (2nd phase)
ZOH Vancouver CAN	14/2/2010	New moon (1st phase)
7.SP Kontiolahti FIN	13/3/2010	Last quarter (4th phase)
8.SP Oslo NOR	18/3/2010	New moon (1st phase)
9.SP Khanty-Mansyisk RUS	26/3/2010	First quarter (2nd phase)

The running performance was assessed using a 100-point scoring system according to the rules of the Slovak Biathlon Association. The achieved results were converted to points. The basis of the point score was the percentage of the achieved performance of the biathlete, his time difference from the overall winner's time. This value was subtracted by the percentage of the time difference of the next biathlete. The point scores were rounded to two decimal places.

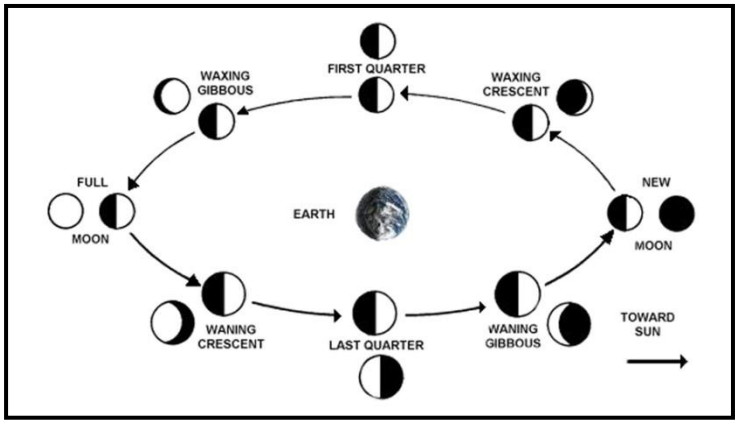

Figure 1. Phases of the moon (retrieved from www.paganinstitute.org)

The lunar rhythm was divided into 4 phases according to Jančoková (2000): new moon (first phase) – first quarter (second phase) – full moon (third phase) – last quarter (fourth phase) (see Figure 1). To assess the biathletes individually, the case study method was used.

ANALYSIS OF THE RESEARCH RESULTS

The analysis of running performance of the biathlete H.P. in the YTC 2008/2009 (Fig. 2) showed the highest point score equaling 96.54 points in the fourth phase of the moon. The lowest number of points 91.22 was recorded identically during the fourth phase of the moon. At the peak of the season, which means the World Biathlon Championship, we registered one of the lower point scores of 92.16 points in the third phase of the moon.

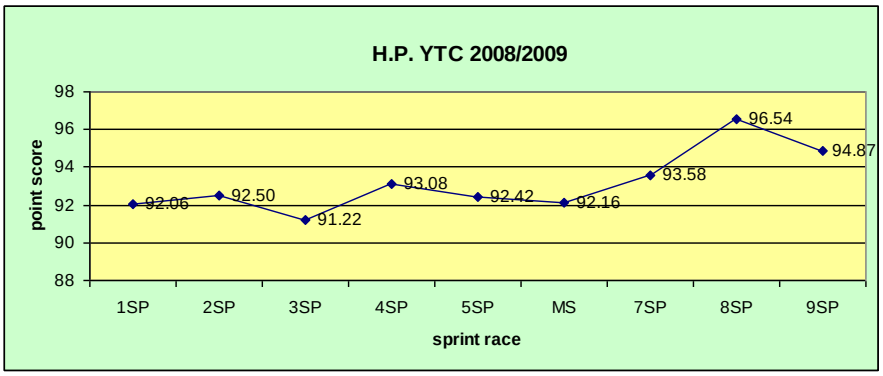

Figure 2. Point score of H.P. achieved in the sprint races in the 2008/2009 season

The point scores of the biathlete H.P. showed that the third phase of the moon was most appropriate for his running performance. The highest point score of running performance was recorded at the end of the YTC 2008/2009, which according to the biological year made part of the biological spring and summer, where according to Jančoková et al. (2011) the training effect in speed-strength athletes reaches its peak.

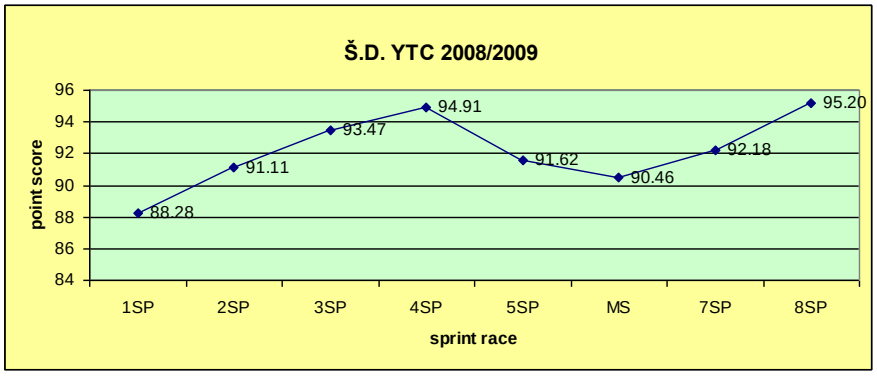

Figure 3. Point score of Š.D. achieved in sprint races in the 2008/2009 season

The analysis of running performance in the biathlete Š.D. during the YTC 2008/2009 (Fig. 3) showed that the highest level of running performance equaling 95.2 points was found in the fourth phase of the moon. However, the lowest level of running performance equaled 90.46 points, which was one of the lower scores in the third phase of the moon. The most favorable phase in terms of running performance in the biathlete Š.D. was the fourth phase.

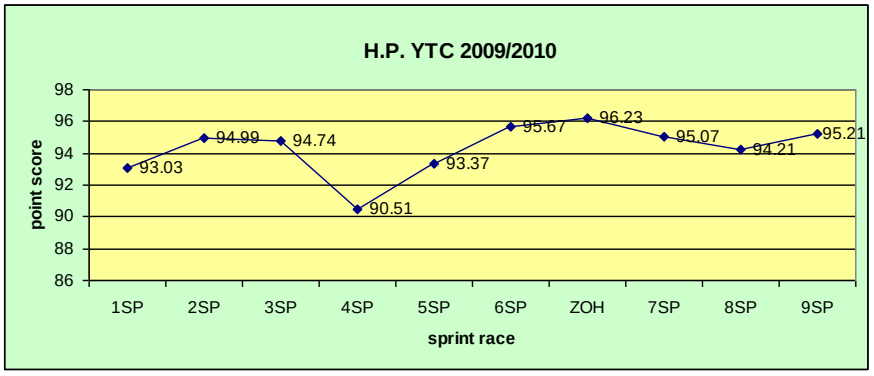

Figure 4. Point score of H.P. achieved in sprint races in the YTC 2009/2010

With regard to the rhythmicity in the YTC 2008/2009 in the biathlete H.P. the running performance increased, which is the goal of long-term planning of sports performance. Regarding the yearly biological rhythms, at the start of the season biathletes found themselves in the first phase of the biological year, which was the biological autumn and winter, which are according to Jančoková (2000) characterized by decreased training effect.

The rhythmicity of running performance in the biathlete Š.D. was of sinusoid character. The lowest score recorded at the start of the season was also observed during the first phase of the biological year.

The analysis of running performance during the Olympic YTC 2009/2010 in the biathlete H.P. showed that performance level equaling 96.23 points peaked in the first phase of the moon. The lowest point score was recorded in the fourth phase of the moon. The most favorable phase of the moon for the biathlete H.P. was the first and the second phase of the moon.

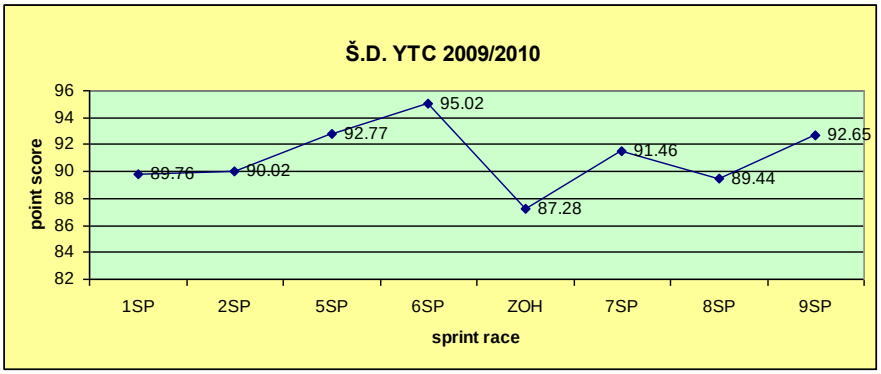

Figure 5. Point score of Š.D. achieved in sprint races in the YTC 2009/2010

In the biathlete Š. D. during the YTC 2009/2010 (Fig. 5) the analysis of running performance paradoxically revealed the lowest point score equaling 87.28 points at the peak of the season during the first phase of the moon. On the contrary, the highest point score equaling 95.02 points was recorded in the second phase of the moon. We may conclude that in biathlete Š.D. the most favorable phase of the moon was the second and fourth phase.

From the viewpoint of yearly rhythmicity, the runnning performance in biathlete H.P. was adequate as the biathlete's performance level peaked during the Olympic YTC 2009/2010, which he confirmed by his bronze medal winning performance at the Winter Olympic Games in Vancouver 2010. In biathlete Š.D. the Olympic YTC 2009/2010 was charaterized by the lowest point score from the aspect of the rhythmicity of running performance.

SUMMARY AND CONCLUSIONS

The objective of the research was to determine the effect of the low-frequency biorthythms on running performance in elite Slovak biathletes during the YTC 2008/2009 and 2009/2010 in the World Cup sprint races.

The method used to interpret results was the method of case study as we did not note any significant difference in the performance level in the examined YTC.

The comparison of the YTC 2008/2009 and YTC 2009/2010 in the biathlete H.P. showed that the least adequate phase of the moon was the fourth phase. On the contrary, the most appropriate phase of the moon characterized by the biathlete's highest point scores was the first and the third phase. Overall, we may conclude that in the biathlete Š.D. the most favorable phase of the moon was the fourth phase and the least favorable was the first and the second phase of the moon.

When applying the findings into practice, we may assume that at the XXII. Winter Olympic Games in Sochi the biathlete H.P. will achieve higher point scores in the mixed relay races (19/2/2014) and in mass start races (16/2/2014), which will take place during the third phase of the moon. In the biathlete Š.D., this holds true for relay races taking place on 22/2/2014 and in the fourth phase of the moon.

We assume that external environment affected by several external factors connected with lunar rhytms individually influences the organism's sensitivity of man, who uses his endogenous functions to maintain the homeostatic state. The use of the natural biological rhythms of human organism and its interaction with outer environment is one of the options for increasing training efficiency. When applying the research findings into practice, we have to take into consideration the individual character of biorhythms.

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