



Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Based on the biological rhythm gymnastics athletes sport ability analysis of the model

Guanghong Liu

Institute of Physical Education, Shenyang Sport University, Shenyang, China

ABSTRACT

With the development of human society and the deepening of scientific research and development, time biology has been widely introduced into the field of sports science, the scientific research worker, coaches and athletes pay more and more attention to the study of athletic time, focus on sports and the relationship between human biological rhythm. This paper is to study from the viewpoint of human biological rhythm gymnastics athlete's sports ability, in this paper, first of all, according to the characters of the rhythm of the organism is established based on the macro and micro mechanism of the biological rhythm of model biological rhythms mechanism model, and analyzes the significance of each parameter in mathematical model based on the cardiopulmonary function of gymnasts, qi and blood of circadian rhythm characteristics were analyzed, and to provide more scientific reference for gymnastics strategy, finally analyzes the embody the ability of gymnastics athletes body function indicators, and reflect the gymnasts were analyzed from the side muscle strength, speed, endurance and ability of stress hormone levels of biological rhythm characteristics. Through the established mathematical model and the experimental data with the analysis method and the analysis results, for the gymnastics training and competition to provide a more scientific strategy, and provide theoretical basis for the study of the biological rhythm characteristics.

Key words: Biological rhythms, frequency, differential equations, peak time, median level

INTRODUCTION

The functions of biological activity, growth, and vice so that some subtle morphological structure, with the passage of time may present some regular change again and again, this is the biological rhythm, therefore, human biological rhythm and there exists a certain internal relations in sports training, if can reasonable use of human biological rhythm law quality and improve the performance of sports training has a good effect, by grasping the athletes physiological and biochemical indicators of change and the approximate circadian rhythm characteristics, using biological rhythms to arrange and adjust the training plan, training implementation timing [1]. This article is that the gymnasts biological rhythm features of sports ability, for example, the study of the characteristics of the human biological rhythms are present and biorhythm mathematical model.

For biological rhythm model and the study of gymnastics athletes sport ability the efforts of many scholars have the combination of the two contents of the research process and the degree of influence the development of gymnastics movement level, if can use biological rhythms in the process of gymnastics training more scientific, better able to promote the development of the sport, some domestic scholars some views and conclusions are given, including: Wang Yiwen proposed the gymnasts biological rhythm model to implement scientific sports training process monitoring, reasonable arrangement of sports load and the prevention of sports injury, improve training efficiency, to overcome the jet lag and so on, by adjusting the individual state of competitive state in order to achieve the "best" [2]; JiSi chao deng reveals the rhythm theory influence on athletics gymnastics movement performance, the results show that under the physical, emotional and intellectual rhythm theory system is not suitable for athletics gymnastics movement [3]; Dong Renwei discusses the ultra in rhythm in college students' cardiopulmonary

endurance level and the correlation between physical biorhythm, obtained suggest physical biological rhythms can affect college students' cardiopulmonary endurance level [4,5].

In this paper, on the basis of predecessors' research in gymnastics athlete's sports ability as the research object, established the macroscopic and microcosmic mechanism of the biological rhythm of model, and collected the gymnasts cardiopulmonary function index, qi and blood index function, the function of the body, hormone levels, the data of indicators, in order to explore the influence of biorhythm on gymnastics athletes sport ability, arrange for gymnastics training and competition of science to provide feasible Suggestions.

MATHEMATICAL MODEL BIOLOGICAL RHYTHM

Human body as a senior life in nature, there are many cycles in the system and the class of circadian rhythms phenomenon exists, the phenomenon of circadian rhythms in response to external stimuli will be adjusted by its own internal feedback mechanism, its a form to roughly frequency change amplitude unchanged, a constant frequency and frequency and amplitude are changing. In this paper to study the biological rhythm, in order to form through the change of the biological rhythm, reflecting the gymnastics athlete's sports ability, therefore this chapter first analyzes the mathematical model of biological rhythm.

Biological rhythm model can through the data and the mechanism of two angles, which based on the data model is based on the study of the biological rhythm of statistics, ignore life complex mechanism, extraction and biological rhythm the external manifestations of law, and based on the mechanism of the model is based on ignore rhythm mechanism of secondary factors, and then carries on the reasonable assumption of the model, the extraction mechanism of main factors in the system, finally using the mechanism of main factors in modeling, this paper mainly analysis the mechanism of the biological rhythm model.

Type macro mechanism of biological rhythm model:

From a biological point of view, when the process of human movement cause the increase of the oxygen consumption rate, the body will be through a variety of enzymes and the nervous system, feedback mechanism to adjust the amplitude and frequency of heart beat rhythm, to improve the rate of pumping blood, heart rhythm, for example in this section to establish macro type model, the mechanism of heart beats as an inherent rhythms phenomena of the body, its role is to pump blood through each rhythm cycle of heart contractions, to meet the needs of the human body's oxygen.

In order to establish the reasonable macro mechanism of cardiac rhythm model, then the model should meet the four features:

- 1) When the oxygen consumption rate of smaller cases, conveying the beating of the heart blood moment can meet the demand of human body oxygen;
- 2) When the oxygen consumption rate is bigger, the heart beat of the rhythm of adjustment to keep up with demand and will appear the phenomenon of hypoxia temporarily after radical movement;
- 3) when the oxygen consumption rate of return to normal level after a sharp rise in cases, the heart rhythm with lag effect, which is after the radical movement, the beating of the heart rate will still be faster, only in the last a period of time after the heart rate will return to normal levels, and for a period of time to a phase of the oxygen quantity have a compensation;
- 4) When the amplitude of the beating of the heart rate than the frequency change hours, the distribution of the amplitude variation can use parameters setting.

In order to model the reliability and operability, the model is shown in the following 3 points

- 1) The oxygen consumption in order to satisfy the human body, the heart to beat it amplitude feedback adjustment, the judgment standard for the oxygen consumption of the instantaneous value;
- 2) The rhythm of the heart beating only under the influence of oxygen consumption rate;
- 3) Heart no hysteretic of perception of oxygen consumption rate.

In the above hypothesis, we have the basic description equations of the beating heart, as defined in formula (1) below.

$$y = A(t)\sin[2\pi \cdot f(t)] \quad (1)$$

In Formula (1) $f(t)$ represents the actual frequency of the heart rhythm, $A(t)$ indicates the actual amplitude of the heart rhythm, y represents the displacement of the heart beat.

If the oxygen consumption rate is positively proportional to the rate of blood volume delivery, and the blood volume delivery is positively proportional to the product of double frequency and amplitude, meanwhile introduce the time constant k , and then it satisfies the relationship in formula (2) below.

$$2kf_g(t)A_g(t) = I(t) \quad (2)$$

In formula (2) $f_g(t)$ represents the target frequency of heart rhythm, $A_g(t)$ represents the target amplitude of heart rhythm, and $I(t)$ means the oxygen consumption rate. Human heart rhythm frequency and amplitude cannot increase unrestrictedly in movement, and we know the lower limit of oxygen consumption rate is zero; in order to reflect the limit of physiological factors, the text set up V_{\max} to represent the maximum rate of oxygen consumption.

The human body's oxygen consumption will increase during exercise, and the heart rate will significantly increase two; heart rate amplitude is fairly stable compared to heart frequency, but there will still be a slight variation; in order to denote the variation quantity we introduce an allocation factor β ; If the factor is 0, then heart rate amplitude will remain constant, and the frequency change will be responsible for all the increase amount of oxygen, therefore we can obtain the formula (3).

$$\frac{dA_g(t)}{A_g(t)} = \frac{df_g(t)}{f_g(t)} \quad (3)$$

The frequency and amplitude change may be as described in the formula (4) and (5).

$$y = \frac{2V_{\max}}{\pi} \arctan\left(\frac{\pi}{2V_{\max}} x\right) \quad (4)$$

$$\frac{dA(t)}{dt} = \frac{2V_{\max}}{\pi} \arctan\left(\frac{\pi}{2V_{\max}} (A_g(t) - A(t))\right) \quad (5)$$

In the formula (4) when the relation satisfies $y' = 0$, then $\Delta x = \Delta y$; when $x \rightarrow \infty$, then $y = \pm V_{\max}$; y is the odd function. The macro-type mechanism model to describe the beating heart rhythms can be seen as the equations as in formula (6) below.

$$\left\{ \begin{array}{l} y = A(t) \sin[2\pi \cdot f(t)] \\ \frac{df(t)}{dt} = \frac{2V_{\max}}{\pi} \arctan\left\{ \frac{\pi}{2V_{\max}} \left[\left(\frac{I(t)}{2kc} \right)^{\frac{1}{\beta+1}} - f(t) \right] \right\} \\ \frac{dA(t)}{dt} = \frac{2V_{\max}}{\pi} \arctan\left\{ \frac{\pi}{2V_{\max}} \left[\left(\frac{I(t)}{2kc} \right)^{\frac{\beta}{\beta+1}} - A(t) \right] \right\} \end{array} \right. \quad (6)$$

Type micro biological rhythms mechanism model:

All of the organism's physiological and metabolic activity and behavior process generally show a 24 hours for the cycle of circadian rhythm, in order to research on biological rhythm gymnastics athletes, in order to explore its movement ability, this section is set in the biology changes in body temperature rhythm type micro rhythm mechanism model is established, in order to extract the main factors that influence situation, this paper reflects the

circadian rhythms of the spring oscillator model is established.

The body temperature rhythm characteristics exist in the following five features:

- 1) Temperature observation there is a stable equilibrium;
- 2) Input does not exist when the outside world, under the condition of temperature observation will maintain its own shock;
- 3) When the outside world under the condition of constant input, temperature observation will keep unchanged cycle, can change over time but the amplitude attenuation;
- 4) When the temperature observes induced by input, changes will be synchronized;
- 5) When the input phase change, temperature observation quantity happens disorder, but then will gradually enter the synchronized with the outside world.

In order to extract the main regularities of the variation of the temperature rhythm, the model for the following two assumptions:

- 1) The object of study the inherent mechanism of an organism will not be changed in a short time;
- 2) Temperature observation of circadian rhythms by amplitude, frequency and phase.

Spring vibrator physical model is shown in Fig.1:

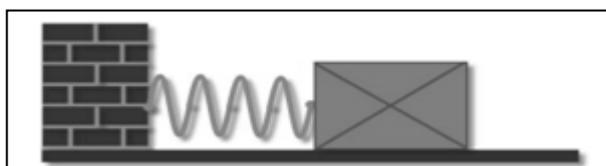


Fig.1 The physical model schematic of spring oscillator

As shown in Fig.1, the temperature of the observed quantity as spring, will input as the external force of the outside world, will be within the system to observe the amount of obstacles as resistance, can be concluded that the spring vibration subsystem, the dynamics equation of as shown in type (7).

$$m\ddot{x}(t) + kx(t) + b\dot{x}(t) = f(t) \quad (7)$$

In the formula (7) $x(t)$ represents the difference between the observation and stable point of organism's circadian rhythm phenomena; m represents inertia of observations; k indicates the recovery ability to a stable state; b means the hinder ability to the change of observation amount; $f(t)$ means external associated input. The left side of formula (7) is only related with the organism, and in the control system theory it can be seen as system internal mechanism; and the left side of the equation represents some external input means; for each given input, we can get an unique output by solving the second-order differential equation shown in equation (7); the structure of the input, the system and the output is shown in Fig.2.

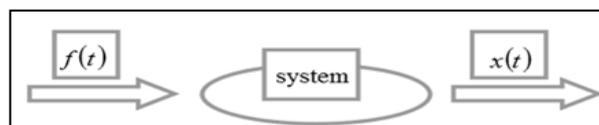


Fig.2: The input-output schematic of the system

Typically, the organism is in a certain state m, k, b can be considered as a constant; only when the state of the organism changes significantly, m, k, b will also change accordingly and then change to another constant. Typically the status change of organism will not be too obvious. When the external input will not change again, that is $f(t) = c$ and c is a constant, equation (7) turns into a second-order differential equations with constant coefficients, and its characteristic equation is in the formula (8) below.

$$a^2 + \frac{b}{m}a + \frac{k}{m} = 0 \quad (8)$$

To make the formula (7) have a periodic solution, the parameters must satisfy equation (9).

$$\frac{b^2}{m^2} < \frac{4k}{m} \quad (9)$$

The solution of two-order differential equations with constant coefficients in Formula (7) is shown in equation (10) below.

$$x(t) = c_1 e^{-\frac{b}{m}t} \cos \omega t + c_2 e^{-\frac{b}{m}t} \sin \omega t + \frac{c}{k} \quad (10)$$

In the formula (10) ω represents the angular frequency, and the value is in the formula (11); the value of the constant c_1, c_2 is determined by the initial state; when the external input has a periodic variation, we can suppose the input function as shown in formula (12); generally $\omega \approx \omega_0$, then the solution of the differential equation is shown in the formula (13) below.

$$\omega = \frac{1}{2} \sqrt{\frac{b^2}{m^2} - \frac{4k}{m}} \quad (11)$$

$$f(t) = c + A \cos(\omega_0 \cdot t) \quad (12)$$

$$x(t) = c_1 e^{-\frac{b}{m}t} \cos \omega t + c_2 e^{-\frac{b}{m}t} \sin \omega t + \frac{c}{k} + \frac{A}{\sqrt{(b - m\omega_0^2)^2 + k^2\omega_0^2}} \cos(\omega_0 t - \phi) \quad (13)$$

BASED ON THE ANALYSIS OF BIOLOGICAL RHYTHM GYMNASTICS ATHLETES SPORT ABILITY

The gymnast's biological rhythm analysis:

This section for gymnastics athlete's cardiovascular function, respiratory function and blood gas index of circadian rhythm characteristics is analyzed, including cardiovascular and respiratory function are collectively referred to as cardiopulmonary function indicators, the indicators are the important factors that affect athletes endurance quality, it is also commonly used in the sport medical supervision indicators. Gymnast is proved by experiments and the cardiopulmonary function such as athletes from other sports, the same time also have obvious rhythmic.

Table 1 and Table 2 commentaries on the cardiovascular and respiratory function in the process of gymnastics practice on the circadian rhythm characteristics.

Table 1: Gymnast cardiovascular circadian rhythm feature list

Cardiovascular indicators	Median level	Peak time	P values
1	0.790	18:23	<0.05
2	18.33	18:42	<0.05
3	11.03	18:20	<0.05
4	37.11	16:18	<0.05
5	6.080	17:05	<0.05
6	5.720	17:10	<0.05
7	14.72	18:24	<0.05

Note: 1-7 said heart ejection speed (m/s), the ejection acceleration (m/s²), ejection distance (cm), cardiac index (l/min/m²), cardiac output (l/min), heart, doing work (kg/m) and systolic blood pressure (kPa)

By the data in Table 1 of each index can be concluded that cardiovascular peak moment distribution is shown in Fig.3

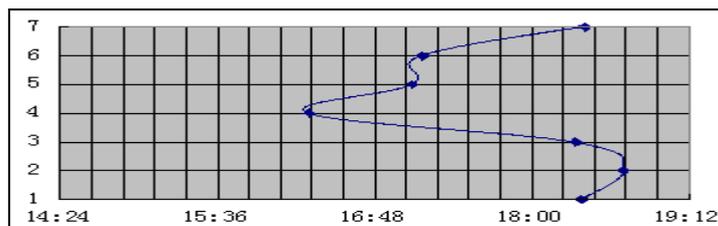


Fig.3: The distribution feature of the cardiovascular indicators at the peak time

The Fig.3 shows that cardiovascular index 1, 2, 3, 7 on the peak time between 18:00 - at 19:00, the whole seven indicators peak time between 16:00 - at 19:00, also said the gymnasts match between 16:00 - at 19:00, the cardiovascular indexes will appear in the best condition.

Table 2: Gymnast circadian rhythm feature list of respiratory function

Cardiovascular indicators	Peak time	Variation ranges
1	18:00	16:00-22:00
2	06:00	05:00-07:00
3	18:00	17:00-21:00
4	18:00	16:00-20:00

Note :1-4 represents vital capacity, lung resistance, oxygen uptake and respiratory rate

Data in Table 2 shown in gymnasts respiratory function distribution of the four indexes of peak time, therefore, in addition to lung resistance peak concentration in the surf, the remaining three indicators on 18:00, comprehensive data in Table 1 and Table 2 shows the athletes at 19:00 on 16:00 - best movement between the heart and lung function, it is human body fitness and sports scores higher than the morning in the afternoon time biological reasons, so generally experienced coaches will arrange in the afternoon and evening, physical training and some important game will be in the evening.

Gymnast blood gas index mainly reflects human transport and maintain the acid-base balance function, the two function is one of the important reasons, influence gymnast fitness also gymnast blood gas index in day and night time also has its own rhythm characteristics, the data in Table 3 is shown in the exhibit gymnast quiet condition characteristics of day and night.

Table 3: Gymnast blood gas index circadian rhythm feature list

Vital energy and blood indicators	Median value	Peak time	P values
1	130.8	15:30	0.005
2	44.55	05:17	0.236
3	4.300	03:06	0.054
4	7.020	11:54	0.732
5	24.40	16:10	<0.001
6	21.30	16:06	<0.001
7	7.290	17:12	<0.001

Note :1-7 indicates hemoglobin (g / H), oxygen saturation (%), the oxygen partial pressure (KPa), carbon dioxide partial pressure (KPa), bicarbonate radical ion (KPa), standard bicarbonate (KPa), and PH value

According to the data in Table 3 we can obtain the distribution feature of gymnast's blood and vital energy indicator at the peak moment in a quiet state as shown in Fig.4.

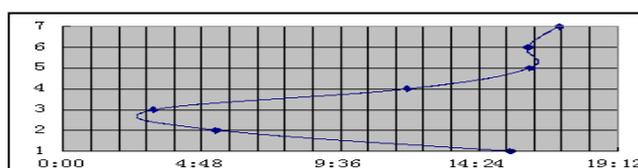


Fig.4: Qi peak moment distribution index

Fig.4 illustrates the gymnasts with other project athletes many of the blood gas indexes in quiet condition can show the obvious diurnal variation rule, thus the reasonable training plan should be of the qi and blood of athletes is taken into account.

The gymnast's rhythm analysis of physical changes:

Due to the physical body is the human body in the process of movement of synthetic biology function ability, so the gymnasts fitness, hormone levels and the change of body temperature is also present the features of approximate circadian rhythm. If divide the functional fitness according to the part of the body, it is can be divided into the ability to work as a whole and partial functional capabilities, in the premise of understanding the physical rhythm characteristics of the gymnasts, for selecting excellent athletes and athletes understand exactly physiology state has very important significance.

As shown in Table 4 gymnasts the body's ability to the partial and the whole work of circadian rhythm characteristics.

Table 4: Gymnast human body's enginery circadian rhythm feature list

Human performance indicators	Peak time	Variation range
1	19:28	18:00-20:00
2	17:00	16:00-18:00
3	17:00	16:00-18:00
4	17:30	17:00-18:00
5	17:00	16:00-18:00
6	15:00	12:00-17:00

Note : 1-6, denotes: overall physical fitness, runaway speed, 100 meters sprint speed, the speed of hand slap, pinch strength and push-ups

Shown in Table 4 the circadian rhythm characteristics of the gymnasts, the blood concentrations of testosterone and cortisol levels and the characteristics of biological rhythm also directly affects the and athletic performance is closely related to the rate of muscle strength, endurance and physical stress, such as ability, blood concentration characteristics of the above two hormones also revealed a circadian rhythm, rhythm characteristics of these two hormones can reflect the gymnasts from the side of muscle strength, speed, endurance and stress ability, as shown in Table 5.

Table 5: Gymnast testosterone and cortisol circadian rhythm of blood content feature list

Hormone indicators	Median level	Peak time	P values
Testosterone(mol/L)	23.140	07:00	<0.05
Cortisone(mol/L)	218.08	06:00	<0.05

For gymnasts biological rhythm model refers to the physiological and biochemical indexes of every athlete cyclical change model processing, then concluded the research content of rhythm time curve, the corresponding parameters, the best functional status, median level and the normal range, finally through the model results reasonably come to the training plan and scientific competition schedule.

CONCLUSION

Based on the mechanism of macroscopic type building method of biological rhythm model, the analysis of the meaning of the parameters in the mathematical model of biological rhythm; analyze play Huang Zhenzi model, a gymnast analogy temperature change characteristics of rhythm, the body temperature rhythm changes into a second order differential equation solving process, for the biological rhythm analysis provides a good analysis method; gymnast cardiopulmonary function obtained by the experimental data of circadian rhythm characteristics, gives the corresponding time arrangement for the training and match of the gymnasts strategy, analyzes the current most important sports games the rationality of the time; quiet condition is given in this paper at the same time the gymnasts circadian rhythm characteristics of qi and blood index, scientific arrangements for athletes training and competition to provide the reference on the other hand; in order to explore the function of human body ability characteristics of the gymnasts, the circadian rhythm characteristics of the human body function is given in the paper, analyzes the gymnast sports ability is affected by the rhythm, rhythm changes from hormones in the blood content profile analysis of muscle strength, speed, endurance athletes and stress ability of rhythm changes; needed at the end of the paper gives the human biological rhythm model parameter data and the model of establishing purpose, in order to through the model and the model of solution for gymnastics athletes training and schedule to provide a more scientific strategy.

REFERENCES

- [1] Wen Mei-li. *BOJI(WUSHUKEXUE)*. 2012. 9(3),118-120.
 [2] Wang Yi-wen. *Journal of Jinggangshan Medical College*. 2007, 14(15), 51-53.

- [3] Jose P. Martino. *Technological Forecasting & Social Change*. **2003**. (70), 719-733.
- [4] Andrewj Rohm, Georger Milne, Marka Mcdonald. *Sport Mar Heting Quart*. **2006**. (15), 29-39.
- [5] Han Hua. *Journal of Tianjin sports college*. **2005**. 20(2), 24-26.