Acta of Bioengineering and Biomechanics
Vol. 14, No. 3, 2012

Original paper
DOI: 10.5277/abb120303

Influence of time of rest on the power decrease during exercising on the inclined plane

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The aim of this paper is to investigate the influence of the time of rest on the change of maximal and average power as a function of time during training on an inclined plane. The values of power, developed during 7 series of 10 bounces with a 0.5 and 1 minute break, were analyzed. The research was conducted on 10 female students from the second year of master studies with a major of physical education. Taking into account the results obtained, which were compared to data from other sources, it is possible to conclude that the value of maximal power for the whole group examined during the training with a 0.5 minute break decreased by 22%, and for the training with a 1 minute break by 12%. One can assume that the training with a 0.5 minute break was more tiring, and for that reason students were not able to regenerate fully so as to bounce in the subsequent series. That is why one should say that the second method of training is more efficient for the evaluation of the maximal power of the contestant.

Key words: *inclined plane, maximal power, average power, training, break*

1. Introduction

Endurance training combines a number of variables, indicated by the American College of Sports Medicine, such as: intensity (burden), number of series and repetitions, length and type of muscles, type of exercise and speed of repetitions [1], [2]. The application of these variables during different types of training can change the adaptability of organism, muscular strength, endurance, power and heart work. For instance, while the high intensity training leads to an increase in muscular mass, the low intensity training is connected with a better muscular endurance [3].

Research that has been carried out in biomechanics labs lead to the creation of many universal methods, i.e., cinematographic, dynamometric, goniometric, etc. Authors that carry out such research, use these methods for they are of the utmost importance. Biomechanics evaluation of physical capability of an athlete is usually conducted on the basis of values (absolute or relative) of muscular strength and power [4].

Manifestation of the contestant's power during training can be evaluated by different sorts of tests, such as: International Test of Physical Fitness, Eurofit, Cooper's Test, etc., [5], [6]. The above-mentioned research methods are a rather easy way to evaluate individual motor features. For more precise measurements of power all testing apparatuses are used, since they are more accurate and credible. Within biomechanics power is measured in laboratory conditions. What is more, different training simulators are also adapted for research purposes, which show basic moving parameters immediately. While KOSMOL et al. [7] and RICARD et al. [8] applied a 30-second test on cycloergometer to this evaluation, CHEETMAN et al. [9] used a running track for this purpose. There are also a pendulum training stimulator and an inclined plane with a trolley, in which values of individual variables are registered by a computer [10], [11]. Training

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Received: June 8th, 2011
Accepted for publication: May 21st, 2012

stimulators are so constructed that they eliminate or reduce influence of technique and moving tactics. Each subject makes movement of the same structure.

The training stimulator and the inclined plane are used for the measurement of different parameters and physical features [12]. The option that allows us to register the maximal power and endurance of the whole organism or individual muscular groups enables evaluation of the basic state of parameters and development of physical features of contestants of different sport disciplines [13]. According to FIDELUS et al. [14], the ability to develop maximal power, which is a product of strength and speed, is connected with an ability to control a great number of variances. It is assumed that the strength developed by human depends on:

- the number of muscles involved,
- the level of a subject's physical features – inborn and trained,
- duration time of physical effort,
- type of physical effort – stable, proportional to the extension, dependent on acceleration,
- stimulation.

Brakes between series during the training seem to be important variables, which have direct influence on tiredness, changing endocrinological and metabolical reactions and executions of subsequent series of the training [15], [16]. The latest research shows that different interval trainings cause different adaptations in hormonal and neuromuscular systems [17], [18].

When NORKOWSKI [19] was analyzing anaerobic functions of representatives of selected sports games, he stated the essential connection between values of maximal and average power developed during exercising on the Wingate testand a trained sport discipline. Contestants who train sport games or sport fights are characterized by the change of intensity and duration time of physical effort during practising sport actions. In this case, muscles of contestants need not only anaerobic energetic sources but also aerobic ones. This is proved not only by the aforementioned data of FOX et al. [20], but by the results of studies on the structure of physical "match" effort in different team games. In the case of handball, ca. 30–35% of the game time is in the sphere of anaerobic physical effort [21], and in football up to 12% of so-called "normal game" is covered by maximal anaerobic physical effort [22]. Research on interval trainings shows that anaerobic function is very important in the whole energetic potential.

Many authors used in their research a training stimulator "inclined plane". STANISZEWSKI et al. [23] conducted research on students of the third year from the University of Physical Education in Warsaw. Students were divided into groups A and B of thirteen subjects each. Subjects participated in the training on the inclined plane, which took place every day from Monday to Friday and lasted 4 hours. Students from group A in a one training unit had to make 40 bounces in 4 series of 10 repetitions with 90-second brakes between these series. Students from group B had to participate in the stable physical effort realised in 40 bounces. The results of this experiment proved the data from other sources that in the interval training the values of power are higher than in the stable physical effort. Moreover, the well-adjusted time of brakes enables subsequent series to be made with similar intensity [24]. It was also revealed that among subjects from group B there was a considerable danger of overburden of muscular system, which appeared due to the much greater changes in creatine kinase activity in comparison to group A [25], [26].

When SENNA et al. [27] were analyzing the influence of 2 and 5 minute breaks during a resistance training on a number of repetitions in a series and during the whole training, they found that 2 minute breaks in an interval training give lower results than with a 5 minute breaks. The results show that the training with a lower time for rest gives lower effect, and a lower progress between series.

Studies conducted to date concerning the interval training with different breaks do not allow a final conclusion to be drawn. Taking this into account, the test was undertaken so as to determine changes of biomechanical data during 2 different trainings on the inclined plane, with brakes of 0.5 and 1 minute.

The aim of this paper is to determine the influence of breaks on the changes of maximal and average power as a function of time during training on the inclined plane.

2. Materials and methods

Investigations were conducted on 10 female students from the second year of master studies of physical education major (average age 24 ± 1.0 years, mass 64 ± 7.2 kg, height 170 ± 7.3 cm). Students had good health, and they did not practise sport professionally. It was assumed that their physical fitness was on a similar level. A body mass index was equal to 0.0022.

The measurement was conducted in dynamics conditions on the inclined plane in the biomechanics laboratory of the University of Physical Education in Warsaw (figure 1).

Fig. 1. Stand for power measurement

Each subject was tested twice. During the first training, after a standard warm-up, female students executed 7 series of 10 bounces on the inclined plane. Each series was the following: a student exercised 10 bounces, then she rested for 30 seconds, after break she executed the subsequent 10 bounces and rested for 30 seconds, and so on.

After a 3-week brake, students had to take the second training. It also included 7 series of 10 bounces. However, in this research brakes were longer. After the first 10 bounces, the break was taken for 1 minute, after that there were the subsequent 10 bounces, then 1 minute break and so on.

The measuring device, so-called "inclined plane", consisted of rails inclined at $\alpha = 15°$ to the level and of a trolley moving on the rails, with a mass of 44 kg. On the bottom of the downward slope there was a dynamometric platform that registered reaction forces during the contact with the ground. On the trolley there was also an encoder, which was connected to a computer IBM PC by means of a PIO 8255 card. This system used the software package "TRP", which enabled movement variables and the work executed to be measured and calculated. Biomechanics quantities that were measured by the system were: displacement of the trolley, ground reaction forces, time of bounce and series and the number of bounces. On this basis, speed, work, power and strength impulse were calculated.

Differences between the results obtained in groups were analyzed by means of Test T and descriptive statistics in the program STATISTICA v. 7.1. The level of significance was set at 0.05.

3. Results

During training with 0.5 minute breaks till the 3rd series there are no significant differences in maximum values obtained by students, only the power decreases slightly (figure 2).

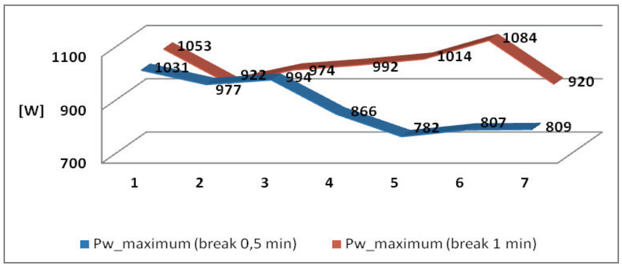

Fig. 2. The course of maximum values of PW (power) in all students during training: 7 series of 10 bounces with breaks of 0.5 and 1 minute

However, between the 3rd and 5th series the power decreases by 213 W (which constitutes 23%) due to the fatigue of the body. After the 5th series there is a slight increase in PW_max.

During training with 1 minute breaks, in the second series the power decreases by 131 W which equals 12%. After that there are no clear changes in the values obtained, even maximal power increases till the 6th series by 162 W (17%). However, in the 7th series there is a drastic fall of power by 164 W which constitutes 15%.

Comparing the power obtained by students at the beginning and at the end of training, one can see that the values of power obtained at the end of the training are lower by 223 W, which stands for 22%, however, during the 2nd training by 133 W (12%).

Values of average power obtained by all students are arranged similarly (figure 3).

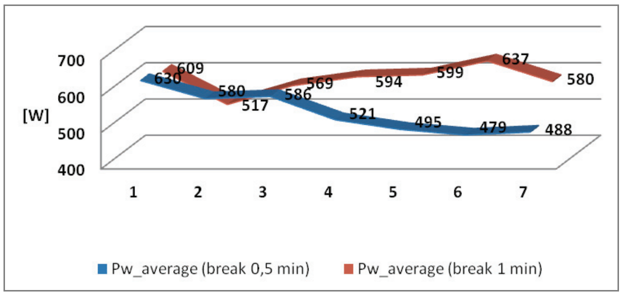

Fig. 3. The course of average values of PW (power) in all students during training: 7 series of 10 bounces with breaks of 0.5 and 1 minute

During the training with 0.5 minute breaks the values drop from the beginning until the 6th series by 151 W which constitutes 26%.

However, during the training with 1 minute breaks, power in the second series decreases by 12%, and then increases continuously till the 6th series by 21%. In the 7th series, it decreases by 9%.

Values of average power are lower at the end of both trainings. In the training with 0.5 minute breaks it decreases by 22%, and in the case of training with 1 minute breaks by only 4%.

4. Discussion

The aim of this paper is to present the methodology of the research conducted, to evaluate the results obtained and show the influence of the time of brakes during training on the values of maximal and average power. Moreover, the purpose of this research is to show during which type of training, with a 0.5 or a 1 minute break, students achieve higher values of power. What is the course of power changes during the first and the second type of training? Which variant of the training is better?

The research was conducted in laboratory conditions at similar time of the day. Each test was carried out after a 3-week break so as the subject was regenerated fully after the first training. The results were analyzed by comparing average values obtained by all female students. The results of Pw_max and Pw_mean obtained during 2 trainings were also compared (with a 0.5 minute break and a 1 minute break between series). The results were analysed statistically. It appeared that higher values of maximal and average power were obtained by persons during training with 1 minute breaks. The power during the 1st training with 0.5 minute breaks practically decreases among all female students. It is clear that the organism is tired. However, during the second training with a longer break, one can see that values of power are almost on the same level, and they even increase to a certain level. Probably in this case a 1 minute break between series is sufficient for the full regeneration of the organism.

After the analysis, the influence of break time between series during trainings is clearly seen. It affects the course of reconstruction of energetic source used during the work of muscles. Break time is the more important, the more it influences compound genesis, which is responsible for the intensity of subsequent series. The time of 0.5 minute break during this type of training has negative influence on the results obtained. The power in each of the next series is lower. However, a 1 minute break is sufficient before the next series. The power does not change significantly, it even increases sometimes. It is advised in the majority of articles to use 3-minute breaks, which is also justified by biomechanics reactions of the organism to fatigue [28], [29].

In accordance with claims concerning training process its efficiency is determined by the intensity of physical effort, which in this case is measured by the value of maximal power and average power during series. Due to the fact that the decrease of power in 7 training series was much lower during training with a 1 minute break, it can be concluded that this variant is more efficient.

HILL-HASS et al. [30] conducted interval trainings with a 20 and a 80-second break. They proved that the longer break is more efficient. The power after training with a 20-second break increased by 19.6% only, while for an 80-second break by 45.9%.

Table 1 presents results of maximal power of students in comparison to other female students and 18-year-old girls.

The highest results were obtained by female students from the University of Physical Education (AWF) during the training with a 1 minute break between series. The average maximal power equals 985 W. Slightly higher results were achieved by 18-year-old girls investigated by URBANIK and NOWACKA [31]. In comparison with female students maximal power is lower only by 72 W. It is a little strange that female students from AWF during the training with a 0.5 minute break achieved lower results by ca. 39 W than those girls. One could say that female students

Table 1. Comparison of average values of max. absolute power [W] and relative one [W/kg] obtained during research on an inclined plane with results of other authors

Author	URBANIK 1995		URBANIK and NOWACKA 1997	Own research	
Research material	18-year old girls	female students	18-year old girls	female students (0.5 minute break)	female students (1 minute break)
Pw_max [W]	778	806	913	874	985
Pmax/m [W/kg]	13.3	14.1	–	14	15

from AWF are fit so their power should be of higher level.

The lowest maximal power, of only 778 W, was obtained by 18-year-old girls investigated by URBANIK [32]. Female students in the year 1995 achieved the average maximal power on the level of 806 W, which is about 179 W less than that for female students from this research. One can say that the level of power is today higher than in the previous years.

When comparing the values of maximal and average power obtained during training on the inclined plane, one should not forget that this power depends on many factors. These include weight, age, sex, type of sports training [33]. However, this method and application of the training stimulator reduce the influence of other factors, such as technique or tactics. Subjects can make the same structure of movement.

The application of different types of training stimulators has a double meaning. The first one can be connected with the training process, and it belongs to trainers. However, an interesting option is to use training stimulators in order to evaluate the state of physical features, their changes during different types of trainer's influences, etc. The above-mentioned application was presented in this paper. It is not a final outcome. One should continue similar research, taking into account the influence of other factors on the reaction of an organism to prepared variants of training's physical effort, changing the subjects of research for persons with a different fitness level, etc.

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