OPTIMIZATION OF THE EFFORT PREPARATION PROCESS AMONG THE SHORT TRACK FEMALE COMPETITORS IN A YEAR CYCLE

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Abstract. The aim of conducted research was an attempt to define the dynamics of aerobic and anaerobic endurance changes in the short track female competitors training during a year cycle which is dependent on the energy characteristic of training burden. Nineteen female competitors of OMKŁS Opole club and KU AZS PO Opole, were put through the examination. Eight of them were members of National Team and Olympic Team (Vancouver 2010), moreover, the competitors participated in the World Cup, World Championship, European Championship. The other examined competitors were members of National Team. With the help of terrain and laboratory tests, an official record was made on every lap time, final time of every trial, HR max and HR medium as well as the concentration of lactate in blood in fourth minute after an effort. In the thirtieth minute, after an effort, HR and lactate concentration were registered in order to define the course of restitution. Anaerobic and mixed parameters were examined by the Wingate test in 7.5% load formula of body weight. The results of researches proved that a selection of applied training burdens was not conductive to the adaptation of process according to the Mathews, Fox model (1976). In the short track, a training burden should reflect the specific of an effort in this discipline, emphasising an anaerobic energy type in a year cycle of preparations.

Key words: physical effort adaptation, aerobic endurance, Wingate test

Introduction

The search of training solutions, helpful in raising training effectiveness during the short track, requires the accurate assessment of endurance changes, which are the effect of applied training stimuli. The second crucial element, on the road to optimization sport training, is to define interrelation between the endurance level and the size as well as the structure of training burdens. The fundamental purpose of conducted researches was the attempt to define the dynamics of aerobic and anaerobic endurance changes in the short track female competitors training during a year cycle, which is dependent on the energy characteristic of training burden. In accordance with accepted in sport training rule, it was assumed that the structure of training burdens is characteristic for training periods, assigned in a year cycle training, and it remains in strict interrelation with tasks that result from sport rivalry (Bompa and Haff 2010; Dovalil et al. 2002; Moravec et al. 2007). Considering lack of scientifically proven conceptions how to solve this problem in Polish competitors' training, the division of training tasks was put into practise, which was applied to Canadian short track competitors (Speed Skating Canada's Long-Term Athlete Development Plan, www.speedskating.ca). According to assumptions of long standing training system in Canada in a year cycle training, the basic tasks were guided on the sport rivalry ability, optimization of the functions of energy systems and movement system as well as fast ride improvement and endurance shaping. The second aspect of training burden classification, beside sport training periodization, is the energy characteristic that defines dominant metabolism type, produced during diverse exercises (Sozański 1999). The basic purpose of training process in sport is to achieve the highest adaptation level, which is reflected in increasing the rate of efficiency and progression of sport results. Taking the criterion of the direction of change of bioenergy in the body, the authors divided the means and methods of training into four categories, which were used in the analysis of research results (Dick 2002; Sozański 1999; Płatonow 1999):

- Burdens realized in the aerobic changes area, which intensity do not exceed the anaerobic changes level.
- Burdens realized in the aerobic and anaerobic changes area. We can distinguish subcritical intensity burdens (intensity below VO_2max level) and overcritical (exceed VO_2max level) among them.
- Burdens realized in lactic acid anaerobic changes area, while the best activity in anaerobic metabolism zone is registered.
- Burdens realized in lactic acid anaerobic changes area, whose intensity correspond with maximal anaerobic power level.

In the first phase of the researches, the specific features of polish female short track competitors course in a year cycle was established. In the general preparation period the basic training task was focused on shaping aerobic endurance. This kind of direction appears in majority of sport disciplines that have similar energy of start effort to short track (Bartkowiak 1999; Banister et al. 1999; Bassett and Howley 2000; Ingham et al. 2002; McKenna et al. 1988). In this period, the biggest volume of training work was realized by using low and very low burdens intensity, which constituted adequately 28% and 24% of total training burden. According to Laursen and Jenkins (2002), Dick (2002) works, the acceptance of such intensities does not constitute the base for considering the training stimulus as sufficient enough to the development of aerobic endurance. As a result of the inclusion of measures related with the beginning of training on the ice during the preparation of specialized period, the training burdens structure has slightly changed. The necessity to solve a new task by changing the structure of training burdens, also caused changes that head towards the endurance of tested competitors. The participation in total training burdens of measures that form the aerobic endurance (regeneration and developing) remains at level (53%), which is similar to general preparation season. In terms of volume, the third ones become measures of mixed (aerobic-anaerobic) character, and their share in total training burden constitute 24% of the whole burden of this period. The structures of burdens during specialized preparation season, with a dominant role as measures of aerobic metabolism character, indicate a delayed competitors entry in the starting period. Similar conclusions were reached in Steinacker (1993) researches. The work, executed in the second intensity range (aerobic, developing range), does not stimulate aerobic endurance of skaters. The frequency of heart rate, at the threshold of AT, reduce after a period of general development and specialized preparations. Such an organism reaction indicates a failure to achieve the desired training effect. The same interrelations are described by Londree (1997), Shave and Franco (2006).

In the works of Wang and Ruon (2007), Wang (2007), Zhang et al. (2007), the authors pay attention to the function that perform the preparation in the aerobic endurance area during the short track competitor training. Lack of sufficient level of specialized endurance, constitute a serious limitation on the possibility of forming anaerobic, lactic acid endurance (Zhang et al. 2008). This area of an effort adaptation was exposed to particularly strong impact on pre-competition period. This period contains a large increase in burdens, almost in all ranges of intensity, including primarily specialized training as well as control competitions. According to training plan assumptions, a contribution of aerobic burdens (supporting and aerobic range) decreases to 40% of total training volume, which is accompanied by a 30% increase of anaerobic burdens. Such a burden structure is typical of the specialized preparation period in other sports. The level of basic rate of skater's aerobic endurance, which is HRat, clearly increases at the end of pre-competition period. The observed dynamics of HRat parameter, indicates the significant training impact on aerobic endurance development of competitors, in the third intensity range. It is confirmed in Laursen and Jenkins (2002) as well as Shave and Franco (2006) researches. The nature of the relationship between dynamics of aerobic and anaerobic endurance parameters and the energy structure of executed training burdens proves that the tasks and assumptions which were supposed to be done, were not fulfilled during training.Conducted research showed that anaerobic, both lactic acid and non-lactic acid stimuli have typically significant influence on sport result in the short track.

Materials and methods

The researches involved 19 female competitors aged 18–23 years, training in the OMKŁS Opole club and KU AZS PO Opole, whose training experience was 7–10 years. Eight of them were members of the National Team, including Olympic Team (Vancouver 2010), furthermore they participated in the World Cup, World Championship and European Championship. The others examined competitors were members of the National Team. The examined group was realizing an annual training plan, taking into account current results and participation in competitions. The training plan consisted of five periods: general preparation period, specialized preparation period, pre-competition period, competition period and deconditioning. During the researches period, competitors were participating in trainings which took up to 180 minutes per day, realizing up to 11 training units per week except competition period and temporary period. In order to determine the interrelations between examined variables, the Pearson product-moment correlation matrixes were calculated. The characteristic of interdependencies between particular parameters in each of the four training periods was based on the correlation analysis between anaerobic as well as aerobic efficiency and the size of training burdens, realized in various training periods.

Table 1. Register of parameters with the assignment to the specific type of tests, effort trials and results of control competitions

Parameter	Type of a test or an effort trial
HRmax – maximum frequency of heart rates LAmax – maximum concentration of lactate after an effort, time (s) gained during tests 60%, 80% and 100% Vmax	Test 3 × 7 laps, break 20 minutes
WTOT – total work HRmax – maximum frequency of heart rates LAmax – maximum concentration of lactate after an effort	Cycle Ergometer Test 3 × 60 (s), break between tests 20 minutes
Time gained from the sport distances 500 m, 1,000 m, 1,500 m	Results of control competitions

Terrain trials and laboratory diagnostic methods, evaluating the competitors' endurance in short track:

1. Interval effort test performed on ice 3 × 7 laps.

The test consisted in three times skating on the 777 meters of ice (7 laps) with increasing speed according to the programme: I repetition – 70% speed on the life record level in the distance of 1,000 meters; II repetition – 85%, III repetition – 100%. The break between repetitions was 20 minutes. During every effort the HRmax, HRmedium, concentration of lactate in blood in the fourth minute after an effort, the time of each lap and the final time of the whole test were registered. In the thirtieth minute after an effort, HR and concentration of lactate were registered in order to define the restitution course. The test of Canadian trainer, Iv Nado, is commonly applied by trainers all over the world.

2. Interval test 3 × 60 s. performed on Cycle Ergometer.

The test consisted in making an effort (3 times in 60 s.) with 20 minutes break between repetitions. The number of spins was determined by the average number of spins, made by the subject during Wingate test. The size of the burden was as follows: I effort 60% average number of spins, II effort 80% average number of spins and III effort 100% average number of spins registered in Wingate test. Burden 7.5% body mass.

The indicators registered during the test:

– $HR_{max,}$ HR_{medium}, HR w 4 minutes after effort,
– HR before each test, HR in 30 minutes after three tests,
– LAsp1, LA4 – concentration of lactate before an effort and in the fourth minute after finish,
– LAsp2, 3 LA30 – concentration of lactate before the second and the third effort and in the thirtieth minute after finishing the test.

The test was conducted in order to evaluate the endurance in laboratory conditions which reflect the effort on ice while skating 1,000 m. So far, the research concerning application of this test in diagnostics of the short track competitors were not published.

3. Time results from the control competitions in which subjects took part at 500 m, 1,000 m and 1,500 m. Control competitions took place in each of defined training periods.

Results

The analysis of a year cycle structure which consist of five training periods showed that the skaters did the greatest work as regards the volume. In the I range of intensity (aerobic support area) – 27%, then in the III range (aerobic-anaerobic area) – 21%, and subsequently in the II range (aerobic, developing area) – 18%, in IV range (anaerobic lactic acid area) – 15%, in VI range (anabolic area) – 10% and in V range (anaerobic non-lactic acid area) – 9%. The greatest work of total volume in a training year cycle, the competitors did during the pre-competition period – until 33%, then during the competition period – 25%, during the period of general preparations – 22%, during the period of specialized preparations – 14%, and during temporary period – 6%.

Figure 1 shows the characteristics of the training burdens dynamics in a year cycle of sport training (five periods of training). The highest values characterize the burdens in I and III intensity range – during the pre-competition period for the I range, and during the competition period for the III intensity range. The lowest values were registered in V and VI intensity range, adequately in the first and the second training period.

Figure 2 shows the dynamics of training burdens volume in different intensity ranges. The highest values gained in IV training period (competition period) – III range of burdens intensity and during third pre-competition period – I range of training burdens intensity. The lowest values were registered in the first and the second training period – V range of training burdens intensity.

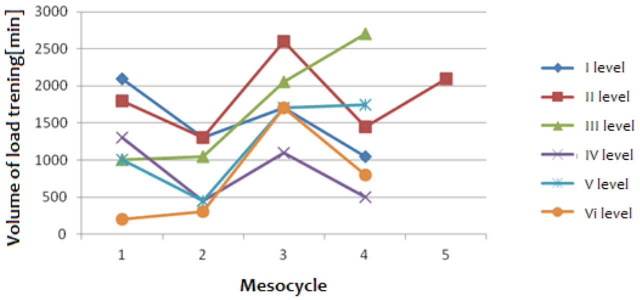

Figure 1. The burdens dynamics in mesocycles of a year cycle sport training in short track (1 – II–II mesocycle, 2 – IV–V mesocycle, 3 – VI–IX mesocycle, 4 – X–XII mesocycle, 5 – XIII–XIV mesocycle)

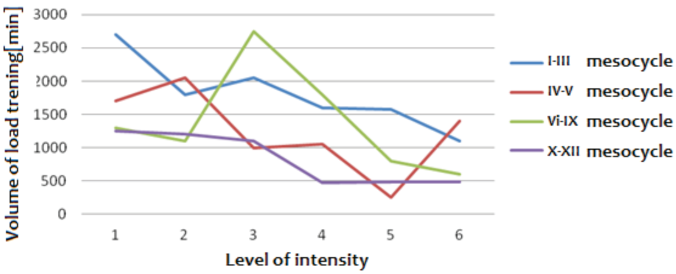

Figure 2. Burden dynamics in different intensity ranges in next mesocycles of sport training in a year cycle

Figures 3–6 show the volume of carried out burdens of different intensity ranges in the skaters' year cycle training.

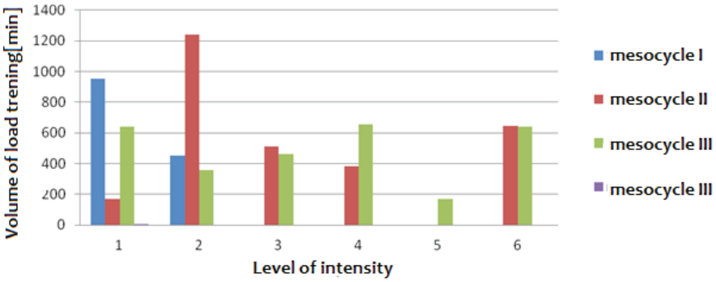

Figure 3. Training burdens volume carried out in different intensity ranges during three mesocycles of general preparation period

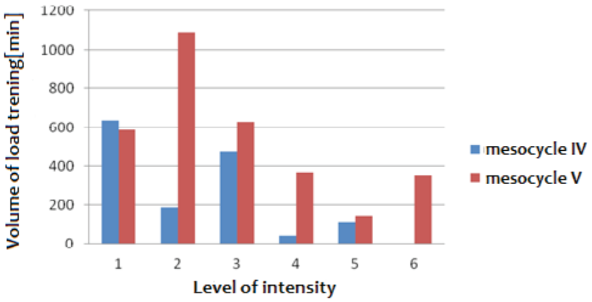

Figure 4. Training burdens volume carried out in different intensity ranges during two mesocycles of specialized preparation period

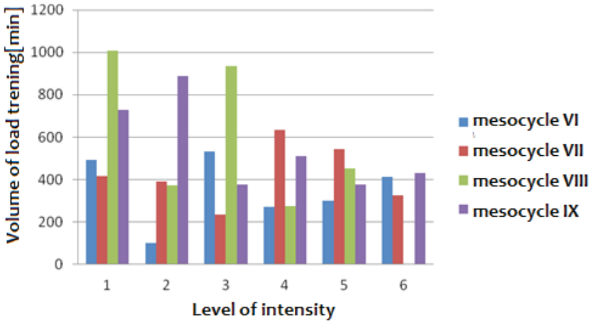

Figure 5. Training burdens volume carried out in different intensity ranges during pre-competition period

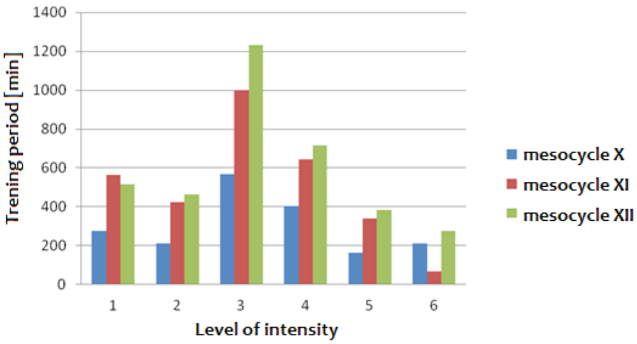

Figure 6. Training burdens volume carried out in different intensity ranges during three mesocycles in competition period

Discussion and conclusion

The competition period is a goal of all-year competitor's preparations (Bompa and Haff 2010). The short track characteristic feature during this period is a training burdens structure with a great contribution of anaerobic measures which constitute 31% of total training volume. The basic assignment of this period in a year cycle is to achieve and maintain the top physical condition, which guarantees a high disposition during main competitions of season (Bompa and Haff 2010; Sozański 1999). All training activities are subordinated to described task. A characteristic feature is reducing the burdens carried out in support and aerobic range (from 52% to 28%), as well as increase of volume measures from 30% during general training period up to 64% during competition period, carried out in intensity areas with the share of anaerobic metabolism (mixed range and anaerobic, lactic acid and non-lactic acid). Such dynamics of changes in the structure of training burdens is characteristic of sport disciplines with a significant share of anaerobic metabolism during start effort (Bangsbo et al. 1991). Lack of desired increase in aerobic endurance during the general preparation period, as a response to the highest burdens volume in a year cycle with predominant share in the energy of aerobic metabolism effort, authorise to propose a thesis on interrelation between training burden and its effect which reflects competitors' preparation in short track. Excessive increase of low intensity burdens is not conductive to aerobic endurance development. Moreover it can indirectly influence on lowering its level. This is a result of disturbance in the optimal relation between stimulus of varying power impingement on different metabolic areas of athlete's organism (Gabryś 2008). In the testing group, the most effective in shaping aerobic endurance were the stimuli with the power corresponding with AT intensity threshold, even slightly above the threshold. The effectiveness of such a solution in shaping the aerobic endurance was proved by Zając and Cholewa (1996) in their work. The authors indicate the extensive interval method as the most effective in shaping aerobic endurance, which was the basic training measure in pre-competition period in connection to significant share of trainings on the ice. Such work intensity level stimulates the metabolism of free fatty acids (Raczyński et al. 1994). The result is a body fat loss and increase in active body mass as well as lowering the pace of muscle glycogen consumption. On the one hand, the lower body mass in relation to active mass is conductive to train for speed and endurance, which is typical in short track (Hoffman et al. 2009; Nemoto et al. 1990). On the other hand, during such a training, the economy of energy reserve usage is being increased which constitute a competitor's protection from a sudden decrease of physical effort ability (Buglione et al. 2011; Costa et al. 2012; Szymański et al. 2010). According to Bomp and Haff (2010) the basic factor determining high effort adaptation during endurance sports like short track, is not training volume, but adequate diversity of trainings and various intensity ranges. The thesis is confirmed by the results of researches by many authors (Bartkowiak 1999; Colwin 2002; Maglischo 2003; Ratel 2011; Zieliński et al. 2011). Guo (2006), Wang (2007), Zhang et al. (2008) who paid attention to the preparation role of short track competitors as regards anaerobic endurance. Also own researches indicate that there are permanent tendencies in the changes characteristics of indicators size of this area in a year cycle. Anaerobic, lactic acid capacity in tested group showed a range of changes inconsistent with the expected changes. Lack of statistically significant changes of this indicator, including pre-competition and competition period, points to the insufficient size of burdens aimed at shaping the sphere of preparations. The only indicator that informs about changes in preparations to anaerobic lactic acid efforts of tested competitors group is the growing size of lactate concentration in blood, which can be interpreted as an increase in the capacity of anaerobic energy source (Laursen and Jenkins 2002). The comparative analysis of the changes in the parameters values registered in the laboratory and specific tests indicated an increase in efficiency of the effort performed with the intensity based on aerobic-anaerobic metabolism and adaptation to the effort performed with maximum intensity through an increase in the activation of anaerobic glycolysis (Capelli 1999; Di Prampero 2003). There is a downward trend in concentration of lactate in blood after exercise made with 60% intensity. After exercise made with 80% intensity, the LAmax value in blood submits to statistically insignificant hestitations depending on training period. During exercise of maximum intensity there is statistically crucial increase in the LAmax value ina year cycle. The specificity of effort in a short track distances considerably influence the characteristics of the changes in sizeof anaerobic, not lactic acid endurance indicators. This area of endurance performs an important function of making effort in maximum two laps. This is the half of the shortest distance (500 meters), thus the anaerobic not lactic acid endurance in limited range is used during sport fight, especially while achieving a high sport condition i.e. in competition period (Zhang et al. 2009). In a year-long training cycle the anaerobic lactic acid endurance, that is evaluated in changes of values rates in laboratory and terrain tests (on ice), is characterized by periodic changes. The maximal power is characterized by twofold values increase – during preparation and competition period. During the pre-competition and competition period the highest increase in anaerobic, not lactic acid capacity is achieved. The general preparation and specialized preparation periods are the part of year cycle training in which the training burdens structure do not possess a positive transfer on desired development of parameters of short track competitors' anaerobic not lactic acid endurance. The construction of a year cycle training is determined of the optimal calendar of competitions. At the selection of competitions the preparation of a competitor is taken into account (Bompa and Haff 2010; Moravec et al. 2007). The basic criterion for participation in the competitions is the motor preparation taking into account the capacity and the power of particular systems of energy metabolism (Gabryś 2008). The foregoing issue should be considered from two points of reference. The first is the opponent and a state of his or her preparation, the second is the level of self-preparation and the relation between the preparation areas, which undergo some changes in a training year cycle (Cai et al. 2008; Tong and Cai 2008; Wang 2008). On the basis of analysis of the literature as well as own research results, it can be concluded that the selection of training burdens that was used during the test of short track competitors preparations did not favour the process of adaptation according to Mathews, Fox (1976) model. In can be concluded that in a short track the training burdens should be selected in a way as competition burdens. The main energy supply security system is the anaerobic system. The training which should be responsible for increasing the efficiency indicators that determine the sport score in a short track such as VO_2max, maximal power, VO_2max on the AT threshold and a result of competition, would have to be a training focused on the anaerobic efficiency. The aerobic training could be a connective element of main trainings, moreover it could also be a method for quick regeneration. When analysing the correlation between the results from the 3 × 7 laps test (20 minutes break) and the training burdens in subsequent periods of training, the authors came to the following conclusions:

1. During all-purpose period, the increase of burdens in the second range results in the growth of HRmax parameters during running on the ice with 60% and 80% intensity. The increase of burdens in IV intensity range results in the growth of HRmax during running on the ice with 100% intensity. Otherparametersdid not show statisticallycrucialinterrelations.
2. During specialized preparation period, the increase of burdens in the second range, results in the growth of HRmax during running on the ice with 80% and 100% intensity. The increase of burdens in V intensity range, results in lowering of acidification (LA) after running with 100% intensity. The application of burdens

anabolic (6 range), results in lengthening the skating time with 60% and 80% intensity. Other parameters did not show statistically crucial interrelations.

3. During pre-competition period, the change in training burdens did not show statistically crucial interrelations with the parameters of applied physiological tests.
4. During competition period, the change in burdens in IV range results in lowering of acidification (LA) after skating with 100% intensity. Other parameters did not show statistically crucial interrelations.

Analysing the correlation results between tests results on the Cyclo Ergometer 3 × 1 minute (break between tests 20 minutes) and training burdens in subsequent training periods, the authors came to following conclusions:

1. During all-purpose period, the increase of burdens in the sixth range results in the growth of LA after first trial with 60% intensity. Other parameters did not show statistically crucial interrelations.
2. During specialized preparation period, the increase of burdens in the first range results in the growth of HRmax after first section with 60% and 100% intensity. Training burdens in IV range result in lowering of LA in third section with 100% intensity. Training burdens in V range result in lowering of LA in first trial with 60% intensity, whereas the increase of training burdens in sixth range results in lowering of spins speed in three intensities and lowering of HRmax in the second trial. Other parameters did not show statistically crucial interrelations.
3. During pre-competition period parameters did not show statistically crucial interrelations.
4. During competition period, increase of burdens in fifth range results in lowering of HRmax after first trial with 60% intensity.

Analysing the correlation between results from control competitions and training burdens in subsequent periods, the authors came to following conclusions:

1. During all-purpose periodan increase of burdens in the sixth range results in lengthening of time on 1,000 meters and 1,500 meters.
2. During specialized preparation period, an increase of burdens in the sixth range results in lengthening of time on 1,500 meters.

During pre-competition and competition period, despite the competitors were gaining better results on three distances, the change of parameters of training burdens did not show statistically crucial influence on the sport score.

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