ANALYSIS OF TRAINING LOADS AMONG SWIMMERS WITH DISABILITIES DURING SPECIFIC PREPARATION PERIOD

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Abstract The research goal was to analyse training loads during specific preparation period among swimmers with disabilities. Double examination of 20 athletes with disabilities of motion and sight organs, at the beginning and at the end of the period was conducted. Garmin Forerunner 735XT device was used as a measuring tool, which registered heartbeat rate during training sessions. Records of the heartbeat rate were sent up to Garmin Connect programme, where percentage share of each energy zone in the whole training volume was calculated. Taking into consideration the achieved results, during specific preparation period, swimmers were training mostly with moderate and high intensity and the biggest training volume was registered in zones EN2, EN3 and SP1. Additionally, between the first and the second measurement, the biggest decrease in training volume took place in EN, whereas the biggest increase in training volume took place in zone SP1 what indicates increase of work in the field of specific endurance.

Key words sport of disabled people, swimming, energy zones

Introduction

Swimming is one of the sport disciplines which became more inclusive for people with disabilities in the last decade of XX century. It means that majority of people with disabilities can achieve success in this sport, through division for groups and starting classes which is helpful. Athletes classification is essential to assure fairness of competition. It is a result of disability differences in types and degrees, as well as functional abilities of the athletes.

System of functional classification was introduced in 1992 at the Paralympic Games in Barcelona with the division for groups and starting classes (Molik, Kosmol, 2003; Oh, Burkett, Osborough, Formosa, Payton, 2013). The aim of creating such a system was to equalize chances for all athletes during the sport rivalry, in all swimming competitions. Since that time, it has been continuously modified, however it does not seem to be completely

adequate (Seidel, Bolach, Kachnikiewicz, Walowska, 2012). Based on actually valid laws and regulations of World Para Swimming (WPS) in the starting group "S" in freestyle swimming, there are 10 classes in motion organs disabilities and 3 classes in sight organ disabilities (Tweedy, Vanlandewijck, 2009). Training loads of disabled athletes are usually lower than able body swimmers, they are also dependent on the type and degree of disability. The more severe disability, the lower number of kilometres per training.

During the specific preparation period the biggest emphasis is put on tasks and exercises which improve particular elements of specific athleticism – distance and style, in training load in which the athlete is specializing. The energy supply comes mainly from the anaerobic and mixed, aerobic and anaerobic, energy systems. Technique improvement and optimization are priorities here as well as movement patterns which are the base of swimmers speed abilities development (Bolach, Bolach, Doliński, Seidel, 2004; Bolach, Seidel, Fic, Adamczak, 2013; Seidel, Bolach, Szafraniec, Machuła, Bolach, 2017; Bolach, Seidel, Sobczak, Stępień-Słodkowska, Bolach, 2019; Bompa, 2011).

In training loads we should focus on determining energy zones during given training unit. We can distinguish following zones: REC – refers to warm up (slow swimming); EN1 – base training; EN2 – anaerobic threshold level; EN3 – overload endurance level (VO2max); SP1 – lactate threshold tolerance training; SP2 – threshold similar to the previous zone (the distance is shorter; the breaks are longer); SP3 – creating the high power phosphagen system.

When it comes to the specific preparation training, EN1, EN2, EN3 and SP1 are dominant zones. Each energy zone causes specific adaptation changes in the body of an athlete, so properly planned participation of each zone in the training unit allows to optimize the whole training process.

Research goal

Analysing training loads in specific preparation period among the swimmers with disabilities was the ultimate goal of this research.

Research questions:

1. Is there any difference in training loads between the beginning and the end of the specific training period among the athletes with disabilities?
2. Which energy zones determine the biggest training load of the whole period?
3. What are the differences between the level of each energy zone on the beginning and at the end of specific preparation period?

Material and Methods

20 athletes, 8 women and 12 men with disabilities of motion and sight organs participated in this research. All of them were professional swimmers of Voivodeship Sport Association of Disabled "START" in Wroclaw. In order to standardize the research group, criteria of practice experience and performance level were introduced. Age of the examined athletes differed between 14 and 28 years, with the average of 19.4 years. Practice experience differed between 5.5 and 14 years, with the average of 9.3 years. All research subjects were medallist of Polish Championships or international championship competitions. Both swimmers and their coach agreed to conduct the research during their training sessions at the swimming pool of the Academy of Physical Education in Wroclaw in April and May 2019. Research was conducted twice, at the beginning and at the end of the specific preparation period.

Research was conducted using heart beat rate monitor Garmin Forerunner 735XT (monitoring system consisted of heart beat rate sensor placed on the wrist and the electrode belt on the chest of athlete). It was a non-invasive research method.

Before the beginning of the research all athletes participated in blood count examination. In order to determine concentration of La in plasma photometr LP – 400 was used. The research has begun from the step test (lactate) and consisted of 8 reps 100 meters freestyle swim intervals.

Speed and intensity of each consecutive interval were determined individually for each swimmer. First three 100 meters intervals were performed at 77% of the best result in actual training period. Next two intervals at 83%. Sixth and seventh interval at 88% and 93%. The last one with the maximum intensity 100%.

During the research, heart beat rate and concentration of lactic acid in blood were measured. Heart beat rate was checked at the beginning, during rest and then after performing each interval. Lactic acid concentration was tested after performing third interval; during the first minute after 5 interval; during third minute after 6 interval; during first and third minute after 7 interval; during third, sixth and ninth minute – among women; during fourth, sixth and ninth minute – among men after performing the last 100 m interval. During the research resting periods were applied in appropriate time spans. After 3 and 5 interval rest lasted three minutes; after 6 interval – five minutes; after 7 interval – twenty minutes; in other cases rest lasted one minute.

Second examination consisted of measuring heart beat rate during 1.5-hour training session. It was conducted at the beginning and at the end of the specific training period. Garmin Forerunner 735XT was used to measure desired data. Garmin Connect (Foster, 2001) software was used to save and process the data.

Statistical analysis method

Based on W. Shapiro-Wilka's test, it was stated that empirical distribution of analysed data, did not differ significantly from the normal distribution. It allowed to use parametric test t-Student for dependent samples during size volume change evaluations of each energy zone. For statistical significance evaluation criterion $p < 0.05$ was introduced. Calculations were performed by using Dell (Fergusson, Takane, 2007) company's programme STATISTICA 13.1

Results

Analysis of training loads at the beginning of examined period

Beginning of specific training period consists above all of swimming at the level of anaerobic transformation, which is marked with the high production of lactic acid. Athletes were training also, during this period, with aim to increase aerobic capacity and adaptation for heavy loads and they were progressing despite swimming only 3–7% above the level of anaerobic transformation. The biggest training load was observed in zones EN1 and EN2 (each 25%), when the base training in aerobic transformation zone made 19%. According to this fact basic aerobic endurance was being built and the biggest training loads were stabile under the 5% level. The smallest percentage of volume was observed in the anaerobic non-lactic acid zone SP3 – 5% (Figure 1).

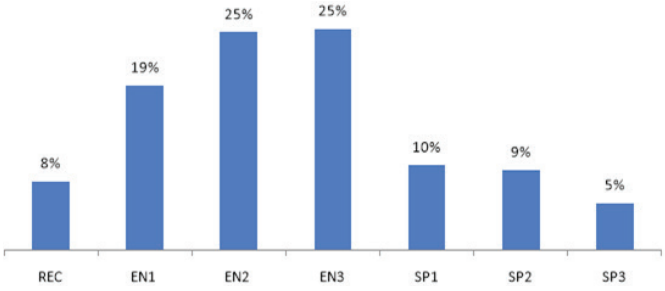

Figure 1. Volume of energy zones at the beginning of specific training period

Analysis of training loads at the end of examined period

The biggest training volume was recorded in zone SP1 – 25%, whereas zones EN2 – 18% and EN3 – 17% represented lower percentage. Trainings in zone SP1 were characterized by high intensity, creating specific endurance and lactic acid tolerance. Participation of aerobic and aerobic-anaerobic transformations was smaller and trainings in these zones were building aerobic capacity (VO2max). The smallest were training loads in zone SP3 – 7%, which were based on creating phosphagen power and speed (Figure 2).

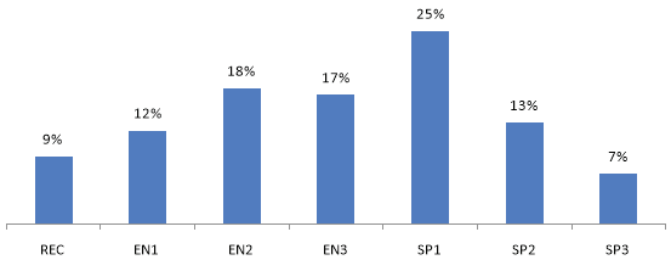

Figure 2. Volume of energy zones at the end of specific training period

Comparison of training loads at the beginning and at the end of the training period

Comparing training loads at the beginning and at the end of the specific training period it can be observed that, at the beginning, athletes were training mostly in aerobic and aerobic-anaerobic transformation zones (EN1, EN2 and EN3) and working with medium intensity. It was aimed to adapt athletes to desired loads. At the end of the period, zones EN2 and EN3 were still representing high percentage of total training amount. The biggest difference in volume occurred in zone SP1 – 15%, and the lowest in zones: REC, SP2, SP3. In both cases athletes have worked for the shortest amount of time in zone SP3 in the area of phosphagen capacity and power (Figure 3).

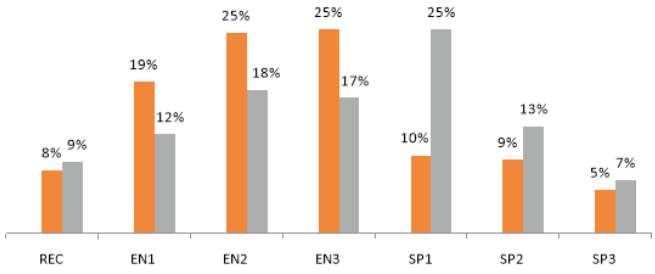

Figure 3. Comparison of volume in each energy zones at the beginning and at the end of the specific training period

Changes of energy zones volume at the beginning and at the end of the period

The biggest, possible to notice, changes occurred in the anaerobic zone SP1 with the sharp increasing tendency. It means that at the end of the period athletes have spent much more time creating specific endurance by training with high intensity. Decreasing tendency was noticed in zones EN1, EN2 and EN3. Similar training volume at the beginning and at the end of competing period was noticed in zones REC, SP2 and SP3 with increasing tendency (Figure 4).

Changes of average volume in zones EN1, EN2, EN3 and SP1, SP2 were statistically significant ($p < 0.05$) (Table 1).

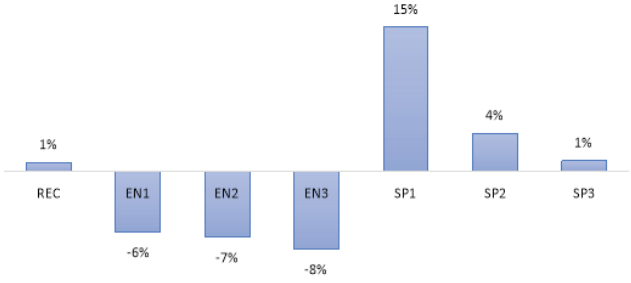

Figure. 4 Changes of energy zones volume at the beginning and at the end of specific training period

Table 1. Volume comparison of each energy zone at the beginning and at the end of specific training period. Statistically significant values p in Student's test were marked with red colour ($p < 0.05$).

Energy zone	Specific training period				Average change (%)	Student's test	
	at the beginning		at the end			T (%)	p
	average (%)	standard deviation	average (%)	standard deviation			
1	2	3	4	5	6	7	8
REC	8	0.008920	9	0.014120	1	–1.26	0.221665
EN1	19	0.017280	12	0.034055	–6	5.03	0.000074
EN2	25	0.040280	18	0.057280	–7	5.16	0.000055

1	2	3	4	5	6	7	8
EN3	25	0.037400	17	0.079775	–8	4.87	0.001070
SP1	10	0.008280	25	0.068000	15	–11.14	0.000000
SP2	9	0.016095	13	0.042055	4	3.27	0.003989
SP3	5	0.011055	7	0.018295	1	–1.41	0.174672

Discussion

Training concept of disabled swimmers is still not researched enough. This process requires more time and coaching practice before being as conceptualized and analysed as able-body swimmers. However, differences in training are not as significant, what enables to be based on able-body athletes systems, alongside learning correct modifications for disabled swimmers. It is only a matter of time when the training knowledge will simplify creating training plans for disabled athletes and guarantee the highest sport achievements. Right choice of training loads is the determining part of a training.

Only a few authors have handled the subject of training loads in annual training cycle of disabled swimmers. If so, they were concerned about heart rate and blood pressure during periods of annual training cycle. That is how Bolach (et al., 2004) were analysing blood pressure (RR) and heart rate (HR) during 5 training sessions of specific training period. Measurement was done during six 90 minutes sessions: before physical effort; after warm-up; during the peak; at the end of main part; after the main part and after 15 minutes of restitution. Research group consisted of 19 swimmers divided into two groups (advanced and intermediate) aged between 19–43 with the average of 25.7 years. Advanced athletes' experience was between 5–28 years with the average of 11.1 years. Whereas in the intermediate group it was between 2–4 years with the average of 2.7 years. Research findings indicated than heart rate in group I was lower than in group II, whereas the blood pressure was similar but in different time spans of training session. For group I at the end of main part and for group II at the peak of main part. Heart beat analysis demonstrated significant statistical differences however in case of blood pressure significant statistical differences were not observed.

Similar research was conducted among swimmers from sport classes S4 and S10 during the specific training period (Bolach et al., 2013). They applied the Cooper Test, where results were registered by Polar RS 800 CX sport tester. Differences only in energy zone EN3 were observed. In other energy zones differences were small and insignificant.

Bolach and others (Seidel et al., 2017) analysed also energy zones in disabled swimmers training during the specific training period in classes S4 and S10. Researched athletes were medallists of Polish Championships with the average age of 18.7 years and average experience of 4.9 years. Individual energy zones were determined based on modified Cooper Test, which was chosen due to the ease of application, regardless of disability level. It relied on swimming the longest possible distance during 12 minutes. Score of this test was registered by sport tester RS 800 CX. Athletes of both starting classes trained the smallest amount of time in energy zones REC and SP1 and the biggest amount of time in EN1, EN2 and EN3. Athletes from class S4, during training session, were training mostly in zone EN2 and at the very last in zone REC. Slightly different scores were among swimmers in class S10, who were training mostly in zone EN3. Variations of average time effort in energy zones REC, EN1, EN2 and SP1 were slight. It was observed only that athletes from class S4 have spent more time in energy zones REC, EN1 and EN2 than swimmers from class S10, whereas in energy zone EN3 and SP1 athletes from class S10 have been for

a longer period of time. Nevertheless, observed differences were slight and statistically insignificant. Slightly bigger differences between classes S4 and S10 were noted in the average time spent in energy zone EN3. In this case training time of athletes from class S10 was 4.25% longer, which is statistically significant.

Size of training volume during the pre-start preparations period was researched by Bolach (et al., 2019). Research was conducted among 11 disabled swimmers during I microcycle (10 training units) and III microcycle (10 training units) od pre-start preparation period. Experiment related to athletes from 4 classes: "S7", "S9", "S10" and "S12" from sport club "Start" Wrocław. Swimmers were aged between 16–25 years with the average of 19.4 years. Their experience was between 5–13 years of training, with the average of 8.2 years. Hear rate values were analysed during 10 training units w six chosen moments of training (0', 10', 45', 80', 90' and 105'). Sport tester Polar RS 800 CX was used. Results showed that in I microcycle intensity was higher than in III micocycle (pre-start preparation period). Additionally, it was stated than volume of training loads had no impact on correlation of age and experience. It was also concluded that the amount of training volumes among disabled swimmers was similar despite the differences in level and kind of dysfunction in both microcycles (pre-start preparation period).

Sport is influencing people with disabilities in a very positive manner, taking into consideration both cultural and social aspect. In professional sport, long lasting and systematic training is required. It may though lead to many additional injuries and overloads of motion organs. For people with disabilities it is very important to properly adapt trainings in order to prevent undesirable outcomes like loss of fitness and aggravation of general health condition. Comparing both able-bodied and disabled athletes it appears that body reserves of disabled ones are smaller. Proper selection of training loads its volume and intensity is crucial (Costill et al., 1991). Implications of those components are internal burdens with the heart rate (HR) as the best indicator to measure it. In swimming athletes are required to have high physical capacity, which is acquired by performing properly prescribed trainings. Properly matched training load is a determining factor of high physical adaptation. Trainer should individually adapt training loads in order to achieve high sport results of swimmer (Bompa, 2011, Collette, Kellmann, Ferrauti, Meyer, Pfeiffer, 2018). Analysing up to date knowledge concerning training loads we can conclude that we have to be aware of athletes physical capacity which is changing alongside consecutive training units and based on that proper training loads should be matched (Costill et al., 1991; Halson, 2014; Szafraniec, Seidel, Kruszyna, Żurowska, 2012). Energy profile and biological predispositions are crucial for every athlete, because thanks to them, right training loads can be prescribed in order to shape his optimal metabolism. Being aware of athlete's individual predispositions, trainer is able to prepare him to appropriate distance. Application of step testing and knowledge of heart rate value, enabled to determine anaerobic threshold and intensity level of each disabled athlete. Distance performed during training lead to creating individual training programme.

Analysis of disabled swimmers training load during specific training period was the research question of this work. As a result, training load of specific energy zones was determined. Analysis was performed at the beginning and at the end of specific training period, where swimming speed and number of performed kilometres enabled to determine differences. According to performed research, the biggest volume was present in zones EN2, EN3 and SP1. Due to this fact we can conclude that athletes performed anaerobic effort as well as aerobic with increased intensity equally when the period was ending. It can be stated based on decrease of zones EN2 and EN3, whereas increasing tendency was observed in zones SP1 and SP2. Finally, it means that volume of swimming in the specific endurance increased at the end of analysed period and volume of aerobic endurance decreased. Alongside decreasing volume, training intensity was increasing. Initially long distances in zones EN1, EN2 and EN3 aimed

at preparing athletes for anaerobic training, which are characterized with much higher intensity (Fulton, Payne, Hopkins, Burkett, 2009).

Analysing training loads among swimmers with disabilities it is extremally important to take into account physical capabilities of an athlete and continuously observe changes by performing control testing. Significant amount of trainers do not take these aspect into consideration which prevent quick and forecasted athlete's development. Change of attitude may lead to facilitating perfection pursuit aimed on achieving desired sport results.

Researches performed in this field enrich specific knowledge and may be used in creating more adequate conditions which are optimizing training process of swimmers with disabilities on different levels of sport advancement.

Conclusions

1. Among athletes, a significant difference in performed training loads of zones EN3 and EN2 occurred with respect to the final assumptions of the specific training period.
2. The biggest training volume of analysed period consists of energy zones EN2, EN3 and SP1.
3. The biggest decrease in training volume, between the beginning and the end of analysed period, occurred in energy zone EN3 and the biggest increase in zone SP1.
4. During the specific training period athletes with disabilities were swimming with moderate and high intensity. It is indicated by values of energy zones which were obtained based on heart rate (HR) of each examined athlete, counted up to date by Garmin Connect programme.

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