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Characteristics of the competitive loads of Polish National Amputee Football Team. Pilot studies

Charakterystyka obciążeń startowych piłkarzy nożnych Reprezentacji Polski AMP Futbolu. Badania pilotażowe

Abstract

BACKGROUND: Information about competitive loads of amputee soccer players are very limited. This element should be one of the base to prepare appropriate training program according to individual needs of players, as well aims of season. The main aim of this pilot study was to describe the characteristics of selected elements of the internal competitive load of football players after unilateral amputations.

METHODS: The subject involved a group of 15 Polish National Amp Football (PNAF) players after unilateral amputations of the upper or lower limbs. The age, height and weight were 27.1±8.4 years, 176.2±7.3 cm, 72.0±14.2 kg, respectively. The information were recorded during match between PNAF Team and representative of Polish Clubs, using Polar Team 2Pro System. The data base was analyzed using standard tools and differences among variables was checked by Wilcoxon test.

RESULTS: During whole games value of HR_{mean} was 132.6±10.56 bpm with a range from 87.3±10.6 bpm to 182.3±10.69 bpm and energy expenditure was 612.7±164.86 kcal. General, Values of observed variables were higher in the 2nd part of the match but differences among them was not significance.

CONCLUSION: Characterizing the competitive effort will allow to diagnose and determine the nature of the work to use it as specific requirements of the discipline. It can be expected that these information will contribute to the improvement the training process for AMP Footballers and optimize training of the disabled people.

Keywords: adapted football/soccer, sport, internal loads, HR, EE, monitoring of the game

Streszczenie

WSTĘP: W literaturze jest mało informacji na temat obciążeń startowych zawodników po amputacjach. Niemniej jednak ten aspekt jest jednym z podstawowych elementów przygotowania właściwego procesu treningowego, dostosowanego do indywidualnych

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predyspozycji i uwarunkowań zawodników. Stąd też głównym celem badań pilotażowych była charakterystyka obciążeń piłkarzy po jednostronnych amputacjach.

METODY: Grupę badawczą stanowiło 15 zawodników Reprezentacji Polski AMP Futbolu po jednostronnej amputacji kończyn dolnych lub górnych. Wiek badanych wynosił 27,1 ± 8,4 lat, wysokość ciała 176,2 ± 7,3 cm oraz masa ciała 72,0 ± 14,2 kg. Badania przeprowadzono podczas meczu między Reprezentacją Polski AMP Futbolu a zawodnikami polskich klubów występujących na poziomie AMP Futbol Ekstraklasy za pomocą Polar Team 2Pro System. Dane zostały opracowane statystycznie, różnice między zmiennymi zostały sprawdzone za pomocą testu Wilcoxona.

WYNIKI: W trakcie gry średnia wartość HR wynosiła 132,6 ± 10,56 uderzeń na minutę w zakresie od 87,3 ± 10,6 uderzeń na minutę do 182,3 ± 10,69 uderzeń na minutę, a wydatek energetyczny wyniósł 612,7 ± 164,86 kcal. Wartości obserwowanych zmiennych były wyższe w drugiej części meczu, ale różnice między nimi nie były istotne.

WNIOSKI: Charakterystyka obciążęń startowych pozwoli zdiagnozować i określić charakter pracy, aby wykorzystać ją jako specyficzne wymagania dyscypliny. Można przypuszczać, że informacje te przyczynią się do udoskonalenia procesu szkolenia dla piłkarzy AMP Futbolu i optymalizacji procesu szkolenia osób niepełnosprawnych.

Słowa kluczowe: adoptowany futbol / piłka nożna, sport, obciążenia wewnętrzne, HR, EE, monitorowanie gry

1. Introduction

The topic of internal competitive load is known in various sports disciplines: football (soccer), field hockey, handball, etc. (Reilly 1994, Bloomfield, Polman, O¨Donoghue 2007, Ziv, Lidor 2009, Konarski 2010). Detailed studies mainly discuss such issues as heart rate variability, energy expenditure, selected biochemical parameters, variation between the first and second half of the game. Despite of this issue, many sports disciplines still lack information about such parameters what was confirmed in article's review especially is the sport of people with disabilities which develop in very dynamic way. One of such example could be Amputee Football. According to this situation and to prepare more adequate training program for this group of people, as well taking into consideration their physical activity level there is observed an urgent needs to expand information on competitive loads. Our pilot study showed just some selected elements of the internal competitive load of football players after unilateral amputations.

In present-day sport it is necessary to use modern technology to obtain information about individual reactions to the work performed both during warm-up and training (Bishop 2003a, 2003b, Chmura 2014, Ayala, Calderón-López, Delgado-Gosálbez 2017). Expanding the knowledge on this subject allows for an optimal understanding of the physiological phenomena that accompany the sport training process with respect to the adopted sports and training objectives and their relativity.

The system of control and evaluation indicates the necessity of observing the player directly during work (ongoing control), the reaction to the work performed (operational control) and the total aspects of the workout analyzed during the periodic control (Ważny 1999, Krustrup et al. 2005). One of the most important tools used to collect data are the diagnostic tests. The use of appropriately selected tests allows for an adequate control of the current level of fitness that the trainer has at their disposal in the training

process. Analysis of the results describe some selected elements of the internal competitive load of football players after unilateral amputations. In future we will be conducting more extensive research for assessing the effectiveness of applied forms, means and training methods (training and starting workload) aimed at improving the level of training of the players. Information provided by the trainer is used to optimize the sport training process. It gives the basis for proper proceeding in accordance with the accepted principles of broadly understood individualization. One of the most commonly used tools is pulse measurement and analysis, which shows the reactions of the body to the effort, informing about the possible effects of the activity in the training process and, with systematic measurement, of the adaptive changes of the organism under the imposed workloads (Gil et al. 2007, Costa et al. 2013). Measurement of internal competitive load serves to determine the proper direction of action in the training cycle and is one of the main factors determining the choice of training exercises (Jastrzębski et al. 2013).

In football, with the increasing effectiveness of the training process, there is a constant need to modify the physical and temporal structure of sport training (Chamari et al. 2004). This applies to both fully fit and disabled people.

The effort taken by AmpFutbol players is mainly attributed to a group of speed-endurance and speed–strength efforts. Research has shown that athletes performing speed - strength and speed - endurance sports, including football players, have a significant potential for high intensity work based on oxygen metabolism. It is important to schedule time for aerobic, mixed, anaerobic, anaerobic acidic and anaerobic non-acidic work in the planning of sport training (Schepard, Astrand 1992, Reilly 1994).

It should also be noted that the effort during a football match is of interval character (Reilly 1994). Therefore, the principle goal of the football training process is to shape the adaptive processes of the athlete's body, aiming at taking the characteristic short-term effort of submaximal and maximal intensity with the interval specificity resulting from the analysis of initial loads - recorded during matches (Chamari et al. 2004).

The increase in results achieved by athletes is the result of the individual reaction of their organisms to a given stimulus within a years-long training process. Therefore, the issue of individual selection of training tasks (loads, methods and forms of realization) becomes one of the leading research problems (Reilly 1994, Bompa, Haff 2009, Kalinowski, Karpowicz 2015).

One of the simplest, non-invasive, and at the same time widely available methods of monitoring the load of the athlete is to measure the heart rate and to estimate the energy expenditure based on it (Impellizzeri, Rampinini, Marcora 2005, Dellal et al. 2008, Konarski, Strzelczyk 2009). Despite a number of studies using specialized and modern equipment, a small number of studies on these elements have been reported in athletes with disabilities following the amputation of lower limbs.

In the field of Amp Football there have been few studies thus far, despite the continuous dynamic development of this sport discipline. The Amp Football competition is aimed at people suffering from unilateral amputation of the limb and persons with other unilateral congenital limb defects. In order to characterize the nature of this discipline, it is necessary to look at its history.

Its origins date back to the 1980's in the United States. The game was started by a group of post-amputation skiers who started to play football to stay fit during the summer. The founder of *AmpSoccer* was Don Bannett. Another important figure that influenced the development of this discipline was football referee Bill Barry. In 2007 the first World Cup was held in Turkey, organized by the World Amputated Footballers Federation (WAFF). In Turkey, 12 national teams participated in the tournament, whereas

in the next world championship (Argentina 2010) there were already 18 teams. At the 2014 World Cup in Mexico a record-breaking number of 22 national teams was recorded (Wegner, Kalinowski 2015).

Football after unilateral amputations is a team sport game played between two teams. Each team consists of seven players, including one goalkeeper. The game lasts 2x25 with a 10 min break between halves. The Amp Football' playing field dimensions are: 55-70m in length and 30-60m in width (Yazicioğlu 2007). The criterion for participation in the game is a one-sided amputation or congenital malformation of the lower limb A2/A4 for field athletes or a unilateral amputation of upper limb A6/A8 for goalkeepers. Amp Football is a very dynamic game, characterized by a large number of duels and direct contact. It is characterized by a variable pace of action in the attack and defense. The incommensurable character of the game, the type of amputation, the recovery time and the large number of factors that affect the game's requirements make the athlete's fitness profile very varied. An important function in the fitness preparation of athletes is played by the motion organ compensating for the amputated limb. As a result, the comprehensive model of AMP Football players training is difficult to define. Hence, aiming at rationalizing and optimizing the training process, taking into account the fitness, technical-tactical, functional and mental preparation, it seems to be reasonable and a priority to apply individualization in training.

Athletes move on the field using the Canadian elbow crutches (there is an absolute ban on the use of prostheses during the game). Deliberately playing the ball with a crutch is treated like using a hand. On the other hand, deliberate aiming of the crutch at another player is treated as a foul resulting in the opposing team being given a penalty kick. The place of the offense does not matter. There is no offside or an offside area rule during the game. For safety purposes, it is also forbidden to perform slides during a match. Such play is a penalty in consequence of which the opposing team takes a direct free kick. When the ball is kicked into touch, the opposing team makes an indirect free kick. Due to the goalkeeper's full range of movement, any exit from the penalty area is a foul and as a consequence the goalkeeper is removed from the field (red card) and the opposing team receives a penalty kick. There are hockey changes that take place in the change zone after the judge's permission, with the intention of making up to two changes at the same time (Yazicioğlu 2007).

The most important forms of match activity are: starts, moving in different directions, acceleration, moving with the ball and without the ball in the distance of several meters, marching and jogging. On the field, players use a variety of tactical and technical actions, which consist of individual actions: serving, receptions, sidesteps, dribbling and strikes. It can be assumed that the most important in terms of motoric efforts are acceleration and starts. The energetic effort during the game is of interval nature and with no doubt in the case of football it is oxygen-anoxic.

Polish representation at AMP Football was founded in March 2012. Its biggest success so far is its 4th place in the 2014 World Cup in Mexico. Since 2015, the Premiere League of AMP Football has been established in Poland. The first Polish Champion were the players of Husaria Krakow (Kalinowski, Ołpińska-Lischka 2016). Previous studies on athletes of AMP Football did not characterize players in terms of training or initial loads.

In the above considerations, the main aim of this study was to develop the characteristics of selected elements of the internal competitive load of football players after unilateral amputations.

For the purpose of refining the objective, the following research questions were formulated:

1. What characterizes AMP Football?
2. What are the values of heart rate and energy expenditure observed in football players from the Polish National Football AMP representation during the match?
3. In which part of the game were the higher values of the maximum heart rate recorded?

2. Materials and methodology

The study involved a group of 15 Polish National Amp Football players after unilateral amputations of the upper or lower limbs, who on a daily basis play in the Amp Football Premiere League competitions, representing their clubs. The age at the time of the test was 27.1±8.4 years, height and weight were 176.2±7.3 cm and 72.0±14.2 kg, respectively. Athletes were informed about the purpose of the study. The research team distinguished 2 goalkeepers, 5 strikers, 5 midfielders and 3 defenders in the study group. The research was conducted during the championship match between the national team and representatives of the best club teams. This study followed the principles of the Declaration of Helsinki and was approved by the Human Ethics Research Committee of Karol Marcinkowski University of Medical Sciences in Poznan (Poland).

Table I. The general characteristics of the study group

Variable	Amp Football					
	N	M	Min	Max	SD	SE
BM	15	72	45	98	14,24	3,68
BV	15	176,2	160	187	7,28	1,88
Warm up HRmin	15	93,27	75	107	8,76	2,26
Warm up HRAver	15	131,87	103	154	11,79	3,04
Wurm up HRmax	15	173,93	155	195	10,75	2,77
Wurm up EE	15	478,2	302	772	137,79	5,58
1 half HRmin	15	90,8	70	122	13,99	3,61
1 half HRAver	15	136	94	155	15,77	4,07
1 half HRmax	15	178,6	130	193	15,66	4,04
1 half EE	15	258,67	154	437	79,70	20,58
2 half HRmin	15	95,67	79	110	8,07	2,08
2 half HRAver	15	137,47	110	153	12,56	3,24
2 half HRmax	15	176,67	148	196	14,40	3,72
2 half EE	15	278,47	159	483	87,03	22,47
Total HRmin	15	87,27	70	101	10,06	2,60
Total HRAver	15	132,6	108	148	10,56	2,73
Total HRmax	15	182,27	154	196	10,69	2,76
Total EE	15	612,73	388	1038	164,86	42,57
Age	15	27,11	14,42	43,61	8,44	2,18

The following elements were measured:

Height:

The subject was standing upright, propped up with Canadian crutches, with the head positioned in the Frankfurt plane. The height of the body was determined by the

0064istance of the Vertex - Basis points using the Holtain (UK) hand-held anthropometer with precision to 1mm.

Body mass:

The electronic weight (Wagi Wielkopolska, Poland) was used to measure body weight with precision to 0.1 kg.

Heart Rate measurement:

Heart rate was recorded using Polar Team2 Pro system (Finland), and the Team^2 version 1.4.5. The program, based on individual athlete's data and the volume of exercise and heart rate, estimated the energy expenditure.

Statistics:

The results of the study were compiled using standard statistical methods. Shapiro-Wilk test was used to check the normal distribution. Basic descriptive characteristics were calculated (arithmetic mean - M, standard deviation - SD). Comparisons between subgroups were made using the Wilcoxon test with post hock, assuming a statistical significance of $p \leq 0.05$. Analysis were made using STATISTICA (data analysis software system), version 12. (StatSoft, Inc., 2014).

4. Results

The values referring to the characteristics of the initial load of the observed athletes are presented in Table 1. During whole games value of HR_{mean} was 132.6±10.56 bpm with a range from 87.3±10.6 bpm to 182.3±10.69 bpm and energy expenditure was 612.7±164.86 kcal. General, Values of observed variables were higher in the 2nd part of the match but differences among them was not significance. During the analysis it was observed that in the parameters studied the higher values of average heart rate and energy expenditure occurred in the second half of the analyzed match than in the first. Only the maximum heart rate was higher in the first part of the meeting. However, these differences were not statistically significant.

5. Discussion

The test results allowed for the first time in the country to prepare a preliminary characteristic of the initial internal load of Amp Football players playing on the national level.

The observed differences will allow to make appropriate optimization treatments aimed at a more precise preparation of players to sports and at reducing the risk of strain injuries. Amputee football *(Am. Amp soccer)* is a sport discipline for players with unilateral amputations of upper and lower limb or with defects of those limbs. The Polish Amp Football representation was formed in 2012. The amputee football is a rapidly growing and gaining more and more popularity. The Polish National Team is very successful in the international arena (www.ampsoccer.org; www.ampfutbol.pl) (Kalinowski et al. 2016) and could be observe as modeling team for other AMP football teams to prepare more precise training program.

The new discipline has quickly gained popularity and is well known today, as evidenced by the fact that it is played in over 35 countries in the world (Frère 2007). As a result of this dynamic development AMP Football was recognized by FIFA as a variant of football (Wegner, Kalinowski 2015, FIFA 2017).

In the game, the rules are the same as in FIFA's football with some exceptions, related to the selection of the team. It is worth recalling that goalkeepers are after amputation or with a congenital defect of the upper limb, while athletes are either after the amputation or with congenital defect of the lower limb. Possible changes are made by the World Amputee Football Federation (Frère 2007).

The technical elements of AMP Football include: maintaining the balance needed to build proper coordination, running, fast turns, jumps, sidesteps, passing the ball, controlling the ball, following the ball, avoiding the opponent, hitting the ball with the head, goal shots (Arnason et al. 2004, Genç 2007). Undoubtedly the football training of amputee players improves efficiency, endurance, coordination. Playing Amp Football also has an impact on enhancing self-confidence (Lisytsyn 2007).

Sports for the disabled can be understood and seen in many ways: from the form of rehabilitation to professional sport. In the case of disabled people, it is an Adapted Physical Activity, under which the Adapted Sports exist (Koper, Tasiemski 2013).

In the case of soccer after amputation, the benefits are undoubtedly multiple. It functions as rehabilitation, but many athletes treat this sport not only as a recreational activity, but as an exercise, finding the meaning of life again. With the training volume that is found in competitive sport, it is impossible to design workloads without planning. It is necessary to always set the right workload and train athletes in such a way that their training and sports goals are met, and in the case of people with disabilities also a therapeutic goal is being achieved. However, in order to achieve this, the generally applicable training rules musts be obeyed. These include well-chosen tests for the control and evaluation system (Ważny 1999, Reilly 2007) and the development of a model that characterizes training and initial loads based on several different components (Baangsbo, Michalsik 2002, Impellizzeri, Rampinini, Marcora 2005, Konarski et al. 2012).

These undoubtedly include the traversed the distance and the achieved speed, biochemical parameters, registration of tactical solutions, etc. (Tomáš et al. 2014, Bujnovsky et al. 2015, Podgórski et al. 2015, Andrzejewski et al. 2017). Such observations, however, require special equipment that is sometimes available only in big rich clubs but thanks to cooperation on different level "*nothing is impossible*" and example of such cooperation is presented during this investigation. One of the alternatives, with some limitations, is the registration of internal workloads using heart rate and energy expenditure (Konarski, Matuszyński, Strzelczyk 2006, Konarski, Strzelczyk 2009), which is also necessary for disabled athletes. The need for heart rate monitoring among this group of athletes is also noted by other authors (Roy et al. 2006, Kowalski, Bolach, Kowalski 2012).

For people with a disability to exercise sport, it is easy for overstraining and injury. Therefore, it is necessary to try to determine the initial loads and to develop optimization standards for the training of AMP Football athletes. As already mentioned, there have been thus far very few works devoted to amputee football. This work is the first considering the initial loads of AMP football players. Similar research was conducted mainly among able-bodied athletes (Esposito et al. 2004, Dellal et al. 2008, Konarski 2010 Belka et al. 2014),

It is also possible to find individual studies on people with disabilities (Barfield et al. 2005, Bolach, Stańdo, Bolach 2015), but they concern mostly people in wheelchairs, usually after spinal cord injury, whose cardiovascular system reacts differently to the effort (Piesiewicz et al. 2009).

Conducting a research to optimize sports training among people with disabilities seems to be particularly important because of the changed capacity of the body,

the internal load will be different from that of athletes without disabilities. The research is designed to provide more precise, optimal and amputation-friendly options, to prepare athletes for sports and to reduce the risk of injury.

Thus far, a significant number of studies have been published that address the topic of training optimization and characterizing the internal loads among athletes without disabilities.

Among the high-performance athletes practicing field hockey during the game the average heart rate tested with a Polar pulsometer oscillated between 130.7 ± 8.52 and 123.7 ± 10.04 in subsequent games, with a maximum heart rate of 186 ± 6.53 and 182, respectively, 5 ± 6.75 in the second measurement, which the authors interpret as high physiological requirements for athletes during the game (30 Konarski 2006; Astrand & Rodahl 1987). Similar HR values were obtained in the same group in 2010 (average HR M = 135 beats/min, maximum HR M = 187 beats/min) (Konarski 2010).

In own research, Amp Football athletes achieved a mean heart rate of 132.6±10.56 bpm, while the maximum values were 182.3±10.69 bpm, which means that the average HR values maintained during the game were higher than those of field hockey players and the maximum values were comparable (Astrand, Rodahl 1987, Konarski, Matuszyński, Strzelczyk 2006). This demonstrates the very heavy workload of disabled athletes, and also shows how much training demands they are facing.

When examining the leading female handball players from the Czech Republic Belka et al. (Belka et al. 2014) observed a decrease in mean heart rate in the second half compared to the first half, but this difference was not statistically significant. A similar tendency was observed in the course of own research on Amp Football players.

Belka et al. (2014) also observed very high intensity during the handball match - the average intensity during the matches was 90% HR max. Athletes maintained an intensity above the threshold of anaerobic transformation for more than 80% of the duration of the meeting. The HR values measured by the Polar pulsometer were 184.8 ± 7.4 bpm and 184.5 ± 7.2 bpm respectively in the first half. However, it should be noted that goalkeepers did not participate in the study, the age of the study group was 17.9 ± 0.3 years, and each of the players remained in the game for about 14.5 minutes in each half, rest time was not taken into account, which can partly explain such high mean HR values. Regardless, it is important to recognize that handball is a sport characterized by intense interval effort.

In the Bujnovski et al. (2015) study, the Polar pulsometer was used to assess the internal load of football players according to their position. The study was conducted among players at the highest level in the Czech Republic during three international training matches. Researchers have observed differences in internal physical load during the game depending on the player's position. In the own research on Amp Football players, the HR value of the players in all field formations showed lower values in the second half compared to the first half. The average and maximum HR values in the study of Bujnovski et al. (2015) throughout the football match of the able-bodied players were, respectively, among defenders: mean M = 165±3.1 bpm, max M = 181±3.5bpm; central defenders: mean M = 166±4.0bpm, max M = 184±4.5bpm; midfielders: mean M=160±2.5bpm, max M=179±3.1bpm; central defenders: mean M=170±4.6 bpm, max M = 187±3.8 bpm; forwards: mean M=159±2.5 bpm, max M=178±2.5 bpm. In own research, the athletes with amputations obtained HR values depending on their position: forwards: mean 134.6±5.41 bpm, max: 183.0±8.43bpm; midfielders: mean 136.2±7.40bpm, max 188.2±3.11 bpm defenders: mean 128.3±17.79 bpm, max 177.3±8.14 bpm; goalkeepers: mean 125.0±18.38 bpm, max 173.0±26.87 bpm.

Amp Football players were characterized by lower average HR values and very similar HR max values across all field formations compared to able-bodied players.

It is worth noting that the pulse values achieved by players after amputations are not significantly different from the values achieved by able-bodied athletes of different team sports, and max HR are often even higher than those of athletes without disabilities, confirming the view that training loads in modern sports of people with disabilities are similar to those faced by athletes without them (Koper, Tasiemski 2013). Among the research on disabled athletes, as mentioned above, most of the studies were conducted on athletes in wheelchairs. Due to the involvement of only the upper body muscles during such efforts and a different reason for the disability than amputation, the obtained results should not be compared. However, due to a similar study area, works of similar subject with the participation of persons with disabilities are listed below. Kowalski et al. (2012) studied pulse patterns in athletes of the Sport Club "Start Wroclaw" playing basketball in wheelchairs during the general training subperiod. Among the investigated basketball players were also athletes after the amputation of the lower limbs. Pulse values, as in our presented study, were recorded using a Polar sport tester. Researchers in their study found that there is a relationship between the heart rate and the athletic class. The effect on both resting and stressed heart rate was also observed in terms of the player's experience.

Research on the workload of athletes with disabilities was also conducted by Roy et al. (2006). They monitored the heart rate of tennis players playing in wheelchairs during the game. Some athletes also had amputation of the lower limbs. In addition, researchers estimated the maximum consumption of the oxygen (VO_2max). They have shown that tennis players in wheelchairs should do fitness training outside of the court game itself, as there is a significant cardiovascular burden during the match.

The above considerations indicate there is still a considerable area of ignorance regarding the optimization of the training process of people with disabilities in various sports. The research presented is one of the first to fill this gap. Characterizing the effort during the match will allow to diagnose and determine the nature of the work that must be done during the preparation and playing season to meet the specific requirements of the discipline. It can be expected that these reports will contribute to the improvement of the training process for AMP Footballer players and that they will be of interest to researchers in the field of optimization of sport training of the disabled people.

6. Conclusions

The analyzes of data let to present the following conclusions:

1. It has been observed that in the studied parameters higher values of mean heart rate and energy expenditure occurred in the second half of the analyzed match.
2. Players were characterized with a higher level of the maximum heart rate in the second part of the meeting.
3. This pilot study, has also shown that it is very important to continue research on the dependence of the startu-up load ant the effectiveness of the annual cycle of preparations.

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