Original Article

Comparison of influence of eight-week preparatory period on changes in selected morphological parameters in seventeen-year-old football and ice hockey players

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Abstract:

Sport training in elite athletes has an effect on the degree of adaptation of many body systems. One of the important categories, where adaptation changes can be observed, is the area of somatic characteristics. The aim of this paper is to identify the changes in selected morphological parameters in seventeen-year-old football and ice hockey players with regard to eight-week fitness training. The research included young football players (n = 21) and ice hockey players (n = 39) aged 17.00 to 17.99 of top performance level. To determine body composition by the BIA method we used the Tanita BC-418 MA instrument. The BIA measurement and anthropometric examination were carried out in accordance with the recommended domestic and international standards of the International Society for the Advancement of Kinanthropometry. During the investigation we monitored nonsignificant changes in the morphological parameters with a small to medium effect size in seventeen-year-old boys of both sports specializations with regard to the duration of sport training during an eight-week period. Larger differences in the changes in the monitored morphological parameters were observed in young ice hockey players compared with football players. The presented outcomes document specific changes in selected morphological parameters with respect to intensive fitness training during an eight-week period in seventeen-year-old football and ice hockey players. The findings enrich the theoretical knowledge in this area and are well applicable in the optimization of the training process of young athletes of the selected specializations.

Key words: physical parameters, elite sport, Juvenis, sport training

Introduction

Elite sport is closely linked with performance, which is the essence of it and without which elite sport would be meaningless. Therefore, maximum performance is the ultimate goal in performance and elite sport. During the past decades there have been significant changes in world sport with a direct effect on the evolution of the training process. The progress is driven by the constant increase in the number of competitions, high financial incentives for elite players, closer cooperation between coaches, and the introduction of modern sports technology and training methods (Issurin, 2010). It is obvious that all of these changes are reflected in the training process and subsequently in the actual game performance of a football or ice hockey player.

Football is of an intermittent load character with changes in physical load (Bujnovský, Malý, Zahálka, & Malá, 2015). Running at high to maximum speed (lasting 30-90 seconds) is followed by running at medium speeds (lasting 3-6 s) or intervals of a lower intensity activity – standing, walking, jogging, running at lower speeds (lasting up to 10 seconds). Lower intensity intervals outweigh high and maximum speed running intervals and are of a recovery nature (Psotta et al., 2006). Individual activities change 10-15 times per minute (Ekblom, 2003). An elite football player covers 10-11 km during a 90-minute match, a goalkeeper covers 4km (Stølen et al., 2005). Average oxygen consumption (VO_2) during a match is 70-75% of maximum oxygen consumption ($\text{VO}_{2\text{max}}$) of a player and corresponds with exercise intensity of 5-10% below the anaerobic threshold (Psotta et al., 2006). Currently in soccer, a player's strength, speed and endurance are an extremely important components in terms of an active approach in both offensive and defensive phases, which are characterised by an involvement of a greater number of players (Malý, Zahálka, Malá, & Teplan, 2014).

Ice hockey is one of the fastest and most demanding sports games. From a physiological perspective, ice hockey is an interval and intermittent type of physical activity, which requires a wide range of motor skills, reaction and decision-making abilities, quality and coordination of analysers, and a high level of overall fitness. The game itself is characterized by changing cyclic (skating) and acyclic physical activities (shooting). Short periods of maximum acceleration and sprint alternate with smooth skating, personal challenges, passing and shooting. An ice hockey match is of an interval character represented by approximately 50-60 second periods of load intermitted by 10-20 second periods. The load-rest ratio is usually 1: 3 to 1: 5. The total active time of a player in a match is on average 20 minutes of net time. Average heart rate (HR) during the game is around 170 to

175 beats/min. and during rest 120 beats/min. In players of junior age the average HR on the ice achieves 90% or more during each shift. On average, the players use 70-80% of their maximum aerobic power; there are differences due to various skating levels of individual players. Physiological demands on the players vary depending on the position of each player in the team (goalkeeper, defender, forward) and their playing style (Brocherie et al., 2005; Hoff et al., 2005; Manners, 2004; Montgomery, 2006; Quinney et al., 2008; Sigmund, Kohn, Sigmundová, in press; Vescovi et al., 2006).

The facts mentioned above have an effect on the structure of sports training with regard to sports specialization. Period around seventeen years of age goes concurrently with period of significant development morpho-functional parameters. In this period it is possible to gradually maximize burden teenage body, of course, always with respect to the healthy development of individuals. Impact load is then reflected in the level of development of individual morphological of young athletes. The training of an ice hockey player should focus especially on the development of strength, along with the development of anaerobic performance (Burr et al., 2008). Furthermore, training should focus on the development of aerobic endurance, speed abilities and agility, also in football players with a general effort for transfer into playing practice (Behm et al., 2005; Hůlka, Bělka, Cuberek, & Schneider, 2014; Psotta et al., 2006; Wong et al., 2010; Zemková & Hamar, 2014). In football, the main components of football specific fitness include acceleration, anaerobic repeated sprint ability and explosive power of the lower extremities. These components are, in particular, associated with the production of dynamic force during running, turns, kicking, jumping, tackling and maintaining balance (Psotta et al., 2011; Stølen et al., 2005). A precondition for achieving a high performance level is the greatest possible development of these motor skills and physiological parameters. The development of these parameters is supported primarily by fitness training.

The effect of sport training is also reflected in the level of development of individual morphological parameters. The values of the development of physical parameters in athletes usually differ from the values of the common population. The differences in values between athletes and the common population increase with increasing age of athletes and length of their training (Malina, Bouchard, & Bar-Or, 2004). Physical parameters represent an important part of the structure of sports performance and significantly contribute to the overall performance of an ice hockey and soccer player. The optimal development of physical parameters that predict possible success in the sport specialization, or rather optimal adjustment of training process should take into account various gaming positions and players' roles. Similarly, athletes of various sports disciplines differ in physical parameters because for each sports discipline specific morphological dispositions are appropriate (Kostopoulos, 2015; Kutáč, 2013; Sigmund et al., 2014).

The aim of this paper is to identify the changes in selected morphological parameters in seventeen-year-old football and ice hockey players with regard to eight-week fitness training.

Material & methods

Subjects

The research included young football players ($n = 21$) and ice hockey players ($n = 39$) aged 17.00 to 17.99 of top performance level. The eight-week fitness training was taken by football players in January – February, and by ice hockey players in May – July in 2014. The ice hockey players took the entire training off ice.

Measurement

To determine body composition by the BIA method we used the Tanita BC-418 MA instrument (Tanita, Japan). The BIA measurement and anthropometric examination were carried out in accordance with the recommended domestic and international standards of the ISAK (Heyward & Wagner, 2004; Hume & Marfell-Jones, 2008; Marfell-Jones et al., 2006). The anthropometric survey used the following instruments: body height was determined by the A-213 anthropometer (Trystom, Czech Republic) with a permissible measurement error of 0.5 cm; body weight was measured by the Tanita BC-418 MA instrument (Tanita, Japan) with a measurement accuracy of 100g; body circumferences (chest, abdomen, gluteal, arm, thigh) were measured by a medical flexible tape (Holtain, UK).

Statistical analysis

Statistical result processing was conducted using the Statgraphics programme v. 10.0 (Statistica, Tulsa, USA). For each variable, basic statistical quantities were calculated and distribution normality verified. To assess the differences and rate of significance between the sets, the Student t-test was used. The level of statistical significance was tested at $p \leq 0.05$; $p \leq 0.01$. Effect Size was expressed in Cohen's d values, and defined as a difference between two means divided by a standard deviation for the data. The most frequent assessment of effect size d is 0.2 – small effect, 0.5 – medium effect and 0.8 – large effect (Thomas, Nelson & Silverman, 2011).

Training programme

The training programme is shown in Table 1. The quantification represents an estimate of the exercise during the monitored eight-week fitness training. This is a qualified expert estimate by head coaches and coaches who performed the entire fitness training with the players. All coaches have the top coaching licence in their sports specializations.

Table 1. Indicators of training load during the preparatory period (8 weeks) of observed young football and ice hockey players

Type of training (17.00–17.99 yrs.)	Football (min.)	share (%)	Ice Hockey (min.)	share (%)
<i>Fitness training</i>				
Power training	565	14.3	1 200	26.9
Anaerobic training	185	4.7	520	11.7
Aerobic training	880	22.3	680	15.2
<i>Skill-oriented training</i>				
Technical and tactical training	490	12.4	600	13.5
Training game	575	14.5	420	9.4
Fitness swimming	-	-	240	5.4
Regeneration	360	9.1	800	17.9
Match	900	22.7	-	-
Total (min.)	3 955	100.0	4 460	100.0

Results

Tables 2 and 3 present the values of the first measurement, second measurement and the changes in selected morphological parameters in seventeen-year-old football players (Table 2) and ice hockey players (Table 3) in the context of intensive eight-week fitness training.

During the investigation we monitored generally nonsignificant changes in the monitored morphological parameters with a small to medium effect size in seventeen-year-old boys of both sports specializations. Larger differences in the changes in the monitored morphological parameters were observed in young ice hockey players compared with football players.

Table 2. Morphological parameters in seventeen-year-old football players before and after the preparatory period (8 weeks)

Morphological parameters	$M \pm SD$	$M \pm SD$	Δ	p	d
	1 st measurement	2 nd measurement			
Body height (cm)	180.6 $\pm$ 4.22	180.9 $\pm$ 4.23	0.3	ns	0.07
Body weight (kg)	72.2 $\pm$ 6.85	72.8 $\pm$ 7.07	0.6	ns	0.09
BMI (kg/m ²)	22.1 $\pm$ 1.56	22.1 $\pm$ 1.51	0.0	ns	0.00
BMR (kcal)	1 802 $\pm$ 127	1 811 $\pm$ 135	9.0	ns	0.07
FFM (kg)	61.1 $\pm$ 5.23	62.6 $\pm$ 5.87	1.5	ns	0.27
Body fat (kg)	7.4 $\pm$ 2.16	6.4 $\pm$ 2.14	-1.0	ns	0.47
Body fat (%)	10.2 $\pm$ 2.63	8.6 $\pm$ 2.52	-1.6	ns	0.62
Cf. chest (cm)	89.1 $\pm$ 4.56	88.3 $\pm$ 4.53	-0.8	ns	0.18
Cf. abdomen (cm)	76.8 $\pm$ 5.89	76.7 $\pm$ 5.82	0.1	ns	0.02
Cf. gluteal (cm)	89.5 $\pm$ 6.74	90.1 $\pm$ 6.99	0.6	ns	0.09
Cf. arm contr. dx. (cm)	30.0 $\pm$ 1.53	29.6 $\pm$ 1.61	0.4	ns	0.25
Cf. arm contr. sin. (cm)	30.0 $\pm$ 1.62	29.5 $\pm$ 1.54	0.5	ns	0.32
Cf. middle thigh dx. (cm)	52.9 $\pm$ 2.12	53.6 $\pm$ 2.11	0.7	ns	0.33
Cf. middle thigh sin. (cm)	53.0 $\pm$ 2.19	53.8 $\pm$ 2.19	0.8	ns	0.37

Legend: BMI–body mass index; BMR–basal metabolic rate; FFM–fat free mass; Cf.–circumference; contr.–contraction; dx.–dextra; sin.–sinistra; M–mean; SD–standard deviation; Δ –differences; p –statistical significance; ns–non significant; d –effect of size (Cohen)

Table 3. Morphological parameters in seventeen-year-old ice hockey players before and after the preparatory period (8 weeks)

Morphological parameters	$M \pm SD$	$M \pm SD$	Δ	p	d
	1 st measurement	2 nd measurement			
Body height (cm)	180.6 $\pm$ 4.68	181.2 $\pm$ 4.56	0.6	ns	0.13
Body weight (kg)	76.7 $\pm$ 5.96	78.6 $\pm$ 6.27	1.9	ns	0.31
BMI (kg/m ²)	23.7 $\pm$ 1.78	24.0 $\pm$ 1.83	0.3	ns	0.17
BMR (kcal)	1 859 $\pm$ 142	1 877 $\pm$ 156	18.0	ns	0.12
FFM (kg)	66.5 $\pm$ 6.74	69.3 $\pm$ 7.19	2.8	ns	0.40
Body fat (kg)	9.9 $\pm$ 3.15	8.7 $\pm$ 2.83	-1.2	ns	0.40
Body fat (%)	12.8 $\pm$ 5.19	10.9 $\pm$ 4.07	-1.9	ns	0.41
Cf. chest (cm)	97.4 $\pm$ 4.35	98.3 $\pm$ 4.29	0.9	ns	0.21
Cf. abdomen (cm)	82.4 $\pm$ 5.12	81.3 $\pm$ 4.87	1.1	ns	0.22
Cf. gluteal (cm)	95.7 $\pm$ 5.34	96.5 $\pm$ 5.38	0.8	ns	0.15
Cf. arm contr. dx. (cm)	33.1 $\pm$ 1.64	33.8 $\pm$ 1.72	0.7	ns	0.42
Cf. arm contr. sin. (cm)	32.5 $\pm$ 1.82	33.1 $\pm$ 1.63	0.6	ns	0.35
Cf. middle thigh dx. (cm)	55.4 $\pm$ 3.10	56.5 $\pm$ 3.21	1.1	ns	0.35
Cf. middle thigh sin. (cm)	55.7 $\pm$ 2.87	56.9 $\pm$ 3.05	1.2	ns	0.41

Legend: BMI–body mass index; BMR–basal metabolic rate; FFM–fat free mass; Cf.–circumference; contr.–contraction; dx.–dextra; sin.–sinistra; M–mean; SD–standard deviation; Δ –differences; p –statistical significance; ns–non significant; d –effect of size (Cohen)

Discussion

The study compares a possible effect of intensive fitness training between the mentioned sports specializations with identical training duration, i.e. eight weeks. During this period the monitored players underwent regular exercise, the basic parameters of which are specified in Table 1. A comparison of the volume of exercise shows that training of young football players focuses especially on the development of aerobic endurance and playing skills. In young ice hockey players this particularly includes the development of a complex of strength, anaerobic capacity and agility (Brocherie et al., 2005; Burr et al., 2008; Hoff et al., 2005; Psotta et al., 2006; Quinney et al., 2008; Sigmund, Kohn, Sigmundová, in press; Stølen et al., 2005; Vescovi et al., 2006). With regard to the difference in the fitness training, one could assume different changes in selected morphological parameters.

The changes in the values of body height will not be commented on in detail as this is a basic somatic characteristic under a strong endogenous influence. The overall changes in the values of body weight in our samples as a result of the eight-week fitness training are marked by an increase of 0.6 to 1.9 kg, with higher changes observed in young ice hockey players. Similar values of body weight increase were also observed in other studies (Sigmund, Dostálová, & Brychta, 2013). In a study Psotta et al. (2012) focusing on motor and morphological changes in relation to high-intensity eight-week fitness training in an adult professional player of the Canadian-American NHL, the authors reported a body weight increase of 0.6 kg. Thus it is apparent that in younger age categories the changes in body weight are more significant. On the contrary, in nineteen year-old football players a decrease in body weight by 0.7 kg was observed (Botek et al., 2010). The data on the development of body weight with respect to fitness training seem incomplete unless we know the changes in the mutual ratio of individual body fractions, particularly between fat-free mass and body fat.

The proportion of body fat in our sample ranges between 10 and 13%. In general, the percentages of body fat have a decreasing tendency. In football players there was a decrease by 1.6%, which represents an absolute value of 1 kg, and overall proportion of body fat of 8.6%. In ice hockey players we observed a decrease in the proportion of body fat by 1.9% (absolute value of 1.2 kg), overall proportion of body fat being 10.9%. The comparison of the fat proportions in seventeen-year-old football and ice hockey players revealed similar values, yet the result was achieved by means of a different quantity and structure of exercise. During the same eight-week period, ice hockey players underwent fitness training of 4.460 minutes, where almost 40% was represented by strength and anaerobic training. Football players took a smaller amount of training (3.955 minutes) with the highest proportion of aerobic training and training matches included in the overall fitness training. These facts are also reflected in the changes in fat free mass (FFM) proportions. In young football players we observed a total increase in FFM by 1.5 kg. In ice hockey players, the increase is almost double, specifically 2.8 kg. We assume that especially the changes in FFM proportion, expressed mainly by increased skeletal muscles, significantly correspond with the identified differences in the fitness training between seventeen-year-old

football players and ice hockey players during the eight-week intensive fitness training. In nineteen-year-old football players, an opposite trend was observed; during fitness training a slight increase in absolute as well as relative proportion of body fat and a decrease in FFM were observed (Botek et al., 2010). In the context of these and other findings, the authors of the study conclude that the changes in the monitored parameters are not considered crucial with regard to individual playing performance in football players. At the same time however, they emphasise the fact that the traditional model of training young football players does not lead to the desired changes in physical parameters (Botek et al., 2010). The assessment of selected morphological parameters in our samples (Tables 2, 3) suggests that this type of training has rather positive effects and indicates good readiness of the players for the next season.

Regarding the fact that the measurements were performed at the beginning and at the end of the preparatory period, it is not clear in which part the largest decrease in body fat and increase in fat free mass took place. As a result, a topic for discussion may be the effect of individual training stages. In a study of the effect of fitness training on the changes in body fractions in a player of the Canadian-American NHL, the authors revealed that as much as 80% of the changes took place during the first half of fitness training, i.e. during the first four weeks (Sigmund, Brychta, & Dostálová, 2013). This provides space for further research studies focusing on the assessment of the effects of fitness training in various sports specializations.

Regarding possible limitations of the paper and the design of the research, the authors are aware that it is impossible to clearly define the effect of specific variables that could causally explain the findings presented. The authors believe that the main contribution of the present study lies in practical implementation of the findings in the area of sports practices in the particular specializations. From a research perspective, further hypotheses emerge, the validity of which should be tested.

Conclusions

The present study examined the changes in selected morphological parameters in relation to training program in the preparatory period in seventeen-year-old male footballers and ice hockey players. We observed nonsignificant changes in the monitored morphological parameters with a small to medium effect size in both sports with regard to the duration of fitness training during an eight-week period. Larger differences in the changes of the monitored morphological parameters were observed in young ice hockey players compared with football players. The presented outcomes reflect specific changes in selected morphological parameters with respect to a limited period of intensive fitness training in boys of the selected age category of various sports specializations. The findings enrich the theoretical knowledge in this area and are well applicable in the optimization of the training process of young athletes of the selected specializations.

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