



## REFLECTIONS ON THE CHANGES OBSERVED IN THE STRUCTURE OF MOTOR SKILLS IN YOUNG ATHLETES

doi: 10.2478/humo-2013-0027

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### ABSTRACT

**Purpose.** The main objective of the study was to discern what trends are present in the structure of motor skills in young athletes by analyzing a group of basketball players within a context of their sports-specific training. **Methods.** Data were collected over a five-year period between 2006–2010 from 82 young Polish basketball players aged 15–16 years. In order to determine their motor skill level, the International Physical Fitness Test (IPFT) was administered. Basic somatic parameters, such as height, weight, and body mass index, were also recorded. **Results.** Analysis of the significant differences between the mean IPFT scores for each year found relatively few statistically significant changes. No statistically significant changes were noted for somatic build. For motor skill level, an upward trend was found for speed, lower limb strength, arm strength, hand strength, abdominal endurance, and agility. Total IPFT scores for each subsequent year indicated a systematic improvement of the participants' general physical fitness levels. **Conclusions.** Despite only few of the results being statistically significant, the general trend of the changes in physical fitness levels is easily observed. Apart from the issue around the selection of surrounding selecting individuals to play in competitive sports, and in particular in which specific sports discipline, it was found that the training loads (such as the one used in boys basketball) have in most cases a positive impact on general physical fitness.

**Key words:** young athletes, basketball, structure of motor skills

### Introduction

Participation in sports play a very large role in the lives of both adults and children. For adults, the practice of various types of sports disciplines does not necessitate meeting any specific prerequisites to being trained. All that is required is meeting the minimal physical, mental, psychological fitness requirements for a given sport. For children and even adolescents, participation in sports is a far more complicated matter. This is especially so when taking into account their participation in the realm of competitive sports, as it is necessary to consider that during these early years of life the body undergoes numerous physical, structural, hormonal, emotional, and psychological changes. As a result, it is important that the athletic training of children and adolescents take into consideration their various phases of development.

In all regards, sports for this age group should be treated as part of a gradual, long-term developmental process, all the while keeping in mind the “importance of not disturbing the natural rhythm of their development, only stimulating it to follow in the direction of a future sports specialization so as to achieve not only superior results when at full maturity but also the promoted behavior needed to maintain a successful sports career” [1, p. 34].

Nonetheless, it is well known that the training period children and adolescents undergo when they are still young is one of the most important steps and components that can decide on their future success as adult athletes [2]. The level of preparation put in learning various abilities in this period is known to determine the effectiveness of learning and perfecting technical skills, to have a profound impact on the efficiency of tactical play, and to affect mental disposition [3–5]. Furthermore, the type and level of physical preparedness an athlete possesses is based on a cumulative effect of both the development and shaping of their individual motor skills and abilities. This, however, is not a simple calculation but a specific functional model dependent on such conditions as featuring correct motor development or initial motivation [3, 6].

The conceptual model of the motor preparation of children and adolescents has over the past decades undergone significant change. One of the main factors determining this change was the advancement of knowledge on the body's functional adaptations to physical activity and ontogenic background of motor development. In addition, the demands placed on the body when practicing various types of sports have changed [7–10]. Such contemporary knowledge induces one to reflect on the training methodology that has been presently employed at early stages of sports training. This stems from practical problems that have arisen from a lack of a precise characteristics on the interactions of training stimuli, a lack of differentiation in regards to the development of individual abilities, and an incom-

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patibility with the natural dynamics of the systematic transformations that occur during puberty. Furthermore, there is the notion that training exercises do not generally effect the body but instead involve specific functional mechanisms leading to specific and not general adaptive changes [10, 11].

This prompts us to consider what relationships exist between general workouts and sports-specific exercises in the sphere of athletic training. It seems that in many cases the principle of applying general workouts is considered to be rather marginal, due to the relatively low effectiveness of such general workouts as well as the problems faced by coaches that require them to specify what concrete measures should be used all the taking into consideration the individual dynamics of motor skills development. Therefore, it seems easier to follow the principles of sports-specific training, or otherwise known as specialized training. Of some assistance, in this regard, should be the use of training stages and their related goals on completing process tasks, which can also help determine the relationship between general and sports-specific training [12, 13].

In light of the above, it can be assumed that sports effectiveness involves one to possess a sufficiently high level of general physical fitness. This is reflected by the division of the entire training process in various stages, beginning with a general fitness regime followed by targeted and then specialized training, with the aim of the targeted stage to “focus training on recognized predispositions and profiling potential motor abilities as a functional base for future specialization” [14, p. 179].

The physical fitness profile of a youth athlete is dynamically shaped throughout the entire period of maturation (puberty). Its development is thus determined by a dynamic system of functions and not static components of recognized motor abilities. From this point of view, training conducted during the growth spurt should be directed towards improving general physical fitness and only later should start developing specialized skills when the dynamics of physical changes that occur during puberty diminishes [1, 9, 14–18].

The above considerations, though themselves largely accepted, are in the realm of sports training often overlooked. Although the role of sports in stimulating body development is well known, we often forget that simply increasing training load in specific areas only leads to temporary gains. Hence the training process in sports require constant monitoring, where competitive scores and rankings cannot be the sole criterion for ascertaining a young athlete’s improvement [2]. Reviews, evaluations, and eventual corrections of the training process should include such factors as biological development, motor potential, functional capacity, motor abilities, (technical) motor skills, inner motivation, accrued knowledge about the sport, the will to persist, and endurance levels. Only such a system of checks on training effectiveness can allow a coach to individually optimize the type of training and intensity for his/her players.

In light of the above considerations, the aim of this study was to determine what trends exist among the structure of motor skills and motor skill level by analyzing a group of young basketball players over a five-year period by taking into account the general fitness tasks they perform aimed at forming a functional and technical basis but also those that take into account the basic adequate prerequisites for a player’s intended specialization for an individual at this stage in training.

The use of young basketball players for verifying this issue is due this being a discipline featuring the most complex movement structures. In this regard, realizing the potential of complex motor activities, learning new motor acts, and the plasticity of ingrained habits all require a high level of concentration abilities, which themselves significantly determine the mastery, improvement, and effective use of technical skills [19–21].

### Material and methods

Data were collected over a five-year period (2006–2010) on a group of talented young basketball players from the province of Greater Poland, all of whom were competing in the Youth Sports System program as members of their local Provincial Junior Team. The sample consisted of 96 young basketball players 15–16 years of age. However, only the results of those who participated in all physical fitness tests were subjected to analysis, which amounted to 82 boys (Tab. 1).

The study was conducted in partnership between the University of Physical Education in Poznań and the Greater Poland Sports Association. Data were collected each year in the second half of March, with all tests performed on the University premises. The specific days when measurements were taken were subject to the training calendar of the participants as they belonged to different basketball clubs.

The participants themselves were a select group of young basketball players who were some of the best players in the province of Greater Poland and were engaged in pre-season training at loads typical of this age group (‘cadet’ level). The training objectives at this phase of the training process were focused on strategic (theory and in competition), tactical (use of different plays), and operational (exercises) goals [22]. The participants’ weekly training volume was on average eight hours, with approxi-

Table 1. Number of participants over the course of the study

Year of research	Boys ( <i>n</i> )
2006	16
2007	17
2008	17
2009	16
2010	16
	82

mately 40 games played in a season. The end of the study (in 2010) coincided with Greater Poland Cadet A-League championships, in which participants' teams played on average 20 games. The participants' overall training program at this point in time was focused on improving their individual technical-tactical skills in both offensive and defensive play and was also aimed at preparing them for the basketballs finals in the National Junior Olympics that were to be held at the end of April 2011.

The structure of the participants' motor skills and their motor skill level was assessed using of the International Physical Fitness Test, a test battery that consists of eight basic components allowing for a comprehensive physical fitness assessment. Its origins date back to the 1964 Olympic Games held in Tokyo, Japan. On this occasion, the International Committee on the Standardization of Physical Fitness Tests was organized to unify and standardize the methods available for assessing physical fitness levels. After many years of work, the end result was then finalized and approved at a conference held in Oxford, England. Today, after a history of more than 40 years, the International Physical Fitness Test is often criticized as outdated. However, it is still widely used by many coaches and researchers as an uncomplicated tool in measuring motor skill performance [23]. In Poland, it is also recommended by the Ministry of Sport and Tourism as a useful gauge in determining the physical fitness levels of young athletes.

Measures of participants' motor skill level and flexibility were performed in accordance with the recommendations set forth by the International Physical Fitness Test [24]. **Speed** was measured by the 50 m speed test (also known as a sprint test); **endurance**, based on the 1000 m run; and **agility**, evaluated by a 4 × 10 m shuttle run. Measures of strength included evaluating **lower limb explosive strength** by the standing long jump and **abdominal endurance** with the 30-s sit-up test. **Grip strength** was measured by a hand dynamometer, while **upper limb and shoulder strength** with the bent-arm hang or a pull-up test on a bar. **Trunk flexibility** is an anatomical feature of the body that describes the range of movement of the spine and hip and was measured by the standing forward bend.

The results obtained for each test component were then converted to a 0–100 point scale (based on a T-scale) depending on chronological age, as for young athletes this is one of the main selection criterion for joining different training groups at various stages of training. It was for this reason the scores were not age-adjusted for body height, which is used as an indicator of somatic development. The results were then compared to the norms proposed by Pilicz et al. (Tab. 2).

Basic somatic parameters such as body height and mass were also measured and used to calculate the participants' BMI [25].

Basic statistical methods were used to analyze the obtained scores, which included calculating the arith-

Table 2. Classification of physical fitness level (International Physical Fitness Test) [24]

Physical fitness level	Point range (regardless of age or sex)
High	481 and above
Average	320–480
Low	319 and below

metic means, standard deviations, and minimum and maximum values. Significant differences between each year's mean scores were calculated by Tukey's Honestly Significant Difference (HSD) test [26].

## Results

The descriptive characteristics of the results for each year are presented in Table 3 and include the means, standard deviations, and minimum and maximum values. The results from the International Physical Fitness Test for each individual are provided as point values standardized for age.

Analysis was first performed on the significant differences between the mean results by employing Tukey's Honestly Significant Difference test [26], with the results presented in Table 4.

Analysis of the significance of differences between the mean scores in the following years of research found statistically significant differences between 2006 and 2007 (based on the total number of points on the IPFT) as well as between 2009 and 2010 (hand strength and agility capabilities).

Based on the assumption that the differences in the results during the analyzed period may have unevenly progressed, as confirmed by the age-related differences (Tab. 4), it was decided to determine what trends were present in terms of the development of the analyzed parameters. Using the method of least squares, the time frame of these changes were plotted as first- or second-degree polynomials [26], with the results presented in Figures 1–12.

The presented figures show that the parameters characterizing somatic build in the subsequent years of the study are similarly shaped, with the curves characterized by a sinusoidal pattern, finding a coefficient of determination ( $R^2$ ) between 74% to 98%.

With regard to motor skill levels, as determined by using the International Physical Fitness Test, an upward trend was noted in terms of running speed (50 m run), lower limb strength (standing long jump), arm strength (pull-ups), hand strength (dynamometer), abdominal endurance (sit-ups), and agility (4 × 10 m shuttle run). However, the opposite was found when analyzing the results of the endurance race (1000 m run). The relatively low level of resistance to fatigue steadily declined from 2008, which contrasted to the steady increase observed

Table 3. Statistical characteristics of the scores attained over the course of the study

Year		Body height	Body mass	BMI	50 m run	Long jump	1000 m run	Hand grip strength	Pull-ups	4 × 10 m run	Sit-ups	Standing forward bend	IPFT score
		cm	kg	kg/m <sup>2</sup>	pts.	pts.	pts.	pts.	pts.	pts.	pts.	pts.	pts.
2006	Mean	183.19	72.16	21.48	57.06	57.94	55.31	56.25	20.63	59.50	55.31	54.00	383.63
	Minimum	163.00	50.00	17.84	47.00	40.00	42.00	45.00	0.00	53.00	41.00	31.00	344.00
	Maximum	196.50	84.00	25.28	64.00	73.00	64.00	68.00	52.00	66.00	79.00	70.00	432.00
	Standard deviation	9.41	8.82	1.94	4.55	10.22	5.68	5.90	24.37	3.97	10.73	12.02	26.19
2007	Mean	179.74	66.81	20.57	58.38	57.75	56.13	52.06	31.38	62.56	58.38	53.88	430.50
	Minimum	159.50	49.50	18.50	49.00	43.00	33.00	37.00	0.00	48.00	45.00	29.00	403.00
	Maximum	195.20	90.10	23.65	65.00	70.00	66.00	82.00	62.00	69.00	71.00	66.00	491.00
	Standard deviation	9.27	10.04	1.64	4.36	7.12	7.72	12.40	22.55	5.72	6.80	9.43	26.13
2008	Mean	181.83	72.01	21.68	59.25	60.44	58.19	60.44	37.38	63.31	53.00	53.56	445.56
	Minimum	161.00	52.00	19.81	50.00	48.00	52.00	49.00	0.00	57.00	45.00	41.00	358.00
	Maximum	197.00	86.40	24.81	66.00	71.00	67.00	74.00	60.00	68.00	69.00	61.00	504.00
	Standard deviation	10.26	10.20	1.67	3.96	7.01	5.96	7.26	19.35	3.72	7.81	7.36	36.05
2009	Mean	183.02	71.06	21.16	60.94	58.24	56.53	55.65	37.71	62.94	57.29	55.71	445.00
	Minimum	164.50	52.80	17.91	46.00	50.00	52.00	45.00	0.00	56.00	40.00	44.00	387.00
	Maximum	203.00	87.00	26.76	70.00	75.00	60.00	67.00	52.00	70.00	69.00	67.00	489.00
	Standard deviation	10.13	11.13	2.47	5.55	6.25	2.43	5.78	14.73	4.08	7.65	5.91	25.61
2010	Mean	180.24	66.11	20.31	63.71	65.18	52.59	66.29	48.00	68.29	59.29	58.59	481.94
	Minimum	160.00	53.00	17.27	56.00	55.00	33.00	49.00	39.00	60.00	43.00	48.00	454.00
	Maximum	195.00	80.70	23.91	70.00	73.00	68.00	83.00	59.00	77.00	71.00	76.00	528.00
	Standard deviation	9.83	8.48	1.70	3.96	5.04	9.10	9.55	5.61	4.31	9.33	7.16	26.62

IPFT – International Physical Fitness Test

Table 4. Significant differences between the participants' mean scores over the course of the study (Tukey's HSD test)

		Body height	Body mass	BMI	50m run	Long jump	1000 m run	Hand grip strength	Pull-ups	4 × 10 m run	Sit-ups	Standing forward bend	IPFT score
		cm	kg	kg/m <sup>2</sup>	pts.	pts.	pts.	pts.	pts.	pts.	pts.	pts.	pts.
Mean	2006	183.2	72.2	21.5	57.1	57.9	55.3	56.3	20.6	59.5	55.3	54.0	383.6
Mean	2007	179.7	66.8	20.6	58.4	57.8	56.1	52.1	31.4	62.6	58.4	53.9	430.5
Difference		-3.4	-5.4	-0.9	1.3	-0.2	0.8	-4.2	10.8	3.1	3.1	-0.1	46.9
Significance		0.8571	0.5347	0.6682	0.9236	1.0000	0.9968	0.6375	0.4704	0.2934	0.8500	1.0000	0.0002*
Mean	2007	179.7	66.8	20.6	58.4	57.8	56.1	52.1	31.4	62.6	58.4	53.9	430.5
Mean	2008	181.8	72.0	21.7	59.3	60.4	58.2	60.4	37.4	63.3	53.0	53.6	445.6
Difference		2.1	5.2	1.1	0.9	2.7	2.1	8.4	6.0	0.8	-5.4	-0.3	15.1
Significance		0.9746	0.5636	0.4771	0.9820	0.8350	0.9008	0.0525	0.8879	0.9889	0.3966	1.0000	0.5637
Mean	2008	181.8	72.0	21.7	59.3	60.4	58.2	60.4	37.4	63.3	53.0	53.6	445.6
Mean	2009	183.0	71.1	21.2	60.9	58.2	56.5	55.6	37.7	62.9	57.3	55.7	445.0
Difference		1.2	-0.9	-0.5	1.7	-2.2	-1.7	-4.8	0.3	-0.4	4.3	2.1	-0.6
Significance		0.9968	0.9988	0.9346	0.8198	0.9082	0.9504	0.4951	1.0000	0.9993	0.6055	0.9523	1.0000
Mean	2009	183.0	71.1	21.2	60.9	58.2	56.5	55.6	37.7	62.9	57.3	55.7	445.0
Mean	2010	180.2	66.1	20.3	63.7	65.2	52.6	66.3	48.0	68.3	59.3	58.6	481.9
Difference		-2.8	-5.0	-0.8	2.8	6.9	-3.9	10.6	10.3	5.4	2.0	2.9	36.9
Significance		0.9217	0.5800	0.7002	0.3917	0.0526	0.4115	0.0045*	0.4837	0.0061*	0.9602	0.8646	0.0027*

\* denotes significant differences at  $p \leq 0.05$ ; IPFT – International Physical Fitness Test

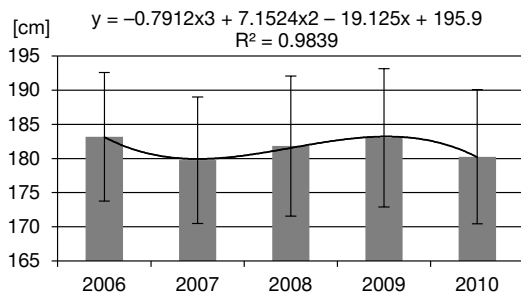


Figure 1. Body height

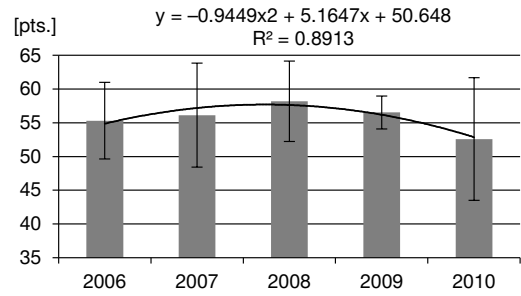


Figure 6. 1000 m run

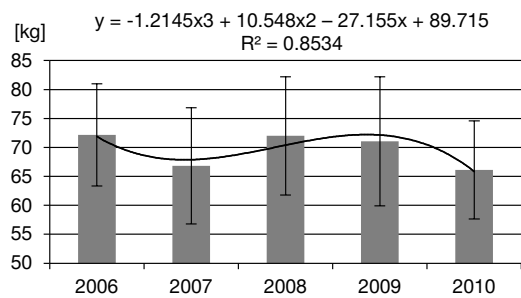


Figure 2. Body mass

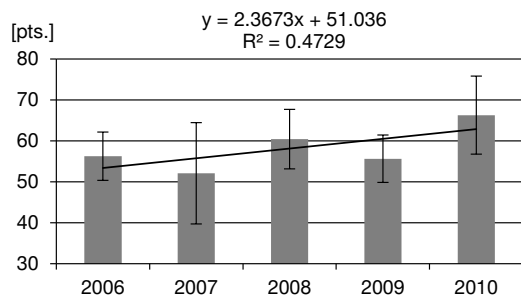


Figure 7. Hand grip strength

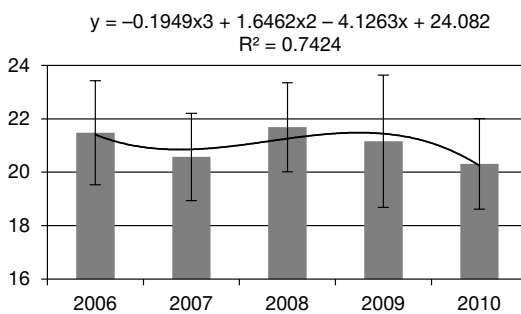


Figure 3. BMI

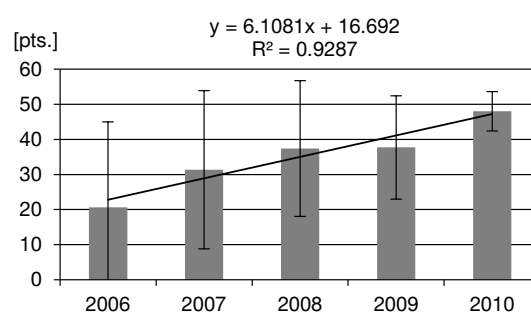


Figure 8. Pull-ups

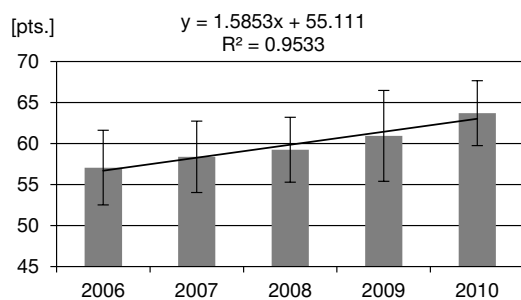


Figure 4. 50 m run

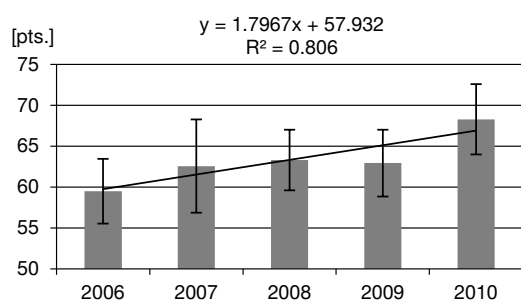


Figure 9. 4 x 10 m run

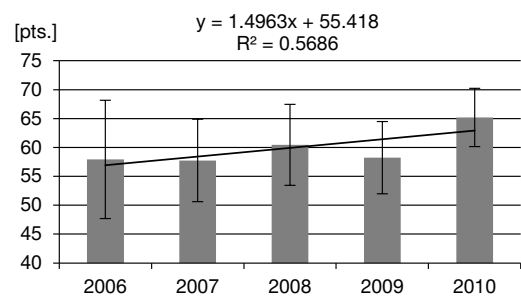


Figure 5. Long jump

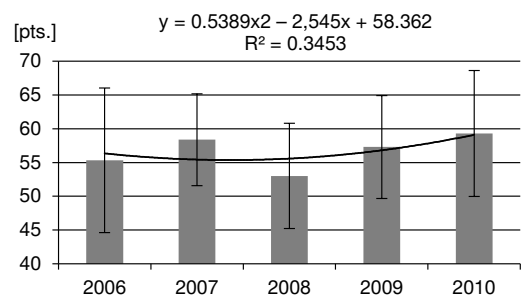
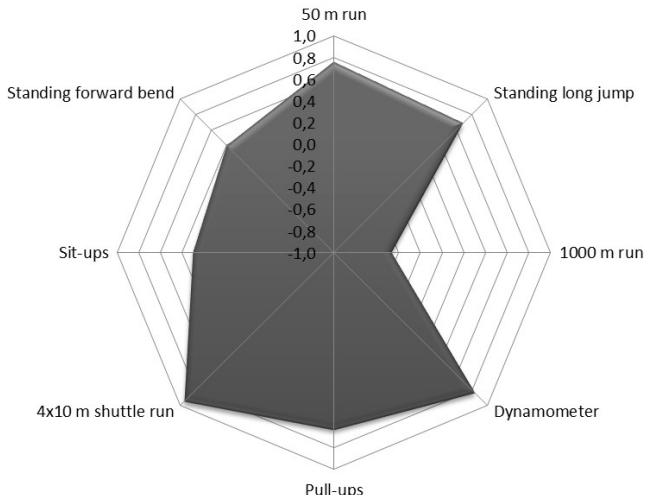
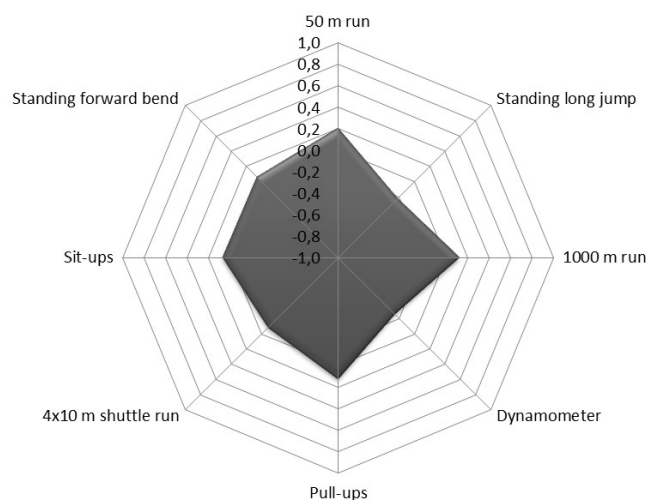
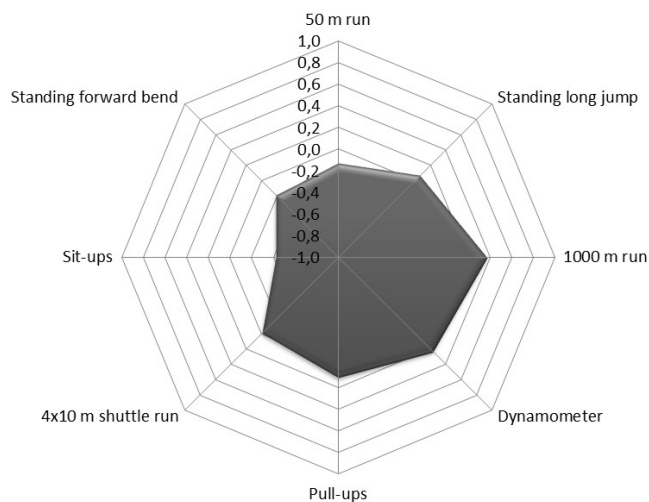
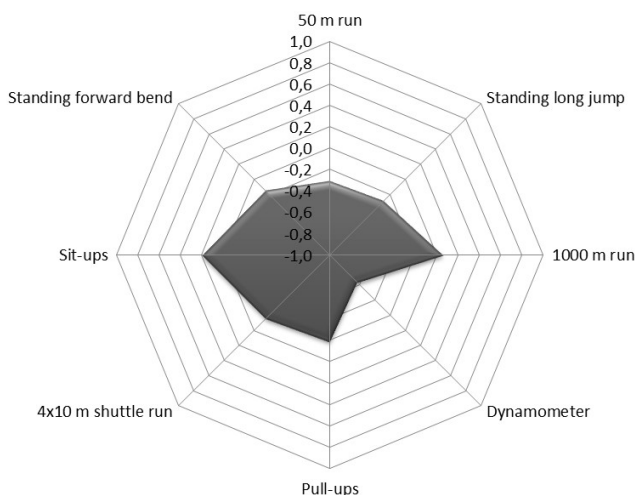
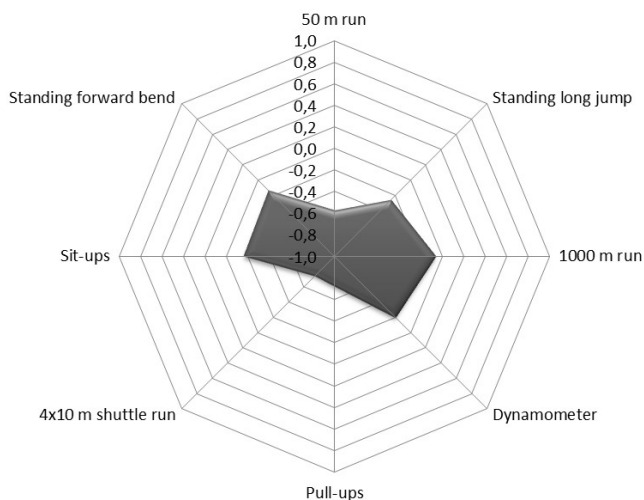
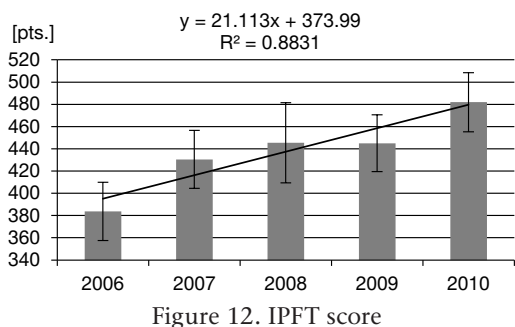
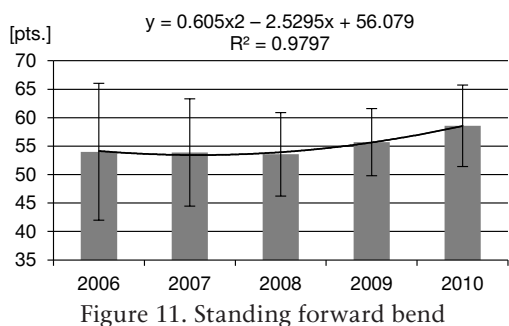


Figure 10. Sit-ups





between 2006–2008. Overall, the participants' total point score on the International Physical Fitness Test over the course of the study pointed to a systematic improvement in their physical fitness.

Analysis of the participants' structure of motor skills, based on their motor skill level profiles normalized for mean and standard deviations, found that it also underwent change (Fig. 13–17), clearly indicating an upward trend. This is particularly evident in the results from 2010, where most of the trials were found to be higher than the mean by about half a standard deviation. The only exception were the results from the 1000 m run, which in 2010 were found to be half a standard deviation lower than the arithmetic mean.

### Discussion

As an indicator of body development and general health, physical fitness is a focal subject in numerous studies analyzing physical culture. One item of interest in the literature on the subject is analysis of the intergenerational differences in motor skill development, with studies repeatedly finding that it has a regressive character [27–29].

This has led some to justify their interpretation of such changes in terms of the formation of a new type of physical fitness barometer as a consequence of the changes in lifestyle now faced in the modern world. This includes the adoption by today's youth a different system of values, including their preferred form and dimension of physical activity, which naturally affects their participation in sports. Nonetheless, as overall physical fitness is the cornerstone in learning sports techniques and tactics, there still exists a need to separately train motor skills [30–32].

The purpose of the present study was to determine what trends are present in the structure of motor skills and the motor skill level of young basketball players by analyzing them over a period of five years. As a result, this study can be used as a reference for comparing the motor development of subsequent generations of talented young athletes. In the course of the study, it was found that the structure of motor skills of the participants showed relatively comprehensive and uniform motor preparation. The only exception to this general trend was the young basketball players' endurance levels. This may obviously have a detrimental outcome, as basketball is a discipline that requires both speed and stamina. However, the differences for this component were not statistically significant.

Analysis of how the participants scored on the International Physical Fitness Test over the studied time frame indicates that their overall physical fitness levels systematically improved. Although the differences in only a few cases were statistically significant, the general trend is easily observed. This is contrary to the aforementioned regressive trend observed among successive

generations, which may likely be due to the participants involvement in athletic training, which obviously positively stimulates body development. In this regard, sports for children and youth should have a general fitness, health, and educational character and, above all, it should be performed in tune with their biological and physiological development.

The physical fitness level of the participants, as based on the classification standards of the International Physical Fitness Test [24], can be described as average, although the results recorded in 2008 and 2009 had them already approaching high levels of physical fitness. By 2010 they were classified at the lower limit of the high level. It should be therefore expected that this trend for future age groups ought to be maintained.

The significant improvement in the motor skill level of each subsequent age group seems to differ from the observations put forward by advantage Przewęda [33], who studied the physical fitness of Polish youth. He believes that if the current trend in physical activity levels is maintained, then one could then speak of the predominance of physical fitness based on speed-agility over physical fitness determined by strength.

### Conclusions

Apart from the issue around the selection of individuals who should play competitive sports, and in particular in which specific discipline, while also taking into consideration the significant impact of such a choice on the morpho-functional characteristics of young athletes, it can be concluded that training loads at this stage (such as the one used in boys basketball) have in most cases a positive impact on general physical fitness, as an indicator of human health and development, and consequently on sports performance.

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Paper received by the Editors: August 22, 2012

Paper accepted for publication: June 3, 2013

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