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IDENTIFICATION OF DETERMINANTS OF SPORTS SKILL LEVEL IN BADMINTON PLAYERS USING THE MULTIPLE REGRESSION MODEL

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ABSTRACT
Purpose. The aim of the study was to evaluate somatic and functional determinants of sports skill level in badminton players at three consecutive stages of training. **Methods.** The study examined 96 badminton players aged 11 to 19 years. The scope of the study included somatic characteristics, physical abilities and neurosensory abilities. Thirty nine variables were analysed in each athlete. Coefficients of multiple determination were used to evaluate the effect of structural and functional parameters on sports skill level in badminton players. **Results.** In the group of younger cadets, quality and effectiveness of playing were mostly determined by the level of physical abilities. In the group of cadets, the most important determinants were physical abilities, followed by somatic characteristics. In this group, coordination abilities were also important. In juniors, the most pronounced was a set of the variables that reflect physical abilities. **Conclusions.** Models of determination of sports skill level are most noticeable in the group of cadets. In all three groups of badminton players, the dominant effect on the quality of playing is due to a set of the variables that determine physical abilities.

Key words: badminton, sport training, recruitment and selection

Introduction

Badminton is one of the most popular racket sports. The origins of badminton date back to the second half of the 19th century. Organizations and associations for badminton players are registered in over 90 countries [1]. This sport has attracted the interest of researchers in many academic fields. Numerous scientific studies have dealt with physiological, biomechanical, somatic and psychological conditions, and badminton movement technique [2, 3]. Other reports have demonstrated health benefits of playing badminton [4].

A comprehensive development of motor abilities is needed to become a successful badminton player. Players often perform jumps, sudden directional changes on the court, a broad range of movements of the upper limbs and changes in body posture [5, 6]. From the standpoint of energy demands, badminton is characterized by movements with very high intensity, alternate with short periods of low-intensity exercise or rest [2, 7]. During the game, energy is largely fuelled by aerobic pathways (around 60–70%), while around 30% of the energy is generated from anaerobic processes [3]. With its total time of the game and the character of exercise during individual actions, badminton can be considered as a speed and endurance sport. Anaerobic exercise during the game of badminton is observed during individual actions, whereas aerobic exercise results from the duration of the game and the number of various movement sequences repeated during the game [3, 8].

Another important factor that affects the effectiveness of the game is optimal level of somatic parameters. These problems have been documented for example in [3, 9–10]. These studies have shown that optimal body build of a badminton player is characterized by substantial body height and slim body. The findings obtained in many countries [3, 9] have demonstrated that mesomorphy and ectomorphy should be preferred among badminton players.

A specific level of coordination motor abilities is also important in badminton. The complex character of the game requires a perfect performance of movement tasks with high complexity and adaptation to frequent changes in the situation on the court [10, 11–13]. Therefore, similar to combat sports and other games (mainly team sports), badminton is classified in the third (the hardest) category of sports, characterized by the highest level of variability of movement structure, which is attributable to the dominance of external stimuli and open movement structure.

The effectiveness of the game of badminton depends on many combinations of the factors which determine the effectiveness of coaching in badminton. In the practice of training, one should take into consideration interactions between genetic and training factors. Therefore, both talent identification and training optimization are of key importance for final success in the sport

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[14]. The basic criterion during development of this type of champion model is always the analysis of key variables in the specific sport, with strong genetic determination [15]. Each "champion model" implies the necessity of using only the variables which can be realistically anticipated over the training. Anticipation of adaptations in this field should be based not only on the knowledge of problems connected with human ontogeny but also on the awareness of individual differences in speed of development of children and young people.

Identification of the determinants of the effectiveness of actions is essential for athletic training. Unfortunately, few reports have attempted to find variables which should be preferred in badminton (at each stage of sports training). Furthermore, few studies have examined optimization of sports training [16].

Therefore, the main aim of this study was to examine somatic and functional determinants of sports skill level at three consecutive stages in badminton training. The following questions were addressed in the study:

– Which somatic characteristics, physical abilities and neurofunctional abilities are of key importance to the sports skill level in badminton players?

– How does the configuration of determinants of badminton performance change at each consecutive stage of the training process?

Material and methods

The results recorded for 96 badminton players in three training categories: 40 younger cadets (aged 11 to 13 years), 32 cadets (aged 14 to 16 years) and 24 juniors (aged 17 to 19 years) were analysed. Mean experience in competition was 3.8 years in the group of younger cadets, 5.9 years in the group of cadets, and 8.2 years in the junior group. The athletes were from the following sports clubs: MKS „Spartakus" from Niepołomice, UKS „Orbitek" from Straszęcin, LKS „Technik" from Głubczyce, UKS „Sokół" from Ropczyce, UKS „Trójka" from Tarnobrzeg, UKS „Badmin" from Gorlice, UKS „Hubal" from Białystok, MKS „Orlicz" from Suchedniów.

Their sports skill level was evaluated indirectly using the ranking lists prepared by the Polish Badminton Association. The lists are updated annually after completion of cycles of tournaments. Players are awarded ranking points based upon their achievements in each tournament, and the ultimate position on the annual ranking list depends on the player's total score. In the case of the equal number of points or other doubts, the evaluation was supplemented with the expert method.

The study was conducted according to the Declaration of Helsinki. Informed consent prior to participation was obtained from children's parents or guardians and coaches. Each player was informed that they can stop the examination at any moment without giving the reasons for such a decision.

Scope of the study

Martin's technique was used to measure somatic parameters: body height, length of upper limb, height in the sitting position from the sitting level to the vertex point, range of the arm with racket during the forehand stroke, shoulder width and hip width. Body mass, lean body mass (LBM) and fat mass were evaluated using TANITA TBF-551 body composition analyser. Flexibility – the depth of the seated forward bend [17]. Amplitude of movements in the radiocarpal joint was measured in the four basic directions in the frontal plane and sagittal plane using a goniometer.

The analysis focused on the following tests of motor fitness:

a) long jump from standing position – explosive leg strength,

b) overhead medicine ball throw (2 kg) with both hands, with legs spread apart – explosive arm strength,

c) measurement of hand grip strength – force generated under static conditions,

d) measurement of maximal force and perception of half of its value – kinaesthetic differentiation of the force,

e) run with changes of directions (envelope run) – running speed,

f) 10 × 5-metre shuttle run [17] – ability of quick muscle recruitment,

g) endurance shuttle run [17] – cardiovascular endurance,

h) sit-ups – abdominal muscle power,

i) power tests according to the procedure proposed by Spieszny et al. [18] – 10 × 3-metre shuttle run; overhead medicine ball throw (1 kg) from the kneeling position; "tapping" with the medicine ball (2 kg) – 10 cycles of overhead hitting with the ball held with two hands against the wall and against the ground between the legs spread apart,

j) maximal anaerobic power (MAP) was calculated as the product of body mass and standing long jump or overhead medicine forward throw [19].

Coordination motor abilities were also analysed: kinaesthetic differentiation of temporal motion parameters, frequency of hand movements, visual-motor coordination, spatial orientation (free and forced modes), mean reaction time to auditory stimulus (minimal, mean, maximal), mean reaction time to visual stimulus, mean selective reaction time to visual and auditory stimuli (minimal, mean, maximal), movement rhythmization, movement integration, kinaesthetic differentiation (spatial-dynamic parameters).

The testing procedure, program settings and characterization of the equipment used for the examinations were described in the monograph by Jaworski [15].

Statistical analysis

1. Prior to the main statistical analysis, the consistency of the distribution of the variables with normal distribution was verified by means of the Shapiro-Wilk test.

2. In order to reduce the number of variables used in the regression model, we used factor analysis performed previously in the study [20]. The variant of the analysis based on the principal component procedure developed by Hotelling with Tucker's modification was used, supplemented with Varimax rotation proposed by Kaiser. The variables with factor loading of over 0.5000 were selected for further analyses.

2. Coefficients of multiple determination were used to evaluate the effect of structural and functional parameters on the sports skill level in badminton players. This study used the stepwise regression. Forward selection was adopted as a method for selection of variables introduced to the system. Other variables were qualified only in the situation where it was possible to reject the hypothesis of zero contribution to the model (Snedecor's F-distribution meets the condition of confidence at the level of 95%, $p < 0.05$). The variables previously separated using factor analysis were considered as independent, and introduced to the regression model. Analysis of the results was performed by dividing all the variables into the three sets: somatic characteristics and structural-functional ones, coordination abilities, and physical abilities. Each set represented the basis for development of a separate model of multiple correlations with sports skill level. The procedure was repeated for each age group (younger cadets, cadets, and juniors).

Calculations were made using Statistica 10.0 PL for Windows software package. The significance level was set at $\alpha = 0.05$.

Results

The problem of correlations between the sports skill level of athletes and their morphological aptitudes and motor fitness was attempted to be solved through in-depth analysis of the phenomenon based on the interpretation of coefficients of multiple determination. The factor analysis [20] and its pragmatic interpretation allowed for selection of up to 26 variables for these statistical procedures (see Table 1).

In the context of the research questions, the most interesting information was provided by the analysis of multiple determination that allows for evaluation of the combined effect of the structural-functional characteristics on the sports skill level in badminton players in different age categories. Determination of the combined effect of variables found through factor analysis seems to be more justified than seeking individual cause-and-effect correlations between isolated variables.

The results were analysed using the typology that allows for division of all the parameters into the three sets: somatic aptitudes, structural and functional characteristics; coordination abilities; and physical abilities. Each of them represented the basis for development of a separate model of multiple correlations with sports skill level. The procedure was repeated for each age groups (younger cadets, cadets and juniors).

In the group of younger cadets (see Table 2), quality and effectiveness of playing are mostly determined by the level of physical abilities. This model is based on the results of two speed and strength tests that evaluate lower limb fitness. They explain 33% of the sports skill level. This system of variables is also reinforced (to a slightly lower extent) by the endurance variable and, to an insignificant extent, by the parameters that determine MAP of the upper limbs and static strength. It is noticeable that most of the tests formed a factor which was conventionally (in previous analyses) termed as comprehensive anaerobic power. The whole system of physical

Table 1. Set of variables introduced to the multiple regression model

No.	Variable	No.	Variable
1.	Body height	14.	Visual-motor coordination (free mode)
2.	LBM	15.	Spatial orientation (free mode)
3.	Shoulder width	16.	Spatial orientation (forced mode)
4.	Arm range (with racket)	17.	Differentiation of force parameters of motion
5.	Flexibility	18.	Standing long jump
6.	Wrist mobility	19.	10 × 5-meter shuttle run
7.	Kinaesthetic differentiation of temporal parameters	20.	Cardiorespiratory endurance
8.	Frequency of movements	21.	Envelope run
9.	Visual reaction time	22.	MAP, lower limbs
10.	Auditory reaction time	23.	MAP, upper limbs
11.	Selective reaction time	24.	Abdominal muscle power
12.	Rhythmization	25.	Forward medicine ball throw
13.	Movement integration	26.	Static strength

Table 2. Coefficients of multiple determination between sports skill level and morphofunctional variables in the group of younger cadets

Group of variables	Variable introduced to the model	R	R^2	R^2pop.	F
Somatic and structural-functional characteristics	Wrist mobility	0.28	0.08	0.05	3.04
	Arm range (with racket)	0.37	0.13	0.09	2.83
	Shoulder width	0.47	0.22	0.15	3.27*
Coordination abilities	Spatial orientation (forced mode)	0.27	0.07	0.04	2.80
	Visual reaction time	0.32	0.10	0.05	2.07
	Movement integration	0.36	0.13	0.06	1.79
Motor physical abilities	10 × 5-meter shuttle run	0.53	0.28	0.26	14.26***
	MAP, lower limbs	0.61	0.37	0.33	10.53***
	Cardiorespiratory endurance	0.66	0.44	0.388	9.02***
	MAP, upper limbs	0.67	0.45	0.389	7.06***
	Static strength	0.69	0.47	0.393	5.92***

The results statistically significant * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 3. Coefficients of multiple determination between the sports skill level and morphofunctional variables in the group of cadets

Group of variables	Variable introduced to the model	R	R^2	R^2pop.	F
Somatic and structural-functional characteristics	Flexibility	0.67	0.45	0.43	18.18***
	Body height	0.69	0.48	0.43	9.74***
	Arm range (with racket)	0.71	0.51	0.44	7.06***
Coordination abilities	Spatial orientation (forced mode)	0.46	0.21	0.18	5.91*
	Rhythmization	0.55	0.31	0.24	4.62*
	Differentiation of force parameters of motion	0.64	0.41	0.33	4.70*
	Visual-motor coordination (free mode)	0.68	0.46	0.34	4.07*
	Frequency of movements	0.71	0.50	0.36	3.46*
Motor abilities of physical nature	Envelope run	0.66	0.42	0.39	15.71***
	Abdominal muscle power	0.75	0.57	0.53	13.87***
	Cardiorespiratory endurance	0.79	0.63	0.57	11.16***

The results statistically significant * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 4. Coefficients of multiple determination between the sports skill level and morphofunctional variables in the group of juniors

Group of variables	Variable introduced to the model	R	R^2	R^2pop.	F
Somatic and structural-functional characteristics	Wrist mobility	0.40	0.16	0.10	2.68
	Body height	0.57	0.32	0.22	3.12
	Shoulder width	0.68	0.47	0.331	3.47
	Arm range (with racket)	0.72	0.51	0.337	2.91
	LBM	0.75	0.56	0.340	2.54
Coordination abilities	Selective reaction time	0.42	0.17	0.12	2.96
	Spatial orientation (forced mode)	0.54	0.29	0.18	2.66
	Movement integration	0.62	0.39	0.23	2.53
	Kinaesthetic differentiation of temporal parameters	0.68	0.47	0.27	2.40
Motor abilities of physical nature	MAP, upper limbs	0.68	0.46	0.43	12.11**
	Envelope run	0.77	0.59	0.52	9.26**
	MAP, lower limbs	0.80	0.64	0.55	7.03**
	Abdominal muscle power	0.82	0.67	0.556	5.59**

The results statistically significant * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

ability variables explains around 40% of the quality of playing in the group of beginners.

In the somatic model, three variables emerge as more indicative than others: wrist mobility, arm range (with racket) and shoulder width. However, it should be emphasized that only the combination of these three variables is statistically significant and explains 15% of the sports skill level.

The effectiveness of playing is even less determined by the structure of coordination ability variables (ca. 6% in general). In this model, the first place is occupied by the spatial orientation test, i.e. reaction to the moving objects, the second by the test of reaction time to visual stimuli, with the variable of movement integration being the least relevant.

A diametrically different construction of all the three models is observed in the group of cadets (see Table 3). It is true that the highest explanation percentage for variability of sports skill level concerned the complex of physical abilities, but it consisted of only three parameters. The first was the factor of MAP for the lower limbs, however, in the other test: envelope run. The motor effect for the results of the test explains 39% of the quality of playing at the level of 39%. Composition with the parameter of abdominal muscle power significantly increases the level of the coefficient of determination (53%), whereas integration of another value that determines the cardiorespiratory endurance leads to an insignificant increase in this index. In this form, it explains around 57% of the variance of the sports skill level.

Configuration of the somatic model in the group of cadets in the context of the previous sequence of variables that determine the level of motor preparation seems to be relatively logical. The first place in the model was taken by body flexibility. Correlations between the next two parameters, body height and the range of arm with racket, are logical for the discussed coefficient of determination. However, they do not significantly change the level of explanation for the sports skill level which in the whole composition is at the level of 44%. Presence of the characteristics of body height in the model may be also correlated with high variability of morphological age in this group of study participants.

The variables which determine coordination abilities also seem to be interesting. The first variable in the model is spatial orientation (forced mode) but with much greater loading that explains sports skill level compared to the group of younger cadets (18%). The whole model is explained by the quality of playing (36%), reinforced by the following variables: movement rhythmization, differentiation of strength motion parameters, visual-motor coordination (free mode), and movement frequency. The significant effect on the level of playing from such a substantial number of factors of motor coordination is symptomatic for this period of development and represents an interesting material for discussion.

In the group of juniors, complexation of variables that form the individual models is also interesting compared to the previously characterized groups (see Table 4). The composition of variables that represent physical abilities is most noticeable and accounts for 55% of the quality of playing. The most important component in the model is anaerobic power of the lower limbs, which seems to be logical since at this stage of training process, the success may be determined by speed and force the shuttlecock is hit with. The parameters that determine the efficient movements on the court (envelope tests and MAP test for the lower limbs) are also important. On the one hand, they can determine successful results in the competition, and on the other hand, their lower level may be compensated by the parameters of body size (mainly the range of the arm with racket) or very efficient movements of the racket that result from high mobility (range of motion) of the wrist.

The reality of this phenomenon can be supported by the structure of the somatic model, with the first place (10%) taken by the variable that determines the amplitude of wrist movements and body size parameters (body height, shoulder width and range of motion of the arm with racket). In general, the combination of these variables accounts for 34% of the sports skill level.

The effect of coordination abilities is weaker at this stage of training. However, it is worth noting that this composition of variables contains parameters of motor coordination with higher degree of organization. The first place is taken in this sequence by selective reaction time, followed by spatial orientation and movement integration and kinaesthetic differentiation of temporal parameters of movement. The whole model determines the sports skill level in juniors at 27%.

Discussion

The observations conducted in the study were aimed to bridge the gap in the area of complex explorations in terms of multi-aspect determinants of sports skill level of young badminton players. They concerned in particular the effect of structural aptitudes, physical abilities and coordination abilities on the development of competitive competencies with age. This complex concept was supposed to gradually lead to identification, structurization and hierarchization of the determinants of proper status of sports skill level at each stage of the athletic training process in badminton.

The principal interpretation of the results was preceded by multidimensional statistical procedures: factor analysis and the Ward's method [20]. This was used to reduce the initial number of variables and select the relatively independent factors that guarantee high sports skill level. This was connected with the need for identification of "shared factors" necessary to identify a set of variables which lead to a reduction in the dimension and indication of the higher order factors until they are logically explained. Eventually, due to these statistical procedures, 26 variables were selected and analysed within three complexes at each stage of the training process.

The selected complexes that determine sports skill level in the group of younger cadets indicate that mainly physical abilities contribute to the positive picture of the game, of which the most important is the player's ability to move on the court. They are connected with performing both the anaerobic and aerobic exercise [3, 8].

In the case of somatic variables constituting the model, it is the whole composition of this group of characteristics that affects sports skill level at a statistically significant level. The importance of these characteristics to the player's effectiveness was indicated in the literature review in the Introduction section. It was essential for the sake of the analysed problems to have identified the cause-and-effect relationships between physical abilities and morphological characteristics. Similar relationships were emphasized by Subramanian [21]. In this group, the factor of motor coordination is getting to be more pronounced but mainly in terms of spatial orientation and reaction time to visual stimuli. In general, playing in the group of younger cadets is based on strong physical abilities.

A completely different structure of the model was observed in cadets. The number of components of motor coordination in this group rose to five. The importance of coordination abilities for badminton players is also confirmed by the findings published by many authors. Jaworski and Żak [10] analysed morphofunctional models in three groups of experience level. In the model obtained for younger cadets, only the results of movement integration and mean reaction time to visual stimulus were above the mean obtained for the whole module. These results demonstrate that the above coordination abilities are essential for recruitment of athletes, whereas sports skill level is determined mainly by physical abilities and wrist mobility. The dominant abilities in the group of cadets were spatial orientation and visual-motor coordination. In the group of juniors, an average level of contribution to the development of sports skill level was observed for spatial orientation, mean selective reaction time, movement integration and kinaesthetic differentiation. Badminton is numbered among one of the fastest racket sports. Therefore, reaction time is one of the most important neurofunctional abilities that affect playing efficiency. Badminton players (both boys and girls) have better results compared to untrained peers [13]. As presented by the authors of the above study, the findings may have been caused by playing badminton. The importance of visual information processing and time needed to anticipate movement, as well as determination of intercorrelations between these variables in elite badminton players was emphasized by Poliszczuk and Mosakowska [12]. In their study, the researchers used two tests from the Vienna Test Battery: anticipation of movement (ZBA) and visual field (PP). They found a relatively extensive range of vision in badminton players (172.9°, with 89.99° for the left eye and 82.86° for the right eye) and significant correlations between the base indices for both tests. Badminton is a sport where players have to respond to strong and fast shots performed by the opponents using the upper limbs. The results of many studies have shown that shorter reaction time in elite athletes compared to other badminton players may be a key variable to distinguish between players at different sports skill levels. Furthermore, the results of the studies concerning the relationships of simple and complex reaction time with muscular strength show that only complex reaction time was significantly correlated with the strength of the right and left arm and was not correlated with the strength of the lower limbs [22–25]. The review of some selected findings suggests the necessity of paying particular attention to development and improvement of technique in this period of training. Coordination exercises are known to stimulate development of special fitness, which, based on feedback, improves the level of coordination skills. In particular, this might concern spatial orientation, which is essential for evaluation of the trajectory of the shuttlecock in space and observation of the current situation on the court. In the context of the game, it also seems essential to maintain the specific rhythm of actions and the action-related frequency of movements. These may include very fast sequences of repeated actions. Good differentiation of force parameters of movement revealed in the factor helps using the racket, whereas visual-motor coordination makes it easy to anticipate the shuttlecock trajectory and hit the shuttlecock with the racket.

The most substantial contribution in this group was observed for the complex of physical abilities, but it was dominated by another test, i.e. the envelope test. However, it should be emphasized that the result of this test is associated not only with the speed of recruitment of energy sources but also with motor coordination (fast and rhythmic changes in the direction of movements). This phenomenon can be associated with the structure of the model in the area of coordination abilities. Also the contribution of the abdominal muscle strength test should be regarded as logical as it is associated with improvement in smashes and clears. The dominant orientation of training towards technique development is insufficient to fully utilize the factor of endurance, which in this phase of development starts playing an essential role in the game [3].

The somatic model of a cadet showed substantial differences in the components of body size. The attention should be paid to the component of flexibility, which was located at the first place. This element seems to be useful for solving tasks on the court. The importance of flexibility for playing effectiveness was also emphasized by Subramanian [21]. In the multiple regression model, this variable explained around 10% of the dependent variable. The second place in the proposed model was taken by speed (around 8%). The analysed model also included arm length and quality of service and attack. All the variables introduced to the model explained around 33% of the playing effectiveness.

The importance of somatic aptitudes and flexibility for the quality of playing was also emphasized by Jeyaraman and Kalidasan [26]. In their multiple regression model, the whole model explained around 81% of the playing effectiveness.

It should also be emphasized that the age of cadets extends over the puberty period, when a decline in the value of this anatomical and functional parameter is more pronounced. Consequently, this might cause a high dispersion of results. Correlation between body size and sports skill level points to a significant role of the developmental age in earlier achievement of better results in competition. This thesis is reinforced by the strongly accentuated views on the variation of the morphological age and its effect on the results achieved in terms of performance of motor tasks. The greatest variation of physical development was observed in the puberty period, which, in extreme cases, may reach the span of eight years. Since the group of juniors was aged from 14 to 16 years, the relationships found in the study seem to be obvious. Slightly better sports results in this group were obtained by accelerants and individuals who were genetically programmed to be tall. Therefore, the factor of the morphological age must be taken into consideration in the athletic training to understand the causes of developmental delay or accelerations. This problem was also emphasized in studies by Waddell and In Hong [27]. They highlighted the importance of adjusting the exercises to developmental abilities of children and reasonable (rational) development of the technique which is consistent with physical abilities of young badminton players.

The system of variables in the models that describe the determinants of the sports skill level in the group of juniors also turned out to be interesting and slightly different than in younger groups of badminton players. At this stage of training process, physical abilities remain to be essential, which is especially noticeable in the dominant variable of MAP of the arms. This phenomenon is logical since juniors do not only have well-developed technique but also the speed and force of hitting the shuttlecock that are necessary at this stage. Furthermore, the efficient shots require fast moving on the court in order to adopt a specific position in time and space. This determines a high level of MAP of the lower limbs, which manifests itself in, for example, the envelope run [19]. The movement actions typical of performance of these tests are immanent in the effective playing.

The composition of variables in the somatic model of junior was connected with the range of arm motion, which can often compensate for the deficiencies in effective movements on the court. However, the variable of wrist mobility was dominant. This can be justified by the fact that this helps a player to generate initial speed and force applied to the shuttlecock.

There is also the problem of coordination abilities which are slightly weakened at this stage of training. This might be the effect of lower dispersion of the results and consequently, equalization of their level in this group of players, although it should be also emphasized that these abilities are of higher level of organization like selective reaction time, reaction to the moving object, movement integration and kinaesthetic differentiation. These abilities have a leading effect on development of technique of movements of higher order, typical of the effective playing at this level of training process.

Conclusions

1. All the models of sports skill level determination are most pronounced in the group of cadets, less pronounced in the group of juniors and the least in younger cadets.

2. In all three groups of young badminton players, the dominant effect on the quality of playing is due to a complex of variables that determines physical abilities.

3. The model of coordination abilities slightly determines the sports skill level on the initial level of training process, and its contribution in this area rapidly increases in the group of cadets and insignificantly declines in the group of juniors. It should also be emphasized that its structure changes not only in quantitative but also in qualitative terms.

4. At the initial stage of training process, sports skill level is determined by a comprehensive fitness. At the next stage, it largely depends on body size and efficiency of moving on the court and a wide set of variables that determine movement coordination. In the group of juniors, this level is more determined by maximal anaerobic power of the upper limbs, wrist mobility and a complex of coordination abilities with higher degree of motor organization.

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