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Effects of Developmental Training of Basketball Cadets Realised in the Competitive Period

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A B S T R A C T

The analysis of effects of a two-month developmental training cycle realised within a basketball season revealed statistically significant positive changes at the multivariate level in components of motor-functional conditioning (fitness) status of the sample of talented basketball cadets (15–16 years). The greatest correlations with discriminant function were found in variables with statistically significant changes at the univariate level, more explicitly in variables of explosive and repetitive power of the upper body and trunk, anaerobic lactic endurance, as well as in jumping type explosive leg power. The presented developmental conditioning training programme, although implemented within the competitive period, induced multiple positive fitness effects between the two control time points in this sample of basketball players. The authors suggest that, to assess power of shoulders and upper back, the test overgrip pull-up should not be applied to basketball players of this age due to its poor sensitivity. Instead, they propose the undergrip pull-up test , which is a facilitated version of the same test. The results presented in this article reinforce experienced opinion of experts that, in the training process with youth teams, the developmental conditioning training programme is effectively applicable throughout the entire competitive season. The proposed training model is a system of various training procedures, operating synergistically, aimed at enhancing integral fitness (preparedness) of basketball players. Further investigations should be focused on assessing effects of both the proposed and other developmental training cycle programmes, by means of assessing and monitoring actual quality (overall performance) of players, on the one hand, and, on the other, by following-up hormonal and biochemical changes over multiple time points.

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Introduction

The game of basketball is a complex motor multi-structured team activity based on the symbiosis of cyclic and acyclic movements of individual players with and without the ball[1], the performance quality of which is directly related to motor -functional conditioning status (preparedness or fitness) of athletes and their body composition. Quantity, intensity and informational complexity of the movement structures executed (technical-tactical elements or skills) directly depend on these two attributes of players. Further, the authors theorise that the greatest impact on internal load players have to sustain in practice and games is caused by his/her role in the game on offence, defence and transition, then by the selected and elaborated system of play and its requirements regarding intensity of play (players moving on ofence and defence). Training, conditioning programmes should be individualised in accordance with all the aforementioned factors.

From the aspect of energy demands and energy sources engaged, it can be stated that basketball undoubtedly appertains to the group of anaerobic sports[2–4]. Korjagin[5] has stated that players, if being on play for the entire game time, on average accomplish 6,000–7,000 metres of running, perform up to 40 various jumps, 280 movement direction changes, 120 ball catches, 80 passes, 16 shootings for a goal and 36 dribblings. Mahorič[6] obtained similar results.

The average heart rate of a player during a match is 167 bpm[6], whereas the heart rate frequency is over the anaerobic threshold for more than 25% of the total game time, that is it peaks above 180 bpm[6,7]. Mahorič has also determined that the chosen system of play, or intensity of play, has the greatest impact on energy demands, consequently on the inner load players must cope with[6].

As far as the motor abilities are regarded, the authors consider that basketball is primarily the sport of agility and the very ability is itself a complex combination of several motor abilities (Figure 1).

In the modern top-quality, professional basketball training practice the two successive objectives and directions of operating are recognisable: the production of elite basketball players and the production of the high competitive and sport achievements. The process of producing top basketball players, which comes first in one's sport career, is a long-lasting system of teaching and learning. It demands hard work and continuity, as well as systematic and gradual approach to acquiring and perfecting skills from different sport preparation training programmes, the general goal of which is shaping, enhancing and maintaining actual quality of players (overall performance in the game)[8]. Common basketball experience has shown that success in competitions (or sports achievement) primarily depends on the actual quality of individual basketball players and their ability to create and function within a team, since they are protagonists of the game on the court, they make it alive.. Therefore, creating elite players by designing and implementing the developmental training cycles, consisting of versatile synergistic training programmes, is almost the most crucial task basketball coaches must accomplish[9,10].

The developmental training can be in general defined as a complex, gradual, and multi-year process directed at gradual acquisition and perfection of technical – tactical skills, knowledge and habits, as well as at encouraging positive changes (transformations) in non-specific (basic) and specific abilities and characteristics that will permit reaching the top performance at every level of long sports specialisation process[11–13]. Successfulness of a player in basketball or overall perfor-

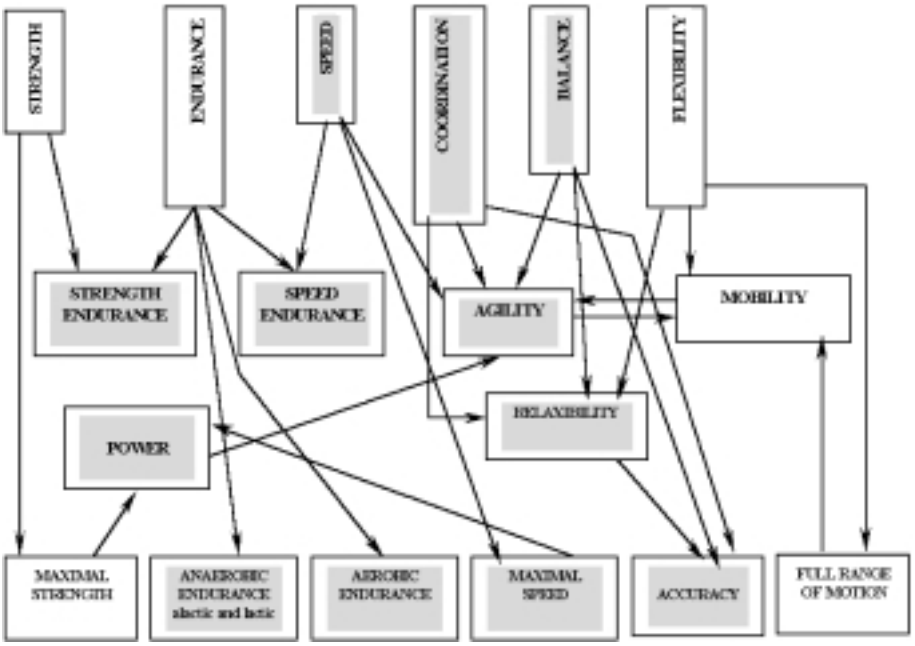

Fig. 1. Phenomenological scheme of mutual dependence of bio-motor abilities (modified according to Bompa[2]). Shaded abilities show attributes specially important to elite basketball performance.

mance quality, at every level of play and all positions and roles in the game, is directly related to the level to which the relevant basic and specific anthropological traits are developed and how they are interrelated. More explicitly, it is dependent to a great extend upon the linkage between motor and functional abilities in players and upon the different combinations between two and/or more abilities (Figure 1). Therefore, to programme adequately developmental training programmes, aimed at developing relevant abilities, attributes, skills and knowledge that significantly determine top basketball performance or actual quality of players[8], one must know relations of motor and functional abilities.

This article is based upon the hypothesis, confirmed in many previous investigations[2,5,11,14–17] that improvement of performance of each player depends on positive influence on his/her basic and specific motor-functional abilities since these abilities are core of player's specific work capacity, and, consequently and eventually, of the intensity of play in general. According to Jelyazkov[12] the top sport form is an integral model of condition (preparedness) of a particular athlete, which enables him/her to realise, to manifest his/her potential for sport achievement in a competition. Therefore, low level of motor-functional condition hinders a basketball player in achieving top sport form and stable performance within his/her role in the game.

The crucial part of the training work with the young is to provide, in a long -term programme of training – sports conditioning, methods of assessing and monitoring the actual quality (overall performance) of every basketball player and to assure linkage between competi-

tion system, on the one hand, and physical conditioning, technical-tactical, psychological and theoretical preparation, on the other, as well as to include system and means of regeneration and recovery (Figure 2).

The experimental plan, programme and application of conditioning and training procedure was based on the system of the two-mesocycle developmental training units composed of the following components of preparation:

– multifaced conditioning programme;
– basic conditioning programme;
– special conditioning programme;
– technical – tactical preparation (conditioning) programme;
– theoretical preparation (conditioning) programme;
– psychological preparation (conditioning) programme;
– system of competition.

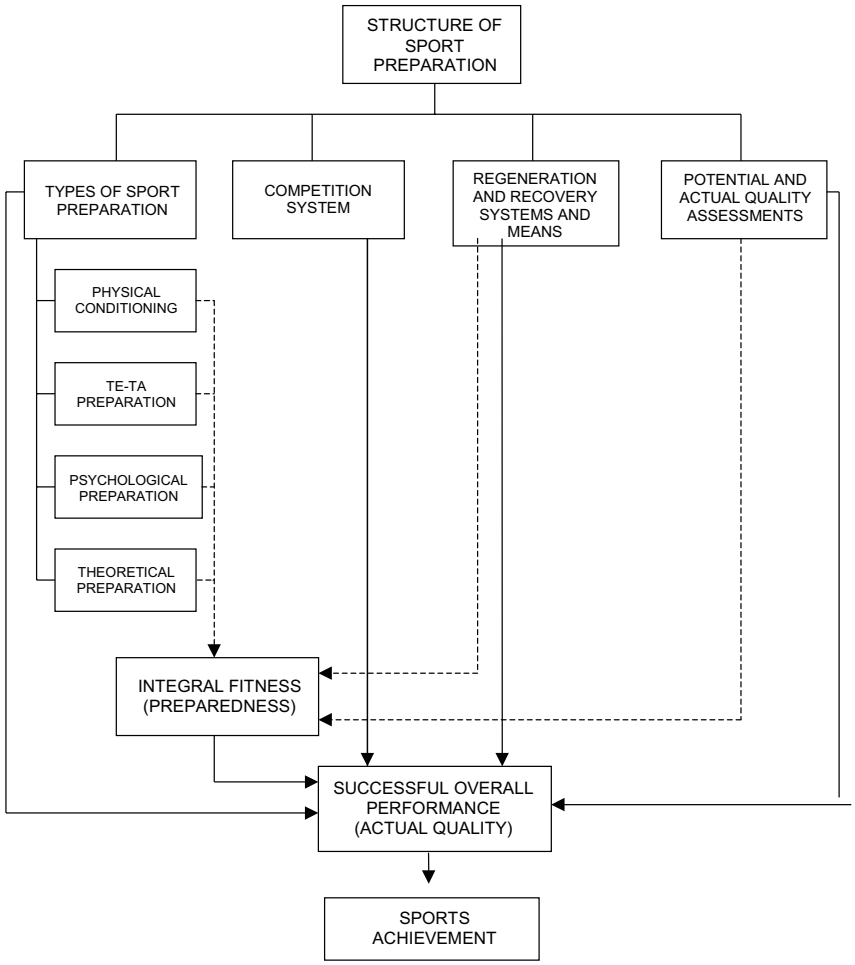

Fig. 2. Structure of sport preparation.

The authors estimated that synergistic interrelations of the mentioned programmes within the integral sport preparation would enable optimal development and improvements of players' actual quality, i.e. their performance during the competitive period as well. Their conviction was founded upon vast research and professional literature, as well as on the rich experience in practice of training.

The main goal of working with the cadet teams (age 15–16) is to develop and improve basic and specific motor-functional abilities and to establish and expand the network of technical-tactical skills and knowledge in every player in order to build up a solid foundations to the predominantly specialised training in the junior selection.

The standard or regular approach to training in competitive season (according to classical periodisation) is based on implementation of relatively steady loading patterns the objective of which is maintenance of motor-functional abilities of players[2,12]. Hence, most of the consulted literature has been dealing with analyses of effects of the training applied during the preparatory period. The results obtained demonstrate that applied programmed training procedures allow for transforming and/or developing motor-functional conditioning status (preparedness or fitness) in subsenior[15,18,19] and senior male basketball selections[17,20]. As opposed to this approach, the basic purpose of the applied and presented experimental plan and programme of physical conditioning and technical – tactical preparation programme, integrated with proper sports nutrition and psychological conditioning, was to induce multiple positive effects (transformations) at physiological, hormonal and neuromuscular level in competitive period.

This research should explore a hypothesis that it is feasible with the basketball players of this age (15–16 years) to integrate the developmental and competitive objectives during the competitive season by alternating intensities during a microcycles, especially because children in late puberty and post-puberty are extremely sensitive to the strength and power developing training, as well as to the game understanding enhancement.

For example, increase in strength for male athletes in post-puberty and adolescence (maturation) is largely a result of muscle hypertrophy caused by explosive increase of male hormone (testosterone) from puberty on[11,21]. However, some authors[22] state that increase in strength and power in puberty and post-puberty is primarily caused by neural, not structural adaptation (hypertrophy). Anyhow, there is a significant possibility to increments of strength in late puberty and post-puberty by means of the training process procedures.

Long term periodisation of sports development guarantees continuous, systematic and gradual development of abilities, attributes and skills of youth selections. An indispensable precondition to successful design of the sport preparation periodisation is an accurate determination of player's current potential (capacities). Only then objectives of the training can be set and, according to both aforementioned factors, training contents and methods should be selected and distributed according to periodisation calendar. Such a load volumes and intensities should be prescribed that will permit developmental training work-outs during the competitive season before the specialisation to the roles/positions in the game. Simultaneously, the degree of biological maturation of basketball players (an early developer or delayed maturer) should be a decisive criterion to individualised programming (prescription) of training. The proposed training model, which regards late puberty and post-puberty, consists of multilateral and introductory-specialised training programmes,

as well as of procedures including early orientation (specialisation) of players to broader roles and/or positions in the game.

Purpose of this research is to determine the effects of the applied developmental training programme in some basic and specific motor-functional abilities of talented cadet basketball players during two months of competitive season. The basic hypothesis is defined as: the training programme will, in the multivariate space, produce statistically significant changes in parameters of motor – functional conditioning between the first and second measurement.

Methods

The sample consists of twelve talented cadet basketball players, 15 to 16 years of age, members of the KK »Cibona« cadet team, who have been actively training and playing basketball for 4–6 years.

The sample of variables contains seven (out of eight) standard tests for assessing basic motor and functional abilities (conditioning status) that are regularly used to determine physical conditioning of NBA players (Basketball Conditioning Power Rating System)[23].

The basic motor abilities assessment variables:

1. SAR – standing vertical jump with arms swing (cm) / explosive leg power of a jumping type;
2. SIT – number of sit-ups in 60 seconds / trunk (core) power;
3. PUSH – maximal number of push -ups / arms and upper back power;
4. FLEX – sit-and-reach (cm) / flexibility;
5. PULL – overgrip pull-ups (number) / arms and upper back power.

A variable for assessing the specific motor ability:

6. AG20 – 20-yard drill (acceleration, deceleration and change direction) / agility.

A variable for assessing functional abilities:

7. AN300–300-yard shuttle run / anaerobic lactic endurance.

Experimental plan and programme of training and competition

The experiment was carried out during the Croatian cadet championship competitive season 1999/2000. The initial measurement was performed before the beginning of the first mesocycle (September 28 and 29, 1999) and the second at the end of the second mesocycle (November 28 and 29, 1999).

The experimental training programme was divided in two mesocycles:

– the first mesocycle lasted 28 days (from September 30 to October 27, 1999) with 21 training sessions and 4 matches. Average duration of the daily training load* (volume) was 145 minutes, while its average intensity** was 60% of the maximum;
– the second mesocycle lasted 29 days (October 30 – November 28, 1999) with 20 training sessions and 4 matches. Average duration of the daily training load (volume) was 130 minutes, while its average intensity was 75% of the maximum.

The load was being progressively increased during the first three weeks in each mesocycle, whereas it was in the fourth week the load was decreased in order to allow for the adaptation. In general, developmental training cycle lasted

* Average duration is a sum of duration of all practices divided by the number of practices.

** Average intensity is a sum of intensities of all practices divided by the number of practices.

57 days and included 41 training sessions or practices and 8 matches. The training cycle intensity varied between 60% and 75%, whereas average duration of a workout was 137.5 minutes.

Two equivalent objectives of the experimental training programme were set: the first, to produce positive changes in parameters of motor-functional condition (preparedness or fitness), consequently, to decrease indirectly injury risks, and the second, to achieve desirable competitive success in the national cadet championship (participation in the Final Four tournament).

Considering the fact that high performance and competitive success is not a primary goal in this age, it was possible to establish structure of contents, methods and distribution of load that allowed for developing and improving conditioning abilities throughout competitive season (period). Interaction of certain volume of technical-tactical programme and physical conditioning workouts was the main attribute of the training structure. The implemented physical conditioning programme was a complex and complementary system of various exercises that helped players to acquire and perfect tasks and exercises from several training technologies, such as light athletics (basic and specific), weightlifting, body-building, aerobics (classic, aesthetic and sport), and cardio-fitness. Such a synergistic physical conditioning programme is called an integrative training technology[24], because it is based on compounding various exercises from different training technologies in certain ratios and order in each training unit. As opposed to conventional programmes, the integrative training technology is designed to elevate and transform basic potential of a player into specific abilities that are further transformed into and eventually manifested as actual quality (performance) of each athlete.

The special objective of the plan and programme was orientation of players to broader position(s) and/or role(s) in the game by means of learning and perfecting polyvalent technical-tactical basketball skills[25].

Table 1 displays the two-month plan and programme of workouts of the developmental training cycle during the competitive period. Due to players' obligations in school, two practices per day were not attainable, so each training session had to be combined out of technical-tactical and conditioning tasks.

The training contents used are aimed at developing and/or maintaining of:

- flexibility – stretching exercises – active method, static and ballistic; passive method and combined method or PNF stretching;
- trunk strength – exercises for the core strength enhancement – abdominal, hip and back muscle groups – especially important to injury risks decrease;
- specific explosive power – vertical jumping ability exercises
- specific ballistic explosive power – exercises of catching and throwing the medicine ball;
- anaerobic lactic endurance – various running exercises over court length and width and systems of the game situational exercises (covering TE-TA skills of playing on transitional offence and defence – high work intensity mode);
- balance (dynamic stability) – equilibrium maintainance and restoring exercises (forwards, backwards, and sideways – balance squats, balance lounges, release lounges, jumps from basketball stance with 90° to 360° turns with open or closed eyes, contact situational exercises with an opponent on offence and defence;
- agility and quick reaction – agility should be developed in puberty and

TABLE 1
TWO-MONTH DEVELOPMENTAL TRAINING PLAN AND PROGRAMME APPLIED IN THE COMPETITIVE SEASON

Period	Competitive season		
Mesocycle	1st	2nd	1st + 2nd
Duration	30.09–27.10.1999	30.10–28.11.1999	30.09.–28.11.1999
MO-FU : TE-TA	35:65	45:55	40:60
Number of microcycles	4	4	8
Number of days	28	29	57
Number of practice days	25	26	51
Number of training sessions	21	20	41
Number of matches	4	4	8
Rest days	3	3	6
Volume	145	130	137.5
Intensity	60	75	67.5
Testing	28.–29.09.1999	28.–29.11.1999	28.–29.09. / 28.–29.11.

MO – FU – motor-functional conditioning as percentage of the maximum value;
TE – TA – technical-tactical conditioning as percentage of themaximum value;
Volume – average duration of each work-out (min);
Intensity – average load level in a single practice (%)

post-puberty, and afterwards it should be maintained[11] – various basketball specific exercises simulating the game structure, e.g. types of moving in basketball stance in all directions, changes of direction along longitudinal court axis with and without the ball, offence exercises without the ball with multiple changes of pace and direction of moving – exercises are aimed at overcoming the body mass inertia at the highest speed and still maintaining balance and purposeful organisation of movement structure;

- arm and upper-back (shoulder) power – weight-room strength exercises – different lat-machine pulls and pull-ups;
- anaerobic – alactic endurance – developmental exercises include starts and accelerations from different positions over distances up to 28 m; series of two- and one-foot hops and jumps from the squat and fall-out up to 10-second; leaps and jumps forwards, sideways and backwards; handicapped sprints over distances up to 28 m and various stepping exercises;
- technical-tactical skills and co-ordination capacities – learning and perfecting TE-TA elements indispensable to improve one's versatility in diverse game systems and concepts; co-ordination is of a determined importance for acquiring and perfecting technique and tactics, as well as for applying them in unfamiliar circumstances of a match[2,11] – exercises focused on versatility of details and technical finesses, as well as on variations of performance rhythm;
- theoretical knowledge – aspects of the game and training, proper performance of TE-TA skills, principles of the game on offence and defence (transition and set), etc.

Tables 2 and 3 display the employed combination of exercises aimed at devel-

TABLE 2
DISTRIBUTION OF EXERCISES, AIMED AT DIFFERENT MOTOR-FUNCTIONAL ABILITIES, IN A MICROCYCLE – THE 1st MESOCYCLE

	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Trunk strength	X	X	X	X	X		
Flexibility	X	X	X	X	X		
Balance		X		X			
Agility		X		X			
Balistic explosive power		X		X			
Explosive leg power – vertical jumping ability	X		X				
Arm and upper-back strength	X		X				
Anaerobic alactate endurance	X		X				
Anaerobic lactate endurance		X		X			
Technical and tactical skills and co-ordination capacity	X	X	X	X	X		
Theoretical preparation						X	
Match						X	

TABLE 3
DISTRIBUTION OF EXERCISES, AIMED AT DIFFERENT MOTOR-FUNCTIONAL ABILITIES, IN A MICROCYCLE – THE 2nd MESOCYCLE

	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Trunk strength	X	X	X	X	X		
Flexibility	X	X	X	X	X		
Balance		X		X			
Agility		X		X			
Balistic explosive power		X		X			
Explosive leg power – vertical jumping ability	X		X		X		
Arm and upper-back strength	X		X				
Anaerobic alactate endurance	X		X		X		
Anaerobic lactate endurance		X		X			
Technical and tactical skills and co-ordination capacity	X	X	X	X	X		
Theoretical preparation						X	
Match						X	

oping or maintaining motor-functional abilities which make the structure of separate training units within a microcycle.

The total training load was being increased over the first three microcycles in a mesocycle by 2.5% by means of increased number of repetitions in a set and number of sets in conditioning drills (volume) and by higher intensity of work (execution pace).

Data processing methods

Data were processed by the statistical software package Statistica 5.0 for Windows. Central and dispersive parameters were calculated for the both measurements. Univariate changes were tested by a series of t-tests for dependent samples. To analyse quantitative changes canonical discriminant analysis of quantitative changes under the model of differences was employed[26–28].

Results and Discussion

Based on the analysis of the first and second measurement data (Table 4) it can be stated that applied transformational process (training) has produced positive numerical changes in all measured variables.

Vertical jumping ability (SAR) increased on average by 8 cm between the first and second measurement. The lowest score obtained in the first measurement increased by 9 cm in the second check point, whereas the highest score increased by 1.5 cm. Agility, measured by means of 20-yard drill with changes of direction (AG20), improved on average by 0.17 seconds. In 300-yard shuttle run test (AN300) the results obtained in the second measurement were better by 2.8 seconds. Repetitive power of arms and upper-back test (PUSH) showed increase of 8 repetitions. Trunk strength test (SIT) revealed positive changes with average score increase of 9.6 repetitions. Positive changes in flexibility test (FLEX) are relatively small, 1.7 cm on average.

Relative arm and upper-back power test (PULL) showed positive changes, but average score did not increase by a single repetition. The minimal score stayed the same (zero), while the maximal score increased by 3 repetitions.

On the basis of the multivariate test (Table 5) it can be concluded that the changes, caused by the experimental programme, between the first and second measurement are statistically significant

TABLE 4
BASIC STATISTICAL PARAMETERS OF THE FIRST AND THE SECOND MEASUREMENT

		X	Min	Max	Range	SD
SAR	1	50.04	37.00	68.00	31.00	7.63
	2	57.75	46.00	69.50	23.50	7.14
AG20	1	4.97	4.48	5.74	1.26	0.32
	2	4.80	4.36	5.71	1.35	0.40
AN300	1	59.79	55.66	67.92	12.26	3.43
	2	57.00	52.20	62.31	10.11	3.09
FLEX	1	15.08	6.00	29.00	23.00	6.86
	2	16.79	4.00	29.50	25.50	7.60
PUSH	1	14.67	5.00	23.00	18.00	6.17
	2	22.50	15.00	32.00	17.00	5.45
PULL	1	1.42	0.00	5.00	5.00	1.98
	2	1.83	0.00	8.00	8.00	2.62
SIT	1	44.00	32.00	53.00	21.00	6.03
	2	53.58	40.00	63.00	23.00	6.44

($p < 0.01$) and that allowed for accepting the hypothesis about significant changes at the multivariate level.

The variables for assessing different dimensions of strength and power (i.e. repetitive trunk power (SIT), repetitive arms and upper-back power (PUSH) and explosive leg power (SAR)) established the greatest correlation (Table 6) with the canonical discriminant function, as well as did variables that assessed anaerobic lactic endurance (AN300) and agility (AG20). Correlations between variables AN300 and AG20 and the discriminant function are negative because those variables have inversed metric scale (the lower the result the better).

There were statistically significant changes in six out of seven measured variables at the univariate level (Table 7). The changed variables are: standing vertical jump (SAR, $p < 0.00$), agility (AG20, $p < 0.00$), anaerobic glycolitic endurance (AN300, $p < 0.05$), number of push-ups in 60 seconds (PUSH, $p < 0.00$), sit-and-reach (FLEX, $p < 0.05$) and maximal number of sit-ups (SIT, $p < 0.00$).

The special attention should be focused on the overgrip pull-up test (PULL), measuring relative arms and upper-back power, because examinees scored very poorly in it (1–2 repetitions only). In other words, this variable has very poor sensitivity for assessing relative arms and upper-back power in cadet basketball players. The authors assume that the key reasons for such a result are biomechanical characteristics of the test, as well as relatively poor arm and upper back power of the examined sample, caused by the exaggerated disproportion among height, body mass and strength of participants. Therefore, the authors consider the overgrip pull-up test to be inadequate for testing basketball players of this age and they propose the undergrip pull-up test instead, as a more adequate, facilitated modification of the same test.

The greatest and most significant changes were found in repetitive power of the mid-section, which was expected, since the largest number of training sessions (five in a microcycle) had been devoted to exer-

TABLE 5
CANONICAL DISCRIMINANT ANALYSIS OF QUANTITATIVE CHANGES BETWEEN TWO MEASUREMENTS UNDER THE MODEL OF DIFFERENCES

Mahalanobis' distance = 29.708
F-test difference = 23.149
DF 1 = 7
DF 2 = 5
p = 0.000

TABLE 6
STRUCTURE MATRIX – CORRELATIONS OF VARIABLES WITH THE DISCRIMINANT FUNCTION (DF)

	DF
SAR	0.22
AG20	–0.20
AN300	–0.26
FLEX	0.13
PUSH	0.38
PULL	0.08
SIT	0.39

TABLE 7
UNIVARIATE T – TESTS OF DIFFERENCES BETWEEN TWO MEASUREMENTS

	t	p
SAR	–4.102	0.00
AG20	3.694	0.00
AN300	4.944	0.00
FLEX	–2.393	0.04
PUSH	–7.260	0.00
PULL	1.448	0.18
SIT	–7.441	0.00

cises strengthening trunk muscles, more precisely, the mid-section muscles were treated in the beginning or end of each practice. The trunk is a body core, a center of body power, a crossroad of energy and bridge between the lower and upper body parts (extremities). Consequently, strong, well balanced, but flexible trunk is a precondition to high level performance[29]. Apart from the core power development, a contribution to prevention from injuries of the locomotor system was particularly given by developing ligament and tendon structures (41 work-outs).

The vertical jumping ability (explosive leg power) was developed in 2–3 practices in a microcycle, that is the total of 20 work-outs. Special emphasis was on the development of ability to perform quick sequential jumps (structurally connected jumps in a sequence) in the eccentric-concentric regime of work. Additionally, there is no doubt that specific basketball training and matches had significantly contributed to the statistically significant increases in vertical jumping ability. Namely, one- and two-foot jumps are an integral part, a fundamental skill of the game of basketball (offensive and defensive rebounding, shot blocks, jump shots, etc.). So, each practice day in a micro-cycle contained a substantial amount of different jumping technique exercises as a part of basketball motor skills (TE-TA skills) development.

Agility and quick reactions, as well as anaerobic lactic endurance were treated in two practices per microcycle, which round up a total of only 16 practices in two mesocycles. Nevertheless, similar as with jumping ability, the high intensity specific basketball training occurred to be the best method of improving the anaerobic capacity, as well as agility and quick reaction[2].

Flexibility was developed and/or maintained every day in the beginning and end of each practice that is in 41 practices. Yet, the positive changes in flexibility tests (FLEX) are statistically significant, but they are numerically the smallest. It is probably due to the initial state of examinees, averaging 15.58 cm in the first test. Comparing this score with the standard model scores (10 cm) of the top senior basketball players, set by the American Basketball Strength and Conditioning Coaches Association[23], one can see that this sample of basketball cadets had great scores, on the average, in the initial measurement and significant changes for this variable could not have been expected.

Although developing of arm and upper-back power had been planned for two sessions in a microcyle, it was actually performed only once in a week. That and biomechanical inappropriatness of the overgrip pull-up test are probably the cause of the lowest improvements in that motor ability.

Conclusions

The research was carried out with an objective of analysing effects of a two -month development training cycle, realised in the competitive season, on changes in certain parameters of basic and specific motor – functional condition (fitness or preparedness) of twelve talented cadet basketball players (15–16 years).

At the multivariate level statistically significant changes ($p < 0.01$) were determined between the two tests. At the univariate level, scores showed statistically significant differences between the two measurements in 6 out of 7 measured variables: standing vertical jump with arm swings (SAR, $p < 0.00$), agility (AG20, $p < 0.00$), anaerobic lactic endurance (AN300, $p < 0.05$), number of push-ups in 60 seconds (PUSH, $p < 0.00$), sit-and -reach (FLEX, $p < 0.05$) and maximal number of sit-ups in 60 seconds (SIT, $p < 0.00$). The variables with statistically significant changes at the univariate le-

vel, namely, sit-ups, push-ups, 300-yard shuttle run and vertical jump, established the greatest correlation with the discriminant function.

The authors are of an opinion that overgrip pull-up test, for assessing arms and upper-back power, is not adequate for basketball players of this age (15–16 years). Because of its poor sensitivity they propose the undergrip pull-up test, an easier modification of the same test.

Finally, it must be underlined that the applied two-month development training process produced statistically significant changes in parameters of the motor-functional condition (preparedness) of young basketball players in competitive season, with no substantial interference with their performance. The team won all eight matches in the period in which the experimental programme was implemented. It indirectly reinforces the opinion of several basketball practitioners that the work on improving motor-functional conditioning during competitive season does not substantially affect adversely overall performance nor situation-related efficiency of basketball cadets. That is probably due to the fact that TE-TA skills and performance are founded on the specific motor-functional condition. The authors are aware that the competition calendar (one match in a microcycle) and just one training session per day enabled such a system of sport preparation (players had enough time to rest and recover).

The observed sample of basketball players had but one loss in thirty-five games in the entire 1999/2000 competitive season. (Unfortunately, it was the semi-final match of the Final Four tournament.) It is an indirect evidence about rather high sport achievement and, which is even more important, about rather stable performance. That allows for assumption that it is possible to join process of producing top-quality players and top competitive results by applying the integrative sports preparation. As opposed to senior teams, where to maintain the condition and sport form is the primary objective of training during the competitive period, in junior and cadet teams it seems feasible to apply the proposed model of the developmental training cycle. The feasibility is based on the main objective of work with that age category: to develop potential of players and transform it, as completely and high as possible, into individual and team performance or actual quality.

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UČINCI RAZVOJNOG TRENINGA KOŠARKAŠA KADETA PRIMIJENJENOG TIJEKOM NATJECATELJSKOG RAZDOBLJA

S A Ž E T A K

Na temelju analize utjecaja dvomjesečnog razvojnog ciklusa treninga u natjecateljskom razdoblju utvrđene su, na multivarijatnoj razini, statistički značajne pozitivne promjene između dviju vremenskih točaka u pokazateljima motoričko-funkcionalne pripremljenosti uzorka nadarenih košarkaša kadeta, u dobi od 15 do 16 godina. Najveće korelacije s diskriminacijskom funkcijom imale su varijable u kojima je došlo do statistički značajnih promjena na univarijatnoj razini, eksplicitnije, u varijablama repetitivne snage gornjeg dijela tijela i trupa, anaerobne laktatne izdržljivosti te eksplozivne snage nogu tipa skoka. Autori smatraju da test zgib nathvatom, za procjenu snage ruku i gornjeg dijela leđa, nije primjeren za košarkaše ove dobi zbog slabe osjetljivosti testa, stoga predlažu korištenje zgiba pothvatom, lakšu modifikaciju spomenutog testa. Ovaj rad potkrepljuje postavke eksperata iz košarkaške prakse kako je, u trenažnom procesu s mladim košarkašima, moguće uspješno primijeniti model razvojnih ciklusa treninga i tijekom natjecateljskog razdoblja. Predloženi model čini sustav različitih postupaka sinergijskog djelovanja kojima je cilj povećanje integralne pripremljenosti košarkaša. Stoga bi slijedeća istraživanja valjalo posvetiti procjeni efekata i drugih modela razvojnih ciklusa treninga praćenjem stvarne kvalitete igrača, s jedne strane, a s druge strane bi trebalo pratiti hormonske i biokemijske promjene kroz više vremenskih točaka.