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DIFFERENCES BETWEEN PERSONALITY CHARACTERISTICS AND SPORT PERFORMANCE BY AGE AND GENDER

Noemi Gyomber, Agota Lenart, Krisztina Kovacs

Department of Psychology, Faculty of Physical Education and Sport Sciences, Semmelweis University, Hungary

Summary: Background: The contemporary literature in sport psychology focuses on several topics, particularly on the well-being of athletes. Sport performance, successful performance is often influenced by the mental health and psychological status of athletes that might be facilitated by sport psychological therapy.

Objective: The aim of the present study is to seek for interrelations of mental health, personality variables and sport performance by age and gender.

Method: Questionnaire survey was conducted among athletes (N = 185) participating in sport psychological counselling and therapy. Personality variables were measured by instruments of California Personality Inventory (CPI-21). Sport performance was measured on a 3-point scale indicating the most successful performance in the last year.

Results: The findings showed several differences in the investigated variable set by age and gender. Sport performance indicated no gender differences; while by age the 21+ age group was more successful than the younger one. Significant differences were found in psychological measurement scales, that is, personality may vary by age and gender. Regression analyses were employed to test how personality factors affect sport performance. The analyses strengthened the impact of personality factors in successful sport performance; where age and gender specific factors could be detected.

Conclusion: The goal of applied practice of sport psychological counselling is to optimize performance and enjoyment through the use of psychological skills, thus patterns due to age and gender should be taking into consideration in sport psychological counselling.

Key words: successful sport performance, personality traits, sport psychological preparation and counselling

Introduction

The contemporary literature in sport psychology focuses on several topics, particularly on the well-being of athletes. Several research investigated arousal, anxiety, personality traits, motivation, self-evaluation, and cognitive skills (Connolly & Janelle, 2003; Crocker et al., 1998; Gould & Udry, 1994; Jones, 1994). Previous research have confirmed that the athletes during physical activity, exercise utilize their psychological skills in a high level, thus sport psychological preparation and counselling can contribute to better sport performance (Andersen, 2001; Anshel, 2003; Hardy et al., 1996). Sport performance, and successful performan-

ce is often influenced by the psychological skills and psychological status of athletes that can be facilitated by psychological therapy (Gardner & Moore; 2006, Omar-Fauzee et al., 2009). Sport psychologists train and supervise athletes' development, they observe how participation in sport and exercise affect psychological and physical factors, and they provide instruction and training of psychological skills for performance improvement by emphasizing the athletes' strengths. The applied sport psychology may include work with athletes themselves, coaches, and parents of young athletes regarding handling injuries, rehabilitation, communication, team building, and career transitions. Moreover, during sport psychological preparation – e.g. psychotherapy, arousal regulation, goal setting, imagery, self-talk and preperformance routines – psychologists make suggestions for improving practice effectiveness due to psychological skills (Harwood et al, 2004; Leunes, 2011, Omar-Fauzee et al., 2009; Shaw et al., 2005; Singer et al., 2001). The goal of applied practice is to optimize performance and joy through the use of psychological skills (Vealey & Garner-Holman, 1998).

Of the basic methods in sport psychological preparation relaxation techniques can be learnt to use individually before and during sport competitions – under pressure – in order to achieve better sport performance consistently, and to hold ability to perform well. Increasing self-efficacy/sport-confidence, ability to focus, and successfully perform a task.

Previous research attempted to explore the role of age and gender specific considerations in effective sport performance. However, findings are vague most of the researchers emphasized the beneficial impact of sport psychological counselling for both genders and any age groups. For instance, Connelly and Janelle (2003) found the evidence that rowers – males and females – performed significantly better when employing associative attention styles, strategies facilitated by sport preparation. Boglar and colleagues (2008) reported no gender differences in a sample of adolescent tennis players concerning anger management. Friedman and Berger (1991) stated that gender has a dominant impact on stress reduction techniques, where high level masculinity provided benefits for students. Omar-Fauzee and colleagues (2009) demonstrated that significant gender differences were found in coping with adversity, where males indicated higher effectiveness in coping among Malaysian athletes. On the other hand, slight gender differences were shown among adolescent athletes in selecting coping strategies (Hoar et al., 2010; Rogowska & Kusniers, 2012). Thus, sport psychology consultants must be sensitive to how personal characteristics work, and considering gender and age might be a remarkable factor in supporting effective performance.

The present paper aims to examine one common area of investigation within sport psychology, namely, the relationship between personality and performance. The present research focuses on specific personality characteristics and the relation to performance variables by age and gender. We assume that specific age and gender related components might support the process of sport psychological counselling and preparation.

Methods

Procedure

Questionnaire survey was conducted among athletes (N = 185) participating in sport psychological counselling and therapy in a certain hospital, in Budapest, Hungary. Participants were informed on the first psychological consultation about the study objectives and their voluntary and anonym participation was ensured. A sport psychologist was present

while carrying out the questionnaire survey. Participants filled in the questionnaires in appro-
ximately 45 – 50 minutes.

Measurement

Of *sociodemographic variables*, age, gender and education of the participants were
noted in the introduction part. Sport-related variables such as "What sport do you do?" and
"What is your best sport performance achieved in the last year?" were asked. Sport perfor-
mance was measured on a 3-point scale indicating the athlete's most successful performance
in the last year ('1 = International ranking 1 – 6'; '2 = National ranking 1 – 3'; '3 = Other'). Then,
a set of measurement tools were introduced concerning psychological skills. Personality
variables were measured by the instrument of *California Personality Inventory* (CPI-21 cf.
McAllister 1996). CPI is a self-report inventory that was first published in 1956 and CPI
focuses on measuring and understanding common interpersonal behaviours (e.g., self-control,
dominance etc.) in the general population. This comprehensive tool enhances (1) measures
of poise, ascendancy, self-assurance, and interpersonal adequacy; (2) measures of socializa-
tion, responsibility, intrapersonal values, and character; (3) measures of achievement poten-
tial and intellectual efficiency; (4) measures of intellectual modes and interest modes (Gough
& Bradley 1996). The inventory contains 434 items which can be scored to yield 21 scales
(Dominance, Capacity for Status, Sociability, Social Presence, Self-Acceptance, Indepen-
dence, Empathy, Responsibility, Socialization, Self-Control, Good Impression, Communa-
lity, Sense of Well-Being, Anxiety, Tolerance, and Achievement via Conformance, Achieve-
ment via Independence, Intellectual Efficiency, Psychological-Mindedness, Flexibility, and
Femininity-Masculinity). CPI is often used, since includes Social Performance scales that
capture Big Five personality traits, namely Extraversion/Sociability, Agreeableness/ Likabi-
lity, Conscientiousness, Ego Control/Neuroticism and Intellectance/Openness.

Analysis

SPSS 20.0 was used for statistical analyses. For descriptive statistics, frequencies, inde-
pendent samples tests and chi-square tests were used. For further analyses, linear regression
analyses with backward method were employed. The level of significance was set to 0.05.

Results

The sample characteristics are presented in Table 1. The mean age of the respondents
was 21.23 years. Males were represented in the sample with 60.5 %, and more than half of
the respondents obtained university or college degrees (51.9 %).

Concerning sports by type a widespread range was represented in the sample, such as
individual sports (e.g. athletics, golf, cycling, swimming, tennis) and team sports (basketball,
football, and handball). There was no significant difference in sports by type based on gender
($\chi^2 = 0.4$, $p > 0.05$), however, females prefer slightly more the individual sports than males
(90.4 vs. 87.5 %). Significant differences were found by age, namely, the younger age group
tend to choose individual sports compared to team sports ($\chi^2 = 7.5$ $p < 0.01$; 93.3 % vs. 80 %).

Table 1

Sociodemographics of the sample (N =185)

	Mean (SD)	**Frequency**
Age	21.23 (7.2)	
Gender		60.5 % male 39.5 % female
Education		48.1 % high school 51.9 % university or college degree

In sport performance we found that 8.6 % of the sample achieved International ranking 1 – 6, 25.9 % National ranking 1 – 3, and 65.4 % obtained other ranking. No significant difference was found by gender, that is, the successful sport performance of males and females was balanced in the sample. In addition, age showed significant difference in sport performance, namely, the 21+ age group had more successful sport performance ($\chi^2 = 6.5$ p < 0.05). Figure 1 shows that the 21+ age group achieved better international ranking 62.5 % than the under 21 years olds, 37.5 %.
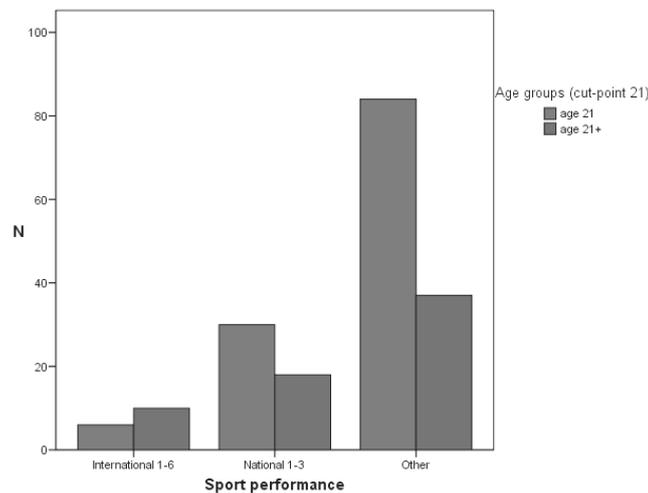
Figure 1

Sport performance by age

In the next phase of the analysis gender differences were investigated in personality variables by employing independent samples t-tests. The findings showed that age group and gender differences are present in certain scales of the personality scales (Table 2), namely, Self-acceptance, Good Impression, Communality, Achievement via Independence, Intellectual Efficiency of CPI scales were higher among females, while Sense of Well-Being showed higher scores among males. Concerning age under-21 group achieved higher scores on

Dominance, Sociability, Self-Acceptance, Anxiety, Socialization, Good Impression, Achievement via Conformance and Intellectual Efficiency scales. The age 21+ group showed higher mean scores on Flexibility and Femininity-Masculinity scales.

Table 2

Age and gender differences

	Total	Female	Male	Age	
				under 21	21+
Dominance (DO)	51.5	52.3	51.0	54.7**	45.5
Capacity for Status (CS)	52.1	53.7	51.0	52.3	51.7
Sociability (SY)	59.6	59.1	59.9	64.7**	50.3
Social Presence (SP)	54.4	55.5	53.7	55.4	52.6
Self-Acceptance (SA)	50.2	52.8*	48.4	51.8**	47.1
Sense of Well-Being (WB)	49.0	43.2**	52.8	49.9	47.4
Anxiety (AN)	47.1	47.9	46.6	48.7*	44.2
Responsibility (RE)	38.1	39.0	37.4	38.9	36.6
Socialization (SO)	50.3	52.4	48.9	53.9**	43.6
Self-Control (SC)	44.8	46.8	43.5	46.1	42.3
Tolerance (TO)	39.2	38.8	39.5	39.1	39.5
Energy of Self (ES)	45.8	45.6	46.0	44.8	47.8
Good Impression (GI)	44.8	48.9*	42.1	47.2*	40.4
Communality (CM)	52.7	55.2**	51.0	53.0	52.2
Achievement via Conformance (AC)	54.0	53.2	54.5	57.2**	48.1
Achievement via Independence (AI)	46.0	48.4*	44.4	44.6^{o}	48.5
Intellectual Efficiency (IE)	46.4	49.9^{o}	44.2	54.2**	32.2
Psychological-Mindedness (PY)	52.9	51.3	53.9	54.0^{o}	51.0
Empathy (EM)	53.0	54.3	52.1	53.6	51.8
Flexibility (FX)	42.6	43.4	42.1	40.1*	47.3
Femininity-Masculinity (FE)	45.8	43.8	47.0	44.2*	48.7
Extraversion/Sociability	53.1	55.7^{o}	51.4	55.2*	49.2
Agreeableness/Likeability	53.7	55.1	52.8	57.1**	47.5
Conscientiousness	48.1	50.0	46.9	51.0**	42.8
Ego Control/Neuroticism	43.5	43.6	43.4	43.0	44.8
Intellectance/Openness	42.8	44.6^{o}	41.6	43.7	41.2

* $p < 0.01$ ** $p < 0.001$ ^{o} $p < 0.05$

In Big Five traits (Table 2) – captured by Social Performance scales of CPI – females were represented higher level in Extraversion/Sociability and Intellectance/Openness, where the under-21 age group was overrepresented along Extraversion/Sociability, Agreeableness/ Likeability and Conscientiousness.

The next step of the analysis was to seek for background factors of sport performance, that is, to test what kind of personality variables predict successful sport performance. To investigate the background factors linear regression analyses was conducted. Separate models were run for CPI and Big Five personality variable sets, measurement tools (Table 3).

Table 3

Linear regression models for sport performance

Total sample	Model 1	Model 2
CPI		
Sociability	0.507**	
Social Presence	0.229*	
Self-Acceptance	0.262**	
Self-Control	0.146*	
Big Five		
Extraversion/Sociability		0.170*
Ego Control/Neuroticism		0.406**
Agreeableness/Likeability		0.297**
R Square	0.131**	0.069**
Constant	0.92**	1.53**

**p < 0.001 * p < 0.05   Note: ß values

Regression models with backward method were employed to test how psychological factors affect sport performance. The analyses strengthened the impact of psychological factors in successful sport performance, in the total sample the CPI regression Model 1 showed that Sociability, Social Presence, Self-Acceptance and Self-Control play a dominant role in predicting sport performance (Table 3). The Model 2 showed that within the Big Five scales Ego Control, Agreeableness and Sociability predicts sport performance.

For male-subsample Self-Acceptance (ß = 0.407 p < 0.001), Sociability (ß = - 0.411 p < 0.001), Achievement via Conformance and Flexibility (ß = - 0.257 p < 0.05) had significant effects on sport performance, while for female-subsample Social Presence (ß = - 0.504 p < 0.001), Sociability (ß = 0.471 p < 0.05), Achievement via Conformance (ß = 0.295 p < 0.05), Flexibility (ß = 0.277 p < 0.05) and Responsibility (ß = - 0.259 p < 0.05). Therefore, for both genders improving Sociability, Achievement via Conformance and Flexibility factors should be prioritized (Table 4).

Table 4

Linear regression models for sport performance by gender

	Model 1 for males	Model 1 for females	Model 2 for males	Model 2 for females
CPI				
Sociability	0.407**	0.471*		
Social Presence		- 0.504**		
Responsibility		- 0.259*		
Self-Acceptance	- 0.411**			
Achievement via Conformance	- 0.257*	0.295*		
Flexibility	- 0.257*	0.277*		
Big Five				
Ego Control/Neuroticism			- 0.311**	- 0.299*
Agreeableness/Likeability			0.273*	0.344*
R Square	0.186**	0.212*	0.053*	0.063
Constant	3.57**	2.70**	2.43**	2.23**

**p < 0.001 * p < 0.05   Note: ß values

Concerning Big Five personality traits, both for males and females Ego Control/ Neuroticism, and Agreeableness/Likeability predicted sport performance, however for males the Ego Control/Neuroticism (ß = - 0.311 p < 0.001), for females Agreeableness/Likeability (ß = 0.344 p < 0.05) seems to have stronger influence.

Table 5

Linear regression models for sport performance by age

	Model 1 for under 21	Model 1 for 21+	Model 2 for under 21	Model 2 for 21+
CPI				
Sociability	0.251*	0.378*		
Psychological-Mindedness		- 0.336*		
Responsibility		- 0.301*		
Self-Acceptance		- 0.264*		
Flexibility	- 0.310**	- 0.225*		
Big Five				
Ego Control/Neuroticism			- 0.214*	
Conscientiousness			0.258*	
Agreeableness/Likeability				0.566*
R Square	0.075*	0.228**	0.043*	0.122
Constant	2.78**	4.51**	2.55**	3.34**

**p < 0.001 * p < 0.05   Note: ß values

The age distinguished analysis showed that for younger athletes Sociability (ß = 0.251 p < 0.05) and Self-Acceptance (ß = - 0.311 p < 0.001) is crucial, while in the 21+ age group these – Sociability (ß = 0.378 p < 0.05) and Self-Acceptance (ß = - 0.264 p < 0.05) – were completed by Responsibility (ß = - 0.301 p < 0.05), Psychological-Mindedness (ß = - 0.336 p < 0.05) and Flexibility (ß = - 0.225 p < 0.05). Therefore, Self-Acceptance seems to be the most important predictor under 21 years and Sociability, particularly in 21+ groups is a significant predicttor for sport performance.

In terms of Big Five personality traits, the linear regression analysis resulted in applicable model for under 21 years old athletes. For this age group, Conscientiousness is the stronger predictor (ß = 0.258 p < 0.05) and also Ego Control/Neuroticism (ß = - 0.214 p < 0.05) contributed to the model. It is important to underline that Sociability in 21+ group was supported by Big Five Agreeableness/Likeability trait in successful performance.

Conclusion

The objective of the present paper was to examine the relationship between personality characteristics and sport performance by age and gender. The present research focused on specific personality characteristics – CPI and Big Five personality traits – and the relation to performance variables (Goldberg, 1992). Examining the choice of sports by type younger age and female group tend to choose individual sports compared to team sports. No significant difference was found in ranking by gender, that is, the successful sport performance of males and females was balanced in the current sample. Not surprisingly, age showed significant differences in sport performance, namely, the 21+ age group had more successful sport performance due to the fact that they have spent longer time run in sporting. 21+ age group achieved International ranking 1 – 3 nearly twice more than under 21 years old group.

The present findings showed that there is a different personality and psychological profile of male and female, and younger and older athletes (cf. Boglar et al. 2008; Connelly & Janelle, 2003; Friedman & Berger, 1991; Hoar et al., 2010; Omar-Fauzee et al. 2009; Rogowska & Kusniers, 2012).

While investigating the personality factors, the data showed that Self-acceptance, Good Impression, Communality, Achievement via Independence, Intellectual Efficiency of CPI scales were higher among females, while Sense of Well-Being showed higher scores among males. Thus, that means there are more personality factors among females that might contribute to better performing. On the other hand, males rate better their Well-being during exercise and sport performance – and their general well-being – than females.

Concerning age significant differences showed that under-21 group achieved higher scores on Dominance, Sociability, Self-Acceptance, Anxiety, Socialization, Good Impression, Achievement via Conformance and Intellectual Efficiency scales. We might emphasize here the crucial role of adolescence. During this age phase high dominance is linked to the characteristics of adolescence, namely, it is a highly ego-cantered period, where sociability plays a dominant role due to high sociability and high relevance of the peers group, peer acceptance. In general, dominance might be higher because of the status and prestige of peers involved in elite sports. The values demanded by elite athletes influence the identity positively. Based on the high status of elite athletes and the high level of peer acceptance self-acceptance is triggered and adolescent elite athletes tend to rate their own skills higher than others.

The older age group showed higher mean scores on Flexibility and Femininity-Masculinity scales. This can be explained also by age characteristics, that is, the older group has already overcome the identity crisis and focuses more on intimacy issues (cf. Erikson psycho-social development model). In this age phase individuals are dealing with masculinity and femininity features of relationships and the masculine and feminine roles are prioritized. These roles are integrating into the personality during this period. In addition, significant development of cognitive skills progresses where coping potential is improved. In summary, the aforementioned changes have important effect on personality, on sport behaviour and sport performance.

In Big Five personality traits, – in harmony with previous theories (cf. Friedman & Berger, 1991) – females were represented significantly higher level in Extraversion/Sociability and Intellectance/Openness. Females focus on their peers more dominantly and since puberty occurs earlier than among males, they open to others more widespread. The under-21 age group was overrepresented along Extraversion/Sociability, Agreeableness/Likeability and Conscientiousness. Besides the age characteristics, the overwhelming changes of the 21st century might be mentioned, the complex challenges that youth are facing, e.g. goal-orientation, fighting for better performance, being innovative in the rushing environment.

In the next step, a set of linear regression models was employed in order to reveal how the different personality traits predict successful sport performance in the total sample, then divided by age and gender. Of CPI scales Sociability seems to have the most remarkable influence on sport performance, particularly among females and the 21+ age group. Females, in general, are more sociable and tend to pay attention to social networks in a high level. Furthermore, sociability might play a significant role in every elite athlete's life due to the fact that they spend a large amount of time with their sport peers. The sport peers operate as significant others, reference group that mediate values, and ensures cohesion based on the common experiences, trainings and competitions.

In Big Five scales, Ego Control/Neuroticism presented the highest ß value, particularly it had stronger influence on males. Ego control as an internal locus of control is crucial in the life of elite athletes since increased internal control supports the integrity of the individual and contributes to better sport performance via decreasing anxiety and additional negative emotions towards competition.

In summary, we can state that there are several important personality profiles or features, which might vary by age and gender (cf. Boglar et al. 2008; Connelly & Janelle, 2003; Friedman & Berger, 1991; Hoar et al., 2010; Omar-Fauzee et al. 2009; Rogowska & Kusniers, 2012). In sport psychological counselling these factors and skills must be taken into consideration and developed in order to increase successful performance (Andersen, 2001; Anshel, 2003; Hardy et al. 1996; Leunes, 2011). Thus, sport psychology consultants must be sensitive to how personality characteristics work, and considering gender and age might be a remarkable factor in supporting effective performance. As a conclusion we underline the importance of personality profiles or features in sport performance that can be facilitated and fostered in sport psychological preparation.

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RESUMÉ

OSOBNOSTNÉ CHARAKTERISTIKY A ŠPORTOVÝ VÝKON VO VZŤAHU K VEKU A K POHLAVIU ŠPORTOVCOV V MAĎARSKU

Noemi Gyomber, Agota Lenart, Krisztina Kovacs

Súčasné štúdie v oblasti psychológie športu sú zamerané na viacero tém, zdôrazňujúcich pocit zdravia (well-being) športovcov. Športový výkon býva často ovplyvnený duševným zdravím a psychologickým stavom športovca, ktorý môže uľahčiť psychologická terapia. Cieľom štúdie je zistiť a porovnať zmeny osobnostných charakteristík a športového výkonu vo vzťahu k veku a k pohlaviu športovcov.

Metodika. Dotazník bol distribuovaný medzi športovcami (n = 185), ktorí sa zúčastňujú psychologického poradenstva a terapie. Osobnostné charakteristiky boli zisťované pomocou dotazníka "California Personality Inventory" (CPI-21). Športový výkon bol meraný trojbodovou stupnicou označujúcou najúspešnejšie vystúpenie v minulom roku.

Výsledky. Výsledky naznačili rozdiely v niektorých sledovaných premenných vo vzťahu k veku a k pohlaviu. Kým medzi pohlaviami sme nezistili žiadne rozdiely v športovom výkone, vo vzťahu k veku bola skupina repsondentov nad 21 rokov úspešnejšia ako mladší respondenti. Signifikantné rozdiely sme zistili v osobnostných charakteristikách, čo naznačuje vekové a pohlavné odlišnosti. Regresná analýza bola uplatnená na overenie vplyvu osobnostných charakteristík na športový výkon. Výsledky analýzy podporili vplyv osobnostných faktorov na úspešný športový výkon, pričom vek a pohlavie boli špecificky detekované.

Záver. Aplikovaná štúdia psychologického poradenstva s cieľom optimalizácie výkonu a stavu "well being" pomocou psychologických zručností potvrdila, že pri psychologickom poradenstve je potrebné brať do úvahy aj vek a pohlavie športovcov.

DIAGNOSTICS OF SPEED STRENGTH ABILITIES AND SKILLS IN 15-YEARS-OLD BASKETBALL FEMALES

Jaroslava Argajová, Tomáš Kampmiller

Faculty of Physical Education and Sport, Comenius University in Bratislava

Summary: Diagnostics of skills and abilities is important in overall evaluation of basketball players and it provides feedback on the effectiveness of training programmes focused on speed, strength, agility, flexibility etc. The aim of the study was to develop a test battery which can be used for diagnostics of individual skills and speed strength abilities in youth basketball. Furthermore there was performed mutual validation of the tests. For the diagnostics of the level of speed strength abilities there were used following tests: bench press, 10 second maximal jumping test, drop jumps from different heights (0.2, 0.4, 0.6, 0.8 m), countermovement jump, seated box jump, bar/barbell squat jump. The level of individual skills was evaluated by following tests: agility test, dribbling slalom, repeated rebound test, wall pass test, timed layup test, shooting from 4 meters test, free throws test. The factor analysis showed following factors in the test battery: factor of strength speed abilities of lower limbs (10 second maximal jumping test, drop jumps from different heights (0.2, 0.4, 0.6, 0.8 m), countermovement jump, seated box jump), factor of strength speed abilities of lower limbs with additional weight (bar/barbell squat jump), factor of strength speed abilities of upper limbs (bench press, wall pass test), factor of technical skills -shooting (timed layup test, shooting from 4 meters test, free throws test), factor of specific speed (dribbling slalom, repeated rebound test), factor of agility (agility test). Practical application of the study is to provide a test battery of skills and abilities usable in sport practice in youth basketball.

Key words: diagnostics, basketball, speed-strength abilities, individual skills

Introduction

Based on the definitions of basketball (Mangi, Jokl, Dayton, 1987; Luig, Henke, 2010) we can state that it is characterized by huge dynamics and intense body contact. In order to perform at a high level, the players should be sufficiently prepared, so naturally there is a need to make the preparation of players as effective as possible. This can be achieved by accurately determining player´s current level of performance and also by determining the changes in performance influenced by different types of exercise.

According to Kolb (2003), basketball skills are important in determining whether a player can be competitive, formally assessing physical capabilities can provide valuable information about what the player can do on the court and in which areas the player needs to improve, both to enhance performance and prevent injuries. Evaluating physical fitness allows the coach and player to identify any deficits in this area and provide opportunity for correc-

tion. This process also allows the coach to set basketball-specific physical goals unique to the player.

Effective testing procedures should according to NBCCA (2007) include the following:

1. Developing and using standardized norms and numbers.

2. Using proven tests that have been repeated several times.

3. Creating your own testing procedures that are safe and effective and that accurately measure what is intended to be measured.

NBCCA (2007) furthermore states that the testing results provide direct comparisons between current players and players who have previously been tested. Data collected also allow the coach to make changes in the program to improve the quality of the program. By continually examining the program and the athletes involved, coaches are able to change and improve the program. These evolving improvements help to solidify and strengthen the assessments of the athletes in the program.

The aim of the study was to design a test battery which can be used for diagnostics of individual skills and speed strength abilities in youth basketball. Furthermore there was performed mutual validation of the tests.

Methods

The battery of tests which were chosen was tested on a group of 27 young female basketball players from Bratislava. The average body height was 171.78 ± 5.69 cm, average body weight was 63.96 ± 7.93 kg, mean body mass index was 21.63 ± 2.08, average age was 15 ± 0.39 and average sport age was 4.85 ± 1.96 years. The tests were carried out as a part of a one week training process.

The devices used in testing speed strength abilities were: Fitro Dyne Premium and Fitro Jumper. Fitro Jumper is a PC based diagnostic system for the assessment of jumping performance. The system (consisting of contact switch mats connected by means of an USB interface to the computer) measures contact and flight times (with accuracy of 1 millisecond) and calculates basic biomechanical parameters of serial jumps. High reliability of Fitro Jumper has been proven by Bosco et al. (1983); Komi, Bosco (1978); Tkáč et al. (1990); Zemková, Hamar (2005). Fitro Dyne Premium is a computer based system for the assessment of strength capabilities and feedback monitoring of strength training. The device registers and displays in both graphical and digital form basic biomechanical parameters involved with weight exercise, i.e. velocity, force, power and displacement. High reliability of Fitro Dyne Premium has been proven by studies of Jennings et al. (2005) and Fry et al. (2006).

For the diagnostics of the level of speed strength abilities there were used following tests:

Bench press: diagnostic series with 10 kg, 12.5 kg, 15 kg, 17.5 kg, 20 kg barbell. Power output was taken into consideration. Devices used: computer, Fitro Dyne Premium, barbell, barbell discs. Test reliability: Jennings et al. (2005).

10 second maximal jumping test: 2 attempts, power output in active phase and jump height in 3 best jumps during the better out of two attempts were taken into consideration. Devices used: computer, Fitro Jumper. Test reliability: Tkáč et al. (1990).

Drop jumps from different heights (0.2, 0.4, 0.6, 0.8 m): 2 attempts, jump height in the better attempt is taken into consideration. Devices used: computer, Fitro Jumper, plyo-boxes. Test according to Zemková, Hamar (2004).

***Countermovement jump*:** 2 attempts, jump height in the better attempt is taken into consideration. Devices used: computer, Fitro Jumper.

***Seated box jump*:** 2 attempts, jump height in the better attempt is taken into consideration. Devices used: computer, Fitro Jumper, a box.

***Bar/barbell squat jump*:** diagnostic series with a plastic bar (0 kg) and barbell (10 kg, 12.5 kg, 15 kg, 17.5 kg, 20 kg, 22.5 kg, 25 kg). Power output and jump height were taken into consideration. Devices used: computer, Fitro Dyne Premium, Fitro Jumper, bar, barbell, barbell discs, cloth cube for indicating depth of squat. Test reliability: Jennings et al. (2005).

The device used in testing skills was Fitro Agility Check. It is a PC based diagnostic system for the assessment of agility performance.

The system consists of four contact switch mattresses connected by means of an interface to the computer. A special software measures the times subject needs to accomplish foot contact with the mattress corresponding with the position of visual reaction stimulus in one of the four corners of the screen. The reliability of this device was evaluated as sufficient by Zemková, Hamar (1998).

The level of individual skills was evaluated by following tests:

***Agility test*:** Modified test by Zemková, Argaj (2007). Two attempts, the mean of the four best reaction times in better attempt is taken into consideration.

***Dribbling slalom*:** Test by Bös (1988). Two attempts, time of the completion of the slalom are measured. Better attempt is taken into consideration.

***Repeated rebound test*:** Test by Bös (1988). Test lasts 30 seconds, there are 2 attempts. Better attempt is taken into consideration.

***Wall pass test*:** Test by Bös (1988). Test lasts 30 seconds, there are 2 attempts. Better attempt is taken into consideration.

***Timed layup test*:** The adjusted form (Tománek, 2006; Pimpa, 1968) of the test by Bös (1988) is used. There are 2 attempts. Better one is taken into consideration.

***Shooting from 4 meters test*:** Test by Bös (1988). Test lasts 1 minute, there are 2 attempts. Better attempt is taken into consideration.

***Free throws test*:** Test by Brace (1966).

Results and Discussion

The results of the analysis of the data obtained in testing are shown in Tab.1. The data were processed by means of factor analysis (IBM SPSS Statistics).

In our test battery there were determined 6 factors (in decreasing order of importance):

- factor of strength speed abilities of lower limbs (10 second maximal jumping test, drop jumps from different heights (0.2, 0.4, 0.6, 0.8 m), countermovement jump, seated box jump),

Table 1

Factor analysis of the data obtained in the testing battery

Rotated Component Matrix *

	Component						
	1	2	3	4	5	6	7
Timed lay-up test (s)					*-0.784		
Free throws test (n)					0.715		0.444
Driblling slalom (s)						*-0.695	*-0.401
Shooting from 4 meters tes (n)					0.596	0.326	
Wall pass test (n)				0.740		0.458	
Repeated rebound test (n)	0.302				0.313	0.522	
Agility test (s)							*-0.738
Seated box jump (m)	0.864						
Countermovement jump (m)	0.771						
Drop jumps from different heights (0.2, 0.4, 0.6, 0.8)	0.816 0.845	0.882 0.675					
10 seconds maximal jumping test – Power output (W/kg)	0.768						
10 seconds maximal jumping test (m)	0.866						
Bench press 10, 12.5, 15, 17.5, 20 kg power output (W/kg)				0.360 0.830 0.838 0.868 0.849			
Bar/barbell squat jump – 0, 10, 12.5, 15, 17.5, 20, 22.5, 25 kg power output (W/kg)		0.858 0.924 0.925 0.934 0.941 0.935 0.791 0.838					
Bar/barbell squat jump – 0, 10, 12.5, 15, 17.5, 20, 22.5, 25 kg height (m)	0.686 0.476 0.681 0.604 0.467 0.399 0.378 0.328		0.392 0.509 0.638 0.731 0.789 0.842 0.309 0.789 0.804				

- factor of strength speed abilities of lower limbs with additional weight (bar/barbell squat jump)
- factor of strength speed abilities of upper limbs (bench press, wall pass test),
- factor of technical skills – shooting (timed layup test, shooting from 4 meters test, free throws test),
- factor of specific speed (dribbling slalom, repeated rebound test),
- factor of agility (agility test).

According to NBCCA (2007) most important performance categories in basketball are identified as follows: lower body power, agility, speed, upper body strength, flexibility. We have identified similar factor categories, however in different order of importance.

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Kolb (2003) recognises much more items in physical fitness tests of basketball players: agility, aerobic fitness, full-court shuttle, vertical jump, flexibility, balance test, muscle endurance, half-court speed, squats, and bench press.

According to Cook (2002) important are resistance exercises (to test muscular strength and endurance), speed and quickness (to assess specific motor skills), athletic power (to test the ability to generate force) and conditioning (to assess anaerobic/aerobic fitness).

The investigation of Hopkins (1977) confirmed following factors in the basketball testing: shooting, passing, jumping and movement with and without the ball. Therefore he recommends that a test battery be comprised of the following items: jump and reach, dribble, speed pass, front shot.

Conclusions and Recommendations

We have created the test battery for basketball which consists of tests for strength speed abilities as well as individual skills of players. Factor analysis showed that the very important for basketball are speed strength abilities of lower and upper limbs, technical skills, specific speed and agility. Based on the results of our analysis and when compared to the results of different authors we can recommend that our test battery be used for youth basketball. Further research in this area should be carried out, preferably one including more tests.

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RESUMÉ

DIAGNOSTIKA RÝCHLOSTNO-SILOVÝCH SCHOPNOSTÍ A HERNÝCH ČINNOSTÍ JEDNOTLIVCA 15-ROČNÝCH BASKETBALISTIEK

Jaroslava Argajová, Tomáš Kampmiller

Diagnostika schopností a zručností je dôležitá z hľadiska celkového hodnotenia športovcov. Poskytuje spätnú väzbu, pokiaľ ide o efektivitu tréningových programov na rozvoj rýchlosti, sily, agility, flexibility a pod. Cieľom práce bolo zostaviť testovú batériu pre diagnostiku rýchlostno-silových schopností a herných činností jednotlivca a ich vzájomnú validáciu. Na diagnostikovanie rýchlostno-silových schopností sme použili testy: tlak na lavičke, opakované vertikálne výskoky za 10 sekúnd, zoskok – výskok z rôznych výšok (0,2; 0,4; 0,6; 0,8 m), výskok zo stoja s protipohybom a s pohybom rúk, výskok zo sedu bez pohybu rúk, podrep – výskok s tyčou/činkou na pleciach. Úroveň herných činností jednotlivca sme zisťovali testami: test agility, driblingový slalom, doskakovanie na vytrvalosť, prihrávanie na presnosť, streľba po dvojtakte, streľba z miesta/z výskoku zo 4-metrovej vzdialenosti, streľba trestných hodov.

Na základe faktorovej analýzy výsledkov testovej batérie sme vyčlenili nasledujúce faktory: faktor rýchlostno-silových schopností dolných končatín (opakované vertikálne výskoky za 10 sekúnd, zoskok – výskok z rôznych výšok (0,2; 0,4; 0,6; 0,8 m), výskok zo stoja s protipohybom a s pohybom rúk, výskok zo sedu bez pohybu rúk), faktor rýchlostno-silových schopností dolných končatín s pridanou hmotnosťou (podrep – výskok s tyčou/činkou na pleciach), faktor rýchlostno-silových schopností horných končatín (tlak na lavičke, prihrávanie o stenu), faktor technických zručností - streľba (streľba po dvojtakte, streľba z miesta/z výskoku zo 4-metrovej vzdialenosti, streľba trestných hodov), faktor špeciálnej rýchlosti (driblingový slalom, doskakovanie na vytrvalosť), faktor agility (test agility). Budúcim cieľom pre prax je vytvorenie testovej batérie, ktorá by sa dala využiť v mládežníckom basketbale.

Relationship between the height of jump reach and the height of ball contact at spike in two different age categories of female volleyball players

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RELATIONSHIP BETWEEN THE HEIGHT OF JUMP REACH AND THE HEIGHT OF BALL CONTACT AT SPIKE IN TWO DIFFERENT AGE CATEGORIES OF FEMALE VOLLEYBALL PLAYERS

[1]Michal Matušov, [1]Ludmila Zapletalová, [1]Libor Duchoslav, [2]Miroslav Hagara

[1]Faculty of Physical Education and Sports, Comenius University in Bratislava
[2]Faculty of Electrical Engineering and Information Technology,
Slovak University of Technology in Bratislava

Summary: The article deals with relations between the height of jump reach and the height of ball contact at spike in female volleyball players of senior and junior age categories. The height of jump reach was tested by means of a standardised test, while the height of ball contact at spike was determined by our own method based on 2D analysis. The main purpose of our research was to compare the rate of the height of jump reach utilisation in the height of ball contact at spike and the variability of the height of ball contact at repeated spike in the above age categories. The sample comprised 8 members of prominent extra league team Slávia EU Bratislava and 7 members of prominent Slovak junior team Slávia UK Dráčik Bratislava. Measured data were processed by Man-Whitney U-test and non-parametric Friedman test (Fr). The level of statistical significance was set to 5 %. Our assumption that women will show a higher rate of the height of jump reach utilisation in attack than junior players was not confirmed. As regards variability in the height of ball contact at repeated spike, an insignificant variability of the height of ball contact ($p > 0.05$) was recorded in women that points to a relatively stable spiking technique. The height of ball contact at repeated spike was found more variable in junior players ($p < 0.05$), suggesting lower stability of the above skill.

Key words: volleyball, spike, women, juniors, height of jump reach, height of ball contact

Introduction

The maximum sports performance presentation needs perfect mastering of certain sports techniques, allowing full materialisation of actual motor and psychical potential of an athlete (Moravec, 2007). Perfect mastering of technique belongs to the basic and most specific factors of performance in sports games (Peráček, 2012).

Demonstrations of technique in various kinds of sport are rather diverse, frequently complex and demanding. It is necessary to consider both external demonstrations of technique and its internal reasons and mechanisms, while respecting the peculiarities of specialisation. The fact that sports performance is directly affected by the factor of technique results from studies dealing with the sports performance structure. Schnabel, Harre, Borde (1998)

defined technique as a characteristic solution to a motor task in sports activity, prospering from experience and psycho-motor predispositions of an athlete. It is immanent in the form of the relevant motor algorithm. Technique depends on constitutional predispositions connected in particular with mobility relating to the anatomical structure of joints and stretch shortening cycle. It depends also on condition, in particular in power and speed-power kinds of sport. Improvement of technique is connected to cognitive processes as well as to motivation.

Except for tactical abilities and skills, potential progress of performance in sports games is limited namely by the level of rational technique and condition. Effective interdependent application of those components determines the degree of athlete's abilities materialisation. Condition proves its worth through the motor structure, while the elements of technique are its carriers. The concurrent development of condition and technique may be the goal or a means of the process of specific motor structure acquisition and improvement.

As regards kinematic characteristics, spiking technique is challenging from the aspect of both speed-strength and coordination abilities. Those challenges are constantly growing not only in professional volleyball, but also in junior teams. This way, maximum dynamism, correct technique and optimum technical variant selection have become the key prerequisites of success. As regards coordination abilities, they include especially the ability of complex merging of motions, sense of locality and orientation in time and space. However, the most monitored parameter in relation to spiking technique is the plyometric force that is considered to be one of the limiting factors of the performance structure in volleyball. It is the best determining factor of the height of ball contact in attack together with the standing reach. However, the height of jump reach at spike can never be utilised in full range. It depends on many factors occurring in solving game situations in practice or in a match, on biomechanical laws and individual particularities of players, including individual spiking techniques and technique shortages. The reason may be that the issue is still little researched.

Vint et al. (2004) studied quantification of deterministic factors of the overall height of ball contact in elite spikers. They found a significant correlation between the overall height of ball contact and the height of jump reach (r = 0.70) where the performance differences were most visible. From the aspect of horizontal velocity of the approach (3.4 m/s), correlation was found between the velocity alone and the height of the centre of mass (CM) (r = 0.60). Other factors affecting the height of the CM include swing action force of arms and the take-off angle. Critical moments of the maximum height of reach include down-swing of the spiking arm and non-stretched hips and spiking arm at the moment of ball contact. Other available studies dealing with the height of ball contact have only marginal character. Li-Fang et al. (2008) dealt with the range of motion of arm swing, timing and coordination of individual segments of the body at spike. In addition to the fact that top female players have wider range of motion of arm swing that allows higher acceleration of individual segments and produces bigger moment of force, from the aspect of our research, a relevant finding is that timing errors decrease the height of ball contact. In case of younger players it was quite common that the hit came too late, i.e. when the centre of body mass began to lower.

The above analysis has introduced several questions: if the players of the senior age category would show higher rate of ball contact height utilisation than players of the junior age category and whether they would show lower variability of the ball contact height at repeated spike than juniors. The purpose of this article is to answer those questions.

Based on the previous analysis, following hypotheses were set up:

- Players of the senior age category will show a higher rate of the height of jump reach utilisation in attack than junior players.
- Players of the senior age categories will show lower variability of the ball contact height at repeated spike than juniors.

Methodology

The sample comprised 15 members of volleyball club Slávia UK Bratislava, playing in season 2012/2013, of two different age categories with different history of sports activity. Players included in our sample were members of the "A" team of Slávia EU Bratislava and the junior team of VK Slávia UK Bratislava. The basic characteristics of the examined players are as follows:

Women: average age: 22 years; average body height: 183.6 cm; average body weight: 70.8 kg; average length of sports practice: 11.4 years.

Girls: average age: 17 years; average body height: 174 cm; average body weight: 63.9 kg; average length of sports practice: 6.3 years.

The required data were obtained by testing the height of jump reach [cm] in individual players by means of a standardised test of the jump reach height. The ball contact height at spike [cm] was ascertained by our own method. Testing took place on 3 April 2013 at Sports Hall Mladosť in Bratislava. Considering the structure of competition, it was the period of season's culmination. Testing was preceded by generic as well as specialised warm-up. As for the order of tests, the first one was aimed at jump reach height determination where each player had 3 attempts. Then the players had 10 attempts in pairs to ascertain the height of the ball contact at spike. Each spike was followed by a one-minute break.

The height of the ball contact at spike was determined with the help of 2D video analysis. Digital record was taken on a HD mini cassette in HD resolution of 1440 x 1080 dpi. Individual attempts were recorded at vertical plane with the help of video handy cam HDV HDR – FX 7 with shutter speed set to 1/300 and optical zoom to 7x so that the optic axis of the object glass was vertical to the plane of the supposed motion. Based on the study and our previous experience, the approach angle in terms of the approach direction in relation to the central line of the court was set to 70º. The video camera was placed as far as possible from the test site (36 m) in order to minimise measurement errors caused by the scene geometry. The camera was placed on a 1.5 m high stand providing the measured data with additional objectification. Each attempt had to be completed within 6 seconds. After each attempt completion, the record was transformed by the camera to 30-second duration resulting in frequency of 60 frames per second (fps). Then the data were transmitted to PC through a firmware cable and the record was split into individual frames to be analysed by means of the Skicár software.

Each attempt was assessed based on 4 frames: two frames before and two frames after the ball contact. The centre of mass (CM) of the ball was determined on every frame in the plane of axis x/y. The frames were marked in the time order, beginning with the oldest up to the newest frame as A, B, C and D. Then the four found parameters were recorded into an Excel form prepared in advance. The ball contact height was the point of intersection L

of two lines (line crossing the points A and B and line crossing the points C and D) minus point P on line EF (Fig. 1).

The resulting height of the ball contact at spike was obtained by multiplication of the found value expressed in pixels with 0.3428 cm/pixel obtained from calibration.
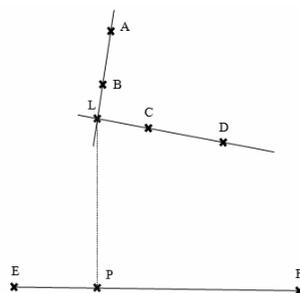

Figure 1

Determination of the ball position in the moment of ball contact

For statistical data processing, we used the basic described characteristics – minimum value (X_{min}), maximum value (X_{max}), variable range (Vr), median (Me) and arithmetic mean (x), re-calculation of the height of jump reach to T-points, relative expression (%) of the the height of jump reach utilisation in the height of ball contact at spike, Man-Whitney U-test and Friedman test (Fr). The level of statistical significance was set to 5%. The results were evaluated with the help of logical methods, such as analysis, synthesis, induction, deduction and comparison.

Results

Rate of the height of jump reach utilisation in the height of ball contact at spike

As regards the rate of the height of jump reach utilisation in the height of ball contact at spike, no significant statistical differences were found between the senior and junior age categories ($p > 0.05$). This statement is supported also by values of the basic characteristics where minimum differences were found between women and juniors (Tab. 1).

The rate of the height of jump reach utilisation by players, expressed in %, was ranked from the lowest (89.1 %) up to the highest (92.6 %) value to which values of the height of jump reach, re-calculated to T-points, were assigned (Fig. 2). An interesting phenomenon of proportional increase in utilisation of the height of jump reach at spike with decrease of the jump reach height can be observed in women. It means that the jump reach height is used more by players with a lower height of jump reach.

It is obvious that there are big differences in the rate of the height of jump reach utilisation in the height of ball contact at spike between individual players of the junior age category (Fig. 3).

Relationship between the height of jump reach and the height of ball contact at spike in two different age categories of female volleyball players

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Table 1

Rate of the height of jump reach utilisation in the height of ball contact at spike in senior and junior age categories

	Rate of the height of jump reach utilisation in seniors (%)	Rate of the height of jump reach utilisation in juniors (%)
Me	91.2	91.0
$\overline{X}$	91.2	90.9
Vr	3.5	3.9
Min	89.1	89.1
max	92.6	93.0
U	25 (p > 0.05)	

Figure 2

Comparison of the rate of the height of jump reach utilisation in the height of ball contact at spike with the jump reach height alone in the category of seniors
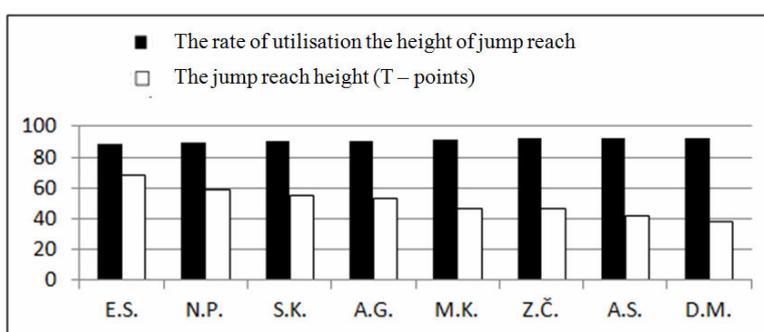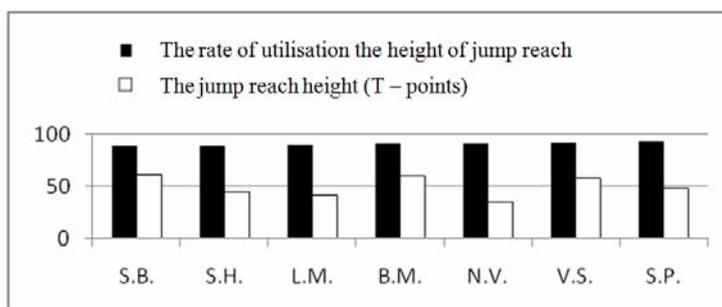

Figure 3

Comparison of the rate of the height of jump reach utilisation in the height of ball contact at spike with the jump reach height alone in the junior age category

Variability in the height of ball contact at repeated spike

The resulting values measured at repeated spiking attempts are presented in tab. 2. As for the ball contact height variability at repeated spike, which is an indirect indication of spiking technique stability, it may be said that differences in the height of ball contact at repeated spike in the senior category are statistically nonsignificant ($Fr = 4.916$; $p > 0.05$). The variability found was low. As regards individual players, the smallest range of variability was 5.8 cm and biggest one 16.1 cm.

Table 2

Ball contact height variability at repeated spike in the senior age category

	Ball contact height at spike [cm]				
	Attempt 1	Attempt 2	Attempt 3	Attempt 4	min.
	Attempt 5	Attempt 6	Attempt 7	Attempt 8	max.
M.K.	269.78	269.04	266.67	270.25	260.55
	260.55	261.06	267.59	265.74	270.25
D.M.	265.58	267.79	270.83	267.93	261.95
	263.46	263.56	261.95	266.14	270.83
E.S.	270.81	273.7	279.85	276.7	270.11
	275.26	270.11	281.09	275.4	281.09
S.K.	276.12	267.59	266.23	276.99	266.23
	274.21	274.3	277.88	273.01	277.88
A.S.	270.83	269.56	267.11	270.78	264.96
	269.59	265.88	267.58	264.96	270.83
A.G.	270.19	277.15	275.37	263.63	263.63
	267.31	277.31	266.96	269.78	277.31
Z.Č.	260.92	275.59	270.64	266.22	260.92
	271.64	272.26	277.02	273.36	277.02
N.P.	272.07	274.43	273.87	272.36	266.88
	272.84	273.15	270.22	266.88	274.43
Fr	4.916 (p > 0.05)				

Statistically significant differences in the height of ball contact at repeated spike were found in the junior age category ($Fr = 19.238$; $p < 0.01$) (tab. 3). The variability found in the height of ball contact at repeated spike was high. As regards individual players, the variable range found was between 11.3 cm and 22.5 cm.

Table 3
Ball contact height variability at repeated spike in the junior age category

	Ball contact height at spike [cm]				
	Attempt 1	Attempt 2	Attempt 3	Attempt 4	Min
	Attempt 5	Attempt 6	Attempt 7	Attempt 8	Max
V.S.	270.91	265.34	262.34	268.77	261.41
	261.41	268.32	272.7	269.99	272.7
L.M.	248.6	248.41	242.38	247.55	241.31
	241.31	253.00	245.72	252.8	253.00
S.P.	264.77	269.63	257.84	266.05	253.85
	254.73	258.55	253.85	266.16	269.63
B.M.	274.47	260.55	268.19	268.6	251.96
	265.13	251.96	272.06	271.81	274.47
S.B.	264.32	248.91	257.9	267.58	248.91
	260.85	270.1	269.09	265.01	270.1
N.V.	248.4	245.08	230.52	245.35	230.52
	242.56	245.66	248.48	245.73	248.48
S.H.	254.36	246.13	250	255.06	240.93
	242.33	242.91	251.43	240.93	255.06
Fr	19.238 (p > 0.01)				

When comparing the lowest value of the variable range found in the senior (5.9 cm) and junior (11.3 cm) age categories, the recorded difference was 5.4 cm. Similar difference was found also in the highest variable range. Its value was 6.4 cm.

Discussion

In our opinion, this research brings forward a whole range of original and interesting results. However, they cannot be overestimated. It is necessary to pay attention to certain limits, connected in particular with the used method of the ball contact height assessment. The accuracy of results was definitely affected by handy cam parameters, such as the shutter speed and fps. Another fact that could affect the results is that the active height of the ball contact at spike was measured as the ball flight direction change, not as the distance between the upper limbs from the ground as in the test of the jump reach height. Taking into account that the ball direction is changed by the flat hand centre and the height of jump reach includes the length of fingers, results of the jump reach height utilisation in the height of ball contact could be partially distorted also by inter-individual finger length variability and the variability of the point of ball contact. Higher objectiveness would be undoubtedly given by

digitalisation of individual attempts by means of 3D analysis where errors caused by the scene geometry, which occur in 2D analysis, would be minimised. Although the camera was placed 36 meters from the fictions plane of the direction of motion in order to minimise errors caused by the taken object and camera arrangement based on the study of Slamka, Duchoslav (2000), a certain error occurred. It should be noted that the method of determination of the ball contact height alone was simplified to a certain extent. Specifically, the height of ball contact at spike was determined based on two frames taken before and two frames taken after the hit. Point L, used for the ball contact height calculation, was an intersection of two resulting lines. If we want to achieve more exact results, the law of gravitation to which every flying object is subject should not be neglected. Namely, a ball never copies a path of a straight line, but always a ballistic flight line. It would be more appropriate to use 5-6 frames before and the same number of frames after the ball contact for calculation, based on which an exact flight of the ball would be expressed as mathematical functions. The results could also be made more accurate with the use of mathematical equalising functions of a higher order.

Nevertheless, our results have confirmed several assumptions. Albeit extra league teams currently employ young players, often also of junior age, top clubs, to which the examined teams belong, were expected to show differences in technical preparation of players. However, no differences were confirmed by our research.

Regarding the analysis of relations between the heights of jump reach and ball contact at spike it must be noted that the test took place under "laboratory" conditions, in opponent's absence. Variable speed of the ball flight, variable direction of hits, angles of received balls in relation to the following attack and setter's tactics, occurring in real game situations solving, were excluded. It is obvious that a match does not offer opportunities to hit the ball at spike in its top height. Moreover, modern volleyball is based also on quick and creative setting to cheat on the opponent's defence both on net and in field. Parameters of the ball contact height at spike are not fully used in the current tactics of match.

If we consider the rate of the jump reach height utilisation at spike alone, we can state that, taking into account our results, it is nearly the same in the both age categories. This fact is logically supported by the values of arithmetic means where the difference in the rate of the height of ball contact utilisation between senior and junior players is minimal (91.2 % versus 90.9 %). It is a rather surprising finding since a higher rate of condition utilisation was supposed in seniors, taking into account close interconnection of all factors of performance. However, the results show an indirect linear dependence between the height of the jump reach and its utilisation rate in the ball contact height at spike in seniors. It was less used by players with higher reach than by those with lower jump reach. This can be an indication of shortcomings in fitness training, motivation in a match, test load, but perhaps also of effects of player's post. However, despite that we must state that players with higher height of jump reach are theoretically better equipped for effective kills than players with lower jump reach.

The results reflect also a non-linear distribution of differences in the height of jump reach and the ball contact at spike which may indicate minor shortcomings in spiking technique of individual players. This is more pronounced in the junior age category. A coach should make every effort to lead the players with higher jump reach to maximisation of the height of ball contact at spike, i.e. to creation of better conditions for spike effectiveness. It

is still questionable to which extent a higher rate of the height of jump reach utilisation in the height of ball contact at spike can affect the attack effectiveness in a match.

By assessing the variable ball contact height at spike in both age categories, stability of individual skill's technique was indirectly ascertained. Based on our results, we want to point to differences between the two age categories. Statistically insignificant differences were confirmed in the senior age category. The variability found was low. Contingent deviations at repeated spike could be caused by small variations in approach timing and ball flight path accuracy, i.e. the ball height and speed. Use of a special "gun" or any other device distributing balls at stabile height and speed would be more objective. However, it would need a certain preparation of players since they are not used to such conditions in practice. Also minor shortcomings in individual skills could play their roles. Junior age category results point to less stabile technique. Based on theoretical knowledge and our experience, we can assume that they are in the phase of improvement. Faults, although only minor, can still be observed in the height of ball contact at spike also under relatively stable spiking conditions.

Conclusion

The hypothesis that senior players will show a higher rate of the height of jump reach utilisation in attack than junior players was not confirmed. This statement results from both the percentage of the height of jump reach utilisation and statistically insignificant differrences in the monitored variables.

Hypothesis of higher variability in the height of ball contact at repeated spike was confirmed in both age categories. Players of the senior age category showed lower variability in the ball contact height at repeated spike than juniors. Variability in the height of ball contact at repeated spike was insignificant in the senior category. The situation is, however, contrary in the junior category. In this case, variability of the height of ball contact at repeated spike is high which points to a less stabile technique.

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RESUMÉ

VZŤAH MEDZI VÝŠKOU DOSAHU A VÝŠKOU ZÁSAHU LOPTY PRI SMEČI V RÔZNYCH VEKOVÝCH KATEGÓRIÁCH VOLEJBALISTIEK

Michal Matušov, Ludmila Zapletalová, Libor Duchoslav, Miroslav Hagara

V príspevku sa zaoberáme vzťahom výšky smečiarskeho dosahu a výšky zásahu lopty pri smeči vo volejbale v kategórii žien a junioriek. Výšku smečiarskeho dosahu sme testovali štandardizovaným testom, výšku zásahu lopty pri smeči sme určovali vlastnou metódou založenou na 2D analýze. Hlavným cieľom nášho výskumu bolo v uvedených vekových kategóriách zistiť mieru využitia výšky smečiarskeho dosahu vo výške zásahu lopty pri smeči a variabilitu výšky zásahu lopty pri opakovanom smečovaní. Súbory tvorilo 8 žien popredného slovenského extraligového družstva Slávie EU Bratislava a 7 junioriek popredného slovenského juniorského družstva Slávie UK Dráčik Bratislava. Namerané dáta sme spracovali Man-Whitneyovým U-testom a neparametrickým Friedmanovým testom (Fr). Hladinu štatistickej významnosti sme stanovili na 5 %. Nepotvrdil sa predpoklad, že hráčky kategórie žien preukážu vyššiu mieru využitia výšky smečiarskeho dosahu pri realizácii útočného úderu ako hráčky kategórie junioriek. Z hľadiska variability výšky zásahu lopty pri opakovanom smečovaní ženy vykázali nevýznamnú variabilitu výšky zásahu lopty (p > 0,05), z čoho môžeme usúdiť na pomerne stabilnú techniku smeča. Juniorky mali výšku zásahu lopty pri opakovanom smečovaní variabilnú (p < 0,05), čo poukazuje na menšiu stabilitu techniky tejto hernej činnosti.

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INFLUENCE OF POINTS SCORED IN A SET ON THE QUALITY OF FINISHING GAME ACTIVITIES OF AN INDIVIDUAL IN JUNIOR VOLLEYBALL TEAM

Vladimír Přidal, Zuzana Bartošová

Faculty of Physical Education and Sports, Comenius University in Bratislava

Summary: The present study tries to identify the grounds of success in junior volleyball teams in according to differences in the quality of the serve, spike and block between winning and losing teams, assessed in both favourable and unfavourable game situations in the initial, middle and final part of a set. In search of relative differences between winning and losing teams when evaluating individual game activities we used the test showing significance of differences in relative values. We suppose that the grounds for winning should be sought in higher success rate in all phases of a set and in lower error rate of spikes after an accurate pass in the middle and final parts of a set ($p < 0.05$), lower error rate of spikes after an inaccurate pass at the end of a set ($p < 0.05$), as well as in higher number of blocked balls under the opponent's attack after an inaccurate pass in the middle and final parts of a set ($p < 0.05$). The research is a part of research project VEGA 1/0270/13.

Keywords: volleyball, juniors, success of a team, game activities of individuals, parts of a set

Introduction

Until now, it was not paid too much attention to assessment of the time factor impact on game performance of a volleyball player or team. Nevertheless, the set's score increase may affect the quality of game performance in both positive and negative way. A set of a volleyball match must end by reaching at least 25 points (the decisive fifth set up to 15 points) and a team must constantly earn points in order to reach this threshold. And it is exactly this need to earn points until the end of a set, i.e. constantly attack and defend, that requires psychical stability of players and maintenance of the set tactics even when the score increases. Přidal, Pělucha ascertained that tactics of attack leading and finishing in top-performance volleyball is not even during a set. Towards the end of a set, attacks are finished primarily from zones 3 and 4. Attacks finished in zones 2 and 1 occurred more often in other parts of a set. Pělucha, Zapletalová (2008) investigated the set's score effects on the zone of attack finishing in top-performance men's volleyball and found that the setter's tactics of sets distribution in the final part of a set is focused on front-row side zones. As regards the choice of the set kind in men's top-performance volleyball, Pělucha, Zapletalová (2008b) ascertained that towards the end of a set, setters prefer namely "slower" sets to zones 1, 2 and 4. Zapletalová, Pělucha (2008) were monitoring also the relations between the set's score and spike effectiveness in men's top-performance volleyball from the aspect of both winning

and losing teams. It appears that effectiveness of a spike after the serve receive was stable over the entire set in winning teams, while decreasing from the set beginning towards its end in losing teams. As regards attacks after a defensive field action, percentage of points earned through a spike by winning teams was decreasing from the beginning towards the end of a set, while the team's error rate was increasing. From the aspect of winning a set, finish appears a decisive factor. Effects of the set's score on the serve quality were investigated by Bartošová, Přidal (2010) who have not revealed any significant relations between the investigated variables in women's top-performance volleyball in total, but ascertained a relation between the score and the serve quality on the level of individual teams. Bartošová, Přidal (2013) investigated the impact of the set's score on the quality of spikes after both accurate and inaccurate serve receive in juniors. They found statistically only marginal differences in the investigated relations in a balanced set.

Methodology

The investigated sample comprised national junior volleyball teams of girls, assessed in matches at the 2010 European Championships and 2011 World Championships. This was a deliberate choice based on availability. 35 sets in 12 matches were assessed in total. This study makes use of absolute, one-step, ex post facto research. The basic methods of data collection included indirect observation and professional assessment. Following variables were evaluated:

– Team's success in a set (the criterion was winning or losing a set).

– Part of the set (initial – up to 8 points, middle – up to 19 points, final – until the end of the set).

– Quality of a serve, spike and block where we distinguished whether it was realised under favourable or unfavourable game conditions.

Assessed were only the so-called balanced sets where the point difference between the winner and the loser was no more than 5 points.

When evaluating the quality of the monitored game activities realisation, four-grade scale of assessment was used:

– Grade 1: game activity realised with maximum effect, resulting in a point earned;

– Grade 2: game activity realised effectively, resulting in game continuation under favourable conditions for the team assessed;

– Grade 3: game activity realised ineffectively, resulting in game continuation under unfavourable conditions for the team assessed;

– Grade 4: error based on which a point was earned by the opponent.

This study investigates relative differences in the quality of monitored game activities of individuals between winning and losing teams separately in individual parts of sets. When searching for relative differences between winning and losing teams within the examined degrees of assessment, Hendl's test of significance of differences in relative values (2009) was used.

Significance of differences was assessed on 5 % and 1 % level of statistical importance. Results were interpreted with the use of logical methods, in particular analysis and synthesis.

The purpose of this study was to determine differences in the quality of finishing game activities of individuals between winning and losing volleyball teams of the junior age category in sets at individual states of score, determined by concrete parts of sets.

Results and discussion

Frequency of the monitored game activities occurrence

Within the monitored balanced sets, 1 640 starts of the track were assessed. This number logically corresponds with the number of serves starting the next rally. In absolute values, most of the assessed contacts with the ball were those of spikes (2 478), however, assessed separately after an accurate pass (1 608) and inaccurate pass (870). It appears that favourable game situations, expressed by higher number of accurate passes, prevail when starting an attack in a match of top-performance junior volleyball teams. Similar results were logically found in blocks after an accurate pass (702) and inaccurate pass (336) too, realised under the opponent's attack. Lower number of blocks in comparison to the number of spikes is given by the block assessment where we assessed only the blocks where the ball was in contact with hands of blockers. Thus, the ascertained number of blocks does not represent all blocks realised in the course of the sets observed.

Analysis of differences in the serve quality between winning and losing teams in individual monitored parts of sets

No significant differences in the serve quality were found between winning and losing teams in individual parts of sets (Fig. 1). However, statistically insignificant differences indicate that winning teams have more effective serves in the first part of a set. They earned more points, forced the opponent to pass the ball more inaccurately (Grade 2) and recorded less errors. In the middle part of a set, the serve quality became balanced in both teams. On the
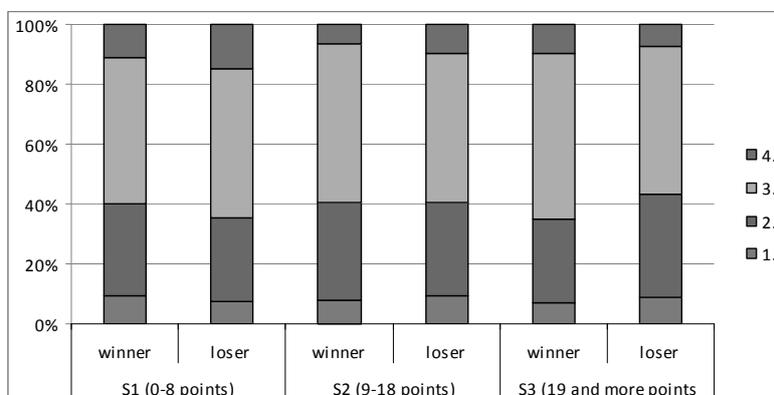

Figure 1

Differences in the serve quality between winning and losing teams
in individual parts of sets

other hand, more effective serving (Grades 1 and 2) and fewer errors were observed in the final part of a set in losing teams. This can be explained by the effort of losing teams to balance the score; they risked more when serving which worked fine since fewer serves were corrupt, but despite that they did not manage to reverse the result.

Analysis of differences in the spike quality between winning and losing teams in individual monitored parts of sets

Spike is a game activity of an individual by means of which a team earns most points. Therefore, its quality is crucial for the team's success. Significant differences in the spike quality after an accurate pass between the winner and the loser were found in all parts of sets ($p < 0.05$). Winning teams had more effective attacks right from the beginning and recorded less errors. The most significant differences were recorded in the final part of sets deciding about the winner (Fig. 2). It can be stated that the quality of spike after an accurate pass is one of the main predictors of winning.
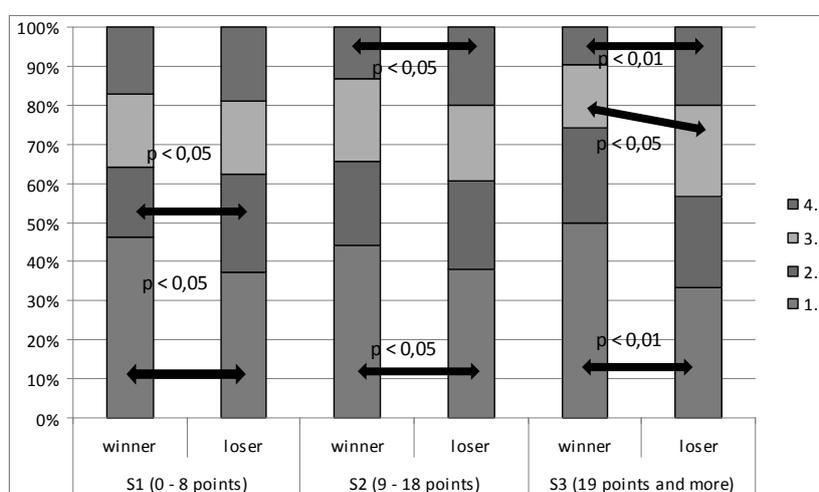

Figure 2

Differences in the spike quality after an accurate pass between winning and losing teams in individual parts of the sets

On the other hand, significant differences in the spike quality after an inaccurate pass in individual parts of sets were found only in two cases (Fig. 3). One of the main reasons for losing a balanced set could be namely the higher error rate of losing teams' attacks in the final part of sets. Another important ground for a team's success in a set is the fact that the relative representation of successful attacks is higher in winning teams right from the set beginning. Those differences were insignificant, but from the objectively logical aspect, also a minimum difference in the observed indicators may have considerable impact on a balanced set since their outer values are reflected in the set's score. The overall quality of attack after an inaccurate pass is significantly lower than after an accurate one, since after

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an inaccurate pass, attackers must attack a well-formed defence of the opponent. It appears that winning teams had better disposed outer hitters in the monitored sets, able to get over the well-formed defence of the opponent during the entire set.

From the aspect of the spike quality in total we may state that the basic characteristics of winning teams are higher maximum success and lower error rates, stable over the entire set, also in balanced sets. Similar results were reached also by Bartošová (2010) in the category of women.
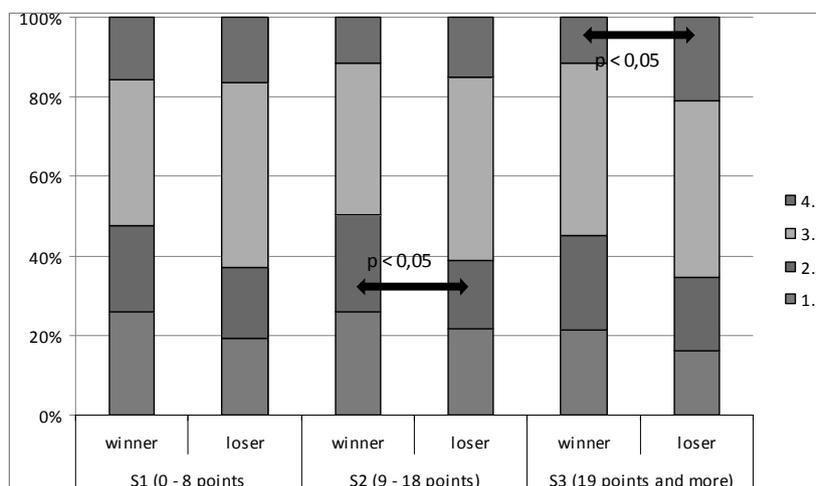

Figure 3

Differences in the spike quality after an inaccurate pass between winning and losing teams in individual parts of the sets

Analysis of differences in the block quality between winning and losing teams in individual monitored parts of sets

Significant differences in the quality of block realised under the opponent's attack after an accurate pass were found only in successful blocks in the middle part of sets ($p < 0.05$) by means of which the team in defence succeeded to create favourable conditions for the following anti-attack (Fig. 4). From the objectively logical aspect, however, better quality of blocs in the middle and final parts of sets was recorded in winning teams in comparison to losing ones.

More significant differences were found in blocking the opponent's attack after an inaccurate pass (Fig. 5). Significant differences between winners and losers were found in all three parts of sets ($p < 0.05$). Significantly higher quality of blocks in the first part of sets was recorded in losing teams (significantly less errors and more direct points earned by means of blocks); however, the block quality in the middle and final parts of sets was better in winners. Its grounds can be found in better ability of winning teams to answer the opponent's attacks during a set either by successful blocking or by a higher quality of field defence, incorporated into the block quality assessment. As it was already mentioned for assessment

of attack after an inaccurate pass, winners had better disposed outer hitters in the middle and final parts of sets, able to get over even a compact block.
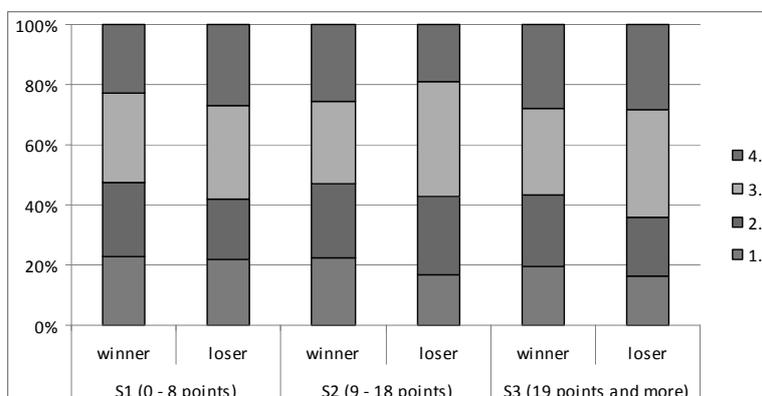

Figure 4

Differences in the block quality under the opponent's attack after an accurate pass between winning and losing teams in individual parts of the sets

Figure 5

Differences in the block quality under the opponent's attack after an inaccurate pass between winning and losing teams in individual parts of the sets
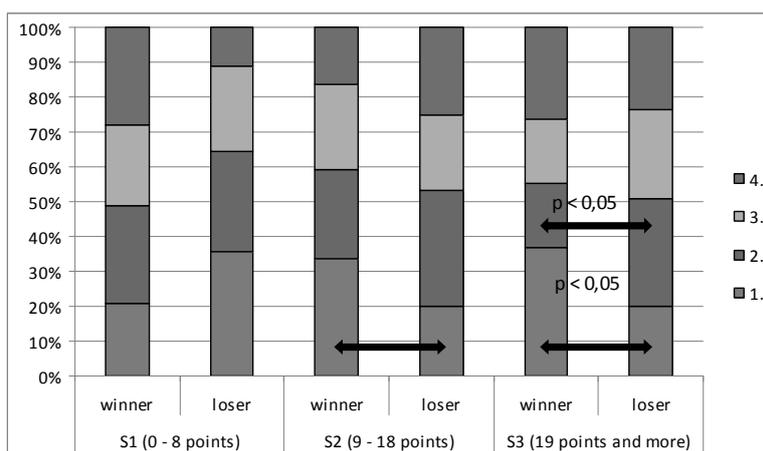
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Conclusions

The purpose of this study was to find whether the set's score, assessed based on the set's division to initial, middle and final parts, can affect the quality of game activities of individuals from the viewpoint of both winning and losing teams. The selected methodological procedure was based on the search for differences in the quality of game activities of individuals between winning and losing teams in the above parts of sets. We assessed finishing game activities of individuals resulting in a point scored. Assessed were in particular serving, spiking and blocking in differentiated game situations.

Based on the achieved results and analyses, the grounds for winning a set may be characterised from the aspect of game performance quality of finishing game activities of individuals in the given parts of sets and concrete predictors may be stated as follows:

– Higher maximum efficiency of spike in all parts of a set and lower error rate in the middle and final part of a set after an accurate pass;

– Lower error rate of spikes after an inaccurate pass at the end of sets;

– Higher relative number of blocked balls under the opponent's attack after an inaccurate pass in the middle and final parts of sets.

From the objectively logical aspect, however, also the found statistically unimportant differences in individual assessment grades distribution are important for the coaching practice. From this aspect it appears that also minimum differences, namely higher efficiency and lower error rate of finishing game activities of individuals in all the assessed parts of sets, may affect the success rate of a team in a balanced set.

We assume that based on the statistical procedures used and objectively logical analysis of results, the goal of our research was reached. Deeper grounds for a top-performance junior team's success in a set were revealed. The results are applicable to the performance and age category observed. Verification of information for other performance and age categories will need special monitoring.

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RESUMÉ

VPLYV BODOVÉHO STAVU V SETE NA KVALITU KONCOVÝCH HERNÝCH ČINNOSTÍ JEDNOTLIVCA VO VOLEJBALOVOM DRUŽSTVE JUNIORIEK

Vladimír Přidal, Zuzana Bartošová

V predloženej štúdii zisťujeme príčiny úspešnosti družstva v sete vo volejbale junioriek na základe skúmania rozdielov kvality realizácie podania, útočného úderu a bloku hodnoteného vo výhodných a nevýhodných herných situáciách medzi víťaznými a porazenými družstvami v úvodnej, strednej a v záverečnej časti setu. Pri hľadaní relatívnych rozdielov medzi víťaznými a porazenými družstvami v skúmaných stupňoch hodnotenia jednotlivých herných činností sme použili test významnosti rozdielu relatívnych hodnôt. Ukazuje sa, že príčiny víťazstva družstva u junioriek musíme hľadať vo vyššej úspešnosti vo všetkých úsekoch setu a nižšej chybovosti v strednom a v záverečnom úseku setu útočného úderu po presnej prihrávke (p < 0,05), nižšej chybovosti pri útočnom údere po nepresnej prihrávke v závere setu (p < 0,05) a vo vyššej početnosti zablokovaných lôpt pri útoku súpera po nepresnej prihrávke v strednom a záverečnom úseku setu (p < 0,05).

UTILIZATION OF COACHING AND THE GROW METHOD FOR SPORT MOTIVATION ENHANCEMENT BY TEENAGERS

VYUŽITIE KOUČOVANIA A METÓDY GROW NA ZVÝŠENIE MOTIVÁCIE U DOSPIEVAJÚCICH ŠPORTOVCOV

Tomáš Gurský

This work deals with theoretical foundations of motivation and analyses the different motivational theories and principles applied in sports. Coaching approach was focused in terms of an increase in motivation of teenage sportspersons. According to this research project coaching approach was examined and compared with an actual coaching and the GROW method has been used as a motivational tool. The results which were obtained by means of psychodiagnostic inventory and motivational questionnaire – designed and examined by the students for this purpose, showed the positive influence of coaching and the GROW method on a motivational level of the experimental group compared to control one. Coaches who have been systematically trained in coaching and in the GROW method, considered these tools as an efficient way to improve internal motivation for teenagers in the field of sport performance.

Supervisor: *Prof. PaedDr. Tomáš Kampmiller, PhD.*

INFLUENCE OF SELECTED DETERMINANTS OF TRAINING ON TACTICAL PERFORMANCE OF PLAYERS IN SOCCER

VPLYV VYBRANÝCH ČINITEĽOV TRÉNINGOVÉHO PROCESU NA TAKTICKÚ VÝKONNOSŤ HRÁČOV VO FUTBALE

Peter Kopúň

The purpose of this study was to find out an influence of selected determinants in training process on tactical performance improvement in youth soccer players. Soccer is an invasion game, where players have to solve and recognize specific-domain situation in it. Our premise was that the difficult exercise and small side games can improve tactics in game. Tactics is determinant of performance and one of the most discussed topic among coaches. Most of authors defined tactics as specific-domain process in game, defeat the opponents or to make right decision. The tactics correlate with psychic and thinking processes.

We compared the efficiency between two groups. Experimental group (n = 21, mean age 17,19 ± 0,59) and control group (n = 20, mean age 16,91 ± 0,79) was in the second league players aged under 19. Average age of playing experience in experimental group was 10,62 ± 1,36 and in control group were 9,5 ± 1,31.

Experimental group took part program, which contained 35% of game situations (1 vs. 1; 3 vs. 2, etc.) and 55 % of small-side games in training and 40 % of game situations (6 vs. 5; 8 vs. 7, etc.) as drill exercises. Control group realised program, which contained 15 % of game situations (1 vs. 1; 3 vs. 2, etc.) and 57 % of small-side games in training and 12 % of game situations (6 vs. 5; 8 vs. 7, etc.) as drill exercises.

We found out that there were not significant differences in tactics during matches, speed of decision making and level of tactical knowledge between groups. Furthermore there were significant differences in tactics during training program ($p < 0,05$). To make comparison between groups we used Mann-Whitney U test and to find out the significant differences in dependent variables we used Friedman test.

Supervisor: Assoc. prof. PaedDr. Pavol Peráček, PhD.

EFFICIENCY OF ROWING STROKE DURING
THE ONE YEAR TRAINING CYCLE

ÚČINNOSŤ VESLÁRSKEHO ZÁBERU V PRIEBEHU
ROČNÉHO TRÉNINGOVÉHO CYKLU

Pavel Lackovič

The thesis was aimed at clarifying the influence of a long-term and short-term rowing training on the efficiency of rowing stroke as well as the importance of this parameter in functional diagnostics. The long-term training effect was assessed by means of a comparison of the level of efficiency of rowing in recreational and competitive rowers, the effect of the short-term training, focused especially on the technique development, was assessed by means of a comparison of changes in the course of a one-year training cycle. Seven competitive (average age 24 ± 3.5 years, weight 83 ± 5 kg, height 187 ± 3.1 cm) and six recreational rowers (average age 28 ± 4.7 years, weight 92 ± 4.8 kg, height 186 ± 5.1 cm) were monitored. The tests were conducted at the end of the preparation period after finishing the winter training and in the competition period, when top rowers took part in the most important races of the season. All subjects completed three one-minute rowing sections on water with maximum effort in the active phase of stroke with at least a 10-minute break. The frequency of rowing in the first two sections was 20, or 25 per minute, and maximal in the third. For testing we used a device that measures the power and performance "on the paddle" continuously, as well as the horizontal speed of the boat. From the measured physical parameters, the diagnostic device calculated the average power and performance of a stroke cycle, the average horizontal shift and speed of the boat of one stroke cycle, the average time of a stroke cycle and work needed for one meter, or one stroke cycle. As a parameter to assess the rowing economy (the efficiency of the conversion of work carried out on the paddle to the horizontal movement of the boat), we used work/meter in J/m. The results showed that compared to recreational rowers, the top rowers needed statistically significantly ($p \leq 0.01$) less energy to cover the same distance, both in preparatory (129.0; 48.3 J/m vs. 156.6; 27.3 J/m) as well as competitive (116.0; 49.1 J/m vs. 150.0; 49.8 J/m) period. The longitudinal monitoring showed a statistically significant ($p \leq 0.05$) improvement of the rowing technique in top rowers after a 12-month training period focused on development of technique (129.0; 48.3 J/m vs. 116.0; 49.1 J/m). The changes in the control group of recreational rowers in the same period were not significant. We can conclude that both long-term training, as well as short-term specific mesocycle positively influences the economy of rowing. The assessment of the effectiveness of the conversion of mechanical work "on the paddle" to the horizontal movement of the boat (rowing economy) represents a significant means to improve the diagnostics in rowing.

Supervisor*: Prof. MUDr. Dušan Hamar, PhD.*

EFFECT OF PHYSICAL ACTIVITY ON STRESS MANAGEMENT

VPLYV POHYBOVEJ AKTIVITY NA ZVLÁDANIE STRESU

Lukáš Chovanec

The study was focussed on finding differential influence of an 8 week resistance and endurance training on the change of psychological and physiological parameters of stress management. 52 young women, aged 18 to 27, taking no active part in sports participated in this study. The subjects were randomly divided in to three groups: resistance training, aerobic training and a control group-without participation in training. A questionnaire about subjective stress perception, PSS (the Perceived Stress Scale; Cohen, Kamarck, & Mermelstein, 1983) and a questionnaire about stress management strategies, COPE (Carver, Scheier, & Weintraub, 1989) were used to monitor psychological parameters of stress management. Reactivity and the recovery of heart rate and skin conductance were used as physiological parameters of stress management. The effect of both training types (endurance and resistance) on stress management led to significant lowering the level of subjectively perceived stress and accelerated heart rate recovery after the exposure to the stress when compared with the initial values of these parameters (measured at the beginning of the study) and with the changes within the control group, as shown in the results. The difference between resistance and endurance training was not statistically significant. Based on these results it can be concluded that the resistance and endurance training led to the lowering of subjectively perceived stress and an accelerated heart rate recovery. The findings can be used to help in lowering the psychosomatic diseases.

Supervisor: Assoc. prof. MUDr. Janka Lipková, PhD.

THE IMPACT OF THE TRAINING PROGRAM ON THE DEVELOPMENT OF SELECTED COORDINATION ABILITIES IN CATEGORY U13 IN SOCCER

VPLYV TRÉNINGOVÉHO PROGRAMU NA ROZVOJ VYBRANÝCH KOORDINAČNÝCH SCHOPNOSTÍ V KATEGÓRII MLADŠÍCH ŽIAKOV VO FUTBALE

Martin Žamba

The level of performance of coordination abilities often decides on the efficiency of solving game situations in the match. The aim of this work was to verify whether it is possible to achieve positive changes in the level of spatial-orientation and kinaesthetic-differentiation of the non-specific and specific forms, through specific stimuli, in the category U13 in soccer in the implementation of the 12-week training program. The basic method to obtain research data was measurement – testing. For processing and evaluation of the results were used nonparametric methods of comparison dependent and independent samples. The results showed that the influence of experimental exposure factor significantly increased the level of selected coordination abilities in their non-specific and specific forms in players' experimental group.

Supervisor: *Prof. PaedDr. Miroslav Holienka, PhD.*