DOI 10.2478/afepuc-2018-0009

DIFFERENCES IN SELECTED COORDINATON ABILITIES BETWEEN PUPILS WITH COMMUNICATION ABILITY DISORDER AND ABLE-BODIED PUPILS

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Summary: The aim of the study was to analyse and compare the level of selected coordination abilities of pupils with communication ability disorder (CAD) and able-bodied pupils in the same age category. Two groups of participants were recruited for the study: (1) pupils attending special elementary school for children with CAD (n = 17; 5 girls and 12 boys in mean age 11.2 ± 0.7 years), (2) and able-bodied pupils (n = 20; 12 girls and 8 boys in mean age 11.4 ± 0.5 years) without gender differentiation. 5 standardised tests measuring coordination abilities were used as a primary research method (Šimonek 2015): low jump test, spatial orientation ability test, circles through running test, one leg stand test, catching ball test. Group differences were analysed with Mann–Whitney U-test for independent samples. The level of significance was $\alpha < 0.05$. We found significantly higher level of spatial orientation ability and static balance displayed by able-bodied pupils comparing pupils with CAD. The level of lower limb kinaesthetic discrimination ability, rhythmic ability, frequency and reaction time in pupils with CAD are comparable to the level of able-bodied pupils. We recommend that children with CAD should participate in regular physical activities and sports after compulsory education together with able-bodied children to improve their fine and gross motor ability, coordination abilities as well as overall physical fitness.

Key words: communication ability disorder, able-bodied pupils, coordination abilities, physical education classes.

Introduction

The level of language skills and mastering the mother tongue is closely related to school performance of pupils (Bendíková 2012). The deficiencies in the usage of the language are shown not only in the external form of the spoken language, but also in the understanding, in the usage of written form of the language, i.e. in writing and reading, and thus in the whole learning process. Difficulties with language, speech and communication which are diagnosed in pre-school age often persist at the beginning of compulsory school attendance for 60 – 80 % of pupils (Zezulková & Kaleja 2015). Pupils with disturbed communication ability can (but need not be) included in the special education. The extent and severity of special educational needs are assessed by special educational or psychological examination by school counselling centre, which justifies the need of special education (Zezulková 2009; Bendíková & Jančoková 2013). Majority of pupils with disturbed communication ability does not qualify for special education (they are not pupils with severe communication ability disorder). However, problems with language, speech and communication of mild and moderate degree can have a negative influence on school performance and on overall development of the child. The teachers, therefore, more likely meet pupils with prolonged physiological problems, on the other hand the presence of pupils with severe communication ability disorder (CAD) is less frequent (Zezulková 2011; Zezulková 2013).

There is a high correlation between the level of motor skills development and the communication abilities development (Lechta 2002). Except of language and speech disorders which are characteristic for disturbed communication ability, children with a specific learning disorders, children with specifically disturbed speech development and children with dyslalia may also have problems with fine and gross motor ability development, graphomotor problems and problems in the coordination of several movements in a row (Vrbova et al. 2012). Based on their practical experience, the authors Kolář et al. (2011) found out, that children with dyspraxia have problems with the balance, mental and muscular relaxation disorders, selective motor disorder, problems with postural adaptation, rhythm disorders, problems of movement's fluency and speed and problem to estimate the movement (Gerlichová & Králová 2014; Bendíková 2011, 2017). Holma & Tamminen (1998) found, that the level of gross motor ability is in 70 % lower in children with CAD compared to able-bodied children in the same age. The results of their research indicate, that only the minimum number of children with CAD achieved the average level of motor abilities compared to the standard. They also found, that the children with CAD significantly improved their motor abilities in four of the five motor tests after specialized motor program application. Snowling (2000) reported, that 60 % children with dyslexia often have problems with coordination abilities development and other motor abilities development. Deelstra (2006) found evidence that children with dyslexia have significant deficit in tests measuring the coordination skills such as foot tapping test and movement repetitive test. Roškotová (2010) confirmed that regularity of the stretching exercises, strengthening exercises and subsequent muscle relaxation will improve fine and gross motor ability of the pupils who have been diagnosed with dyspraxia, dysgraphia and dysorthographia. After individual exercise program application (exercises on trampolines, with over-balls, therapy masters and fit-balls), the children with CAD improved their motor abilities in five of the six tests (Roškotová, 2010). Newmayer et al. (2007) demonstrated a correlation between regular participation in physical activity and speech abilities improvement in the group of 32 children aged 2-5 years who were diagnosed with CAD. Visscher et al. (2007) also confirmed that developmental language and speech disorders are often affected by the level of physical performance.

Considering the previous research findings, the aim of the study was to analyse and compare the level of selected coordination abilities of pupils with communication ability disorder and able-bodied pupils in the same age category without gender differentiation.

Methods

Participants

The research sample comprised 37 pupils attending 5th and 6th grades of two elementary schools in Bratislava (Slovakia). The special elementary boarding school for children with communication ability disorder located at Vlastenecké námestie Street was presented by 17 pupils (5 girls and 12 boys in mean age 11.2 ± 0.7 years) and the regular elementary school of Alexander Dubček at Majerníková Street was presented by 20 able-bodied pupils (12 girls and 8 boys in mean age 11.4 ± 0.5 years) (Table 1). Pupils of both elementary schools attended physical education classes twice a week in 45 minutes duration. None of the pupil took part at extra sport activity after compulsory education.

Table 1

The basic characteristics of research samples

SAMPLES	N	AGE/YEARS	HEIGHT/CM	WEIGHT/KG	BMI
Pupils with CAD	17	11.2 ± 0.7	153.1 ± 9.0	49.0 ± 15.2	21.0 ± 5.3
Able-bodied pupils	20	11.4 ± 0.5	156.7 ± 7.7	46.6 ± 9.0	18.8 ± 2.5

Pupils were informed of the purpose of the research and the procedure for testing the coordination abilities was realised in the presence of their physical education teacher and the researcher. Consent of the legal representatives of the pupils at special elementary school for children with CAD regarding the pupils' participation in the study was obtained well in advance.

Data collection

Five standardized tests measuring coordination abilities were used as a primary research method: low jump test, spatial orientation ability test, circles through running test, one leg stand test, catching ball test (Šimonek 2015).

- ***Low jump test*** to assess lower limb kinaesthetic discrimination ability. Pupils jumped with the legs together from a plinth to a ground for maximum distance twice. After marking 75 % of the maximum performance they were instructed to land with their heels on the marking. The test was performed three times and the distance of each heel from the marking was measured in centimetres for each trial. Distance values were collapsed across heels and trials to obtain one mean value (Hirtz et al. 1985).
- ***Spatial orientation ability test*** to assess spatial orientation ability, reaction time, agility and lower limb explosive power. Six 2-kg-heavy numbered balls were placed on the ground in the semi-circle shape (Figure 1). Pupils were placed behind the zero-ball faced back to the balls. On the teachers' sound signal (by announcing the number of the ball) pupils turned as fast as possible to the ball whose number the teacher has called and touched the particular ball always with the same hand and returned as quickly as possible back to ball number 0 and also touched it with the same hand. While pupils were returning to the zero ball the teacher announced another number. The test ended after the third number was announced, by touching the zero ball. The

test was performed two times and a better attempt was evaluated with an accuracy of 0.01 seconds.

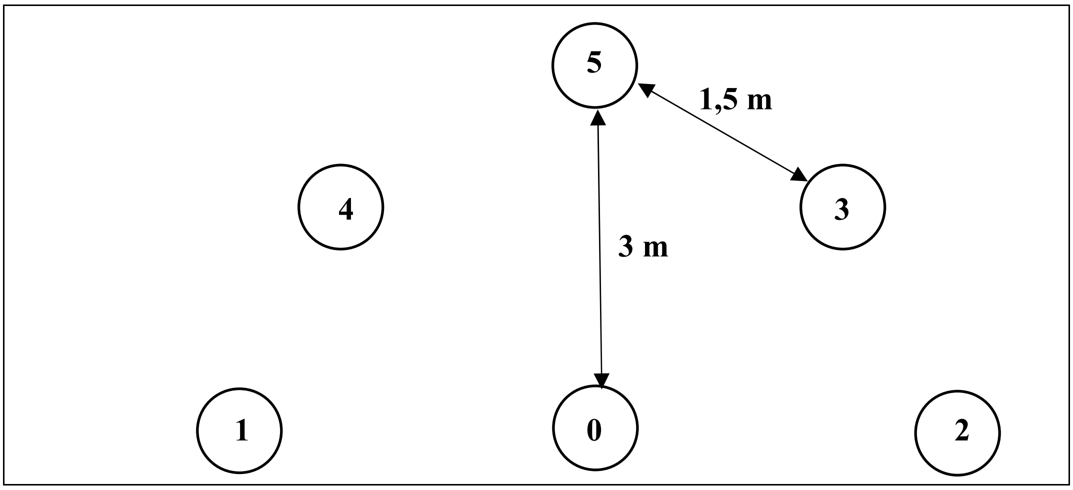

Figure 1

Schema of the spatial orientation ability test performance

- ***Circles through running test*** to assess rhythmic ability, lower limb kinaesthetic discrimination ability and frequency. Two 30 meters long running tracks were marked on the ground (Figure 2). Pupils started to run 15 meters there, then around the cone and 15 meters back as fast as possible (the first track). After 1-minute rest, pupils ran 15 m through the circles, then around the cone and 15 meters back without the circles as fast as possible (the second track). The test was performed only ones and time of the first track and time of the second track was recorded. Difference between the first and second run was evaluated with an accuracy of 0.1 seconds.

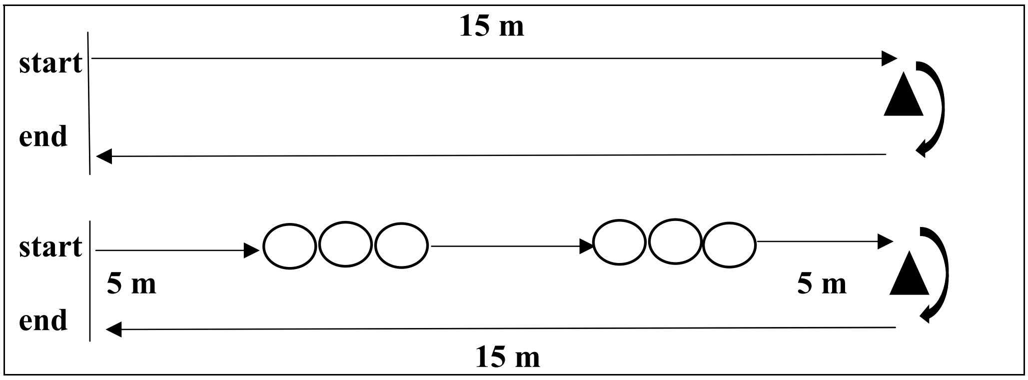

Figure 2

Schema of the circles through running test performance

- ***One leg stand test (eyes closed)*** to assess static balance. Pupils started to balance on two feet, hands on hip. One leg was lifted so that the toes of the lifted leg touched the inside of the knee of the planted leg, pupils closed their eyes (Figure 3). Pupils balanced on a dominate foot for as long as possible or until the foot toughing the knee moved away, or if they moved away from standing spot, or if they moved hands away from hip, or if they opened their eyes. The score was recorded in seconds and the test was performed two times. Better performance was evaluated.

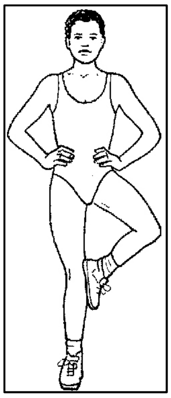

Figure 3
One leg stand test

- ***Catching ball test*** to assess the reaction time. Test was performed in pairs standing face-to face. The teacher held tennis balls in each extended hand to the shoulder width. The pupils stood faced to teacher and waited for unexpected ball release. Immediately when the ball was released by the teacher the pupils tried to catch the ball before the ball falls. The launch of the ball was irregular, and the left and right hands were not shuffled. They had 10 attempts and number of successful attempts was evaluated.

Data analysis

The statistical analyses were carried out with IBM SPSS version 23.0 for Windows. The data were examined for normal distribution and homogeneity of variance. Group differences were analysed with Mann–Whitney U-test for independent samples. The level of significance was $\alpha < 0.05$. The detection of dependence between two groups of variables was expressed by usage the coefficient "r" (Pett, 1997).

Results

Differences in low jump test performance between pupils with CAD and able-bodied pupils were not significant (U = 112.5; Z = 1.75; p = 0.079; r = 0.33) (Figure 4). We found out, that distance mean value presented better level of lower limb kinaesthetic discrimination ability in the group of able-bodied pupils (4.53 ± 2.38 cm) comparing pupils with CAD (6.96 ± 4.26 cm).

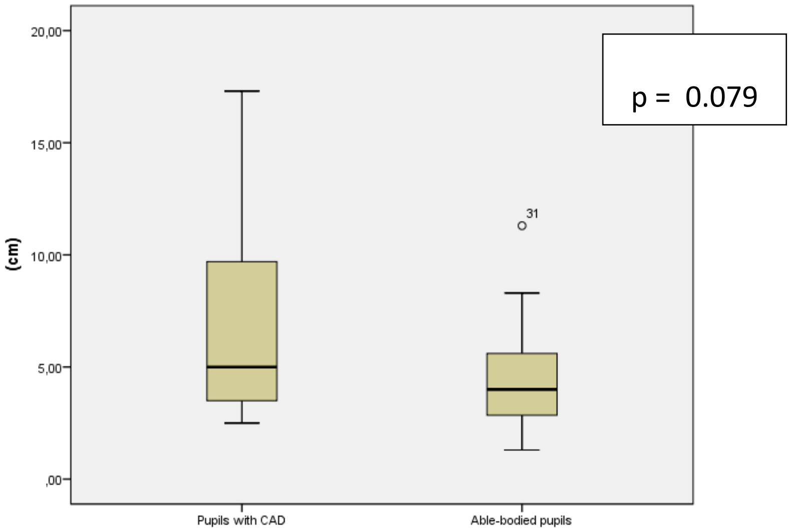

Figure 4
Low jump test performance comparison

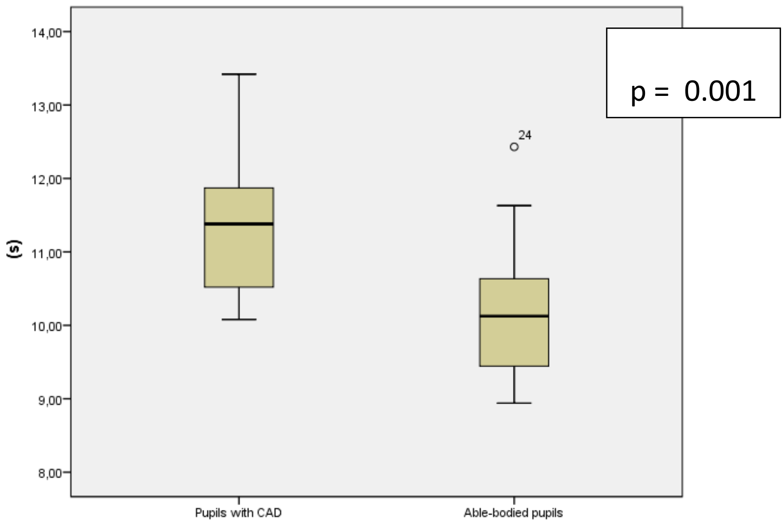

Figure 5
Spatial orientation ability test performance comparison

Analysing the level of spatial orientation ability, we found significant differences in achieved performance between pupils with CAD and able-bodied pupils (U = 64.0; Z = 3.23; p = 0.001; r = 0.52). Significantly higher level of spatial orientation ability was displayed by able-bodied pupils comparing their mates with CAD (Figure 5). Mean value confirm better results in the group of able-bodied pupils (10.14 ± 0.93 s) who performed particular test in shorter time comparing pupils with CAD (11.39 ± 1.12 s).

Performances in rhythmic ability, lower limb kinaesthetic discrimination ability and frequency did not show significant differences between able-bodied pupils and pupils with CAD (U = 156.5; Z = 0.412; p = 0.681; r = 0.10) (Figure 6), as well as mean values declared very similar performances between evaluated groups of pupils (able-bodied pupils 1.4 ± 1.9 s. vs pupils with CAD 1.5 ± 0.5 s.).

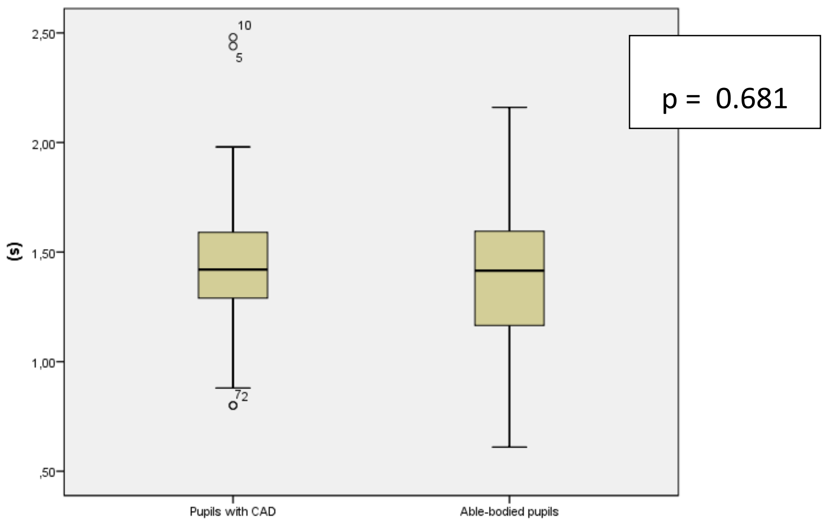

Figure 6
Circles through running test performance comparison

Significant differences between able-bodied pupils and pupils with CAD were presented in static balance performance (U = 87.0; Z = 2.53; p = 0.011; r = 0.23) where significantly higher level of static balance was achieved by able-bodied pupils comparing their mates with CAD (Figure 7). Mean values of achieved static balance ability also show very big differences between evaluated groups of pupils, when able-bodied pupils could keep the static position in mean of 17.3 ± 12.19 seconds comparing pupils with CAD who kept the static position on one leg with eyes closed only 9.05 ± 7.26 seconds.

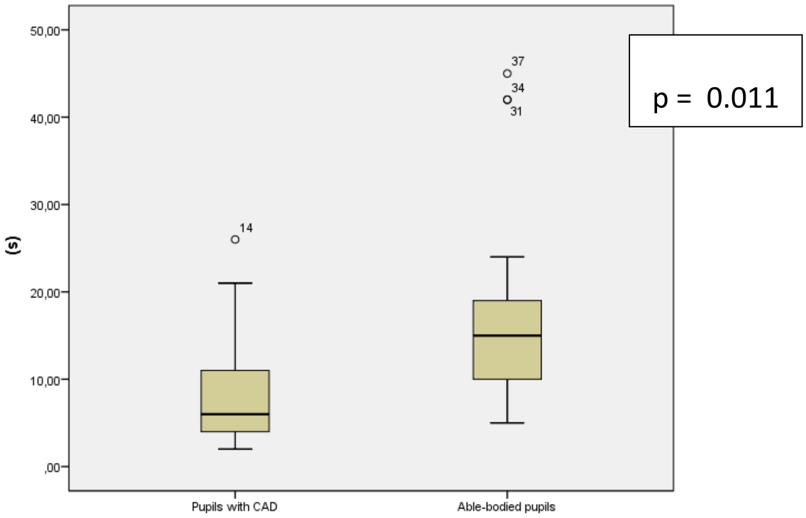

Figure 7
One leg stand test performance comparison

A comparison of the reaction time level using the catching ball test didn't reveal significant differences between able-bodied pupils and pupils with CAD (U = 154.0; Z = 0.494; p = 0.621; r = 0.10) (Figure 8). A mean value also displayed very similar results in successfully caught balls between able-bodied pupils (4.45 ± 2.08 number of successful attempts) and pupils with CAD (4.05 ± 1.78 number of successful attempts).

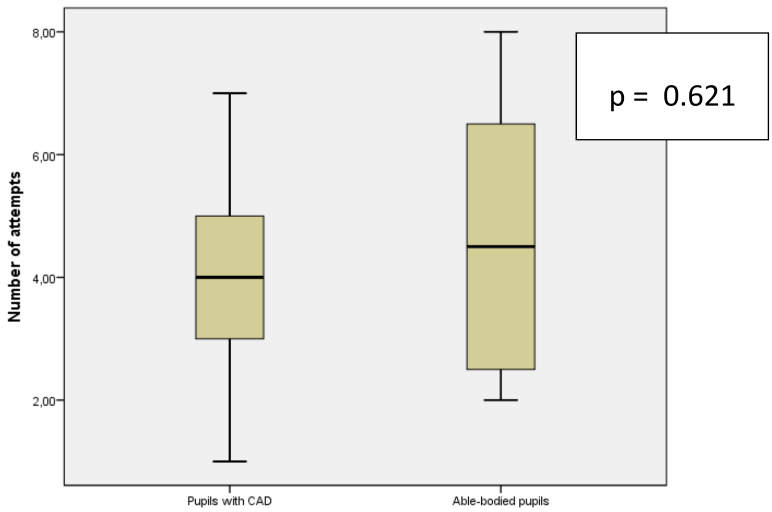

Figure 8
Catching ball test performance comparison

Discussion

The aim of our research was to analyse and compare the level of coordination abilities of pupils with communication ability disorder and able-bodied pupils in the same age category. The level of coordination abilities was assessed by five standardized tests. Concretely we measured the level of lower limb kinaesthetic discrimination ability, spatial orientation ability, rhythmic ability, static balance and reaction time. We found significant differences in two from five assessed abilities, concretely significantly higher level of spatial orientation ability and of static balance was displayed by able-bodied pupils comparing their mates with CAD. We did not confirm significant differences in assessment of lower limb kinaesthetic discrimination ability, rhythmic ability neither of reaction time between evaluated groups of pupils in age category 11 years.

The positive improvement of coordination abilities in the age category of 10-11-year-old children and even younger (6 – 8 year-old children) is successful (Nemček & Chybová 2016). Matějček (1993) argues that the deficits associated with CAD are associated with deficits in movements' coordination, attention, spatial orientation, visual and motor memory. These deviations can be caused by combination of defects in visual perception and rhythm signals that occur in children with CAD (Klenková 2007). Also, Škodová & Jedlička (2007) affirm that in children with developmental dysphasia can occur memory impairments and concentrating disorders as well as coordination disorders and impairments in other motor functions. The authors Engelsman et al. (2001) investigated the level of coordination abilities in children with dysgraphia diagnosis at primary school in Netherlands. The sample comprised pupils of the 4th and 5th grade (n = 125). They found out, that children who have a problem with handwriting showing significantly lower performance in fine motor ability comparing children with good handwriting taking in consideration their chronological age (Engelsman et al. 2001). Müller (2004) revealed defects in fine motor ability and other coordination skills in children with CAD. Other research suggests that children with dyspraxia diagnosis in the age of 7 – 10 years do not have a stable pattern of coordination in catching the ball and have a longer initiatory phase of the movement than children without dyspraxia (Kosová 2015).

Following the Šimonek's (2015) scale of ball-catching (4 – 5 successful attempts form 10) we found out satisfactory level of reaction time in pupils with CAD as well as able-bodied pupils. The research done by Finlay & McFillips (2013) was also aimed to compare the level of selected coordination abilities between two groups of pupils aged 9 – 10 years. One group consisted of pupils with CAD (n = 35) and the control group included pupils without CAD (n = 35). The authors found a significantly lower level of static balance, reaction time provided by catching ball test and agility in pupils with CAD comparing pupils without CAD. The authors did not find significant differences in the level of selected coordination abilities between genders (Finlay & McFillips 2013). Comparing our results, we found significantly lower level also in static balance in group of pupils with CAD comparing able-bodied pupils, but reaction time provided by catching ball test did not showed significant differences between evaluated groups of pupils in our investigation. Our results revealed significantly lower level of spatial orientation ability in the group of pupils with CAD compering able-bodied pupils. Kosová (2015) also confirmed significantly lower level of static balance by usage the same test (one leg stand test-eyes closed) in the group of 9 – 10 year-old pupils with dyspraxia diagnosis comparing their school-mates without dyspraxia.

Another investigation (Getchel et al. 2007) compared the performance of children with and without dyslexia on different subtests of the Test of Gross Motor Development and Movement Assessment Battery for Children and assessed whether there were developmental changes in the scores of the dyslexic group. Participants included 26 dyslexic children (19 boys and 7 girls; 9.5 yr. old, SD = 1.7) and 23 ages and sex-matched typically developing (17 boys and 6 girls; 9.9 yr. old, SD = 1.3) children as a control group. Mann-Whitney U tests indicated that the dyslexic group performed significantly lower than the control group only on the Total Balance subtest of the Movement Assessment Battery for Children. Additionally, the young dyslexic group performed significantly better on the Total Balance subtest, compared to the older dyslexic group. The results of Getchell et al. (2007) further suggest that cerebellar dysfunction may account for differences in physical performance.

Limits of study

The results cannot be generalized, they only attest two schools within the given region. This study was limited due to the low number of participating schools, especially special schools for children with CAD, and the number of pupils, as well as due to the lack of knowledge of the level of current fitness and overall health condition of the pupils under this study. Due to number of pupils we did not provide the gender differentiation.

Conclusion

Based on our results we can conclude that the level of lower limb kinaesthetic discrimination ability, rhythmic ability, frequency and reaction time in pupils with CAD are comparable to the level of able-bodied pupils. The level of spatial orientation ability and static balance was significantly higher achieved by able-bodied pupils comparing pupils with CAD in our investigation. However, based on achieved results, some differences should be implemented in teaching physical and sport education process to improve the level of motor abilities in pupils with CAD that we could recommend:

- It is important to approximate as close as possible to pupils' individual needs.
- Do not burden children with a lot of instructions. Instructions must be formulated briefly and clearly.
- There is need of sufficient explanation of concrete exercise, there is also need to repeat the explanation several times, and demonstrate it.
- There is no need to insist to exercises be excellent performed, it is often enough for the pupil with CAD to get closer to the flawless performance of the exercise.
- There is also important to create pleasant atmosphere in the physical education lessons and calm tempo of the teacher's speech usage.
- As a motivation tool, it is essential to use praise, compliment and small reward. In the assessment, it is necessary to emphasize the pupil's efforts and to follow the improvement compared to the previous period.

The overall view of the difficulty of teaching physical and sports education for children at a special school for children with CAD is comparable to a regular school. Therefor we further recommend that children with CAD should participate in regular physical activities and sports after compulsory education together with able-bodied children to improve their fine and gross motor ability, coordination abilities as well as overall physical fitness.

Acknowledgement

The scientific paper was supported by grant projects VEGA No. 1/0726/17 with the topic *"Sports motivational profile for different groups of population and the influence of various sport activity to improve the subjective dimension of quality of life"*

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DOI 10.2478/afepuc-2018-0010

VO_2MAX LEVELS AS A POINTER OF PHYSIOLOGICAL TRAINING STATUS AMONG SOCCER PLAYERS

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Summary: The purpose of the current study was to evaluate the Aerobic endurance training as indicators of physiological training status among male soccer players. A total of 138 well-trained first division soccer players under 18 years were tested. Testing was based on the Cooper test as a one of simple tests to estimate VO_2max. BMI and BFP as valued anthropometric measurements to control body change relative to maximal oxygen consumption during dynamic exercise with large muscle groups benefit training time soccer training experience. Performance in this experience was based on the subjection that 60 ml/kg/min of VO_2max is the minimum fitness requirement for male soccer players to play at the elite level. Admit in this study as a protocol to categorise our sample into two groups (up and under the range VO_2max ± 60 ml/kg/min) and it was based on statistics applied and the design used. Our results highlighted the importance of aerobic performance up to 60 ml/kg/min as the minimum fitness requirement to enhance the players' aerobic capacity allied to maximal heart rate relative to BFP levels as a better parameter in comparison with BMI for the prediction of low VO_2max concomitant to the physiological training status as requests soccer performance demand.

Key words: BFP, BMI, VO_2max, physiological, soccer player

Introduction

Enhanced aerobic endurance in soccer players needs for trainer to improved soccer performance by increasing the distance covered, enhancing work intensity, and increasing the number of sprints and involvements with the ball during a match (Hoff, Wisløff, Engen, Kemi & Helgerud 2002). However, changes of anthropometry, body composition, and physical fitness during a soccer season in elite young athletes' variations throughout the different training periods (Fessi, Zarrouk, Filetti, Rebai, Elloumi & Moalla 2016). Admit by soccer scientists studies at 60 ml/kg/min of VO_2max suggested as the minimum fitness requirement for male soccer players to play at the elite level (Almeida, Santos Silva, Pedrinelli & Hernandez 2018). Support by (Requena 2017) among Top-Level Professional Soccer Players evaluation of training programs must focus on regaining aerobic capacity and body composition. Investigate in the present founded on Obesity in terms of Fat percentage is a better parameter than BMI for the prediction of low VO_2max (Mondal & Mishra 2017). Backing by hypotheses; which confirm that Body fat percentage as a super factor affecting VO_2 max and thus the cardiovascular status of the athletes (Anjali, Smita & Deshmukh 2014).

Founded on the above and the pro recommendations: (a) that the average maximal oxygen intake for elite adult players is reported to be in the range of 55 to 69 ml/kg/min (Coelho, Figueiredo, Elferink-Gemser & Malina 2016). Where the 60 ml/kg/min of VO_2max is the minimum fitness requirement for male soccer players to play at the elite level (b) that Heart rate monitoring is a valid indicator of exercise intensity. Our analysis in the present study test VO_2max levels as indices to estimate the adapted physiological soccer players' profile. Support by in this study based on VO_2max ± 60 ml/kg/min as the protocol to test the effective Algerian training programs in the solicitation of maximal oxygen uptake allied to player training status correlates to its body adjustment relative to its actual performance.

Methods

A cross-sectional design was used to compare the stature, BMI**,** BFP and VO_2max. Players were classified based on their age categories under 18 years, sex male, senior teams from the Algerian championship national division one. Their age training exceeds 10 years. They play in the same championship, plus 2 years, category senior.

The data used in this study were obtained through the database of Team 5 Physical Education Institute Laboratory OPAPS for the academic year 2016 – 2017. In terms of player-related data, 148 male soccer players under 18 years, play at the Algerian championship national territory. Were examined in parameters (anthropometric and physiological decide for the current study) by Team 5 at the end of the physical preparation for the year 2016 – 2017 after the agreement with their coach, were All examinations were realized for the first weeks before the start of the championship. Whereas too expert the study protocol and methods, we choose the laboratory OPAPS "Institute of Physical Education of our University" who approve it by the professors of football and physiologist of effort.

TESTING PROTOCOL

The maximal aerobic capacity

We have chosen the maximal aerobic capacity based on the formula Test Cooper [16] (VO_2 max = 22.351 d (km) - 11.288 ml/min/kg). Confirms by John Gormley et al. that the Cooper 12-minute test have a corresponding laboratory VO_2 max obtained by the formula (John & Juliette 2009). Report by Daniel Mayorga-Vega, et al as an accurate test with validity around 90 – 95 % (Mayorga-Vega, Bocanegra-Parrilla, Ornelas & Viciana 2016). Support by the Cooper Institute as field test which provides a better picture of endurance of maximal aerobic capacity (Welk & Meredith 2010) which leads to better health and a higher quality of life, according to (Sharon & Hoeger 2015). However, Wener, Hoeger et al. confirm that VO_2max is affected by genetics, training, gender, age, and body composition (W. Hoeger & A.Hoeger 2016). While to calculate HRmax, we use the formula, proposed by Zerf (2017) derived from formula Uth N: Max Heart zones exercise = (VO_2max/15) * Heart Rate (RHR). For RHR, we use the polar watch system to compute Heart Rate.

Anthropometries fat index

Height (m) and weight (kg) were each measured in the standing position (Mohammed, Abelatif, Mokhtar & Ali 2016) to calculate the body mass index BMI = weight (kg) /height (m2) (Skidmore-Roth 2015). Goto et al. confirm that the VO_2 peak is associated with biological status after controlling for height and weight (Goto, Yokokawa, Fukuda, Naito, Hisaoka et al. 2015). For body fat percentage (BFP), we use the formula proposed by Deurenberg, et al. body Fat = (1,2 × BMI) + (0,23 × age) - (10,8 × Sex) - 5,4 (Deurenberg, Westrate & Seidell 1991) s inexpensive and convenient means for our coaches and players.

Statistical analyses

Data analysis was performed using SPSS 22.0 for Windows (32- bit) (IBM, Armonk, NY, USA). Data obtained from the tests showed homogeneity and the deference according to the protocol used, presented as mean ± standard deviation, Levene's test and independent t-test, were the relationship between the variables was analysed by Pearson correlations (r). The statistical significance was set at $p < 0.05$

Results

Table 1

Present the characteristics and differences observed in the sampling

	Groups	**N**	**Mean ± SD**	**F**	**p<0.05**	**T**	**p<0.05**
Weight (kg)	VO_2max ≥ 60 ml/kg/min	67	62,89±7,14	5,493	0,021	-0,719	0,474
	VO_2max ≤ 56 ml/kg/min	71	63,65±5,34				
Height (cm)	VO_2max ≥ 60 ml/kg/min	67	1,75±0,06	2,305	0,131	1,247	0,214
	VO_2max ≤ 56 ml/kg/min	71	1,73±0,05				
BMI (kg/m2)	VO_2max ≥ 60 ml/kg/min	67	20,09±1,58	1,173	0,281	-4,126	0,000
	VO_2max ≤ 56 ml/kg/min	71	21,24±1,69				
VO_2max	VO_2max ≥ 60 ml/kg/min	67	62,56±2,56	5,984	0,016	-6,187	0,000
	VO2max ≤ 56 ml/kg/min	71	56,93±2,02				
BFP %	VO_2max ≥ 60 ml/kg/min	67	9,91±0,78	5,836	0,017	14,364	0,000
	VO_2max ≤ 56 ml/kg/min	71	10,83±0,93				
HRmax %	VO_2max ≥ 60 ml/kg/min	67	187,75±7,64	5,984	0,016	-6,187	0,000
	VO_2max ≤ 56 ml/kg/min	71	170,62±5,96				
AGE (years and month)	VO_2max ≥ 60 ml/kg/min	67	17,50±0,59	2,352	0,127	1,241	0,000
	VO_2max ≤ 56 ml/kg/min	71	17,38±0,50				

Depending on data entry, the aims of the study and statistical processes applied within search limitation. Regarding the impact of Aerobic endurance training on physiological training status among our soccer. Our results in table 1 show that VO_2max of up to ≥ 60 ml/kg/min is an advantage of physiological training response than its less. Claim in the present via the less fat or fatness among our soccer. Inspected via this study based on the sign of the independent T-test as deference record in BMI, BFP, HRmax and VO_2max. In the opposite of age, weight and height. Support by the correlate BFP as a superior index of obesity in term fat to predict the low VO_2max or HRmax more than BMI (table 2).

Table 2

Present Pearson Correlation between physiological and fat index among the total sample

Pearson		BMI	VO_2maxX	BFP	HRmax
VO_2max		-0,43**	1	-0,52**	0,97**
HRmax		-0,45**	0,97**	-0,52**	1
		p<0.05			
	N	138			
**.correlation is significate at 0.01 (bilateral).					

Interpret by (James, Robin, Claire, Andrea & Rodney 2016) via the decline in cardiovascular fitness, owing to the increase of fat overweight or obesity levels. Suggesting this control and training method as a targeted approach used to determine training errors allied to the efforts to achieve optimal improvement in physical fitness performance. The case of this study, supported by previous prevalence studies through the importance of players and coaches to access soccer player's physical status for team selection and training purposes. Admit by Physiological tests as control tools providing information relative to the difficulties in performing the intense physical exertion (Gonçalves & Silva 2016). Establish in this study via VO_2max upper to 60 ml/kg/min as exercise intensity consistent with exercise maximum and energy requirements Zerf 2017. Backing by (Cardoso, Baumgart, Jansen, Freiwald & Hoppe 2018) among individual player data were more variance is recorded through VO_2max total endurance and physical abilities due to the amount of anaerobic or aerobic energy supply. Needing from our trainers a combination of various tests to provide a comprehensive assessment of the players that permitting the optimization of training and testing procedures for soccer players. The case of this study, which confirm the levels of Aerobic endurance training up 60 ml/kg/min to as super indicators of physiological training status recommended for our soccer players to reach the high and global levels derived from soccer sciences research.

Discussion

Based on the study design and statistical applied. Our results confirm:

1. VO_2max up to ≥ 60 ml/kg/min is effective endurance training to improve maximal oxygen uptake, admit in this study as advanced physiological training response than it's under among soccer players. State by (Scribbans, Vecsey, Hankinson, Foster & Gurd 2016) that training at any intensity above ~60 % of VO_2max is likely to improve maximal oxygen uptake in healthy adults. As well as the decreases body weight or stroke. Confirmed by Hassane, LeMoal, Wong, Ounis, Castagna, Duluc, Owen & Drust 2013) in the context of training-related to increased VO_2max after training at high intensity. Indicate by (Thevenet, Tardieu, Zouhal et al. 2007) through the amount of oxygen consumed during exercise that could serve as a good criterion to judge the effectiveness of this exercise on the development of physiological soccer game recruitment. State in the present study through the inverse correlation between VO_2max and the fat index used in this study. Where their upper reduce the levels of aerobic fitness capacity. Shown in

similar, as the basis for a good form of sports players' formation. Support by a number of tests through the increase of the level of maximum oxygen uptake (VO_2max), improves the sports performance of the game. Reviewed by Fortuna, Szczurowski, Zabłocki, Pałasz & Demczyszak (2018) above the player lengthens the distance run during the match, the intensity of the globally performed work increases, the number of sprints increases and the number of actions with the ball increases.

2. VO_2max up to ≥ 60 ml/kg/min for a soccer player is effective endurance training to control body fat or fatness (BFP or BMI). Our results table 1 and 2 lines with Koutlianos, Dimitros, Metaxas, Cansiz, Deligiannis & Kouidi (2013) which confirm the impact of body fat composition in term overweight on physiological capacity. Support by (Mondal & Mishra 2017) via the prediction of the low VO_2max. Confirmed by Laxmi CC (Laxmi, Udaya & Shankar 2014) trendy the effects of increasing fat in compared with muscle mass on Cardiorespiratory Fitness case sports studies and distribution adiposity case the medical studies, according to Tauseef Nab et al. (2015). Although based on the strong negative correlation between VO_2max, BFP and BMI, we agree that an increase in BM of 1 kg can increase the aerobic demand of exercise by 1 to 14 %. Disclose in similar as a significant negative correlation between BMI and VO_2max (ml/kg/min) signifying the possibility of body fat effect on cardiorespiratory function (Radovanović, Kocić, Gajović, Radević, Milosavljević & Nićiforović 2014). From the above, we subject for our trainers, VO_2max up to ≥ 60 ml/kg/min as an effective endurance training to improve the soccer player's maximal oxygen uptake relative to their body weight adjustment allied to fat accumulation. Record in this study through adaptive concerns bodily functions associated with oxygen consumption. Set by similar as an advantage in the benefits of the top team compared with those in the lowest place among the Norwegian elite league, according to Hoff, Wisløff, Engen, Kemi & Helgerud (2002). Interpret by Hassane, LeMoal, Wong, Ounis, Castagna, Duluc, Owen & Drust (2013) as a training body adaptation, allied to body composition management (Paul, Don, Kimberley et al. 2016). Admit in this study via the levels of aerobic capacity relative to changes in body fat percent (Mohammed, Abelatif, Mokhtar & Ali 2016) as efficient endurance training to improve maximal oxygen uptake allied to physiological soccer demand. Conclude via this study, based on V02max upper to 60 ml/kg/min as benefit physiological training status to control the appropriate percentage body fat as the most important body weight management (Draper & Marshall 2014) more associated with the prediction of lesser VO_2max.

Recommended through this study as the most typical method for our trainers to monitor body weight or stroke relative to aerobic fitness levels recommended in this game. Recommend through the high VO_2max as adopt soccer training (McMillan, Helgerud, Macdonald & Hoff 2005). Requesting for our coaches the use of our protocol to have access to objective information on soccer player's physical status for team selection and training purposes. Appraisal in this study via Physiological tests that can provide the soccer adaptation profile supported by the analysis of body composition allied to VO_2max levels (Zerf 2018). State in the current study through VO_2max super to ≥ 60 ml/kg/min as the minimum fitness requirement to enhance the Algerians player maximal heart rate relative to BFP levels as a better parameter than BMI for the prediction of low VO_2max concomitant to the physiological soccer status performance demands.

Conclusion

Our results approve that a training response in soccer game requests VO_2max upper to ≥ 60 ml/kg/min as the minimum fitness requirement to enhance the player maximal heart rate relative to BFP levels as a better parameter than BMI for the prediction of the lower VO_2max. Subjected via this study as accurate systems to monitor the physiological adaptations of soccer training program simultaneously to their endurance training to improve maximal oxygen uptake. Recorded via this study as individual training mistakes to enhance the Algerians players' aerobic endurance performance. Inspected by similar as key soccer status demand to perform at the elite level. Recommended trendy this study via individuation of players load, which should be measured in appropriation with VO_2max related to % BF level. Considered in similar as a factor that contributes to enhancing the individually based training programs. Admit by soccer scientists studies at 60 ml/kg/min of VO_2max recommended as the smallest fitness requirement among European male soccer players to play in the elite level.

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DOI 10.2478/afepuc-2018-0011

BIOMECHANICAL ANALYSIS IN EQUESTRIAN VAULTING

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Summary: The authors focused on biomechanical analysis of the exercising shapes of the compulsory exercises in the equestrian vaulting. It is a sport sector in which similar observations have not been carried out. The use of 3D analysis brought the opportunity to observe the exercising shapes on a simulator and in real conditions on a horse. By the selected 3D approach they focused on three crucial phases of the swing back. This approach helped detect possible mistakes which the coach could not register from one position. The experimental set consisted of highly accomplished riders. The results confirmed that the higher the accomplishment level of a sportsman the fewer are the differences between the performances of an exercising shape. From the above mentioned we could assume that by including exercises on a barrel simulator into training units, we could influence the technique of performance of the individual exercising shapes on a horse in movement.

Key words: equestrian vaulting sport, biomechanical analysis, exercising shapes of the compulsory exercises, swing back, horse movement.

Introduction

Equestrian vaulting is an independent horse riding discipline which allows the vaulters in harmony with horse to display their own individuality through the means of gymnastic and artistic exercising shapes while limited in time and space and adhering to the rules set by FEI (The International Federation for Equestrian Sports). The exercises are performed on a horse at the canter in a circle of 12 – 14 metre diameter. There is a longeur in the middle of it and he/she leads the horse. There are several categories in competition: individual men, women, teams and pas-de-deux. Every category excluding pas-de-deux consists of compulsory exercises and freestyle exercises. The freestyle exercise routine is created by the competitor or the team by putting together their own exercise shapes into one unit which is completed and choreographed into harmony with preselected music.

Equestrian vaulting is one of the few sports where the quality of the sport performance and the overall result is by a great degree influenced by a living creature, specifically by the behaviour of the horse itself (obedience, “by level of riding skills” - horse´s ability to perform dressage exercises at the smallest signal of the rider), its kinetic and somatic dispositions. Apart from the above the performance in equestrian vaulting is highly determined by the level of development of the speed-power abilities with great emphasis on coordinating abilities and the kinetic range of the trainee (flexibility). Each one of these abilities is tested by individual exercise shapes in the compulsory routine of which the technical criteria immediately show the inadequacies of the above mentioned abilities or inadequate technical sophistication of the sportsman.

Equestrian vaulting is one of the younger horse riding disciplines. The sport performances in this area registered a great shift forward. This progressive trend of performance brings forth the need of a deeper analysis and search for factors influencing the sport performance while at the same time determining the level of its influence. One of the areas which could help in this matter is kinematic structure of movement activity.

The development of performance in equestrian vaulting in the past was determined primarily by trainees who on the outset worked on one of the gymnastic disciplines. This was conditioned by the fact that the ability to manage most of exercising shapes of the compulsory routine in equestrian vaulting at high level was related to the level of fitness and coordinating abilities required by gymnastic disciplines. Gymnastic exercises contain a lot of similar, sometimes even identical characteristics compared to exercises in equestrian vaulting. The emphasis is in managing the movement of set exercising shapes, their number, difficulty and obviously the complexity which grows from the lowest performance level to the master level. This issue, also in consideration of the small number of sportsmen in this specialty, has not been dealt with proper attention and scientific research in horse riding sports has not been great overall. Just as in other sport specializations, scientific research is necessary in horse riding sports in order to understand more precisely and better the node points of the optimal technique when performing exercising shapes or when learning certain movement stereotypes. This type of analysis of technique of exercising shapes of compulsory routine was looked at closely by Vaváček & Sklenaříková (2011), Vaváček, Hardoň & Lednický (2012). Klouda (2010) observed the dependence of premature tilt of the upper part of body on quality of performance of the preparatory exercise of the swing back. During the practice the demanding exercises in equestrian vaulting require sequence, knowledge of node phases and their details. One of the ways how to make this process more effective is the analysis of the individual parts of the movement. In sport practice the biomechanical analysis is used primarily for this purpose (Moravec & Slamka 1999; Cihová 2005, 2006; Lednický & Vavák 2007).

The compulsory routine for senior teams and both categories of individuals are identical. The trainees perform 7 exercising shapes overall, out of which 3 are static (basic seat, flag, stand) and 4 dynamic (vault on, mill, scissors and swing off). Junior teams perform their simplified version. The compulsory routine in equestrian vaulting has two sections. Both begin by jumping on into astride position. The exercising shapes follow immediately one after another and despite the fact that they consist of several parts they need to be performed without interruption. Static exercises need to be held for four full strides.

Both sections of the compulsory routine begin with a mount. The mount leads to the astride position on a horse right behind the grips (Figure 1). Ideally, it consists of four phases:

1. jump-off phase,
2. take-off phase,
3. fly phase,
4. sit-down phase.

The vaulter runs parallel with longe towards the horse´s shoulder. On its way towards the horse he/she begins to canter in the rhythm of horse´s front legs. Prior to grabbing onto the grips his/her shoulders and side should be parallel with the horse´s shoulder. Swinging up the right leg the pelvis part of the body will get higher than the head. The left leg remains stretched down from the pelvis. At the highest point the right leg is stretched down into symmetrical position with the left one on both sides of the horse and lands softly, erect and precisely into the seat with the upper body vertical. The vaulter sits erect in the deepest point of the horse´s back, behind the vaulter´s belt, forehead facing frontwards with legs down in contact with the horse creating a strict vertical line through the shoulders, sides and heels. Both arms have to be held to the side and stretched. The ends of the fingers have to be at the eye level. Legs are down and from the frontal view the line of knees, ankles and fingers creates a straight line. After finishing the static part of the exercise the vaulter grabs the grips with both hands at the same time.

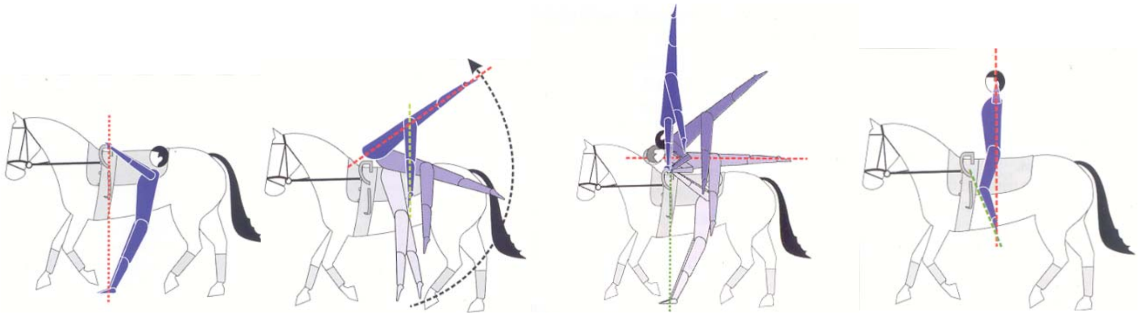


Figure 1
Illustrations of the mount into the seat (Peiler, D. & Peiler, Ch. 2006)

The aim

The aim of this work is to contribute to clarification of kinematic indicators of movement activity of selected exercising shape of the compulsory routine in equestrian vaulting on practice simulator and in real conditions of horse riding.

Hypothesis

Based on the analysis of literary sources and empirical knowledge we assume:

H1: By the means of research, we will be able to determine, or, as the case may be to confirm basic biomechanical characteristics of selected exercising shapes of the compulsory routine in equestrian vaulting

H2: The differences in kinematic indicators during the performance of selected exercising shapes in real, dynamic conditions on a horse at the canter and static conditions on a barrel simulator will be greater among sportsmen with lower performance level.

H3: We assume that the height of the swing forward of the leg during the performance of the exercising shape of the swing back will be greater in regards to the horizontal axis on a horse in movement compared to the barrel in static conditions.

Methodology of research

Video graphical systems allow two dimensional (2D) or spacial, three dimensional (3D) analysis according to the choice of the system operator and assume the use of one (for 2D), two (a minimal precondition for 3D analysis) or more video cameras. 3D analysis is an expansion of 2D analysis (Duchoslav 2005).

During the implementation of the research we used the controlled ex post facto research. In order to record a selected exercising shape (the mount, the swing back) we used optoelectric analyser of the Swedish company Qualisys. The system of its use was described in detail by Soumar (2009). For the purpose of observing the movement of measured object, so not only the sportsman (Soumar, 2009) it uses high frequency video cameras (Figure 2) with the use of passive or active markers. This technology could offer spacial coordinates almost in real time (delay 7 ms). The software tools which are part of the system, allow on the one hand simple calculations of basic kinematic quantities, on the other demanding complex calculations. The system uses the principle of rebound infrared light from reflective material applied to the surface of a marker attached to the moving object (Figure 3). By means of inner algorithms and infrared filter placed in front of the camera lens, the system will achieve that it registers only the reflections from the reflective material on the surface of the markers; therefore it is relatively simple to read the position of the middle of the marker on the recording medium. From the end points on the sportsman´s body we could calculate the centers of gravity and by connecting these end points of position vectors we could attain trajectories of movement of the centers of gravity of the segments. The trajectories contain complex spatial information. In regards to placement, number and setting of video cameras we took into consideration tests of precision of measurement of the analyser. During the experiment we used 10 video cameras Oqus-3 (1.3 Mpx) with a shooting frequency of 120 Hz. Each one of the cameras was connected to each other in a circle with cabling, connected with control unit in the form of PC and placed on stands in space according to the situational scheme (Figure 2).

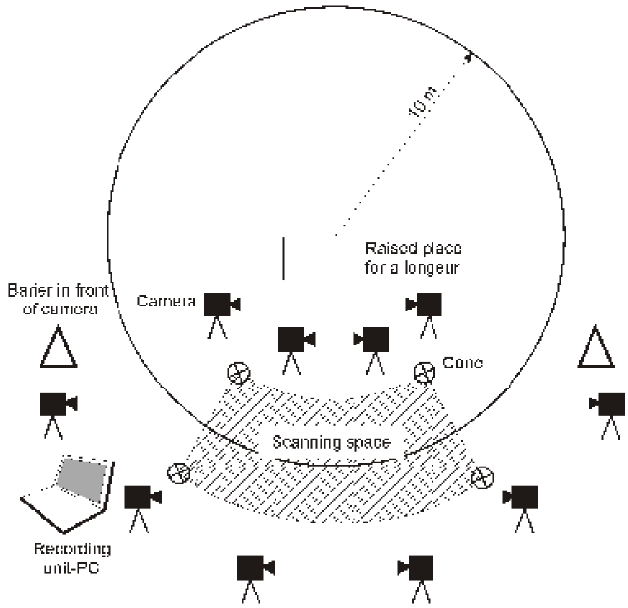


Figure 2

Situational scheme of video cameras placement, material and technical placement
barrier in front of video cameravideo cameraelevated spot for longeurconearea of shooting recording unit – PC

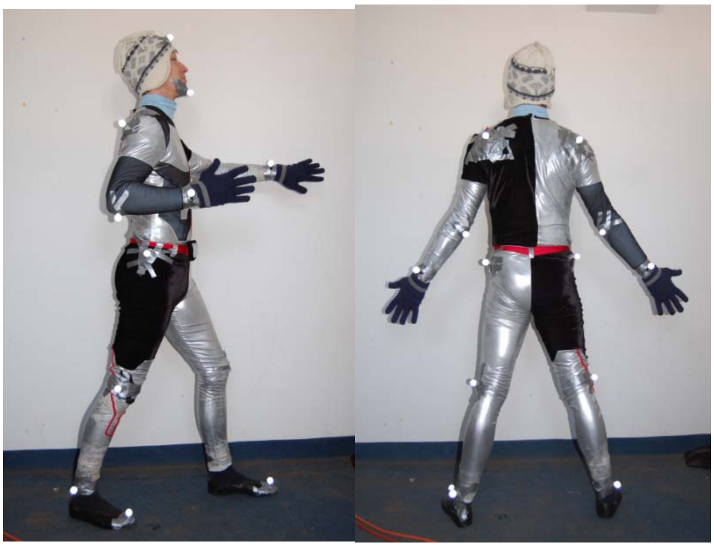


Figure 3
Recorded antropometrical points on sportsman

After placing the individual markers on the body of an experimentee the procedure of organization of the collection of data was as follows: First we placed a barrel simulator into the area of shooting, where the experimentee performed the observed exercising shape. After the removal of the simulator, followed recording of the exercise of the same experimentees on a horse During our measurement we used only one horse due to keeping the conditions standard for all the experimentees (type of canter jump, length of canter jump, height of the animal).

The above mentioned video camera setting allowed us to define the most important indicators of the observed exercising shape – the swing back. There were 21 indicators observed, out of which we evaluated two (U2 and U3) with the assumption that indicator U1 met the conditions mentioned in the chart. Chart 4 and Figure 4 state a more detailed description of the observed indicators.

Table 1
Identification of kinematic indicators of the exercising shape the swing back

Indicator	Decryption	. Unit
U1	Angle of leg against the vertical axis (the angle is created by the tip of leg - coxal-vertical axis) at the moment of the leg being back horizontally (which means the angle between the horizontal axis and straight line of coxal-tip of leg equals zero).	(°)
U2	Angle of leg against the vertical axis (the angle is created by tip of leg-cox-vertical axis) at the moment when the leg is in its highest swing forward.	(°)
U3	Angle of leg against the vertical axis (the angle is created by tip of leg-coxal-vertical axis) at the moment when the leg is the highest while in handstand (straight line cox-tip of leg).	(°)

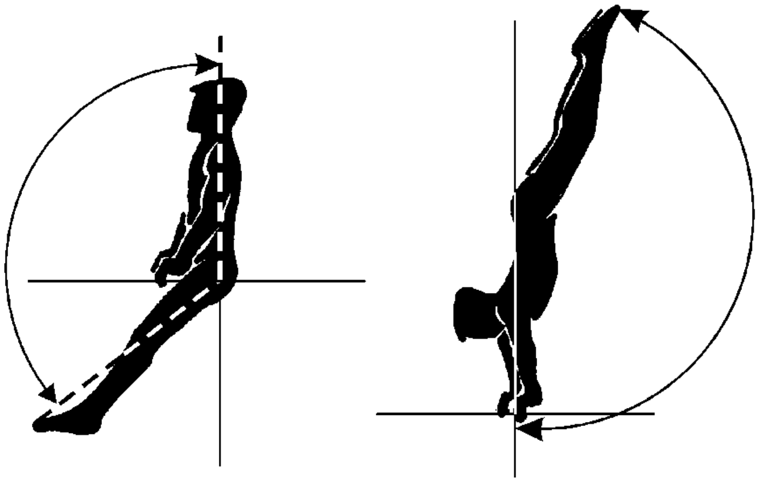


Figure 4
Indicator U2 and U3

Ensemble characteristics

The ensemble of experimentees consisted of 9 trainees from horse riding clubs JK Nitra Kynek, SOUP Šaľa, NZ Topolčianky, UVL Košice, Lucky Drasov, Tlumačov. The trainees (Table 2) were between 20 and 30 years old, actively involved in equestrian vaulting and representing their country at the most prestigious events in Europe and around the world.

Table 2
Basic characteristics of the observed ensemble

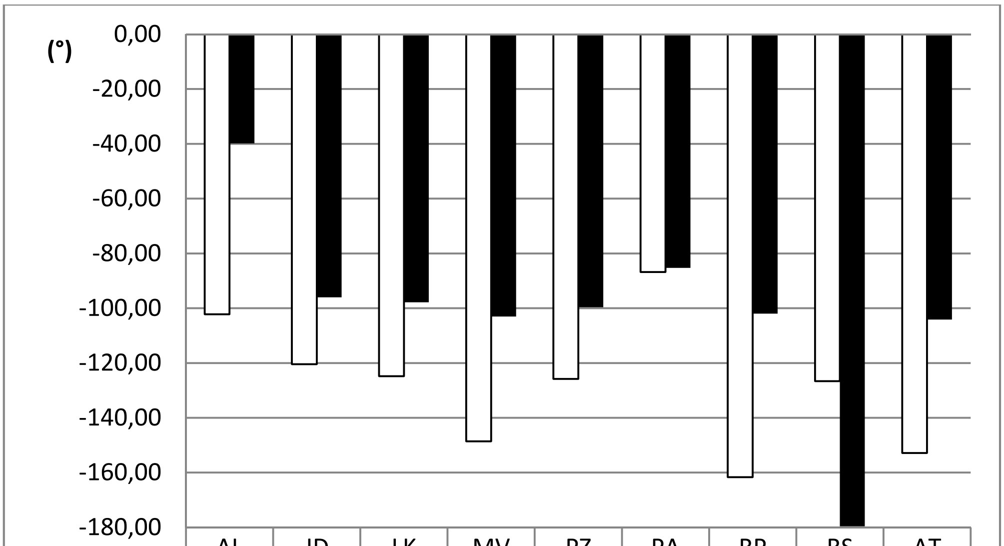
No.	Age	Sport age	Weight [kg]	Height [cm]	BMI (I)
1	16	9	54	163	20,32
2	27	17	85	175	27,75
3	26	17	76	178	23,98
4	31	17	75	180	23,14
5	28	17	66	185	19,28
6	30	20	60	168	21,25
7	22	12	70	183	20,90
8	26	14	66	178	20,83
9	23	9	78	178	24,61

Results

During the measurements the experimentees were not stressed by the succession of exercises or time limits as is the case in conditions of competitions. This was done in order to avoid possible inaccuracies. It is important to stress that during the testing of the unit of trainees which served to gain empirical material about exercising on the simulator and exercising on a horse in movement, we attempted to keep natural but primarily standardized conditions for all the experimentees.

Indicator 1 - angle of leg against the vertical axis (the angle is created by the tip of leg - coxal-vertical axis) at the moment of the leg being back horizontally (which means the angle between the horizontal axis and straight line of coxal-tip of leg equals zero). This indicator is not reproduced graphically, it was the premise for evaluation of selected indicators.

Figure 5 shows the comparison of the status of indicator U2 – angle of leg against the vertical line (the angle is created by points: tip of leg-cox-vertical axis) at the moment when the leg is in its highest swing forward during seat on a horse and on the simulator. In our case it is about the phase of foreswing, which is important in order to gain optimal speed.



	AL	JD	LK	MV	PZ	PA	RP	RS	AT
□ horse	-102,2	-120,4	-124,8	-148,5	-125,7	-86,78	-161,6	-126,6	-152,8
■ barel	-39,85	-96,04	-97,81	-103,0	-99,63	-85,27	-102,0	-179,6	-104,1

Figure 5
Comparison of status of U2 on a horse and on the simulator

Body movement of any kind with the aim of high final speed begins with movement carried in an opposite way (Hochmut 1981) as in our situation depicted in Figure 5. The observed angle diminishes against the vertical axis in direct proportion to the height when putting the leg forward. It is obvious from the Figure that most of the experimentees performed the swing forward higher on the simulator than on a horse. We could clearly explain this by the fact that in static conditions an exercise requires a longer path of “run-up” of leg in the form of swifter swing followed by the acquirement of higher kinetic energy in order to manage the final position for a handstand. We believe, however, that similarly big optimal angle and slightly higher optimal angle speed of the simulator in both observed conditions will allow reaching the required final position of the trainee´s body. From experience we know that the angle of swing forward lower than 90° hinders correct timing of folding of the upper part of the body. This claim is based on experimentee P.A. with which we observed minimal differences in situations on a horse and on barrel simulator. It is possible to say that this is a proof of well managed technique (timing) in both situations. The experimentee P.A. is the world champion of 2008 in Brno and the finalist of the World horse riding games in 2010 in Kentucky (USA). Apart from comparing of the highest point of swing forward of the experimentee P.A. with other experimentees, our findings are based also on facts described by Bibler & Drinker (2003) where they designate as mistake an overdone height of the swing forward (from our observations we consider such height to be more than 90°). The study of the authors also claims that in this part of the exercise the higher the leg gets, the more complicated is the already mentioned correct timing of folding of the upper part of the body over the grips. The authors also bring to attention that if this mistake appears during performance of this exercise on the simulator, the consequences of it will not be as extensive as in conditions on a horse in movement. The movement of the horse in this case acts against the movement of the body of trainee and makes it difficult to achieve a complete perpendicular position in handstand.

In Figure 5 we could observe the comparison of the status of U3 - angle of leg against the vertical axis (the angle is created by tip of leg-coxal-vertical axis) at the moment when the leg is the highest in a handstand (straight line cox-tip of the leg) on a horse and on the simulator. In case of most of the observed experimentees with exception of experimentees M.V., L.K. and R.S., who belong to power types of trainees and although they manage to achieve the closure of the movement of the leg in circle less technically but markedly with power which allows them to get to the required position, the handstand. We could observe that the leg reached closer to 180° on a horse than on the simulator. We could therefore say that the suspension movement of the horse at canter influences in supportive way the performance of this part of the observed exercising shape the swing back.

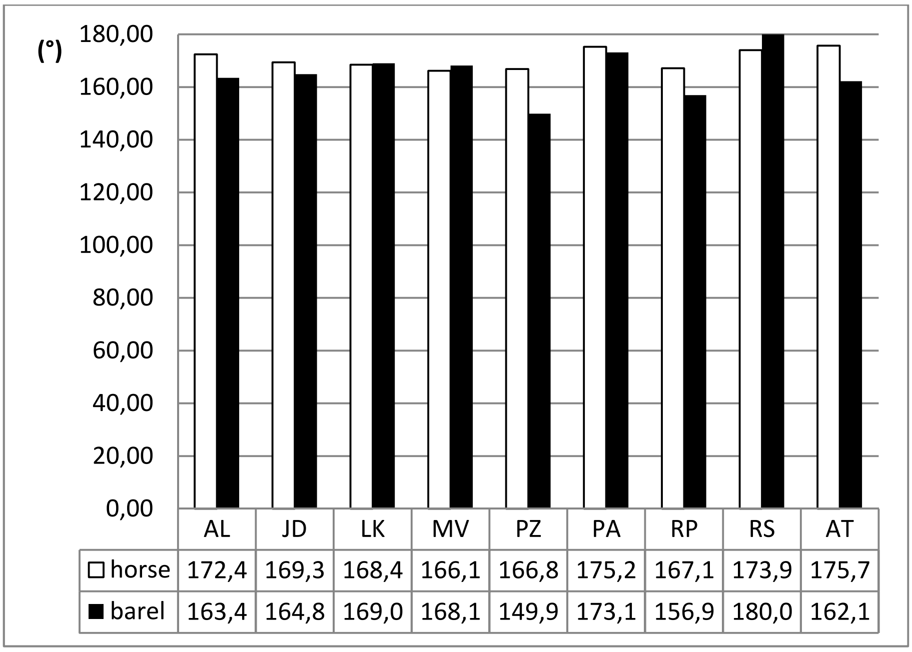


Figure 6
Comparison of state of U3 on a horse and simulator

The top trainees reach typically minimal differences in this part of the swing back on the simulator and on a horse. And they also reach the handstand position at 180° in the same way in both conditions. The rare appearance of perpendicular position in our case we could ascribe to cold weather despite the fact that we attempted to warm them up sufficiently with exercise and prepare them for encumbrance.

Conclusions

In sport disciplines in which difficult exercising shapes are done in succession in a short time period, the knowledge of biomechanical parameters of the movement structure is crucial in order to reach high performance level. There is a growing need for their analyses and for search of other possibilities to work it into the training process with the aim of improving the performance of the sportsmen. By the use of biomechanical 3D analysis, we could gain not only new and deeper information about the structure of individual exercising shapes in equestrian vaulting (regarding angles, speed etc.) but we could also observe the performed acrobatic shape in detail from various angles, something that is not possible in real conditions of the training process or in competition conditions.

Biomechanical approach to solutions for the mentioned issues is based on application of principles of mechanics while taking into account the biological basis of an organism and its individual possibilities. With the help of biomechanical analysis, it is possible to observe parameters which even an experienced coach or a referee could not notice and analyse in detail. While making a 3D recording it is possible to observe the given situation from several angles which allows us more flexible and more precise diagnosis of issues and naturally offers a possibility to visually compare for example the individual attempts within a training unit or a comparison of give performance of an exercising shape with a time gap thanks to the archiving of 3D recordings of the training units. The advantages of 3D analysis in comparison to the two dimensional analysis are primarily in the possibility to observe in complexity and analyse parts of the observed techniques, observe in detail the performance of the exercises from all angles. It is possible even in such complex sport disciplines as is undoubtedly equestrian vaulting in regards to data collection and difficulty of realization of the research situation caused by the necessity to cover a great area by video camera shot. These types of conditions require professional equipment in the means of material and technical accessories and high expertise at work with recording systems as was in our case the system Qualisys. The sophistication of the technology used in our research mad the work with data easier for us since after each shot it was not necessary to process the data in a time demanding way by joining the individual anthropometric points as is the case in 2D analysis. The important factor becomes a high precision where one can surely count on it in this case.

The important findings for practice are the answers to our hypotheses themselves:

Hypothesis H1 was confirmed and based on the research we acquired biomechanical characteristics of selected exercising shapes from the compulsory routine in equestrian vaulting.

Hypothesis H2 was confirmed and based on the research we could say that we recorded different values on the barrel simulator in static conditions and on a horse in movement.

Hypothesis H3 was also confirmed. By researching and observing the indicator U2 we found that all experimentees reached higher values on the barrel simulator than on a horse in movement. But based on more complex observation while taking into account other factors we could say that the experienced and technically well-equipped experimentees as for example experimentees P.A. and L.K. the differences between the measured values on the simulator and a horse in movement are often minimalized. It can also be assumed from this that by implementing exercises on the barrel simulator into training units we could influence the technique of realization of individual exercising shapes on a horse in movement.

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DOI 10.2478/afepuc-2018-0012

EFFECTS OF CONDITIONING PROGRAMME ON THE CHANGES OF MOTOR PERFORMANCE IN YOUTH CATEGORIES IN HANDBALL

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Summary: The ability to perform the stable playing performance during the whole match to larger extent depends on sufficient level of development of conditioning abilities. Technique of playing activities of an individual, decision-making process of players and especially speed of the game are influenced by already mentioned abilities. The aim of our study was to recognize the level of motor performance in regional centres of handball and at the same time to verify the efficiency of sports preparation. This programme includes the change of weekly microcycle practice, consisting of 2 conditioning trainings focused on strength and endurance. The research was realized in these age categories: younger (n=40) and older juniors (n=38). To evaluate the level of motor abilities we selected 5 simply performed activities: bench press (explosive strength of upper extremities), run for 8x5 metres (speed with change of direction), sit-ups for 2 minutes (power of abdominal muscles), standing long jump with legs together (explosive strength of lower extremities) and 12 minutes run (aerobic endurance). When following microcycle programme weekly, the results of motor test pointed out the positive influence of this programme on the development of strength and aerobic endurance ($p \leq 0.05$). In category of older juniors the performance in test of 12 minutes run has fallen significantly in comparison with the first testing ($p \leq 0.05$). The result of this study indicates the lack of recommended aerobic running practice in weekly microcycles of monitored teams.

Key words: handball, training level, strength abilities, endurance

Introduction

We can characterize handball as a power speed collective sports. Among determining conditioning abilities we rank strength, speed, speed and strength abilities and special endurance. The movements in handball are characterized by short accelerations (from 0 – 3 metres), by frequent change of movement direction, sprints (in range of 10 – 30 metres depending on player´s function (Michalsik et al. 2011; Povoas et al. 2012). 1 – 3 % from total playing time are ascribed just to sprints or quick direction changes.

Massuca et al. (2014), Hermassi et al. (2016), Wagner et al. (2014) point out to their physical exactingness as well. Except for technical and tactical skilfulnesses the antropometric characteristies and high level of strength abilities are important factors which influence the successfulness in top handball (Gorostiaga et al. 2005; Rannou et al. 2001). Loftin et al. (1996) affirms that the 90 % of released energy during 60-minute match must be powered by aerobic way the running performance of player is about 4 – 6 km at middle intensity at 80 – 90 % of maximum heart frequency. Sporiš et al (2010) indicate following indicators of maximum oxygen consumption of Croatian players of top level: goalkeeper (53.4 ± 1.2 $ml.kg^{-1}.min^{-1}$), wing (56.0 ± 3.1 $ml.kg^{-1}.min^{-1}$), back (53.7 ± 5.2 $ml.kg^{-1}.min^{-1}$) and pivot player (50.8 ± 0.5 $ml.kg^{-1}.min^{-1}$). Platen (2009) in his research from top event of men presents the spans of VO_2max from 49 – 58 $ml.kg^{-1}$ min^{-1} (wing 57.5 $ml.kg^{-1}.min^{-1}$, back 53.4 $ml.kg^{-1}.min^{-1}$, pivot player 49.4 $ml.kg^{-1}.min^{-1}$, goalkeeper 50.3 $ml.kg^{-1}.min^{-1}$). At comparison of more studies which measured VO_2max in running tests (Buchheit et al. 2009; Michalsik et al 2011b; Rannou et al. 2001) it was found-out that VO_2max in top handball players is fluctuated between 55 and 60 $ml.kg^{-1}.min^{-1}$).

According to Donnelly et al. (2009) aerobic and strength training do not serve only for an increase of level of training state they are important like prevention against injuries they enable to perform daily physical activities without problems. The strength training is performed for increasing the hypertrophy, development of maximum strength and performance which are necessary to implementation of playing activities like shooting, feint activity, screening, quick direction changes at physical confrontation with opponent (Michalsik et al. 2014; Michalsik & Aagaard 2015). The aerobic training serves for increase of level of aerobic performance which is important for maintenance of high intensity during the whole match 2 x 30 minutes. A low level of training state influences negatively the playing performance.

More authors dealt with problems of strength abilities in handball. Gorostiaga et al. (2005) examined strength abilities of Spanish top and amateur players and he found-out that elite players have in bench-press by 22 % higher one-time maximum (1RMBP), higher average performance of upper extremities by 20 % and of low extremities by 16 % higher than the amateur ones. Also this research confirmed that the players at the top level must have the strength abilities at higher level than current players. The players utilize the power/strength at all offensive and defensive activities because the occurrence of contact with opponent in handball is very frequent. In several studies (Chelly et al. 2010; Debanne & Laffaye 2011; Granados et al. 2007; Marques et al. 2007) recorded the positive influence of strength for example on speed of ball flight. Gorostiaga et al. (2005) indicate that the higher values of maximum strength and muscle strength provide a clear advantage for maintaining of muscle contractions during the entire match. The strength training and weight training are important for improvement of performance in handball.

Methdology

The aim of our study is to know the level of motor performance in regional centres of handball. The research team was formed by players of Regional Centres of Handball: younger juniors (n = 40, average body height 186 ± 6.4 cm, sports practice 9 ± 3 years), older juniors (n = 38, average body height 170 ± 6.9 cm, sports practice 7 ± 2 years). Every subject was informed about the scope of the research prior to the testing procedure and gave a written consent to participate in the study.

Reference players are ranked into newly-emerged Regional Centres of Handball which started their efficacy on July, 2017 and they manage sports training in category of youth according to unified methodology with accent on conditioning preparation and individual technique. Based on this requirement of Slovak Union of Handball the weekly microcycle of teams has been regulated according to possibilities of training with engagement of two conditioning strength training in weight training room (60´) and of two running trainings focused on development of aerobic endurance (30´). In weekly microcycle the load presented 840 minutes + 90 minutes was a match. From point of view of content the conditioning training creates 210 minutes, the individual technique 180 minutes and the team training forms 450 minutes. The total volume of strength training was 1 800 minutes during the period under consideration volume of running training was 900 minutes.

For verification of the efficacy of programme but also of activities of centres test battery has been created, which consists of 5 easily implementable tests of general motor performance: bench-press, run for 8 x 5 metres, standing long jump with legs together, sit-up for 2 minutes and 12-minute run. Within the year training cycle 3 stages of testing have been planned: October 2017, February 2018 and June 2018. In the contribution we analyze running results from the first and second testing. Before the first testing check tests have been implemented for verification of test reliability.

Individual teams recorded the content of sports training in computer programme Matchmeeting. Among other things the programme serves also for check of fulfilment of the fixed weekly microcycles. For evaluation of obtained data we used basic mathematical and statistical characteristics, parametric paired T test for dependent samplings and Wilcoxon´s T test. We selected the significance level α = 0.05 for all statistical testings.

Results and discussion

We indicate the gained results from particular tests of motor performance ability of both reference age categories of players in Table 1 and 2.

Table 1

Results of testing motor performance ability of older juniors

	Bench press (kg)	**Agility (s)**	**Sit-up (n)**	**Jump, legs tog. (cm)**	**12-min run (m)**
October 2017	71±13	10,28±0,52	69±14	235±15	2763±320
February 2018	76±14	9,7±0,48	74±13	240±19	2660±326
T test	**p=0.0001 p≤0.05**	p=0.22628 p≥0.05	**p=0.000152 p≤0.05**	**p=0.015484 p≤0.05**	**z=3.7459 p≤0.05**

Table 2

Results of testing performance ability of younger juniors

	Bench press (kg)	**Agility (s)**	**Sit-up (n)**	**Jump, legs tog. (cm)**	**12-min run (m)**
October 2017	65±15	10,39±0,70	70±12	224±19	2690±241
February2018	70±13	10,12±0,54	72±11	229±21	2744±257
T test	**p=0.001697 p≤0.05**	**p=0,044378 p≤0.05**	**p=0.01714 p≤0.05**	**p=0.040941 p≤0.05**	**p=0.033488 p≤0.05**

Average results of tests of motor performance ability of reference players in both age categories were behind requirements of play and claims to players of top level also after verification of training state in the middle of year cycle of sports preparation. In spite of low level of training state the reference teams belong to the best ones in their age category because the level of training state is very weak in area of conditioning preparation in young competitor´s categories. We can see from gained data that the players became better by application of strength programme in tests focused on evaluation of strength abilities ($p \leq 0.05$). We can watch improvement tendency also in test in run for 8 x 5 metres where it came also to improvement in average by 0.58 s. In aerobic endurance we recorded an improvement only in category of juniors which achieved 2 744 metres in average. At its conversion on VO_2 max (Eurofit 2002) it is 49 $ml.kg^{-1}.min^{-1}$. The improved performance in 12-minute run attacks the lower limit of maximum oxygen consumption in which the handball player should fluctuate at top level. In category of older juniors it came to significant worsening, however, what we cannot ascribe to inefficiency of proposed programme, to microcycle respectively, but to its nonobservance in this age category. The average performance in test was also behind performance of younger juniors. On the basis of check of content of training units the proposed aerobic trainings were absent in some teams what influenced also average values of test. At comparison of results of motor abilities with players of junior´s age (age average of 17.6 years) from 1985 (Slovík & Havlíček 1985) there is considerable difference especially in test of 12-minutes run 33 years ago the tested players made 2 993 metres in this time what is by 333 metres more than the performance in test of older juniors in the present day. The performance has been better only in the test of sit-up in the present day (1985 – 69, 2017 – 74). We can confirm also in factor of explosive strength of lower extremities in test of standing long jump that today´s players are behind (1985 – 248.3 cm) and now the average performance of reference players fluctuates between 230 and 240 cm.

This negative phenomenon is characteristic not only for clubs but also for national teams which at multimatch loading "die" gradually. Determination of player´s performance by motor abilities fluctuates within 35 – 68 % (Slovík & Havlíček 1985).

Conclusion

The results of this work confirm the low level of training state of players of junior´s age categories according to present day requirements but also when comparing them with the data achieved the past. For this reason it is necessary to continue in set trend and give conditioning training programme sufficient period of time in weekly microcycle of handball players. Concerning the possibility for clubs in Slovakia to include the strength and running practice in their training programme is: before the handball training or as a part of preparatory/final section of a training unit. To maintain and increase the training state we recommend: during competition period to include running practice in range of 2 times weekly by 30 minutes . It is necessary to implement the strength training in weight training centres in range of 2 times by 60 minutes weekly, During this training we recommend to practice exercises with complementary load, and basic weightlifting techniques as well. For the future we would recommend to complete the testing barrier by specialized tests, or to use diagnostics of aerobic endurance by Beep test which corresponds more with structure of handball player´s loading.

This work is a part of research task VEGA 1/0529/16: Effectiveness of sports preparation of club and national basketball teams depending on age and gender.

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