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INHALT

OBSAH

A COMPARISON OF THE TAKE-OFF AND THE TRANSITION PHASE OF THE SKI JUMPING BETWEEN THE GROUP OF THE SKI JUMPERS AND THE COMPETITORS IN NORDIC COMBINED

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Submitted in August, 1999

Take-off and transition phase were compared with the use of 2D videography by the competitors in ski-jumping and Nordic combined. The basic material was recorded at the events World Cup Liberec'99 and Championship of the Czech Republic. The quality of the motor abilities that are necessary for the performance was measured in the biomechanical laboratory tests. The take-off velocity as well as the vigour is greater together with the lower approach velocity in the ski jumpers. The competitors in Nordic combined realise the transition phase with greater rotation, the performance of the take-off is more variable. The value of the explosive force and the velocity in 15 m run is significantly greater in the ski-jumpers.

Keywords: 2D videography, ski jumping, Nordic combined, take-off, transition phase.

INTRODUCTION

Ski jumping, especially on the jumping hills with a big critical point, is one of the very attractive events. The development of the special movement skills and abilities is necessary for the possibility to reach the maximum performance. Because of the rate of risk, which is typical in the ski jumping, there exist very high demands on the psychic preparations of the sportsman. Therefore it is interesting to determine the influence of the basic parts in the structure of the performance on the final characteristic – the length of the jump. It seems, that the best performance in ski jumping should be reached by the sportsmen with the close specialisation on this sports event. Ski jumping is nevertheless also the equivalent part of the Nordic combined, where the results in jumping are completed with the cross country time. There exist the competitors in Nordic combined with very good efficiency in ski jumping, which can compete against the ski jumpers specialists. The main goal of this paper is to determine relationships between the efficiency of the competitors, external conditions of the contests, and the results in these contests.

PROBLEM

Ski jumping is usually divided into four basic phases – in-run, take-off, transition into flight, flight (Baumann & Galbierz, 1978; Hochmuth, 1959; Komi et al., 1974). Every phase is very important for the good result, but most of experimental studies have considered the take-off as the most crucial phase of the ski jumping. The way of the take-off performance is influenced by the changes in the equipment of the ski jumpers and by the differences in the technique. The most important change in the recent years is the one in the flight phase (V-style). Vaverka (1987) defined 5 factors, which take part in the take-off: vigour (the force perpendicular to the take-off table), rotation, accuracy, aerodynamics and arm activity. The value of these factors, with the exception of the accuracy, could be measured by the use of the 2D (3D) videography. For accuracy and vigour the dynamography could be used. But it is very difficult to apply this method on the jumping hill with snow surface. The way of the take-off execution in ski jumpers specialists has been analysed by several authors (Kaps et al., 1996; Vaverka, 1987; Vaverka et al., 1995; Virmavirta & Komi, 1989). There exist also common papers for the competitors in Nordic combined (Jošt & Pustovrh, 1995), but we didn't find any detailed analysis with the view to this movement activity. The take-off phase influences the transition to the flight (Janura, 1995). For the competitor it is necessary in this phase to take the best flight position by the optimum body rotation without the velocity loss. The last papers (Janura et al., 1998; Vaverka et al., 1997) show, that there could be found the individual model for the performance of the ski jumping, when the range of the measured parameters is very large even in the competitors with similar efficiency.

The rapid extension of the lower extremities is characteristic of the take-off. Explosive strength is the most important movement ability for the good take-off realisation. Not only the magnitude of the force,

but also the timing of the single phases is important. Novosad (1986) divided the velocity abilities into basic components: time of the reaction, velocity of the simple movement, maximal frequency and ability to start the movement in the short time. The good quality of the co-ordination is necessary. Character of the event lays high demands on the equilibrium of the competitor in the in-run phase. The velocity (often higher than 90 km.h^{-1}) in the transition between support and nonsupport phase, the different jumping hill conditions and the surroundings require a good space orientation.

In Nordic combined skiers this complex of abilities is complemented by strength component. During the cross country skiing part of the race muscle contractions are repeated in connection with high demands on aerobic metabolism. Together with skating technique the strength of the lower and particularly the upper extremities has increased. When arms are working oxygen consumption is very high and take-off strength is as much as five times higher in comparison to classic technique (Shephard & Astrand, 1992).

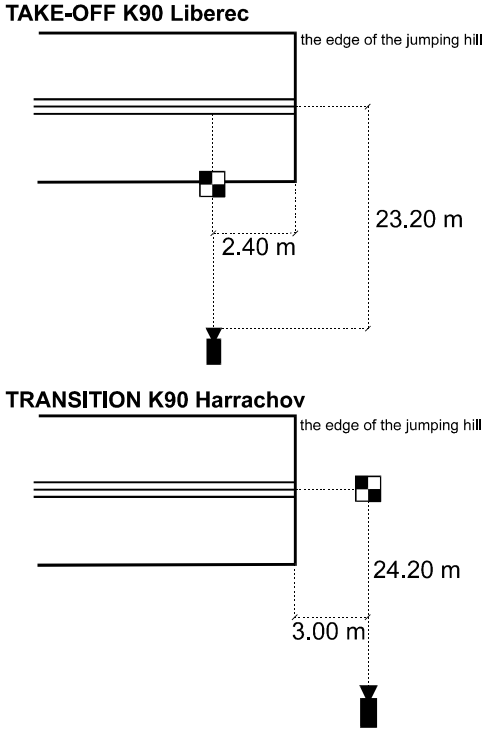
Owing to the differences in determinants of the sport performance in both parts of the contest Nordic skiers possess lower explosive strength. This can be influenced by both heredity and specificity of the training process. The contents and structure of training must be, in comparison to ski jumpers, different and among others based on the generally accepted fact that regular training and development of endurance evokes decreases in explosiveness and vice versa. At the same time exercises aimed at the improvement of the above mentioned motor abilities are not compatible (Zatsiorsky, 1995).

METHOD

The data was collected from the World Cup in Nordic combined Liberec'99 and from the control event of the Czech Republic national team in ski jumping (about a week later) for the possibility to compare the way of the take-off realisation. Both events were realised on the jumping hill K90 m. A 2D kinematic analyses was used to evaluate 10 best jumps in both events at the distance from 5 m prior to 1 m behind the edge of the jumping hill. The placement of the camera is shown in Fig. 1. By the evaluation of the digitised record we obtained basic angle and velocity parameters (Fig. 2). These parameters were obtained in different events. For this reason the take-off can be influenced by the external conditions (direction and speed of the wind, the quality of the snow etc.). In reality, it is very difficult to get the data for the best competitors in both sports events in the same conditions.

The transition phase was recorded at the Championship of the Czech Republic'98 on the jumping hill K90 m in Harrachov, where the best competitors of the Czech Republic in ski jumping and Nordic combined took part. The analysis was realised from the edge to 7 meters behind it. The analysed parameters are expressed in graphical form in Fig. 3. According to our record we chose 10 jumps of ski jumpers and 7 ones with comparable length in competitors in Nordic combined.

Fig. 1
The location of the camcorders during the recording of the take-off and transition phase



The sportsmen in both disciplines regularly take part in measurement of the movement abilities. These measurements are realised in the Laboratory of Human Movement Studies with the use of the biomechanical laboratory tests. For this paper we selected the data which were measured in both the Czech national teams in the period 1996-98. A computer statistical package Statgraphics (non-parametric pair test, cluster analysis) was used for analysis of the results.

Fig. 2
The evaluated parameters in take-off

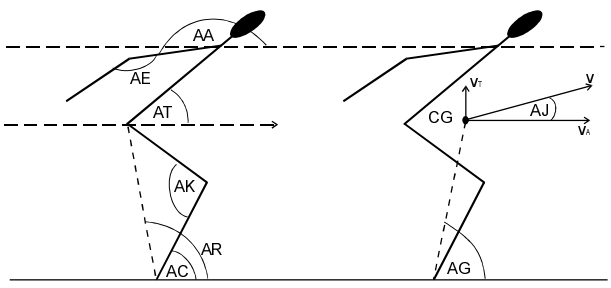
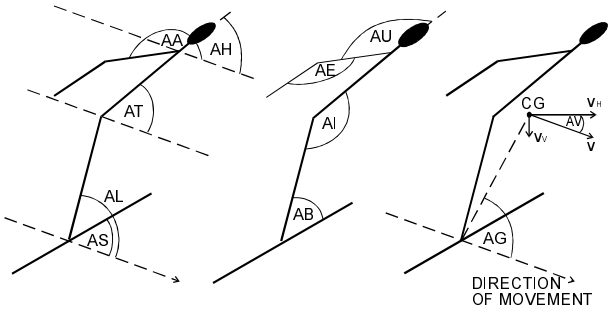


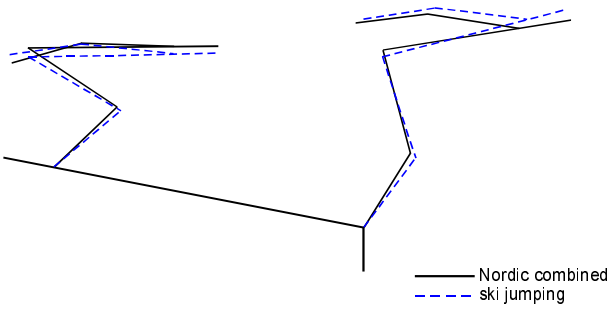
Fig. 3
The evaluated parameters in transition phase



RESULTS

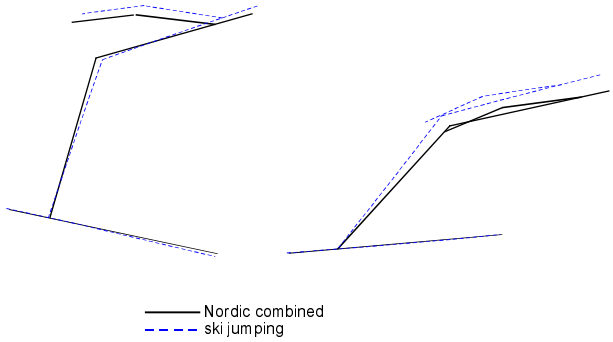
The basic statistical characteristics of the selected parameters at the distance 4 m prior the edge of the jumping hill and on the edge are given in TABLE 1. The length of the jump was significantly bigger for the competitors in Nordic combined (the value of direction and speed of the wind was favourable). There exist statistically significant differences between both groups in angle parameters for the lower extremities and the trunk position on the edge of the jumping hill. The centre of gravity of the ski jumpers is lower and more forward at the beginning of the take-off. In the course of the take-off the angle of the trunk (AT) increases more for this group meanwhile the magnitude of the rotation doesn't differ significantly (Fig. 4). The change of the centre of gravity location with regard to ankle (AR) is more advantageous. The large opening of the trunk is eliminated by the change in take-off velocity. While the approach velocity is significantly higher in the Nordic combined competitors, the take-off velocity is higher in the ski jumpers. Also the velocity in the perpendicular direction to the take-off table (vigour) is higher for this group.

Fig. 4
Graphical illustration of take-off performance at a distance of 4 m prior the edge of the jumping hill and on the edge



We didn't find any statistically significant differences between both groups in the parameters of the transition phase (TABLE 2). From the graphical comparison (Fig. 5) it ensues, that the competitors in Nordic combined have higher rotation at the range from 1 m to 6 m behind the jumping hill edge. The sufficient rotation is the sign of the good performance of the movement in this phase. It could appear, that the rotation in the ski jumpers is not sufficient. On account of the take-off realisation we can explain these tendencies. Ski jumpers can't realise rapid transition to the flight position for the reason of the higher vigour, the trunk position (AT) is also important. However the value of the rotation has to be sufficient, because rotation defends the loss of the velocity in the next parts of the jump. Very important is the find, that the height of the ski jumpers above the ground is bigger. Each group of the competitors solves this phase on account of the movement abilities. Results of the contests exhibit, that the competitors in Nordic combined (the lower magnitude of the vigour) can be successful in the competition together with the ski jumpers only exceptionally.

Fig. 5
Graphical illustration of transition phase performance at a distance 1 m and 6 m behind the edge of the jumping hill



We acquired interesting results by the use of the cluster analysis (Fig. 6). Out of the group of all monitored sportsmen only some differentiate in the phase of take-off. Their way is specific. Clusters in the analysis of the take-off are created, with only one exception, from the competitors of the same event. The number of the clusters with Nordic combined competitors is significantly higher. These differences are not so distinct in the transition phase. Some of the ski jumpers create a separate group.

The graphical comparison of the values (in per cent) of the selected movement abilities which were obtained from the laboratory tests in 1996–98 is in Fig. 7. All differences between the group of the ski jumpers and Nordic combined competitors are statistically significant. The largest difference exists for the height in vertical jump which is the value for the quality of the explosive strength evaluation. The increase in the static strength doesn't influence the velocity of the movement performance as we can see from the comparison of the results in 15 m run. The magnitude of the Rohrer's index (which describes the "density" of human body) has the basic meaning especially in the flight phase. Statistically significant difference in this parameter is one of the reasons, which in the connection with larger vigour serves for transition phase performance with lower rotation by the ski jumpers.

TABLE 1
Angle and velocity parameters of the take-off on the jumping hill edge and its change during the last 4 m of the take-off

Parameter	Ski jumping					Nordic combined					TC
	x	SD	min	max	R	x	SD	min	max	R	
LJ	108.40	5.30	101.00	118.00	17.00	123.90	4.20	118.00	132.50	14.50	3.71 **
AV	93.60	0.71	92.50	94.50	2.00	94.50	0.80	93.30	96.20	2.90	2.31 *
AC	64.30	3.40	57.40	67.90	10.50	68.90	4.10	64.90	76.80	11.90	2.15 *
AK	124.80	6.20	114.00	133.30	19.30	132.70	7.70	123.60	147.20	23.60	2.23 *
AT	25.70	4.90	17.20	32.90	15.70	20.30	3.80	14.10	26.00	11.90	2.38 *
AA	183.90	7.00	168.30	189.70	21.40	182.20	17.20	160.80	216.10	55.30	0.64
AE	164.10	7.90	149.30	173.50	24.20	164.20	14.00	139.30	181.90	42.60	0.26
AR	91.40	2.80	88.60	96.40	7.80	92.00	1.90	88.60	94.70	6.10	0.57
AG	74.70	2.00	72.00	78.90	6.90	75.60	2.10	72.10	78.80	6.70	1.02
AJ	5.41	0.32	4.90	5.80	0.90	5.00	0.85	3.60	6.20	2.60	1.17
V	26.57	0.23	26.36	27.11	0.75	26.46	0.21	26.06	26.80	0.74	0.79
v_T	2.51	0.16	2.23	2.68	0.45	2.30	0.39	1.64	2.85	1.21	1.51
DAC	13.20	3.30	8.00	18.30	10.30	14.20	5.20	4.10	20.10	16.00	0.72
DAK	54.80	5.60	46.20	64.60	18.40	55.80	8.30	42.80	64.40	21.60	0.49
DAT	13.20	4.50	4.30	19.10	14.80	8.50	4.00	3.70	17.10	13.40	2.23 *
DAA	–1.20	7.20	–11.80	9.50	21.30	–6.90	15.50	–28.20	19.70	47.90	0.94
DAE	–1.60	8.40	–19.70	9.50	29.20	–1.80	19.40	–40.50	27.70	68.20	0.19
DAR	–15.10	2.00	–17.70	–10.90	6.80	–12.40	3.10	–18.50	–8.10	10.40	2.08 *
DAG	–0.10	1.60	–2.40	2.50	4.90	0.40	2.60	–4.90	3.60	8.50	0.87
DAJ	3.30	0.60	2.10	4.30	2.20	3.50	0.70	2.30	4.30	2.00	0.68
Dv	–0.16	0.03	–0.22	–0.11	0.11	–0.21	0.05	–0.27	–0.12	0.15	–2.09 *

Legend:
x – average, SD – standard deviation
min – minimum, max – maximum, R – range
TC – tests criterion
d – difference during the last 4 m of the take-off

TABLE 2
Angle and velocity parameters of the transition phase 6 m behind the jumping hill edge and its change at a range from 1 m to 6 m behind the edge

Parameter	Ski jumping					Nordic combined					TC
	x	SD	min	max	R	x	SD	min	max	R	
LJ	89.00	1.20	87.00	90.50	3.50	85.50	1.60	84.00	88.00	4.00	3.09**
AV	85.50	0.20	85.20	85.80	0.60	85.40	0.20	85.20	85.70	0.50	0.59
AL6	61.70	2.70	58.30	66.20	7.90	59.80	6.10	49.50	68.90	19.40	1.12
AI6	142.60	5.40	133.30	153.00	19.70	145.00	7.60	132.40	152.90	20.50	0.83
AT6	24.30	3.90	19.40	31.30	11.90	25.20	5.60	17.50	31.70	14.20	0.44
AS6	14.90	5.30	2.30	19.50	17.20	16.10	8.80	6.30	31.20	24.90	0.24
AA6	198.30	6.10	184.30	206.50	22.20	200.50	7.40	189.80	210.20	20.40	0.54
AE6	164.10	7.60	148.30	173.50	25.20	165.10	4.90	156.10	172.30	16.20	0
AG6	50.20	2.00	47.70	53.20	5.50	50.10	4.80	40.30	55.60	15.30	0.44
AJ6	9.80	1.10	8.60	11.70	3.10	9.70	1.20	8.70	11.60	2.90	0.05
v6	24.27	0.15	24.10	24.50	0.40	24.13	0.11	24.00	24.30	0.30	1.66
DAL	17.70	4.80	8.90	29.60	15.70	22.70	5.90	16.20	30.50	14.30	1.51
DAI	–14.40	8.30	–25.00	–1.30	23.70	–22.90	8.40	–31.90	–9.90	22.00	1.61
DAT	3.20	4.90	–2.70	9.70	12.40	–0.60	4.50	–6.00	8.10	14.10	1.71
DAS	–19.50	4.90	–24.30	–6.90	17.40	–19.60	6.70	–31.50	–12.20	19.30	0.24
DAA	–18.90	10.10	–35.20	–2.10	33.10	–18.70	8.80	–29.90	–6.20	23.70	0.05
DAG	15.30	3.40	10.10	22.80	12.70	16.90	3.60	13.20	22.20	9.00	0.63
DATJ	4.70	4.50	–2.50	11.30	13.80	0.50	4.60	–6.00	8.10	14.10	1.81
s6	–0.23	0.04	–0.32	–0.18	0.14	–0.27	0.06	–0.38	–0.22	0.16	1.86

Legend:
d – difference at a range from 1 m to 6 m behind the edge
dATJ – the change of the trunk position with regard to the horiozontal plane
s6 – the height of the centre of gravity (6 m behind the jumping hill edge) above the edge

Fig. 6
Division of the competitors into groups with the use of cluster analysis

Parameters of the take-off at a distance of 4 m prior the edge of the jumping hill and their changes during the last 4 m of the take-off

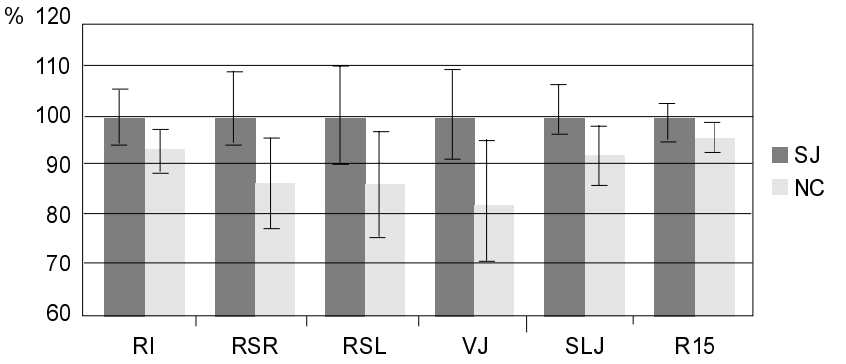
NC													
NC	NC												
NC													
NC	SJ												
NC	NC	NC	NC	NC	SJ	SJ	SJ	SJ	SJ	SJ	SJ	SJ	SJ

Selected parameters of the transition phase at a distance of 6 m behind the edge of the jumping hill and their changes at a range from 1 m to 6 m behind the edge

NC	NC	SJ				
SJ	SJ	SJ	SJ	SJ		
NC	NC	NC	SJ	SJ	SJ	SJ
NC	SJ					

Legend: SJ – ski jumping, NC – Nordic combined

Fig. 7
Graphical comparison of the laboratory test results (expressed in %) in the ski jumpers and Nordic combined competitors



Legend:
SJ - ski jumping, NC - Nordic combined
RI - Rohrer's index
RSR - magnitude of the isometric strength contraction on the right lower extremity
RSL - magnitude of the isometric strength contraction on the left lower extremity
VJ - height of the vertical jump
SLJ - distance in the standing long jump
R - time in the 15 m run

All differences are significant on 1% significance level.

CONCLUSIONS

1. The ski jumpers execute take-off with larger vigour. The take-off velocity of the centre of gravity is higher for this group mean even if the approach velocity is lower.
2. The competitors in Nordic combined take the flight position earlier. Differences in rotation are partially compensated by the influence of the Rohrer's index (significantly lower for the ski jumpers). The height above the ground is bigger for the ski jumpers.
3. The variability of the take-off and transition phase performance is larger for the Nordic combined competitors.
4. The values of the basic movement abilities are significantly better for the ski jumpers.

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VERGLEICH DER ABSPRUNGBEWEGUNG UND ÜBERGANGSPHASE DER SKISPRUNGSPEZIALISTEN UND WETTKÄMPFER DER NORDISCHEN KOMBINATIONEN

(Zusammenfassung des englischen Textes)

Der Skisprung gehört inzwischen zu den hochatraktiven Disziplinen, für die Bewältigung ist die Entfaltung spezieller Bewegungsgeschicke nötig ist, mit der Ausnahme ist der Sprung ein selbstständiger Sportzweig, aber der Skisprung bildet zusammen mit dem Skilanglauf zum gleichwertigen Bestandteil der Nordischen Kombinationen. Zwischen den Wettkämpfern in den Nordischen Kombinationen erscheinen die einzelnen Sprungspezialisten die fähig sind zu konkurenzieren. In vorgelegten Studien haben wir festzulegen versucht, die Qualität der Wettkämpfer zu beeinflussen, sowie wieviel die Wetterbedingungen die Ergebnisse beeinflussen.

Für die mögliche Vergleichsbildphase, Sprung- und Übergangsphase zum fliegen verwendeten wir die 2D kinemathographische Untersuchungsmethode. Der Vormerk der Bewegungen sind bei Wettkämpfen der Nordischen Kombination des Liberec 99 und auf den Kontrollwettkämpfen NM ČR im Sprung, welche auf der Springschanze K90 m in Harrachov stattfanden, aufgenommen worden, wo Springerspezialisten und Wettkämpfer der Nordischen Kombination teilgenommen haben. Die Aufnahmeanalyse des Weitgesprungendsten bekommet im Abschnitt 5m vor und 7m nach der Sprungschanzkante, Basislänge-, Winkel- und Geschwindigkeits-Charakteristik.

Das wir bestimmen können wie das Unterschieds-Niveau der Bewegungsfähigkeit des Sportlers ist, verfolgen wir folgende Disziplin: Vergleich der Werte der repräsentativen tschechischen Nationalmanschaft deren laborative biomechanischen Tests der Jahre 96-98 wir laufend bekommen haben.

Aus Aufnahmeanalysen der Bewegungstätigkeiten infolge Absprung, legen die Springerspezialisten Schwerpunkt sich mehr nach vorne zu beugen, nach dem Absprung kommt es bei ihnen zum weiteröffnen des Rumpfes, das durch Wechsel in der Geschwindigkeit des durchmachens des Sprunges eliminiert wird. Während die Anlaufgeschwindigkeit sehr höher liegt, haben automatisch die Sprünge höhere Schnelligkeit im Schwerpunkt bei der Sprungschanzenkante. Grösser ist auch ihre Schnelligkeit in Richtung der Ebene des Sprungpunktes in der ganzen Nordischen Kombination.

In der Übergangsphase haben wir grössere otationen bei den Wettkämpfern der Nordischen Kombinationen gefunden. Somit kommt es früher zur Flugstellungs-Position, die Absprungbewegung beim Springer solcher Durchführungssprünge nicht ermöglicht, jedoch muss die Niveaurotation genügend sein, das es nicht zu Geschwindigkeitsverlusten kommt. Wichtig ist die Feststellung ,das die Höhe des Springers über dem Teren in dieser Phase höher ist.

Beim Gebrauch der Gesamtanalyse haben wir festgestellt dass die Art der Durchführung der Absprung und Übergangsphase bei Wettkämpfern der Nordischen Kombination die grösste Variabilität hat.

Die Werte der Labortests sind bei allen Messungen der Bewegungsfähigkeiten bei den Springerspezialisten bedeutend besser geworden. Die grössten Unterschiede haben wir bei der Niveauexplosivkraft der unteren Glieder gemessen. Grundsätzliche Aufnahme der Flugphase hat auch Werte im Rohrer-Index (beim Springer bedeutend tiefer) welche die „Dichte“ des Körpers ausdrücken.

Aus gewonnenen Ergebnissen kommt es das die Wettkämpfer von beiden beobachteten Disziplinen Absprungbewegung und Übergangsphase nach ihren möglichkeiten durchführen, Sprung mit Rücksicht ihrer möglichkeiten der Niveaubewegungsfähigkeit und des Geschicks des Somatotyp usw. Ohne genügendes Niveau der Absprungkraft für vergleichbare Bedingungen, können Wettkämpfer der Nordischen Kombination der Skispringer nur teilweise konkurenzieren.

Schlüsselwörter: 2D videographische Untersuchungsmethode, der Skisprung, die Nordische Kombination, der Absprung, die Übergangsphase.

POROVNÁNÍ ODRAZOVÉ A PŘECHODOVÉ FÁZE SKOKU NA LYŽÍCH U SKOKANŮ SPECIALISTŮ A ZÁVODNÍKŮ V SEVERSKÉ KOMBINACI

(Souhrn anglického textu)

Skok na lyžích patří mezi vysoce atraktivní disciplíny, pro jejichž zvládnutí je nutný rozvoj speciálních pohybových dovedností. S výjimkou skoku jako samostatného sportovního odvětví, však skok na lyžích tvoří spolu s během na lyžích rovnocennou součást disciplíny severská kombinace. Mezi závodníky v severské kombinaci se objevují jedinci, kteří jsou schopni konkurovat i skokanům specialistům. V předložené studii jsme se pokusili určit, jak je tato skutečnost ovlivněna kvalitou závodníků a do jaké míry se na výsledcích podílejí podmínky, ve kterých závody probíhají.

Pro možnost porovnání odrazové fáze skoku a fáze přechodu do letu jsme použili 2D kinematografickou vyšetřovací metodu. Záznam pohybu (odraz) byl nasnímán na závodech v severské kombinaci SP Liberec '99 a na kontrolních závodech RD ČR ve skoku, které proběhly na můstku K90 v rozmezí deseti dnů. Pro fázi přechodu jsme použili materiály z MR ČR '98 na můstku K90 v Harrachově, kterého se zúčastnili skokani specialisté i závodníci v severské kombinaci. Analýzou záznamů nejdelších skoků jsme získali základní délkové, úhlové a rychlostní charakteristiky v úseku 5 m před až 7 m za hranou můstku.

Abychom mohli určit, jak se liší úroveň pohybových schopností sportovců v jednotlivých disciplínách, porovnali jsme hodnoty, získané u reprezentačních družstev ČR v laboratorních biomechanických testech v letech 1996–98.

Z analýzy záznamu pohybové činnosti vyplývá, že na začátku odrazu mají skokani specialisté těžiště posunuté více dopředu. Během odrazu u nich dochází k většímu otevření trupu, které je eliminováno změnami v rychlosti provedení odrazu. Zatímco nájezdová rychlost je významně vyšší u souboru severské kombinace, dosahují skokané větší rychlost těžiště na hraně můstku. Vyšší je také jejich rychlost ve směru kolmém k rovině odrazitě – razance odrazu.

V přechodové fázi jsme nalezli větší rotaci u závodníků severské kombinace. Tím dochází k dřívějšímu zaujetí letové polohy. Způsob odrazu u skokanů takové provedení skoku neumožňuje, ale úroveň rotace musí být dostatečná, aby nedocházelo ke ztrátám rychlosti. Důležité je zjištění, že výška skokanů nad terénem je v této fázi větší.

Při použití shlukové analýzy jsme zjistili, že způsob provedení odrazové a přechodové fáze se u závodníků v severské kombinaci vyznačuje větší variabilitou.

Hodnoty dosažené při laboratorních testech jsou u všech měřených pohybových schopností významně lepší u skokanů specialistů. Největší rozdíl jsme naměřili v úrovni výbušné síly dolních končetin. Zásadní význam pro letovou fázi má také hodnota Rohrerova indexu (u skokanů významně nižší), která vyjadřuje „hustotu" těla.

Ze získaných výsledků vyplývá, že závodníci každé ze sledovaných disciplín provádějí odrazovou a přechodovou fázi skoku s přihlédnutím k možnostem – fyzickým předpokladům. Bez dostatečné úrovně razance odrazu se, za srovnatelných podmínek, mohou závodníci severské kombinace v konkurenci skokanů specialistů prosadit pouze výjimečně.

Klíčová slova: 2D videografická vyšetřovací metoda, skok na lyžích, severská kombinace, odraz, přechodová fáze.

RESPONSE OF A PREGNANT UTERUS ON IMPACT LOADING

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Physical activities of pregnant women are appropriately modified. There is indispensable penetration into behavioural mechanical structure of this system. The solution of its strain with aim to avoid of or ease a results of interaction of pregnant organism with the environment. Mathematical modelling may replace or approximately approach the process of the real exertion of the power system of an individual, that, for many practical reasons, cannot be applied *in vivo* (extreme weight load and vibrations, car accidents, experiment expenditures, experiments on gravid women, etc.). One of the important dynamic characters of the system "pregnant uterus and topically relevant organs" is own frequency. There is very important for farther math – physical interpretations including the construction of the mathematical model. By using of the high speed cinematography and the math modelling has been founded exquisite parameters of the impact loading of the pregnant uterus.

Keywords: cinematography, impact loading, pregnant uterus, simulation.

INTRODUCTION

Gravidity is a natural physical state of women that normally lasts 40 weeks. For this reason all physical activities of women in this period are appropriately modified.

On one hand, the physical activities endangering the pregnancy are reduced during gestation. On the other hand, however, it is advisable to maintain or adapt such physical activities that may lead either to psychic health improvement and maintenance, or to convalescence after a possible trauma, or preparation for the childbirth.

The functional ability of the human power system is being changed continually during the lifetime. The ability of a quality movement generation and the efficiency are increased or reduced, and due to the fatigue or an injury the power system may be even mechanically destroyed.

Therefore it is necessary to get into a mechanical structure of this system's behaviour, and solve the system's exertion in order to avoid or reduce consequences of organism's interactions with the environment.

Mathematical modelling may replace or approximately approach the process of the real exertion of the power system of an individual, that, for many practical reasons, cannot be applied *in vivo* (extreme weight load and vibrations, car accidents, experiment expenditures, experiments on gravid women, etc.).

Trauma is one of the very frequent interactions of an individual with the environment. Czech authors dealing with trauma in the area of biomechanics are e.g. Jelen (1991), Karas (1996), Turková (1997) and others.

Injuries in general, and especially injuries of pregnant women are an important theme in a society – e.g. car injuries representing two thirds of all traumas during gestation are linked with a high mortality of the fetus, e.g. *abruptio placentae*.

Trauma as a cause of gravidity complications represents 6–7% of all complications in the USA, and even more in Europe. Farmer (1990), Hoff (1991), Murdoch (1991) and others. A special solution of pregnant women's trauma consequences due to car accidents is a worldwide problem of a great importance. Pearlman (1996), Schneider (1993), Turková (1997), and others.

Regarding the general problem of hydroviscous and elastic vibrations of the systems, solving the vibrations range during gravidity is necessary – in a common locomotion, work and sport activities, or trauma.

Model simulation and experimental studies dealing theoretically and practically with vibrations, rigidity and power effects of the interactions on the human power system focused on gravid women, are necessary for solving the presented problem. Using a sufficient data volume analysis and the latest computer engineering methods relating to such complex systems, a rational solution of the prevention pragmatic tasks can be expected as the result of the knowledge synthesis.

METHODS AND PROCEDURES OF DATA COLLECTION

The speed cinematographic recording method of the frequency of 103 turns/s. was used for the characteristics calculation of a strongly absorptive, aperiodic, overcritical vibration of the abdomen and topically relevant organs of a pregnant woman. A pregnant woman was standing quietly on tiptoe and then fell on her heels. The fall drop on tight lower extremities was 8 cm. The solution was supplied with a point trajectory. For further simplification the point was considered as a mass point, to which the weight of all movable abdomen parts is related. The actuating impuls with a short time duration (with a possibility to neglect the shape of the impuls curve) was 6.4 Ns as a teoretical maximum. The weight (m) of the vibrating abdomen (a gravid uterus with topically relevant organs) was 5.1 kg.

The model was considered as a mass point system located by means of a spring and a shock-absorber in all three directions of the system of coordinates. The dynamic characteristics solution was provided for the perpendicular direction, and consequently the absorptive characteristics were displayed. Except for the vibrating abdomen weight m = 5.1 kg, two absorptive characteristics were the only input data. The discrete points of the y-coordinate were approximated by a polynomial approximation. After appropriate values deduction from the adequately set up graphs, particular frequencies, rigidity and proportional absorption were calculated.

RESULTS

The experimentaly founded frequency and other selected characteristics of a behaviour of an examined object is as follows:

– impuls		2,72					Ns
– frequency	f_0	**1.07**	1.87	2.91	4.78	8.75	Hz
– period	T	**0.933**	0.535	0.344	0.209	0.114	s
– absorption	W_0	**6.73**	11.75	18.34	30.0	54.9	s^{-1}
– amplitude	a	9.22	5.30	3.84	2.95	2.07	mm

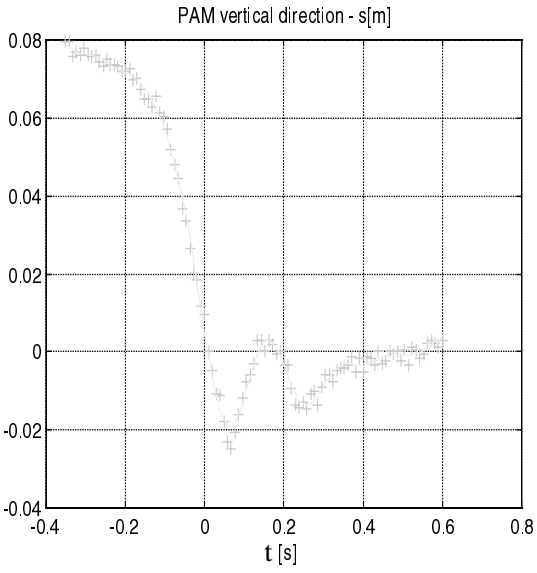
Math model results for critical absorption $\Omega_0 = \Omega_b$

– frequency	f	0.318	0.557	0.796	**1.07**	Hz
– period	T^0	3.14	1.79	1.26	**0.93**	s
– absorption	Ω_b	2.0	3.5	5.0	**6.7**	s^{-1}
– amplitude	y_{minn}	–86.0	–49.0	–34.0	–25. 0	mm
– amplitude	y_{max}	4.0	1.0	1.0	1.0	mm

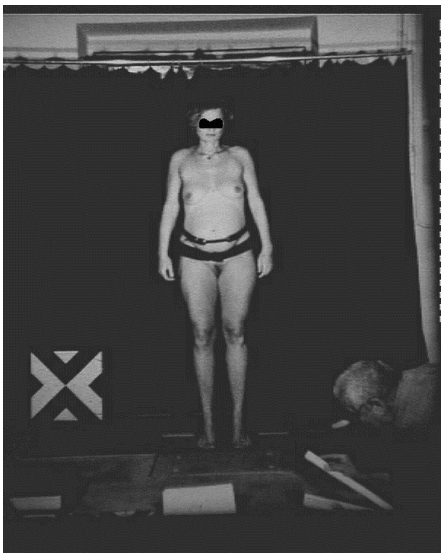
The **BOLD numbers** means the best results of experiment and math model parameters.

Fig. 1
Graphic interpretation of vertical direction analytically deducted from the high-frequency cinematographic recording of the response of a gravid uterus and topically relevant organs on impact loading.

Impact loading course



Experimental situation



DISCUSSION

These measurements and the model interpretation in our case imply that the real frequency of a pregnant uterus (32nd week) and topically relevant organs in the frontal plane of the vibration is cca 1–2 Hz. It implies a high sensitivity to the resonance just for this frequency. The resonance range can be considered one of the ranges of an increased risk for the foetus. This real frequency reflects other quantities – rigidity k and the uterus' weight with the foetus m. It shows that the suspension rigidity of the uterus and the weight m (real frequency) will be significantly changed with a higher gravidity degree. The resonance frequency may be expected to reflect the pregnancy pathology, foetopathy and multiple pregnancy.

CONCLUSION

With respect to the methodological difficulty of gaining the data and a pilot character of the project, the presented characteristics must be taken as limiting. At first the results will be verified by means of dynamic recording of the object, and then made more accurate. Followingly they will be used in mathematical modelling of the gravid uterus' impact loading ("insert pregnant") – Pearlman (1996). Further saturation of the model with a greater number of flexibility and rigidity parameters of the appropriate ligaments, muscles and uterus deducted from the technical examinations of the tissues is pressumed.

Through these steps, the required verification instruments of calculated and measured values of the impact loaded gravid woman will be developed. They will also contribute to a solving of the construction of e.g. passive security elements in the means of transportation, establishment of protective physical activity regimens, aids and systems in overloading of the human organism in essential stress situations in the gravid women's interaction with the environment – especially in the area of trauma due to car accidents of gravid women.

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BIOMECHANISCHE CHARAKTERISTIK DES VERHALTENS VON DER SCHWANGEREN GEBÄRMUTTER BEI DER IMPACTEN BELASTUNG

(Zusammenfassung des englischen Textes)

Bewegungsaktivitäten der Schwangeren werden in entsprechender Weise modifiziert. Darum ist es unentbehrlich, ständig in die mechanische Struktur des Verhaltens von diesem System und in die Lösung seiner Beanspruchung zu durchdringen, wobei das Ziel verfolgt wird, die Folgen der Interaktionen

zwischen dem schwangeren Organismus und der Umgebung zu vermeiden oder abzuschwächen. Das mathematische Modellieren kann den Charakter der reellen Beanspruchung des Bewegungssystems des Menschen ersetzen oder sich diesem aproximativ annähern, der aus vielen praktischen Gründen nicht in vivo anzuwenden ist (extreme Gewichts- und Vibrationsbelastungen, Autounfälle, Kostspieligkeit der Experimente, Experimente an Schwangeren u.ä.).

Eine der wichtigen dynamischen Charakteristiken des Systems „schwangere Gebärmutter und topisch zugehörige Organe“ ist eigene Frequenz dieses Systems, die für weitere mathematisch-physikalische Interpretationen einschließlich Konstruktion des mathematischen Modells von großer Wichtigkeit ist. Mit Hilfe von der Hochfrequenzkinematographie und dem mathematischen Modellieren wurden ausgewählte Parameter der impact belasteten schwangeren Gebärmutter festgelegt.

Schlüsselwörter: kinematographishe Metode, Impactbelastung, Schwangere Gebürmutter, Simulieren.

BIOMECHANICKÉ CHARAKTERISTIKY CHOVÁNÍ TĚHOTNÉ DĚLOHY PŘI IMPAKTNÍ ZÁTĚŽI

(Souhrn anglického textu)

Pohybová činnost gravidních žen je odpovídajícím způsobem modifikována. Proto je nezbytné stále pronikat do mechanické struktury chování tohoto systému a řešení jeho namáhání s cílem vyhnout se nebo zmírnit důsledky interakcí gravidního organismu s okolím. Matematické modelování může nahradit nebo se aproximativně přiblížit režimu reálného namáhání pohybového systému člověka, který z mnoha praktických důvodů není možné aplikovat in vivo (extrémní zátěže hmotnostní, vibrační, autonehody, nákladnost experimentů, experimenty na gravidních apod.).

Jednou z důležitých dynamických charakteristik systému „těhotná děloha a topicky příslušné orgány“ je vlastní frekvence tohoto systému, která je velmi důležitá pro další matematicko-fyzikální interpretace včetně konstrukce matematického modelu. Použitím vysokofrekvenční kinematografie a matematického modelování byly stanoveny vybrané parametry impaktně zatěžované gravidní dělohy.

Klíčová slova: kinematografická metoda, impaktní zátěž, pregnant uterus, simulace.

THE STRUCTURE OF SPACE ORIENTATION AND MOTOR ADJUSTMENT – COMPUTER SUPPLEMENTED DIAGNOSIS SYSTEM

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The main aim of this research programme was related to the diagnosis of the space orientation and motor adjustment. The first phase of the project included the construction of new diagnostic procedures based on computer technology in order to increase the reliability and validity. To determine the inner structure of the described coordinational abilities the factor analysis was applied what allowed reducing a multivariable phenomenon to a smaller number of hypothetical factors. The aim of the research were expressed as in a way of empirical identification of the abilities of the space orientation and motor adjustment in the area of the human coordinational abilities and to determine their inner structure. The research upon which final assumptions and conclusions were made was conducted on 51 female and 58 male students of Academy of Physical Education in Katowice. The student's age ranged from 20 to 24 years. The computer evaluation system of the visual aspect of the space orientation and motor adjustment included 8 groups of tests, which possessed from 6 to 8 options. All together space orientation was diagnosed by 20 different testing procedures, which were chosen from 28 available possibilities. These testing procedures allowed to register 98 variables of which 47 were chosen for further analysis based upon validity and reliability criteria. The results the factor analysis allowed excluding and logically interpreting the following properties hierarchically described upon the percent of common variance:
1. Space orientation: speed of orientation, precision of distance evaluation, precision of shape identification, precision of angular evaluation, complex orientation.
2. Motor adjustment: compensatory adjustment, adjustment in running and balancing, adjustment in translatory movements, simple motor adjustment, speed of motor adjustment, retrospective adjustment (only in males).

Keywords: space orientation, motor adjustment.

INTRODUCTION

Without doubt, the ability to properly evaluate the position of body in space and to adjust it to constantly changing conditions significantly influences everyday motor activities and thereby plays a key role in physical education and sport. Their significance, which constantly rises with the development and progress, is of great interest in theoretical and practical education and sport (Juras & Waśkiewicz, 1998). The current printed knowledge in this area is still rather scarce. The above mentioned coordinated abilities are related to very complicated neurophysiological processes that make the empirical research in this area very difficult and to determine precise diagnostic and training tools is very hard (Raczek et al., 1998). In this situation it seems justified to empirically confirm the existence of these particular coordinated abilities and to identify them. Because of the many forms of outer appearances of these abilities and their heterogeneous character it seems necessary to determine the inner structure. In order to practically conduct the above mentioned goals, it is necessary for the researcher to present new diagnostic procedures for these abilities. At the same time it is necessary to present the validity of different diagnostic procedures (motor field tests, psychomotor apparatus, computer technology). It seems that the introduction into laboratory testing of computer analysis guarantees the precise evaluation of particular aspects of visual orientation and motor adjustment (Juras et al., 1998). As research indicates, specific properties include the ability of time-space orientation and motor adjustment. They consist of human properties where utilitary and athletic significance are unquestionable yet they have not been empirically identified (Waśkiewicz, 1995; Juras, 1995). The above mentioned fact has been considered in establishing the research programme related to the diagnosis of the space orientation and motor adjustment (Waśkiewicz et al., 1998). The first phase of the project included the incorporation of new diagnostic procedures based on computer technology in order to increase reliability and validity. In this project it was assumed that specific motor abilities are identified in statistical analysis on the basis of similar biological background, i.e. type of muscular

contraction, time of contraction, form of movement through which they are expressed (Szopa, 1993; Mynarski, 1995). The effect of such a hypothesis was expressed in the choice of the statistical analysis of the collected empirical data. To determine the inner structure of the described coordinated abilities, factor analysis was applied that allowed the reduction of a multivariable phenomenon to a smaller number of hypothetical factors. At the same time it must be emphasized that during the development of the research concept as well as during the analysis of results a holistic approach to human motor behaviour was applied.

Based upon the current theoretical knowledge in the area of the coordinated abilities structure and diagnosis the following main goals have been established:

1. The empirical identification of abilities of space orientation and motor adjustment in the area of the human coordinated abilities.
2. To determine the inner structure of motor adjustment and space orientation in physical education students.
3. To verify the reliability and validity of diagnostic methods of the researched motor abilities.

PROCEDURES

The research upon which final assumptions and conclusions were made was conducted on 51 female and 58 male students of Academy of Physical Education in Katowice. The student's age ranged from 20 to 24 years. The main testing was conducted in 1994 and was preceded by many pilot researches, which was aimed at choosing the most reliable and valid diagnostic tools.

The visual aspect of space orientation and motor adjustment was evaluated by the use of computer technology and the concept created by the authors. On the basis of the experimental physiology and psychology, assumptions were made for particular testing procedures. The computer evaluation system for the visual aspect of the space orientation and motor adjustment included 8 groups of tests, which possessed from 6 to 8 options. All together space orientation was diagnosed by 20 different testing procedures, which were chosen from 28 available possibilities. These testing procedures allowed to register 98 variables of which 47 were chosen for further analysis based upon validity and reliability of criteria.

1. The computer evaluation of the visual of space orientation:
– length replication
– length division
– angular replication
– shape identification
– numerical sequencing
– sequencing of similar shapes
– alternative shape identification.
2. The computer evaluation of motor adjustment:
– disjunctive adjustment (point the target)
– simple compensatory adjustment (two triangles)
– simple adjustment (point the circle)
– complex compensatory adjustment (pursuit the circle).

In order to completely diagnose the area of coordinated abilities in students the following apparatus were applied which allowed evaluating the level of the following abilities:

– space orientation – stereometer
– simple and complex speed of reaction – reaction time device, Piórkowski apparatus, cross apparatus
– movement differentiation – mirror device, kinematometer, dynamometer, tremometer
– sense of balance – stabilometer.

The research project included also the diagnoses of selected coordinated abilities (space orientation, sense of balance, movement differentiation, motor adjustment, and movement combining) with the use of motor field tests. The field tests for this project were chosen from 60 possible alternatives based on many years of practical experience and scientific research performed in this area at the Academy of Physical Education in Katowice.

The whole collected data underwent basic statistical description (mean, standard deviation, kurtosis, skewness, Liliefors and Kolmogorov-Smirnov test of normality). The validity was established on the basis of factor analysis results by calculating the common factor (Weber, 1992). The main statistical method applied in this research project included the factor analysis based on Hotteling's main components method with Tucker modification supplemented by Kaiser's Varimax rotation (Czyż, 1971; Weber, 1992).

RESULTS

The applied methodology allowed in the first place to determine the inner structure of the visual aspect of space orientation and motor adjustment. The results of factor analysis allowed the exclusion and logical interpretation of the following properties hierarchically described upon the percent of common variance:

1. Space orientation:
– speed of orientation
– precision of distance evaluation
– precision of shape identification
– precision of angular evaluation
– complex orientation.
2. Motor adjustment:
– compensatory adjustment
– adjustment in running and balancing
– adjustment in translatory movements
– simple motor adjustment
– speed of motor adjustment
– retrospective adjustment (only in males).

The analysis of above mentioned factors indicate that space orientation has a heterogeneous structure.

The research also supports the independence of speed and precision aspects of space orientation. The same seems true for motor adjustment. It has been suggested that some similarities have been observed in the inner structure with those presented by Farfiel (1969) where a three level of co-ordination was described. Assuming that particular levels of co-ordination of movements determine specific coordinational abilities, it must be indicated that in this phase of research all measurements performed by computer technology (fine motor movements) and field tests (gross motor) came into the same factors. This phenomenon has a significant influence on the interpretation of the obtained results. It seems that the effects of space orientation arising from computer testing procedures are primarily related to the motor control functions of the central nervous system (CNS). On the other hand, motor field tests evaluating space orientation may be to a certain degree influenced by energetic processes. In the description of space orientation two independent phenomenon must be observed: first of all the exclusion of speed and precision aspect of space orientation based on the CNS functions and second of all the aspect of common interdependencies of particular motor abilities.

The above presented structure of the diagnosed aspects of space orientation allows to categorically state that it is a multiple ability and manifests in a specific way depending upon the motor task. Significant also seems to be the fact, that test describing whole body movements in space and all parts of it came into different factors, what suggests, that they should be treated separately. In first case as space orientation and in second one as space aspect of kinesthetic differentiation. In the same way should be described the speed and precision of space orientation. The analysis of results seems to confirm the necessity of differentiation of gross and fine motor, as well in external and internal aspects. It confirms the Bernstein's (1947) conclusions about different levels of motor control of whole body and its parts.

The above statements have practical implications. They show a necessity for adequate methods in the development and diagnosis of the extracted aspects of diagnosed motor ability.

The above described stage of analysis was also important in order to determine the proper predispositions of space orientation. In case of all factors (aspects) they do not determine the described ability to a significant degree. Given that, diagnose perceptual and intelectual properties are only slightly included in some factors so it is hard to state univocal conclusions. It seems necessary, therefore, to continue the researches in area of neuro-psychological praedispositions of time-space orientation and motor adjustment. In most cases the theoretical model hypothesis were confirmed empirically in the area of motor adjustment. Beginning with basic, suggesting that it should be determined as separate property of human motor behaviour and finishing as confirmation of superiority of motor adjustment in opposite to other coordinational abilities. It seems that the use of computer methods helped to recognise the specificity of this ability, presuming the development of used methods in future.

Resuming the results of factor analysis in the field of motor adjustment, suggests the conclusion that in consideration about this ability should be used diagnosis of two specific aspects: speed and precision of adjustment. It confirms the Roth (1982) hypothesis which was based on Bernstein's ideas, created the hierarchical division of coordinated abilities concept. He distinguished the ability of "coordination in limited time" and "precise motor control".

A battery of factors extracted through factor analysis allows to state, that the motor adjustment ability is not a homogeneous one. This fact produces consequencies in future diagnostic steps because while the diversification of motor adjustment is known it should be always diagnosed in all its aspects, not only in the chosen ones. The most important reason of such a scientific approach is that only then it is possible to formulate the valid conclusions and describe the level of motor adjustment.

Few papers existing in world literature about motor adjustment could be in no way compared with the presented research (Zimmer, 1986; Kubaszczyk, 1993; Diaczuk, 1994). The methods used in other researches describe only locomotor adjustments, and pay little attention to structure and effectiveness of the process. The most important properties in these tests are agility and speed not motor adjustment. Whatsmore they were conducted on small population (often in top athletes) since without precise methods of diagnosis makes the result discussion impossible and not reliable. So, the existing data about motor adjustment does not allow comparison, stating the conclusion and pointing the directions for future researches.

CONCLUSIONS

The acquired data and statistical analysis allows to formulate the following conclusions:

1. The methods used in this project were valid, reliable thereby allowing to use them in further experiments and researches.
2. The abilities of motor adjustment and space orientation were identified as specific properties in the coordinated sphere of human motor possibilities.
3. Space orientation and motor adjustment seems to manifest in light of results in many aspects.
4. During diagnosis of motor adjustment and space orientation should also be diagnosed two aspects: precision and speed.

TABLE 1
The inner structure of visual aspect of space orientation

Variables	Men						Women						
Factors	**1**	**2**	**3**	**4**	**5**	**VC**	**1**	**2**	**3**	**4**	**5**	**6**	**VC**
Error in distance reproduction (vertical, visible pattern)	.84	.11	–.21	–.29	.16	.87	–.11	–.08	.79	.33	.13	.19	.80
Time of distance reproduction (vertical, visible pattern)	.10	.93	.07	.13	.18	.93	.87	.02	–.07	.00	.14	.26	.86
Absolute error in distance reproduction (vertical, visible pattern)	–.67	.14	–.34	–.20	.25	.68	–.20	–.10	.29	.19	.12	.38	.33
Error in distance reproduction (vertical, invisible pattern)	.73	–.09	.16	–.32	–.25	.73	.14	–.29	–.28	–.26	–.22	.32	.40
Time of distance reproduction (vertical, invisible pattern)	.14	.89	–.14	–.03	.27	.91	.80	.16	.02	–.28	.22	.35	.91
Absolute error in distance reproduction (vertical, invisible pattern)	–.61	.29	.12	–.03	–.31	.57	–.01	–.12	.58	.26	.15	.17	.47
Errors in reproduction of closed angles (pattern visible)	.06	–.31	.69	–.33	–.19	.72	–.06	.29	.26	.33	.16	.16	.32
Time of reproduction of closed angles (pattern visible)	.07	.16	.12	.47	–.21	.31	.65	–.23	.23	–.01	.02	–.08	.53
Errors in reproduction of closed angles (pattern invisible)	–.16	.17	.74	.11	.32	.72	.08	–.17	.22	.34	.28	.21	.32
Time of reproduction of closed angles (pattern invisible)	.14	.30	.22	.28	–.25	.30	.60	.04	–.20	–.06	.26	.31	.57
Number of errors in triangle pointing (visible pattern)	.50	–.08	–.03	.00	–.34	.37	–.14	.06	.23	.28	.26	–.42	.40
Precision in pointing the triangles (visible pattern)	.29	.14	–.32	.20	.26	.31	.34	–.06	.15	.58	.15	–.21	.55
Number of errors in triangle pointing (invisible pattern)	.49	–.04	.22	–.14	.14	.33	.31	.10	.04	–.29	.12	.47	.42
Precision in pointing the triangles (invisible pattern)	–.61	.16	–.03	.01	.00	.40	–.22	–.31	.01	.56	.20	–.43	.68
Choosing the numbers (precision)	.84	–.22	.07	–.04	–.18	.79	.25	.25	–.25	.73	.10	.18	.76
Succeeding pointing the same shapes (errors)	–.64	.32	.31	.23	.20	.72	–.11	–.37	.43	–.36	–.17	–.26	.56
Succeeding pointing the same shapes (precision)	.70	.22	.42	.21	.01	.76	.18	–.18	–.17	.32	–.27	.29	.35
Alternative pointing the shapes (errors)	.46	.04	.42	.24	–.26	.51	–.24	–.04	.51	.24	.22	.03	.43
Alternative pointing the shapes (precision)	.21	–.12	–.31	–.03	–.54	.45	.32	.27	–.47	.17	.03	–.04	.43
Pointing the targets (time)	.06	–.46	.23	.26	–.29	.42	–.39	.04	.04	.25	.27	–.25	.35
Pointing the targets (precision)	–.86	–.22	–.03	.06	.25	.85	.13	.08	–.12	–.71	–.06	.19	.58
Piórkowski apparatus	–.10	–.40	–.30	.46	–.32	.58	.26	–.25	–.12	.12	.55	–.19	.50
Crossing apparatus	.04	.47	.19	.51	.34	.63	–.32	.17	–.33	.22	–.57	.20	.65
Tremometer (time)	.28	–.54	.06	–.28	.22	.50	–.30	.12	.27	–.13	–.33	–.18	.34
Tremometer (errors)	–.17	–.18	.31	.06	.59	.51	.26	.67	–.28	–.30	.14	–.28	.78
The shape in the mirro	–.16	–.29	–.11	–.22	–.53	.46	–.17	–.59	–.05	.26	–.13	–.28	.54
Kinematometer (25 deg)	.02	.12	–.27	.19	.85	.85	.05	–.79	–.19	–.05	–.19	.25	.76
Stereometer	.90	–.13	.13	–.26	.10	.92	.16	.11	.19	–.86	–.27	.20	.93
Marching to the target	.92	.09	.05	–.04	.29	.95	–.16	.24	.83	.14	–.27	.02	.87
Run to coloured balls	.10	–.17	.28	–.85	.29	.92	.24	.23	–.27	–.01	.80	.20	.86
Catching the ball on the rope	.26	.13	.33	.29	.59	.63	–.22	.41	.32	.24	.10	.33	.49
Close and far movements (30 deg)	.33	–.06	–.90	–.20	.02	.96	–.05	–.78	.18	.23	–.29	.08	.78
Raven test	.55	.10	.13	.11	.18	.37	.03	.10	.15	.38	.11	.17	.22
Test of squares	.67	.04	.20	.02	.03	.49	.07	.17	.20	.41	.05	.55	.55
Percent of explained common variance	**23,0**	**19,9**	**12,6**	**10,5**	**6,9**	–	**18,7**	**15,3**	**11,5**	**11,0**	**10,5**	**6,9**	–

VC – validity coefficient

TABLE 2
The inner structure of motor adjustment

Variable	Men							Women					
Factors	**1**	**2**	**3**	**4**	**5**	**6**	**VC**	**1**	**2**	**3**	**4**	**5**	**VC**
Disjunctive adjustment	,21	,00	,02	,06	–,05	–,18	,09	,16	,07	–,05	,07	–,25	,10
Simple compensatory – regular movement (time)	–,14	–,08	–,09	,04	,82	,01	,71	–,18	,01	,85	–,05	–,08	,77
Simple compensatory – irregular movement (precision)	,93	,12	–,10	,08	,09	–,09	,92	,76	–,08	,09	,20	,15	,64
Simple tracking – constant speed, envelope (precision)	,30	,21	,03	,79	–,34	–,14	,89	,27	,03	–,34	,08	,87	,95
Simple tracking – constant speed, elipse (precision)	,20	–,10	–,02	,79	,04	,04	,68	,20	–,02	,04	,11	,87	,80
Simple tracking – constant speed, elipse (time)	,37	–,04	–,24	–,10	,82	,07	,88	,38	–,24	,82	,16	–,04	,91
Simple tracking – inconstant speed, envelope (precision)	,16	,15	–,06	,82	,07	,15	,75	–,07	,03	,07	–,06	,88	,78
Complex tracking, constant speed, envelope (precision)	,81	,10	–,13	,00	–,13	,19	,73	,83	–,04	–,16	–,15	,05	,74
Complex tracking, constant speed, the eight (precision)	–,15	,10	–,10	,20	–,81	,27	,81	–,15	,12	–,83	–,09	,05	,73
Complex tracking, inconstant speed, envelope (precision)	,82	,24	,20	,06	–,08	–,18	,82	,84	,06	–,08	,20	,24	,81
Complex tracking, inconstant speed, elipse (precision)	,81	,14	,26	,00	,09	,14	,77	,82	,00	,07	,28	,16	,78
Shape in the mirror	,05	–,05	,75	,17	,12	,60	,97	,02	,87	,02	–,14	–,02	,77
Difference between jump forward and backward	,00	–,01	,74	–,10	,26	,58	,96	–,01	,86	,16	,20	,03	,80
Difference between jump leftward and rightward	–,04	–,71	,20	–,29	–,02	,58	,96	–,29	–,02	,13	–,71	,09	,61
Difference between 15 m dash and 15 m slalom	–,01	–,71	,00	–,12	–,01	,60	,88	,00	–,02	,21	–,79	–,07	,68
Difference between 15 m dash and 3x5 m shuttle run	,05	,19	,78	–,10	–,01	,57	,98	,10	,80	,08	,01	,04	,66
Difference between 15 m dash and 15 m crawling	,16	–,01	,71	,13	–,13	,60	,93	,09	,72	–,03	,12	–,02	,54
Balancing on the ground and on the box (50cm)	,04	–,75	,01	,04	–,26	,51	,89	,86	,03	,28	,05	–,01	,81
Adjustment on stabilometer (integer of module)	–,02	–,76	,13	,17	–,06	,60	,98	–,13	–,83	–,18	,16	,01	,76
Adjustment on stabilometer (changes of direction)	–,08	–,63	,00	–,27	,17	,12	,52	,11	–,02	–,08	,82	,02	,70
Percent of explained common variance	**16,3**	**15,3**	**14,7**	**13,7**	**8,24**	**8,22**	–	**18,3**	**16,7**	**15,4**	**12,1**	**9,1**	–

VC – validity coefficient

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BINNENSTRUKTUR DER RÄUMLICHEN ORIENTIERUNG UND MOTORISCHEN ANPASSUNG IN LICHT EINES COMPUTERGEBUNDENEN DIAGNOSESYSTEM

(Zusammenfassung des englischen Textes)

Ziel des Forschungsprojekts war eine Computergebundene Diagnose der räumlichen Orientierung und motorischen Anpassung/Umstellung. In der ersten Phase wurde eine neue Diagnoseprozedur entwickelt (aufgrund der Computertechnologie) mit dieser die Untersuchungen Objektieviert werden konnten. Die grosse Anzahl der erfassten Merkmale wurden durch den Einsatz der Faktoranalyse auf geringe Faktoren reduziert. Ziel unserer Arbeit fanden Ausdruck in der empirischen Identifizierung der Orientierungs- und Anpassungsfähigkeit sowie Bestimmung ihrer Binnenstruktur.

In den Untersuchungen waren Sportstudenten (51 Frauen, 58 Männer) der AWF Katowice im Alter 20 bis 24 Jahre einbezogen. Die Beurteilung der o/g Dimensionen mit Hilfe des Computersystems erfolgte durch Anwendungen von 8 Testgruppen (6–8 Optionen). Insgesamt wurden 98 Parameter ermittelt.

Die Resultate der Faktoranalyse ermöglichten eine Anssonderung und logische Interprietirung folgender Aspekte:

1. Räumliche Orientierung – Orientierungsschnelligkeit, präzise Entfernungbeurteilung, präzise Gestaltidentifizierung, präzise Winkelbeurteilung, komplexe Orientierung.
2. Motorische Anpassung – Kompensatorische Anpassung, Anpassung im Lauf, Anpassung in translatorischen Bewegungen, Anpassungsschnelligkeit, retrospektive Anpassung (nur bei Frauen).

Schlüsselwörter: die räumliche Orientierung, die motorische Anpassung.

STRUKTURA PROSTOROVÉ ORIENTACE A MOTORICKÉHO PŘIZPŮSOBENÍ – DIAGNOSTICKÝ SYSTÉM DOPLNĚNÝ POČÍTAČEM

(Souhrn anglického textu)

Hlavním cílem tohoto výzkumného programu byla diagnóza prostorové orientace a motorického přizpůsobení. První fáze projektu zahrnovala vytvoření nových diagnostických postupů založených na počítačové technologii, aby se zvýšila jejich spolehlivost a účelnost. Ke stanovení vnitřní struktury popsaných koordinačních schopností byla použita analýza činitelů, což umožnilo redukci proměnlivých jevů na nižší počet předpokládaných činitelů. Cílem výzkumu bylo na základě zkušenosti určit schopnost prostorové orientace

a motorického přizpůsobení v oblasti lidských koordinačních schopností a stanovit jejich vnitřní strukturu.

Výzkum, na jehož základě byly vyvozeny konečné předpoklady a závěry, byl proveden na 51 studentkách a 58 studentech Akademie tělesné výchovy v Katowicích. Věk studentů a studentek se pohyboval v rozmezí 20 a 24 let.

Počítačový systém hodnocení viditelných aspektů prostorové orientace a motorického přizpůsobení obsahoval 8 skupin testů, jež zahrnovaly 6 až 8 možností. Celkem byla prostorová orientace určena 20 různými zkušebními postupy, které byly vybrány z 28 dostupných možností. Tyto zkušební postupy umožnily registrovat 98 proměnných, z nichž bylo na základě kritérií účelnosti a spolehlivosti 47 vybráno pro další analýzu.

Výsledky analýzy činitelů umožnily vyloučení a logické vysvětlení následujících vlastností (jsou seřazeny podle procenta přirozené odchylky):

1. Prostorová orientace: rychlost orientace, přesnost odhadu vzdálenosti, přesnost určení tvaru, přesnost odhadu úhlu, komplexní orientace.
2. Motorické přizpůsobení: kompenzační přizpůsobení, přizpůsobení při běhu a udržování rovnováhy, přizpůsobení za pohybu při přenášení, jednoduché motorické přizpůsobení, rychlost motorického přizpůsobení, retrospektivní přizpůsobení (jen u mužů).

Klíčová slova: prostorová orientace, motorické přizpůsobení.

SWIMMING VELOCITY DETERMINATION BY CRUCIAL POINTS OF SWIMMING TECHNIQUE

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Swimming performance is determined through several factors. In our work we concentrated on the technique of breast stroke. We used the method of tachography to measure the instantaneous velocity of a swimmer in one swimming cycle and to set velocity profiles. 18 elite swimmers, 11 male and 7 female, took part in the measurement. In the following analysis, we divided the curve into three parts and calculated 22 parameters, characterized by the curve and thus the swimmer's technique. The relationship between basic variable, mean velocity in a swimming cycle and other 21 characteristics of a swimming cycle were determined through a statistical method of paired correlation. On the basis of derived results it is possible to state that a significant relationship (at P 0.01) between the mean velocity in a swimming cycle and 11 of the characteristics has been found. With the remaining 10 characteristics, any significant relationship failed to surface. On the basis of this analysis it is possible to determine crucial points of the technique as a reflection of its quality and thus to concentrate on them in practice.

Key words: mean velocity of the swimmer in a cycle, velocity profile, correlation analysis, crucial points of technique.

INTRODUCTION

In its wider perspective, the swimming performance is determined by sources of energy, mental and neuromuscular functions. Experts have focused their attention towards exploring and positively influencing these factors in order to enhance performance.

Amongst the factors determining performance, we concentrated on the swimming technique. The technique, even though one of the neuromuscular functions, influences all functions mentioned above. Without strength and speed we cannot master an optimum technique, without a high capacity of aerobic and anaerobic sources we cannot use it for the whole length of the competition, without a psychological excellence in the demanding training process, prestart conditions, and the competition itself we cannot make full use of even in the case of outstanding physical capabilities. From these reasons, the main part of research in swimming is being shifted into the area of the analysis of technique. With the development of the computer technique an underwater camera in connection with 3D analysis is very often used and thus it is possible to trace the velocity of the movement of individual body segments and the angles between them in the working phases of the cycle (Blaser et al., 1992; Ungerechts, 1992). Frequent interest by authors is directed to the solution of the relationship between the frequency and the length of the stroke during the race (Wirtz, 1992), finding the relationship between the anthropometric parameters of swimmers and their performances (Zhu et al., 1997; Van Tilborg et al., 1984), timing which means the time structure and the synchronization of the arm pull and the leg kick in a swimming cycle (Hahn, 1992). A well known and often used method of swimming technique analysis is tachography which records the changes of the velocity of the swimmer during the whole distance and during a cycle. This method has been used e.g. by Zschorlich (1987), Klauck et al. (1991), Vilas-Boas (1996), Kliche (1996, 1997), Cappaert (1996), Toury (1992) and others. Our work deals with the analysis of a swimming cycle using the tachography method.

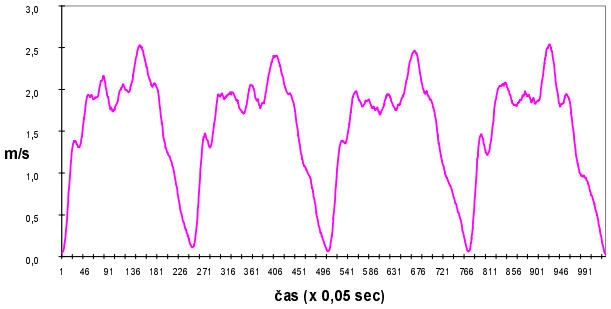
METHOD

Technical equipment

The basic equipment for data collecting is a device which was made according to the design of Prof. Motyčka, PhD and was named "tachograph". The swimmer has an inelastic tape round his hips by which he is connected with a reel from which during the movement the tape reels out and rotates the reel. The reel is braked by an electric motor so that an unwanted reeling off caused by inertia could not appear in the moments of abrupt accelerations of the swimmer, which would influence the results of the recording. The reel is connected with a tachodynamo through gears which on revolution changes reacts by changes in voltage.

This is transfered with a cabel through an AD converter into a portable computer where it is stored in the form of coordinates. The recording lasts 10 seconds with a frequency of 200 data in a second. During that time a swimmer performs 6 – 8 swimming cycles, the fourth cycle is analysed (Fig. 1). For technical reasons, the tape is not in horizontal position but in a 4 – 6 degrees angle to the water level. Taking into consideration that the fourth cycle is analysed, which is at a distance of 12 to 15m from the measuring device, the error in the result equals 0.4 – 0.5 percent and this error is present in all measurements in the same way.

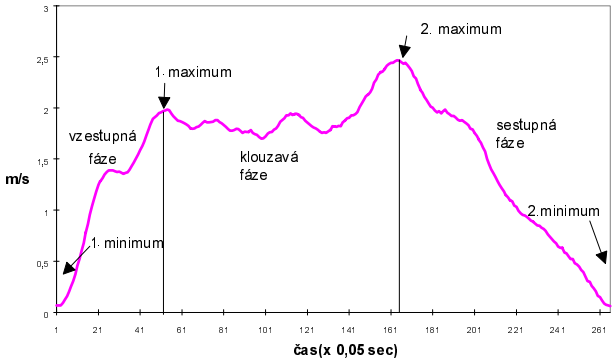
Fig. 1
The velocity profile of the swimmer, breast stroke, several cycles



Methods of elaboration

The recording of the signal was done using the program NV-UM 4, Nextview, further elaboration by using the Excel program. Considering the fact that the data recording device is very sensitive, we had to adjust the curve by means of a moving average from 12 data. This curve, after the adjustment, was devided into three phases – an ascending phase from the first minimum to the first maximum, a gliding phase between the first and second maximum, and a descending phase between the second maximum and the second minimum. Thanks to this division, it was possible to calculate 22 data from the curve which characterize this curve and thus the swimmer's technique, too. These data are as follows: total average velocity, the average velocity of all three phases, the total standard deviation and the standard deviation of the three phases, the total length of the cycle and of all three phases, the difference between the first minimum and the first maximum, the difference between the second maximum and the minimum, the acceleration or deceleration in the first and the third phase. From the relationship of the length of the gliding phase to the sum of the first and third phases, the index of the glideability of the cycle (Fig. 2) was ascertained. In further elaboration, a method of paired correlation analysis was used and statistically significant relationship between the average velocity in one cycle and individual characteristic features counted from this cycle was looked for.

Fig. 2
Velocity profile of a breaststroker, one cycle



The characteristics of the experiment group

The results of 18 swimmers, 11 male and 7 female of both junior and adult age were used in the analysis. All of them were swimmers with the highest performances, champions of CR and finalists whose main specialization was breast stroke event. We also used the recording of the World and European championships of 1997 (see Fig. 2). The measurements were made in the time of the best results in competitions or during the pre-competition practice so that any changes in technique caused by acute fatigue would be eliminated.

RESULTS AND DISCUSSION

Statistically significant relationship was found between the total average velocity and ten technique indicators. They were: average velocity in all three phases, total standard deviation and standard deviation of the first and third phases, the first and second maximum and the difference between corresponding maximums and minimums. Between 11 further characteristic features and the average velocity of a swimming cycle there was found no statistically significant relationship (TABLE 1).

During the critical analysis of the results of our work, we come to following conclusions. The total average velocity depends on the velocity in all three phases, which agrees with logical hypotheses. The standard deviation of the first and the third phases has a similar testifying power as the difference between the corresponding minimums and maximums and shows a statistically significant relationship. Surprising is the non-significant relationship (r 0.403) between the velocity and the standard deviation of the middle gliding phase. This suggests a possible performance variability in this phase of the cycle, which means both a fluent arm pull without a marked undulating movement (flat technique) and a performance with an undulating movement of the body (undulating technique, Fig. 3). A statistically significant relationship between the velocity and the values of both maximums (r 0.742 and 0.823) certifies the necessity of a strength

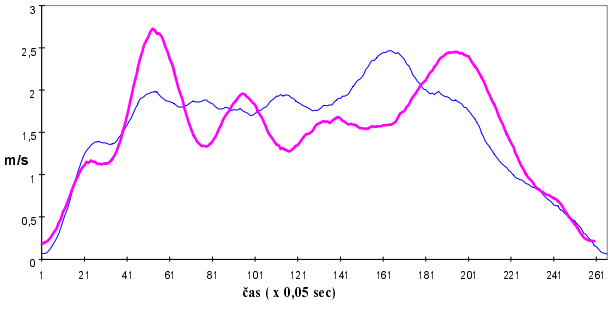
conception, i.e. reaching the highest possible maximum velocity after the leg kick and maintaining it during the arm pull. Having in consideration the values (r 0.385) of the relationship between the velocity and the acceleration in the first phase and the velocity and the length of the first phase (r 0.174), it is not necessary to reach a maximum velocity quickly. On the contrary, the relationship between the velocity and the deceleration in the third phase (r 0.544) indicates a necessity for a quick leg bending and a following quick leg kicking.

In contrast to our expectations, no statistically significant relationship has been found between the index of glideability and the average swimming velocity (r – 0.097), which enables a great variability of swimming technique performance in this phenomenon.

TABLE 1
Correlation coeficients of selected characteristics of a swimming cycle with the average swimming velocity in one swimming cycle
Critical value **r** at P 0.01 is **0.589**

phase 1 speed	**0,628**	total phase length	–0,117	minimum 2	0,024
phase 2 speed	**0,708**	phase 1 length	0,174	phase 1 difference	**0,666**
phase 3 speed	**0,807**	phase 2 length	–0,118	phase 2 difference	**0,670**
total .... devia.	**0,698**	phase 3 length	–0,168	phase 1 acceleration	0,385
phase 1 ... dev.	**0,654**	speed min. 1	0,116	phase 3 deceleration	0,545
phase 2 ....dev.	0,403	maximum 1	**0,742**	glideability index	–0,097
phase 3 ....dev.	**0,672**	maximum 2	**0,823**	bend-kick phase	–0,032

Fig. 3
Various swimming technique performance, flat, undulating, European elite
——— flat technique
——— undulating technique



SUMMARY

On the basis of the results of the analysis it is possible to express the following summary. In a swimming technique there are crucial points whose parameters determine the average velocity in one swimming cycle and thus are decisive for the total swimmer's performance. All significant correlation coefficients were related to both maximums of swimming velocity. This relates mainly to reaching maximum velocity after the leg kick. In the following phase it is necessary to maintain this maximum velocity, or if possible to increase it with the arm pull. These two indicators are evident as fully decisive for the average velocity of a breaststroke swimmer.

The analysis also showed the technique parameters that play no significant role in influencing the total swimming velocity but in coaching practice are often considered as very important and great stress is often given on improving them in practice. Here it should be stressed the fact that fluency, generally accepted as a decisive factor of swimmer's results, did not prove any influence at all on the total velocity (the correlation coefficient of both minimums to the average swimming velocity is 0.11 and 0.02).

In the middle (gliding) phase between both maximums, it is possible to exploit special dispositions of individual swimmers for various performances, i.e. either the undulating or the flat technique, but under one condition only which is maintaining of a high average velocity in that phase (see Table – standard deviation of the second phase and the average velocity of this phase).

CONCLUSION

The results demonstrated in this work are to be taken as an item for a discussion and are to be verified with a larger group of swimmers. A comparison with the results of other authors is difficult as works solving the same questions have not been found. Another big problem can be seen in the fact that it is not possible to compare similar data acquired by various authors because different techniques and devices are used for data measuring and velocity profiles setting, which can influence the results substantially (consulted with Prof. V. Zschorlich).

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DIE DETERMINATION DER SCHWIMMENGESCHWINDLICHKEIT DURCH DIE SCHWERPUNKTE DER SCHWIMMTECHNIK

(Zusammenfassung des englischen Textes)

Die Schwimmleistung wird durch mehrere Faktoren determiniert. In unserer Arbeit haben wir uns auf den Schwimmstil Brust konzentriert. Mit der Tachographiemethode wurden die Momentangeschwindigkeiten des Schwimmers in einem Schwimmzyklus mit der Frequenz von 200 Angaben pro Sekunde gemessen und es wurden Geschwindigkeitsprofile erstellt. An der Messung haben 18 Hochleistungsschwimmer teilgenommen, 11 Männer und 7 Frauen. Bei der folgenden Analyse wurde die Kurve in drei Teile geteilt und es wurden 22 Parameter berechnet, die diese Kurve, und damit auch die Schwimmtechnik des Schwimmers charakterisieren. Mit der statistischen Methode der Paarkorrelation wurde ein Verhältnis zwischen der Grundvariable (durchschnittliche Geschwindigkeit in einem Schwimmzyklus) und den weiteren 21 Charakteristiken des Schwimmzykluses festgestellt. Aufgrund der Ergebnisse kann man konstatieren, daß eine eindeutige Korrelation (bei P 0,01) zwischen der durchschnittlichen Geschwindigkeit bei einem Schwimmstil und 11 Charakteristiken besteht. Bei den weiteren 10 Charakteristiken besteht keine eindeutige Korrelation. Aufgrund dieser Analyse kann man die Schwerpunkte der Technik als die Wiederspiegelung ihrer Qualität bestimmen und sich auf diese Schwerpunkte dann beim Training konzentrieren.

Die Schlüsselwörter: durchschnittliche Geschwindigkeit des Schwimmers in einem Zyklus, Geschwindigkeitsprofil, Zyklusphase, Korrelationsanalyse, Schwerpunkte der Technik.

DETERMINACE PLAVECKÉ RYCHLOSTI UZLOVÝMI BODY U PLAVECKÉ TECHNIKY

(Souhrn anglického textu)

Plavecký výkon je determinován více faktory. V naší práci jsme se zaměřili na techniku plaveckého způsobu prsa. Metodou tachografie byly změřeny okamžité rychlosti plavce v jednom plaveckém cyklu frekvencí 200 údajů za sekundu a z nich byly sestrojeny rychlostní profily. Měření se zúčastnilo 18 plavců nejvyšší výkonnosti, 11 mužů a 7 žen. Při následujícím rozboru byla křivka rozdělena na tři části a bylo z ní vypočítáno 22 parametrů, které tuto křivku, a tím i techniku jednotlivých plavců charakterizují. Statistickou metodou párové korelace byl zjišťován vzah mezi základní proměnnou, tj. průměrnou rychlostí v plaveckém cyklu a dalšími 21 charakteristikami tohoto cyklu. Na základě výsledků lze konstatovat, že byl nalezen významný vztah (při P 0,01) mezi průměrnou rychlostí v plaveckém cyklu a jeho 11 charakteristikami. U dalších 10 charakteristik významný vztah nalezen nebyl. Na základě tohoto rozboru lze určit klíčové body techniky, které determinují rychlost plavce v jednom plaveckém cyklu a tím významě podmiňují celkový výkon plavce – prsaře. Na druhé straně bylo zjištěno, že některé parametry techniky, na které byl kladen důraz z hlediska efektivity plavání nemají ve vrcholovém plavání významný vztah k plavecké rychlosti.

Klíčová slova: průměrná rychlost plavce v cyklu, rychlostní profil, fáze cyklu, korelační analýza, klíčové body techniky.

HEALTH AND RELATIONSHIP TO ONE'S BODY IN STUDENTS OF PHYSICAL EDUCATION AND SPORTS IN PRAGUE, COLOGNE AND MOSCOW

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Submitted in April, 1999

This article presents some of the results generated by the international study on Sports, Health and Body Concepts in Central and Eastern Europe in 1996-97. Results of this study show that Czech students have a tendency to see themselves in the less positive light than the students from Russia and Germany, in spite of their better health behaviour. The Czech students report less smoking, lower alcohol consumption, regularity in daily routines and better diet than their Russian and German counterparts. Russian students have a tendency to pay more attention to their physical appearance and to the external aspects of their lifestyle in general. Students from Germany evaluate their health more positively than the other two groups. This may be related to the high level of German health system.

Keywords: sport, health, body concepts, physical appearance, lifestyle.

INTRODUCTION

The objective reality of one's body is not much influenced by individual behaviour. The subjective perception, of health and physical abilities and of one's body and its appearance, play a very important role in this objective reality. Various body images are created on the basis of own experiences with one's body and on the basis of social norms and social evaluation (Ideals of beauty and health). For these reason it was decided in this study to analyse lifestyles with a larger outlook considering movement activities, health, nutrition and satisfaction with physical self.

Health is understood, according to the WHO definition, as a state of physical, mental and social wellbeing and not merely as absence of disease. On one hand, we can see health as an objective or subjective measure and on the other hand as a physical and mental entity. The subjective aspect of health is based on inner feelings and one's own sense of personal Health State. The sense of being healthy includes the absence of morbidity, such as fever, nausea, fatigue… and at the same time it has the positive aspects such as feeling of a good performance potential, strength, mental balance and enjoyment in life. Among other positive health factors belong physical appearance, self- realisation, and in adulthood a good family and sexual life.

The subjective perception of health does not use the same measures for all people. These measures are dependent on personal traits, psychological sensitivity and temperament. Neurotics and phlegmatic react differently. Sometimes, the objective health does not correspond to the subjective health. One can feel well even though there is the presence of overt or hidden morbidity.

Physical self- concept, which we understand as emotionally affective evaluation of one's body, plays an important role in the life of modern man. The physical appearance, as a part of body image is important in the total self- image. Body is very important in terms of personal satisfaction (sense of height, body shape, body composition... and their evaluation). Images about one's body are important components of personal subjective model of reality, which causes a constant affective, cognitive and con-active appraisal. Body images, evaluations and plans for action are important aspects of this reality. The effort to improve physical appearance can become directly or indirectly an effective motivator for the development of a healthy lifestyle. It can influence daily movement activity and contribute to proper dietary habits.

The objective aspects of health are defined by views of others on one's health. Medical opinion predominates in this evaluation, even though it is not at times exact and independent measure. Physicians tend to evaluate one's health on the basis of comparison with other cases and not on the basis of the individual. The medical health evaluation is influenced by the health of the total population… The symptoms are statistically evaluated and later, the population health norms are developed. It is important to realise that such a norm may not represent ideal health measure

for all individuals. Deviation from the norm is not always a sign of morbidity.

The following factors are major contributors to personal health:

– lifestyle
– environment
– heredity
– available health and medical services

Lifestyle is the most important health factor (Gladkij, 1995). The most negative aspects of lifestyle are:

– smoking
– high energy content and poorly balanced diet
– high psychological stress
– disturbed sexual behaviour
– alcohol and drug abuse

Mortality is one of the important health indicators in a society. Even though, mortality measure is somewhat simplistic and at times not an accurate indicator of health it is frequently used. One of the advantages of using mortality rates is that the mortality data can be used for comparison of different social samples. According to the data from the Institute of Health Information of the Czech Republic (1996), the average life span for Czech men is 69.3 and Czech women 76.5 years. In the neighbouring Germany, the same average for men is 72.8 and for women 79.3 years, almost three years higher than in the Czech Republic. In Russia the average life span is only 58.9 years for men and 71.9 year for women.

It would be interesting to find out why these differences exist. Certainly it relates to differences in lifestyles in different parts of Europe. Along with heredity, the important role in mortality is played by environment, health services, nutrition, exercise habits, psychological stress and abuse of drugs, alcohol and tobacco.

METHOD

The above- described aspects of health were investigated in 1996–97 at universities in Cologne, Moscow and Prague. This research project was funded by the „Club of Cologne“ and by a research grant from Charles University. In this study we reported only on health and own body perception data from students of physical education and sports at three universities. The researched factors were not observed and analysed as independent aspects of individual lifestyles but as the components of the basic body concept. This body concept may be understood as the sum of all cognitive, emotional representations about own body, physical ideals and planned behaviour. Physical satisfaction is a result of individual experiences linked to one's body. In many dimensions a social environment also determines it. There is a large amount of information on sports activities and their influence on one's health, but little is known in the area of intentional, planned behaviour, which contributes to one's health. The subjective mental representations about one's body are very important for a positive change in health behaviour (changes in physical activity, nutrition and health habits). Individual behaviour can change in the desired direction only if a person is able to change subjective representations of self. The observed sample is very homogeneous in terms of age, education, socialisation, recent interests and professional plans for future, consequently, it can be assumed that the observed differences are generated by cultural variables.

Research goals

The purpose of this study was to describe a current state of health, physical satisfaction and also identify similarities and differences among students at Physical Education and Sport at Universities in Cologne, Moscow, and Prague.

Sample

Three national groups of approximately 400 subjects with an equal gender representation were studied. The total sample had 1,205 subjects. Average age of subjects was 21.2 years in Prague, 23.9 years in Cologne and only 19.5 years in Moscow. The length of the pre-university education showed differences in age, which is shorter in Moscow. The youngin Cologne study longer (7 years in average). All subjects were university students enrolled in various streams at faculties of P. E. and Sports. The students completed the questionnaire during the regular class time under the supervision of this report's authors. It was collected for analysis immediately after the class.

Method

Mrazek, Fialová and Bychovskaja modified an open form questionnaire, which has been previously used in Germany. This modification was made for comparison purposes. The presented results are concerned mostly with the differences in health behaviour, and one's body perception. Subjective attitude to one's body is a reflection of goal oriented activities (movement and nutrition), of the social changes in society and in the individual's social environment.

Most questions in the questionnaire are closed questions using five point Lickert scale with the answer range from Never to Very often. Scores of some of the answers were added, which created more complex scales (e.g. attitude toward health, fitness control). Gender differences are not illustrated in the presented graphs, but they are verbally explained.

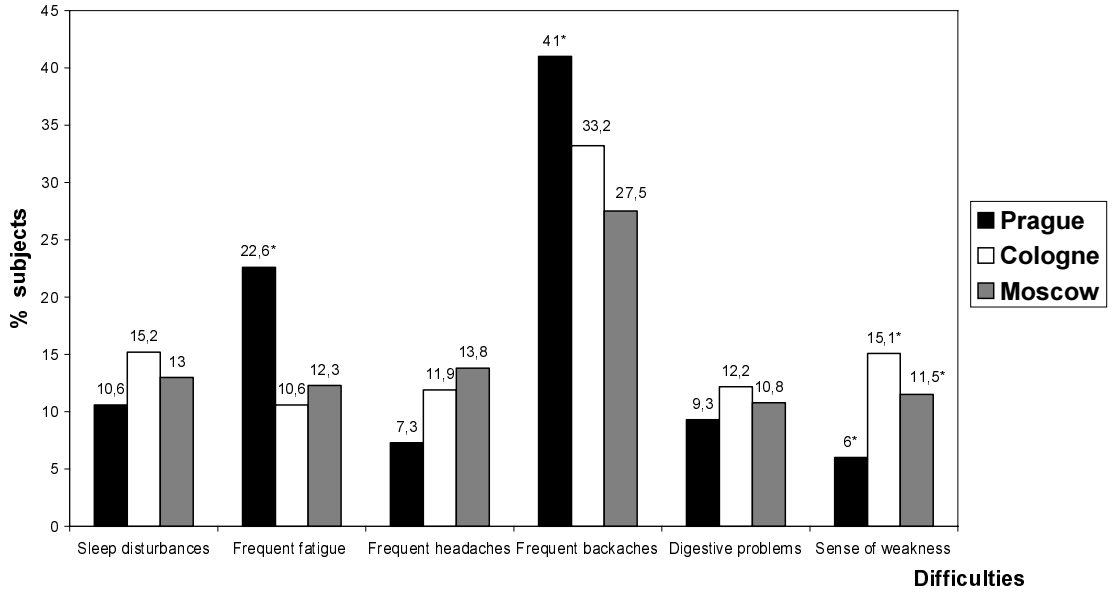
Statistical analysis used an ANOVA SPSS program. An asterisk marks statistical significance at 0.05 level. One asterisk indicates the difference of one group from the other two groups. Three asterisks indicate differences among all three groups.

RESULTS

I. Health

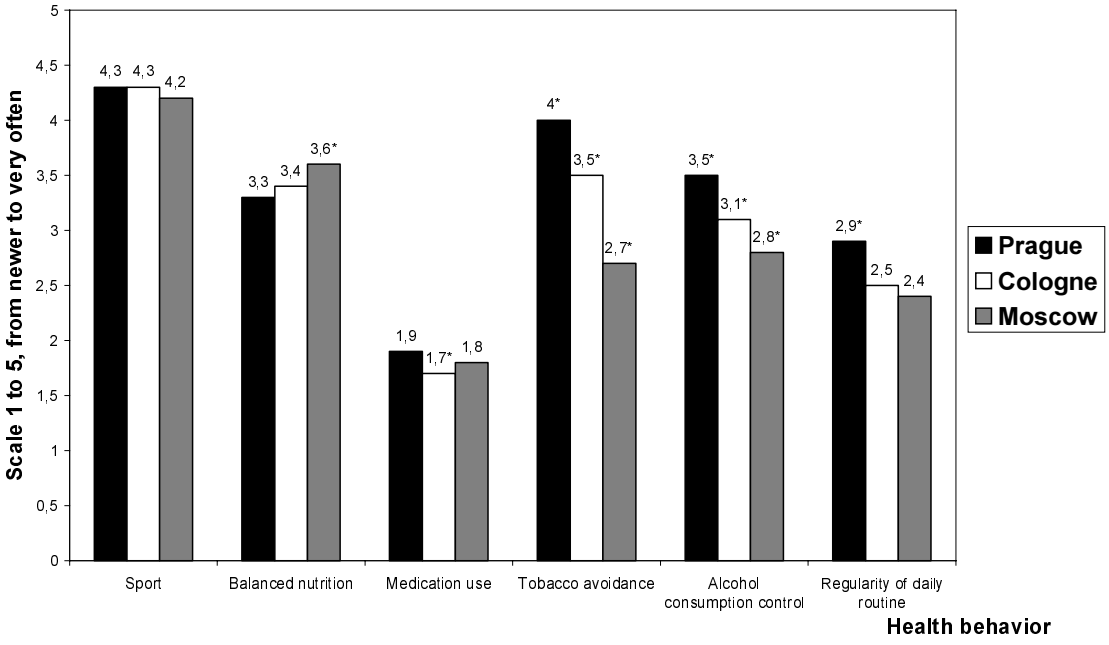
Only data on health problems and health behaviour are presented in the following figures.

Fig. 1
Health problems



The most frequently reported health problem is related to backache, which is reported by almost one third of all students. Students also report sleep difficulties, frequent headaches, and problems with digestion. The Czech student tend to have more backaches but the Russian and German students report frequently the rest of the above mentioned symptoms. Considering young age of the respondents, this finding represents a serious health problem. Unusually high number of students report fatigue and sensation of weakness. This may be generally related to the high activity level in the practical part of their studies and to the more specific environmental problems. For example: the Prague students do not have sports facilities on their campus and they have to commute to attend the activity classes and lectures at other places. The constant commuting is physically and psychologically very stressful. Women reported more frequent psychosomatic problems, which were related to headaches and sense of weakness.

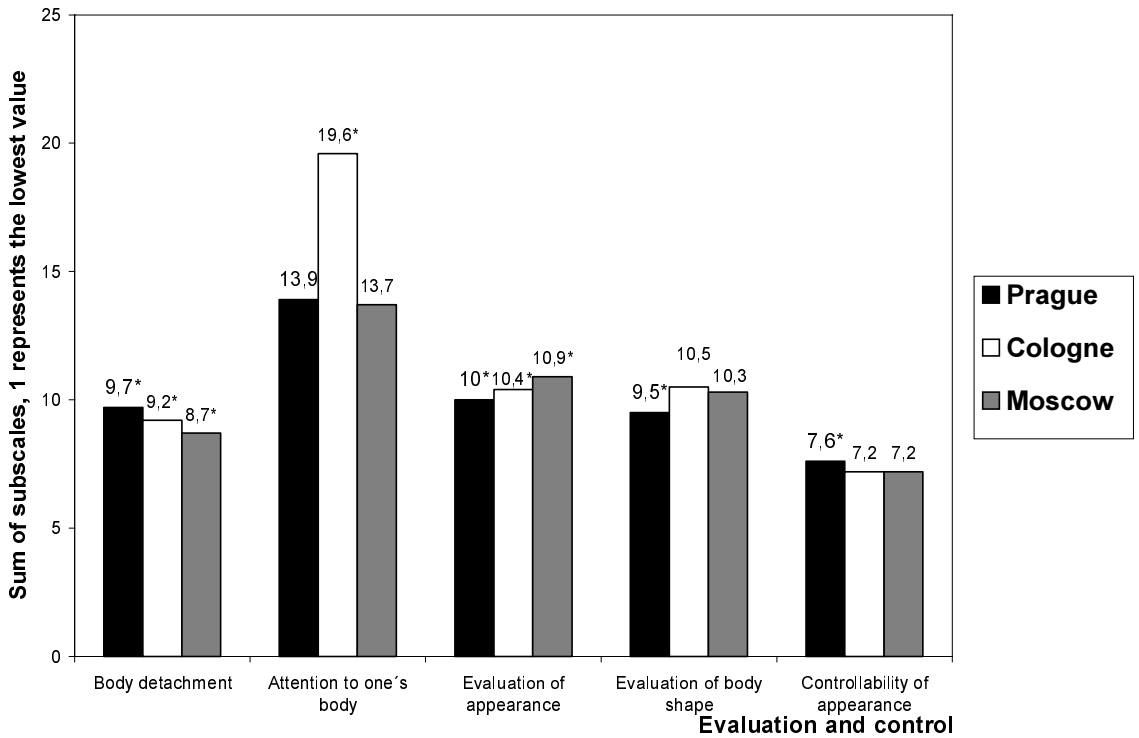
Fig. 2
Health behaviour



The results document a high level of health awareness in all subjects. Students link health and sports activity. The Czech students smoke and drink less than the other students in our sample, they also report more regular daily regime. Nutritional habits appear to be at somewhat lower level in Prague students, but a detailed analysis of the specific answers shows that even Prague students are developing positive nutritional attitudes. They attempt to limit the intake of sugar, fats and at the same time they have highest consumption of fruits and vegetables. Health behaviour seems to be more advanced in female subjects, who have better nutritional habits, control their weight, reduce the stress level and visit their physician more frequently.

higher than the other subjects. They also report fewer problems with their body. The Prague students displayed the highest level of detachment from their body appearance. They evaluate their body more critically in spite of the fact that they attempt to control their appearance more that the other students. In the answers that report on the specific body care, the Moscow students report the highest concern with the "look". For example: a suntan is considered much more important than in the other two groups of students. These concerns generate more active body care. Weight control does not rank among the top concerns but the average score of 3 on the scale 1 to 5 is still very high. Women pay more attention to their appearance that men do. They can identify changes in

Fig. 3
Physical appearance

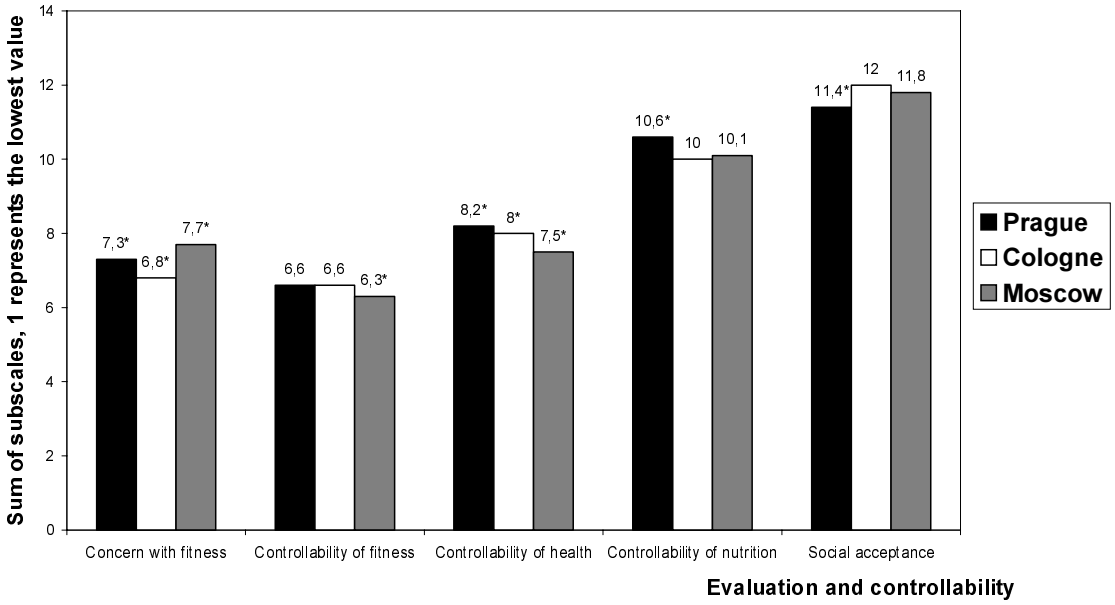


II. Body image

Body image can be understood as a part of total personal image, which has its own structure in with different sub-categories and dimensions. The questionnaire investigated sub-categories of physical fitness, physical appearance and health in the following three dimensions: evaluation, awareness and controllability.

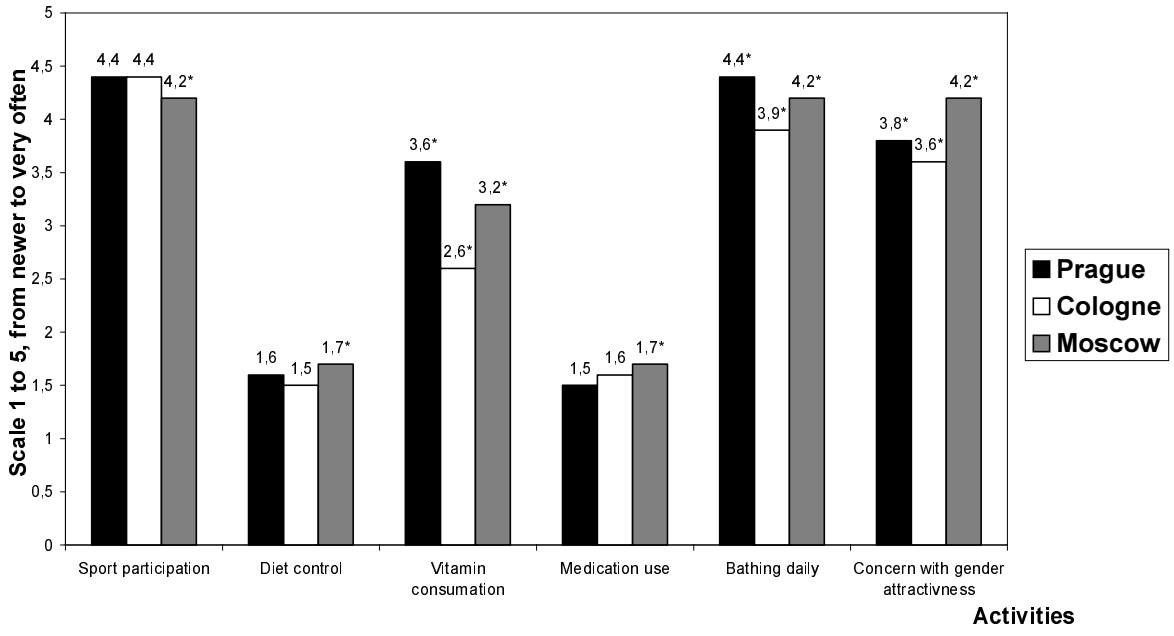
The students from Cologne are more concerned with their appearance and consequently evaluate it their bodies earlier than men, and generally, they are more observant of these changes. On the other hand the female students reported dissatisfaction with the results of their efforts to control their appearance, in the sense, they are more detached from their body than men. Men evaluated their bodies more positively than women, even though they do not display as much effort caring for it.

Fig. 4
Fitness and health



The Czech students displayed a higher controllability in all sub-categories than the others. It appears that all subjects are quite satisfied with their body appearance but they are less satisfied with their fitness. This could be explained by the fact that the physical performance of all sport students must be at a very high level in order to pass the sport performance exams or succeed in sport competition. Students in all groups reported high body awareness in all its aspects. The believe that one's health, fitness or appearance are uncontrollable is low, but it is generally believed that there is a low control of physical appearance. The results document that men control more their fitness and women control more their health and appearance.

Fig. 5
Activity as it relates to the body



Aside from sport participation, which seem to have a similar importance for all subjects, the Prague students seem to display better habits in their physical care, such as in daily hygiene, vitamin use, and limiting medication intake. Women display better care of their health, appearance, body shape, they are also more concern with their clothes and make-up.

DISCUSSION AND CONCLUSIONS

The comparison of the three groups of students in dimensions of awareness, evaluation and controllability leads to the following conclusions:

- Tendency of the Czech students to evaluate body aspects less positively.
- Belief amongst the Russian students that body aspects are more independent of one's effort leads to lower controllability.
- Marked differences among the groups for body awareness as it relates to health and fitness.
- Highly significant differences in the attitude to physical appearance among all groups. The Russian students being especially aware of their appearance and the Czech students displaying the smallest concern with it.

Overall, we can observe a tendency of the Czech students to be more sceptical about themselves and consequently about their bodies. The Russian students care more about the superficial aspect of their bodies and this attitude is possibly spread to the other areas of their lives. The German students do not demonstrate a specific deviation from average except for very high evaluation of their health. It appears that this observation corresponds to the high level of the German health delivery system. Specific health data indicate that the German students have the lowest number of sick days and the highest rate of surgery (surgery may be more affordable and accessible or the German students understand the term surgery in the larger sense, meaning any medical intervention in a hospital setting).

When we started the planning of our research we assumed that the expected inter-cultural differences among all three countries would be rather small. But the data analysis indicated a number of important differences. Similar differences exist in the data comparison from samples of gymnasts and general adult population. Therefore, we can conclude that the basic cultural differences play more important role in the development of health behaviour and body concept than similarities of education and professional orientation.

Most of the observed differences can be interpreted in a clear direction. In modern Western society, people of all ages have a goal to be physically active. This goal becomes a personal need, which is motivated by the enjoyment from movement and by the desire to be fit. In the traditional socialist society, the task orientation demonstrated by high level of performance leads to a more superficial/ external demonstration of individual abilities and systemic societal superiority. Large differences can be seen especially between Russian and German students.

The most marked differences among sports students in all three groups were found in their relationship to self, to one's body and in health behaviour. These factors are strongly influenced by national culture and national traditions.

In conclusion it can be summarised that the Czech students had a tendency to be more sceptical in their view of themselves, and their bodies. They also displayed more controllability in their lives then the other students, consequently their lifestyle is more organised and more directed. This was documented mostly by rational fitness and nutritional behaviour, regularity in daily routines and by avoidance of harmful substances, such as tobacco. The Russian students evaluated all the observed factors in more positive manner than the other students. They reported a high level of concern with the superficial aspects of their lives such as, appearance, social prestige, money and their athletic performance. On the other hand, the German students reported a high concern for their personal health, consequently their energies are directed toward the person centred aspects of their lives.

The analysis of the complete set of data from all groups will be completed and published in year 2000.

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EINSTELLUNGEN ZUR GESUNDHEIT UND KÖRPERKONZEPTE BEI SPORTSTUDENTEN IN PRAG, KÖLN UND MOSKAU
(Zusammenfassung des englischen Textes)

Der Artikel stellt ausgewählte Ergebnisse einer internationalen Studie „Sport, Gesundheit und Körperkonzepte in Mittel- und Osteuropa“ vor. Die Ergebnisse zeigen, daß die tschechischen Studenten sich selbst trotz ihres besseren Gesundheitsverhaltens weniger positiv beurteilen als die russischen und deutschen Studenten. Die tschechischen Studenten geben geringeren Nikotin- und Alkoholkonsum an, mehr Regelmäßigkeit im Tagesablauf und besseres Ernährungsverhalten. Die russischen Studenten zeigen eine Tendenz, stärker auf ihr körperliches Aussehen zu achten und auf die anderen äußerlichen Aspekte ihres Lebensstils. Die deutschen Studenten bewerten ihren Gesundheitszustand am besten. Dies kann mit dem hohen Niveau des deutschen Gesundheitssystems zusammenhängen.

Schlüsselwörter: Sport, Gesundheit, Körperkonzept, Aussehen, Lebensstil.

ZDRAVÍ A VZTAH K VLASTNÍMU TĚLU U STUDUJÍCÍCH SPORT V PRAZE, KOLÍNĚ NAD RÝNEM A MOSKVĚ
(Souhrn anglického textu)

Článek předkládá část výsledků mezinárodního výzkumného projektu „Sport, zdraví a tělesné sebepojetí ve střední a východní Evropě“, který byl realizován v letech 1996 a 7 v Praze, Moskvě a Kolíně nad Rýnem. Výsledky ukazují na určitou tendenci českých studentů hodnotit sebe a své tělo méně pozitivně než ostatní, přestože je jejich chování pro zdraví (omezování kouření, alkoholu, pravidelný denní režim, zdravá výživa …) uvědomělejší než u ostatních. U ruských studentů se objevuje trend věnovat více pozornosti vnějším aspektům svého těla a možná svého života celkově. Němečtí studenti hodnotili své zdraví nejpozitivněji a zdá se, že to souvisí s aktuálním lepším stavem německého zdravotního systému.

Klíčová slova: sport, zdraví, tělesné sebepojetí, životní styl, tělesný vzhled.

THE INFLUENCE OF A SIX-MONTH ATHLETICS TREATMENT INCORPORATED IN PHYSICAL EDUCATION CLASSES ON CHANGES OF MORPHOLOGICAL CHARACTERISTICS IN SEVEN-YEAR OLD BOYS

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This paper analyses the efficiency of a six-month athletics treatment within physical education classes in the first form of elementary school and influence of this treatment on morphological characteristics. For this purpose, the sample of 179 male pupils age 7 was submitted to 14 anthropometric measures twice within a period of 6 months. An analysis of changes in the applied anthropometric measures was made by the algorithm and programme SSDIF. It has shown significant quantitative differences between 39 pupils of the experimental group (attending specially programmed physical education classes conducted in accordance with the current curriculum). Changes were expressed in higher values, especially in the length of the leg, in the knee diameter, shoulder width, height and weight of the body, and in smaller values, especially of the stomach skin-fold. The changes are a probable consequence to the quantitative adaptation to the athletics training and are expressed through five factors of changes.

Keywords: morphological status, athletics treatment, analysis of changes.

INTRODUCTION

The role of physical education in the improvement of public health is nowadays a very important topic. For example, Sallis and McKenzie (1991) emphasize the role of physical education and its impact on public health.

The implementation of physical education in Croatian elementary schools is regarded as not efficient enough, primarily in the transformation of relevant anthropological dimensions. This imposes the need for changing the existing curriculum of physical education.

Physical education classes which lack sufficient scope of work cannot produce the positive changes of morphological characteristics as the basis for development of the essential motor abilities (for example Štihec & Kovač, 1990; Katić & Zagorac, 1993; Katić, 1994).

A good and reliable assessment both of the morphological and of the motor status in children is important particularly in planning and programming the transformation processes equally in the field of physical and health education and/or in various sports activities of children and youth. Thus, when planning such a programme, different initial conditions in invidual dimensions of the psychosomatic status should be considered because they tend to dictate the achievement of various levels of transformation (Mraković & Katić, 1992).

The obtained morphological/motor taxons find its application in forming homogenized groups in physical education curriculum and sports activities in the group of test subjects of this age, with the aim of more efficient influence on the development of relative, above all, motor abilities and desirable morphological characteristics (Katić et al., 1994).

Therefore it is important to show which effects can be achieved through the transformation of morphological characteristics in pupils of the first elementary school form, within the existing frequency of teaching physical education three times a week, when the work programming is done on the basis of defined initial state, homogenization of groups and regularities on which the sport training based, with predominantly athletic content.

Growth and maturation are maintained by the interaction of genes, hormones, nutrients and environmental factors that affects growth and maturation (Bouchard, Thibault & Jobin, 1981).

When well organized, age adapted physical activity has a beneficial effect on the growth phase of the body, and especially of skeletal, muscular and circulatory systems, as well as on body composition (Malina & Boushard, 1991; Parizkova, 1977) which corresponds to the findings of Gualdi et al. (1992) that changes in body composition occur during growth and with aging, in relation to health and nutrition and to physical activity.

MATERIALS AND METHODS

A sample of 179 elementary school first form male pupils from Split, aged 7 on an average, was chosen and divided into two subsamples. One subsample, consisting of 140 pupils, was selected according to the following key: these pupils had no psycho-physical injuries and they regularly attended physical education classes conducted by their physical education teacher according to the current curriculum. This subsample was the control group of testees. The other group, which consisted of 39 pupils who attended physical education classes conducted according to a specially devised curriculum containing athletics elements, represented the experimental group of subjects.

The sample of 14 anthropometric measures was applied twice in this research: the measurement at the beginning of the school year – the measurement having been realized from September 15th, 1992 to October 1st, 1992 and the measurement carried out six months later – the measurement having been realized from March 15th, 1993 to April 1st, 1993.

The anthropometric measures had been chosen in accordance with the virtual four-dimensional morphological space (Stojanović et al., 1975) and the following variables have been applied: stature (STATUR, mm), leg length (LEGLEN, mm), total arm length (TARMLE, mm), biacromial diameter (BIACRD, mm), biiliocrystal diameter (BIILICD, mm), wrist width (WRIST, mm), bicondylar femur diameter (FEMUR, mm), body mass (BODYMS, dkg), forearm circumference (FORARMC, mm), lower leg circumference (LOLEGC, mm), chest circumference (CHESTC, mm), triceps skinfold (TRICES, 1/10 mm), subscapular skinfold (SUBSCS, 1/10 mm), abdomen skinfold (ABDOMS, 1/10 mm).

Research methods and techniques of measurements were designed according to the technique recommended by the International Biological Program in 1981 (Weiner & Lourie, 1981). The instruments used were the internationally standardized tools: Siber Hegner Maschinen AG, Anthropometer, GPM skinfold caliper and platform scale.

In accordance with the aim of research, the results of the first and the second measurement were processed by means of an algorithm and the programme SSDIF (Momirović et al., 1987). Under the model of differences, the programme analysed the quantitative changes, caused by some kinesiological treatment, at two time points.

The results of both measurements were processed by applying the SSDIF based on the discriminant (Romeder, 1973) and factor analysis (Viskić-Štalec, 1991). The program analysed the changes in some time interval on the basis of differences between at least two states of the subjects (initial and final one) which is presented by the values of differences (Measurement 2 – Measurement 1). On the basis of differences in the changes between the control and the experimental group the information was obtained not only about the effect of growth and maturation, but also on the influence of the treatment, i.e. of the training, on the changes. Such methodological approach is appropriate for establishing the effect of various treatments, either in sport or in physical education teaching.

RESULTS AND DISCUSSION

Significant changes occured in anthropometric variables in the elementary school first form boys at the level of arithmetic means and standard deviations of the variables in the first and second measurements for the total of the sample of testees, i. e. the differences of arithmetic means at the beginning of the school year (TABLE 1) and six months later.

The changes from the initial to the final state are of a positive nature and point out the development of morphological characteristics. The changes of measures for estimating the longitudinal dimension of skeleton, mass and volume of the body are especially expressed.

Analysis of variance (TABLE 2) shows that at the beginning the experimental group was significantly different in relation to the control one in the measure of the forearm circumference, chest circumference, length of the arm and knee diameter, which were more expressed in the experimental group.

Six months later, the experimental group, where the physical education classes were conducted by an expert physical teacher, was significantly different in relation to the control one in a larger number of morphological changes. So, the measurement values of the forearm circumference, chest circumference, knee diameter, length of the leg and of the arm were higher in the experimental group, and the measured values of the abdomen and back skin fold were lower.

The analysis of variance has shown how specifically programmed physical education classes, with predominantly athletics content have favourably affected the growth and development of pupils (TABLE 3). This is manifested as major changes, especially in the leg length, knee diameter, shoulders width, height and weight of the body, and in the larger reduction of the fatty tissue, especially around the stomach, in the experimental group, when compared with the control group. It is significant that apparently there were no changes in the circumference measures (muscle mass). However, reduction in the fat tissue content this means that, if there was no difference in measures, then the muscle mass and not fat tissue increased in the experimental group subjects, which confirms a restructuring of the characteristics.

On the basis of Mahalanobis distance measurement, i. e. on the basis of F-test (TABLE 3), the hypothesis that in multivariance space, determined by the morphological variables, the two groups who are equal has been rejected. Partial F-tests of differences between the groups show that all variables changed (in the measures of fat tissue the negative is the reflection of the reduction of fat).

It is evident, that a six-month treatment has significantly affected the total morphological status of children. Namely, more complete and greater physical engagement at this age will tend to optimize somatobiomechanical requirements towards elimination of limiting factors. That will be achieved by developing the somatic levers and their points holders, by improving the quality of firm supporting points (joints) and by reducing the ballast tissue. Without nutritive substances in supporting and building of other tissue, it is not possible to create an adequate basis for more complex and demanding motions and activities.

The simplest way to support this process is to use high-grade kinesiological stimuli which are adequately programmed, with a sufficient load that provokes adaptation.

The correlative and factor procedures of differences make possible the analysis of the interspace by which quantitative changes of superior mechanisms are registered.

The results of this procedure are the indicators by which the changes in individual variable are correlated with the changes in other variables (TABLE 4).

Positive interlinks can be noted between changes in the measurements of skin folds, between measures of volume, and between the variables for estimating skeleton dimensions. This means, indeed, that the somatic development went on in such a way that the basic structure of morphological measures remained intact, but, in the experimental group, all variables were increased quantitatively. Not maybe to a new level, but there was a significant progress in all means.

A component factor analysis in the space of changes in morphological measures (TABLE 5) has revealed 5 factors that are responsible for 5 ways in which the programmed teaching of physical education has been manifested in the development of the treated characteristics of the elementary school first form pupils. A relative contribution of individual factors to the explanation of the total variability of the system in uniform, and a relatively great quantity of common information changes has been isolated (57%). It seems that information is not completely objective, at the level of components, although they are undoubtedly interesting, first of all because of a larger number of isolated factors. Therefore a more qualitative assessment for ways of implementing changes can be obtained by means of the varimax solution (TABLE 6).

Through the first varimax factor, the athletics training included in physical education classes has manifested as increased hips width, height of the body and shoulders width, i.e. in the transversal and in longitudinal changes.

The second varimax factor is responsible for the changes in the amount of fat tissue where higher values of fat deposits are positively reflected in the body weight and length of the arm and negatively in the length of the leg.

Through the third varimax factor, the differences provoked by the athletics training, compared with conventional teaching, are manifested in the changes of the measures of the body volume and especially of the chest circumference. The wrist width shows a suppressive effect, as it is not able, most probably, in such a short period to support an intensive development of muscles and wrist links.

The fourth factor shows that the athletics training is manifested in a larger number of pupils as changes in the knee diameter, length of the leg and diameter of the wrist, which is accompanied, negatively, by changes in the skin fold of stomach.

In the fifth factor of changes, the mass of the body accompanied by the shoulder width and length of the leg are on the positive side, and the length of the arm accompanied by the scope of the under-knee, and knee diameter are on the negative side. That means that the body mass growth occurs inversely proportional to increase in the arm length.

The internal structure of differences is visible from table 6 in which the correlations of discriminant function with the components and varimax factors are given. At the relations of varimax and discriminant function, the highest links are obtained on the basis of the development of skeleton of lower extremities (the fourth varimax factor) and on the basis of body volume and body height (the first varimax factor). It is evident, therefore, that the pupils adaptation to the athletics stimuli has created specific changes mostly in development of skeleton, body and the lower extremities.

The third factor of changes encompasses mostly anthropometric measures for estimating the volume, and it is in correlation with the discriminant function, most probably, through the quality of the muscles tissue.

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AUSWIRKUNG EINES SECHSMONATIGEN ATHLETISCHEN, IN DIE SPORTSTUNDEN EINGEGLIEDERTEN HEILPROGRAMMES AUF DIE ÄNDERUNGEN DER MORPHOLOGISCHEN EIGENSCHAFTEN BEI SIEBENJÄHRIGEN JUNGEN

(Zusammenfassung des englischen Textes)

Diese Studie analysiert die Wirksamkeit eines athletischen 6-Monate Heilprogrammes im Rahmen der Schulsportstunden auf der ersten Stufe der Grundschule und die Auswirkung dieses Heilprogrammes auf die morphologischen Eigenschaften. Zu diesem Zwecke wurden 179 zufälligerweise ausgewählte Schüler – Jungen in einem Alter von 7 Jahren – innerhalb von sechs Monaten zweimal mit 14 zufälligerweise ausgewählten anthropometrischen Einheiten verglichen.

Die Änderungen der angewendeten anthropometrischen Einheiten wurden durch einen Algorithmus und das Programm SSDIF analysiert. Es wurden markante quantitative Unterschiede zwischen den 39 Schülern der Probegruppe (Teilnehmer an Sportstunden mit Sonderlehrplänen, gesteuert in Übereinstimmung mit dem üblichen Lehrplan) festgestellt.

Die Änderungen erwiesen sich als höhere Werte ind der Länge der Füße, im Kniedurchmesser, der Schulterbreite, der Körpergröße sowie dem Körpergewicht, und als niedrigere Werte, insbesondere die der Hautfalten auf dem Bauch.

Die Änderungen sind wahrscheinlich die Folgen der quantitativen Anpassung des athletischen Trainings und werden mit Hilfe von fünf Faktoren der Änderungen ausgedrückt.

Schüsselwörter: morphologischer Zustand, athletisches Heilprogramm, Analyse der Änderungen.

VLIV ŠESTIMĚSÍČNÍHO ATLETICKÉHO LÉČEBNÉHO PROGRAMU ZAČLENĚNÉHO DO HODIN TĚLESNÉ VÝCHOVY NA ZMĚNY MORFOLOGICKÝCH VLASTNOSTÍ SEDMILETÝCH CHLAPCŮ

(Souhrn anglického textu)

Tato studie analyzuje účinnost šestiměsíčního atletického léčebného programu v rámci hodin tělesné výchovy na prvním stupni základní školy a vliv tohoto léčebného programu na morfologické vlastnosti. Za tímto účelem bylo 179 náhodně vybraných žáků – chlapců ve věku 7 let během šesti měsíců dvakrát srovnáno se 14 náhodně vybranými antropometrickými jednotkami.

Změny užitých antropometrických jednotek byly analyzovány algoritmem a programem SSDIF. Mezi 39 žáky pokusné skupiny (účastníky hodin tělesné výchovy se zvlášními osnovami, řízených v souladu s běžným učebním plánem) byly prokázány výrazné kvantitativní rozdíly.

Změny byly vyjádřeny vyššími hodnotami, zvláště změny v délce nohou, v průměru kolena, v šíři ramen, ve výšce a váze těla, a nižšími hodnotami, zvláště změny záhybu kůže na břiše.

Změny jsou pravděpodobně následkem kvantitativního přizpůsobení atletickému tréninku a jsou vyjádřeny pomocí pěti faktorů změn.

Klíčová slova: morfologický stav, atletický léčebný program, analýza změn.

TABLE 1
Central and dispersive parameters of variables in the first (1) and second (2) measurements

VARIABLES	MEASURES	X	SD	MIN	MAX
STATUR (cm)	1	128.22	5.68	114.00	148.43
	2	131.57	5.70	116.13	150.73
LEGLEN (cm)	1	71.19	3.95	60.00	82.10
	2	73.68	3.97	61.67	83.47
TARMLE (cm)	1	52.88	3.10	43.77	65.70
	2	54.07	3.09	44.53	67.00
BIACRD (cm)	1	27.05	1.63	20.30	31.00
	2	28.12	1.55	20.83	32.00
BIILCD (cm)	1	20.37	1.33	17.33	23.50
	2	21.25	1.25	18.07	24.00
WRIST (cm)	1	4.16	0.26	3.63	4.87
	2	4.23	0.25	3.80	4.90
FEMUR (cm)	1	7.75	0.47	6.50	9.50
	2	7.91	0.47	6.70	9.57
BODYMS (kg)	1	26.78	4.41	16.50	45.00
	2	29.36	4.45	20.00	45.83
FORARMC (cm)	1	17.66	1.57	13.90	23.07
	2	18.38	1.57	14.47	24.30
LOLEGC (cm)	1	25.68	2.26	19.20	34.53
	2	26.64	2.21	20.07	36.03
CHESTC (cm)	1	60.06	3.82	49.90	71.17
	2	61.23	3.74	51.00	71.57
TRICES (mm)	1	11.43	3.34	6.17	25.90
	2	10.68	3.45	4.00	25.43
SUBSCS (mm)	1	6.69	2.62	3.47	18.67
	2	6.40	2.36	2.23	18.40
ABDOMS (mm)	1	6.61	3.93	2.97	27.27
	2	6.26	3.83	2.43	21.43

TABLE 2
Central (X) and dispersive (SD) parameters; analysis of variance of variables (F) between the control (C) and the experimental group (E) in the first (1) and second (2) measurements

VARIABLES	MEASURE	X_C	SD_C	X_E	SD_E	F
STATUR	1	128.22	5.75	128.22	5.44	.99
	2	131.37	5.70	132.29	5.69	.62
LEGLEN	1	71.34	3.93	70.63	3.93	.68
	2	73.28	3.81	74.12	4.21	.03
TARMLE	1	52.54	3.97	54.10	4.36	.01
	2	53.79	3.18	55.09	2.50	.02
BIACRD	1	27.08	1.72	26.91	1.28	.57
	2	28.04	1.63	28.39	1.24	.21
BIILCD	1	20.45	1.47	20.11	1.15	.14
	2	21.34	1.25	20.92	1.23	.07
WRIST	1	4.17	.25	4.13	.27	.32
	2	4.29	.26	4.27	.24	.70
FEMUR	1	7.71	.48	7.89	.40	.04
	2	7.86	.47	8.12	.40	.00
BODYMS	1	26.82	4.47	26.66	4.18	.84
	2	29.25	4.55	29.78	4.08	.52
FORARMC	1	17.35	1.45	18.76	1.78	.00
	2	18.08	1.49	19.48	1.35	.00
LOLEGC	1	25.60	2.40	25.96	2.05	.62
	2	26.59	2.28	26.82	1.98	.57
CHESTC	1	59.57	3.77	61.82	3.49	.00
	2	60.78	3.71	62.85	3.39	.00
TRICES	1	11.44	3.49	11.36	2.77	.89
	2	10.73	3.57	10.51	3.00	.72
SUBSCS	1	6.79	2.82	6.32	2.12	.67
	2	6.58	2.48	5.76	1.82	.05
ABDOMS	1	6.74	4.08	6.15	3.30	.59
	2	6.60	4.08	5.05	2.74	.02

TABLE 3
Univariant (q) and multivariant tests (DF) of hypotheses about differences in the first and second measurements between the groups

VARIABLES	X_C	SD_C	X_E	SD_E	q	DF
STATUR	3.15	1.58	4.07	0.88	***	0.44
LEGLEN	1.92	0.88	3.50	1.13	***	0.34
TARMLE	1.25	0.65	0.99	3.42	*	0.35
BIACRD	0.96	0.57	1.48	0.92	***	0.29
BIILCD	0.89	0.59	0.83	0.46		0.38
WRIST	0.12	0.06	0.15	0.09	*	0.33
FEMUR	0.14	0.08	0.24	0.10	***	0.33
BODYMS	2.43	1.31	3.12	1.44	**	0.36
FORARMC	0.73	0.35	0.72	0.84		0.37
LOLEGC	0.99	1.04	0.86	0.41		0.33
CHESTC	1.22	0.82	1.03	0.62		0.28
TRICES	–0.72	1.64	–0.86	1.15		–0.09
SUBSCS	–0.21	1.32	–0.56	0.96		–0.05
ABDOMS	–0.14	1.34	–1.10	1.14	***	–0.05

Significant differences between groups:* $p<0.05$, ** $p<0.01$, *** $p<0.001$

TABLE 4
Correlations of variables between the first and second measurements

VARIABLES	1	2	3	4	5	6	7	8	9	10	11	12	13	14
01. STATUR	1.00													
02. LEGLEN	0.15	1.00												
03. TARMLE	–0.07	–011	1.00											
04. BIACRD	0.34	0.18	–0.16	1.00										
05. BIILCD	0.22	–0.04	–0.08	0.21	1.00									
06. WRIST	0.05	0.18	–0.01	0.08	0.17	1.00								
07. FEMUR	0.26	0.24	–0.02	0.19	0.08	0.27	1.00							
08. BODYMS	0.25	0.17	–0.12	0.22	0.02	0.27	0.04	1.00						
09. FORAFMC	–0.09	–0.08	0.07	0.09	0.05	–0.10	–0.11	0.22	1.00					
10. LOLEGC	–0.12	–0.05	0.10	–0.02	–0.01	–0.13	0.00	0.09	0.22	1.00				
11. CHESTC	–0.12	–0.11	0.10	0.00	–0.04	–0.24	–0.11	–0.05	0.31	0.33	1.00			
12. TRICES	0.08	–0.10	0.03	0.07	0.14	0.07	0.19	0.24	–0.14	0,02	–0.09	1.00		
13. SUBSCS	–0.09	–0.09	0.10	–0.08	–0.04	0.01	–0.04	0.17	0.05	0.20	0.06	0.37	1.00	
14. ABDOMS	–0.14	–0.23	0.23	–0.10	–0.08	–0.17	–0.12	0.04	0.11	0.05	0.03	0.20	0.43	1.00

TABLE 5
Main factor loadings (H), communalities (h^2), variances of main components (LAMBDA) and the quantity of information (%)

VARIABLES	H1	H2	H3	H4	H5	h2
STATUR	0.57	0.16	0.24	–0.26	–0.07	0.48
LEGLEN	0.49	–0.11	0.13	0.57	0.14	0.61
TARMLE	–0.35	0.17	–0.10	0.21	–0.41	0.37
BIACRD	0.48	0.16	0.50	–0.19	0.07	0.55
BIILCD	0.31	0.17	0.25	–0.53	–0.36	0.60
WRIST	0.50	0.16	–0.15	0.34	–0.07	0.42
FEMUR	0.50	0.18	0.05	0.33	–0.50	0.65
BODYMS	0.37	0.48	0.15	0.13	0.57	0.74
FORARMC	–0.31	0.08	0.63	0.03	0.20	0.54
LOLEGC	–0.38	0.16	0.49	0.30	–0.31	0.59
CHESTC	–0.45	–0.01	0.60	0.11	–0.06	0.58
TRICES	0.11	0.72	–0.19	–0.12	–0.16	0.62
SUBSCS	–0.29	0.74	–0.09	0.15	0.09	0.66
ABDOMS	–0.46	0.55	–0.18	–0.10	0.12	0.57
LAMBDA	2.40	1.83	1.53	1.14	1.10	
%	17.16	13.04	10.93	8.16	7.86	
CUMULAT.	17.16	30.20	41.13	49.29	57.14	

TABLE 6
Varimax factors of internal structure of differences (V) and correlations (C) of discriminant function with varimax factors

VARIABLES	V1	V2	V3	V4	V5
STATUR	0.62	–0.05	–0.10	0.19	0.23
LEGLEN	–0.12	–0.23	0.03	0.67	0.30
TARMLE	–0.15	0.27	0.16	0.08	–0.50
BIACRD	0.58	–0.08	0.17	0.17	0.39
BIILCD	0.76	0.00	–0.04	–0.09	–0.11
WRIST	0.06	0.08	–0.25	0.59	0.10
FEMUR	0.31	0.04	–0.06	0.70	–0.23
BODYMS	0.08	0.35	0.01	0.25	0.74
FORARMC	0.03	0.01	0.68	–0.17	0.22
LOLEGC	–0.01	0.14	0.69	0.13	–0.29
CHESTC	–0,02	–0.03	0.74	–0.14	–0.08
TRICES	0.30	0.69	–0.19	0.11	–0.05
SUBSCS	–0.12	0.79	0.14	0.02	0.04
ABDOMS	–0.15	0.67	0.06	–0.30	–0.03
C	0.47	0.02	0.38	0.48	0.21

MOTOR COMPETENCE OF 7–10 YEAR OLD CHILDREN WITH VISUAL DISABILITIES

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Submitted in April, 1999

The aim of this research was to obtain basic information on motor competence (based upon somatic, psychomotor indicators, and socialization) of 6-11 year old children with visual disabilities. A partial aim of our research was to compare the obtained results with those of a section population of children of the same age with normal sight, also tested by us. Finally, we sought to compare such results with national standards and evaluate whether trends in the development of children with visual disabilities are similar to those for children of the same age with normal sight.

Keywords: motor competence, pupil with visual disabilities of elementary school.

INTRODUCTION

Movement and activity play a very important role in child ontogenesis. In the very first months of a child's life, thanks to movement activities, the spine begins to develop and later the developing skills help the child to enlarge his/her visual and social horizons. The development of motor and mental skills, primarily in the early stages of a child's life, are closely linked together; the motor skills of course support activation of mental skills and vice versa. Another important factor in early development is sensation. Sounds and visual stimuli naturally stimulate child's independent activities. Therefore, blindness from birth is likely to influence the child's development in a very substantial way. This will happen to a lesser degree, if natural environmental influences were substituted with appropriate stimuli and active stimulation by the child's parents. The importance of the previous statement is documented by casuistry of two boys, as follows:

Both boys, now almost 20 years old, were born blind. In both, the same visual disability was accompanied by the same level of mental retardation. However, their families' approach towards their rearing were different.

One of the boys spent his first five years in a tiny pen in a kitchen niche. His mother gave him only basic hygienic care and sufficient food, but she hardly played with him and her communication with him was very limited. Due to the limited space in which he had been growing up, his motor skills were substantially delayed. When he was placed into a special kindergarten six years later, changes occurred. At six, his motor development was that of a two-year old child and his mental development that of a three-year old. Despite all special care, he never learnt how to read, write or count. To date, he speaks about himself as "him". He does not manage to take basic care of himself, and spatial orientation he manages only at home. Outside he is not able to move by himself without a guide.

The other boy was raised in a very stimulating environment. His mother and father both gave him lots of care. Since birth, they cooperated with a special pre-kindergarten, which he later attended. His development was slightly delayed, but this is common with children with visual disabilities. Between 7–8 years, he was placed in a special school for children with visual disabilities. He graduated from this school, although his achievements were slightly below average. He is able to work on a special computer designed for people with visual disabilities. He is able to take care of himself and manages spatial orientation on routes that are not too difficult.

Prompted by these facts, we conceived a study the aim of which was to define levels of motor competence of school-children with visual disabilities at elementary school age.

TOPIC DEFINITION

As with children with normal sight, the studies of psychomotor development of those with visual disabilities focus primarily on the initial stage of development, the one that usually ends about the third year of a child's life. Further stages are being mapped in a very schematic way with mainly abstract conclusions. However, for harmonious development of children with visual disabilities, the pre-elementary period is also important, when children develop and reinforce habits of desirable behavior with the goal of

"future pupil" in mind. This is vital, since school entrance is one of the most important milestones in a child's life. The maturity to enter school is reflected in a certain level of somatic, social, and mental dispositions. The next developmental stage – that of the early school age – is, in terms of scientific findings, the age of darkness, as it has been called by Burt (1927). The situation now is quite different; the number of research studies on psychomotor development of children of early school age has increased (as we see in the studies of Kozlík, Šabat & Kittler (1968), Měkota et al. (1988), Mazal (1990), Lievegoed (1992). However, psychomotor development of those with visual disabilities of that age is really close to this above mentioned darkness. There are only few researchers interested in this field. These include Cratty, J.B. (1971), Smýkal (1985), Šamaj (1994), Poráčová (1996), Bunc (1997), Janečka (1998). The aim of our research is to extend knowledge to the population of those with visual disabilities of early school age from 6 to 11 years.

THE AIMS OF THE RESEARCH

The aim of this research was to obtain basic information on motor competence (based upon somatic, psychomotor indicators, and socialization) of 6–11 year old children with visual disabilities. A partial aim of our research was to compare the obtained results with those of a section population of children of the same age with normal sight, also tested by us. Finally, we sought to compare such results with national standards and evaluate whether trends in the development of children with visual disabilities are similar to those for children of the same age with normal sight.

Within our research the following tasks were laid out:

- To measure height and weight and to determine BMI from them. To evaluate body hold up.
- To carry out motor tests focused on:
  - General endurance (Harvard step test)
  - Dexterous abilities (stick movement combination)
  - Dynamic explosive strength of lower limbs (standing broad jump with legs together)
  - Motor balance (endurance in stand hang on one leg on a little form)
  - Dynamometry (hand–grip)
  - Dynamic strength and dynamic local endurance (sit–lie)
  - Mobility skills (forward bend low with reaching in sit with legs together)
  - Static local strength (endurance in bend down)
- To find out the mental level, extent of visual disability, and performance motivation
- To determine extent of socialization through sports activities and games.

Due to the extensiveness of our research, we want to focus in our paper only on some indicators in our paper. From these we shall demonstrate the motor competence level of children with visual disabilities.

We laid out the following tasks:

1. To compare body height and weight of children with visual disabilities with those of our control study group with normal sight and national standard.
2. To compare average values of achieved results in the movement test "standing broad jump with legs together" grouped by sex and by the extent of disability with the values attained by children with normal sight from our control study group and general national standard.
3. To compare average values of achieved performances in movement test "stick movement combination" grouped by sex and by extent of disability with those attained by children with normal sight from our control study group and general national standard.

HYPOTHESES

H 1:
Statistically zero hypothesis.
We assume that average values of weight in 7–10 year old boys and girls with visual disabilities (VD) will not differ in a statistically significant way from those boys and girls of the same ages with normal sight. H0: $\mu 1 = \mu 2$.
H 2:
Statistically zero hypothesis.
We assume that the average height amongst 7–10 year old boys and girls with visual disabilities (VD) will not differ in a statistically significant way from those in the control group of children of the same age with normal sight and national average (NA). H0: $\mu\ 1 = \mu\ 2$.
H 3:
Statistically zero hypothesis.
We assume that the results in 7–10 year old boys and girls with visual disabilities (VD) by extent of disability (B1–B4) will not differ in a statistically significant way from those boys and girls of the same age with normal sight (NS) in respect of the movement test "standing broad jump with legs together". H0: $\mu 1 = \mu 2$.
H 4:
Statistically zero hypothesis:
We assume, that the results for 7–10 year boys and girls with visual disabilities (VD) by extent of disabilities (B1–B4) in movement tests of "stick movement combination" will not differ in a statistically significant way from those boys and girls of the same age and normal sight (NS). H0: $\mu 1 = \mu 2$.

METHODOLOGY

Studied groups

We studied 57 children with visual disabilities in 1–4 grades of elementary school for children with visual disabilities and 91 children with normal sight from common elementary school. The results obtained were compared with the general national standard average for population with normal sight.

The group of children with sight disabilities was divided further by the extent of their visual disability. For the purpose of simplification we used classification recommended and adopted by IBSA (International Blind Sports Association).
Classification by IBSA:
The B letter states for the Blind (i.e. children with visual disabilities).
Number index states for extent of disability
B_1 – total blindness, inability to recognize either objects or contours, no matter how far the distance from the disabled person, with no light perception-light perception.
B_2 – Ability to recognize objects or contours, visual acuity 2/60 with upper limit of visual field of 5^0.
B_3 – Visual acuity 2/60 or restrictions of visual field within $5–20^0$.

METHODS

- Analysis of pedagogic documentation
- Psychological tests
  - To determine mental level (RAVEN for children)
  - To determine emotional stability (JEPI)
  - To determine performance motivation (D – M –V)
  - Slow line (Damping part)
  - Volitional effort (Endurance in bend – range)
- Anthropometric part
  - BMI
  - Determining somatotype (height, weight and four skinfolds)
  - Body hold up assessment by Jaroš – Lomíček
- Psychomotor part
  Motor tests focused on:
  - General endurance (Harvard step test)
  - Dexterous abilities (stick movement combination)
  - Dynamic explosive strength of lower limbs (standing broad jump with legs together)
  - Motor balance (endurance in stand hang on one leg on little form)
  - Dynamometry (hand-grip)
  - Dynamic strength and dynamic local endurance (sit-lie)
  - Mobility skills (forward bend low with reaching in sitting with legs together)
  - Static local strength (endurance in bend down)

RESULTS AND DISCUSSION

Body weight data are listed in the following tables.

TABLE 1
Average weight of boys and girls with visual disabilities.

Group of those with visual disabilities (VD)	Values in kilograms	
	7 – 8 years	9 – 10 years
Total	26.0	32.8
Girls	26.8	29.0
Boys	25.3	36.0

TABLE 2
Average weight of boys and girls with normal sight.

Group of those with normal sight (NS)	Values in kilograms	
	7 – 8 years	9 – 10 years
Total	25.7	29.5
Girls	25.9	29.4
Boys	25.5	29.6

From statistical testing of the H1 hypothesis it is apparent that body weight in both groups are comparable. The only exception is the group of 9–10 year old visually disabled boys in comparison with those possessing normal sight. Here we refuse the zero hypothesis on significant level $\alpha = 0.05$ and adopt an alternative hypothesis. The weight of 9–10 year old visually disabled boys is statistically significantly higher than the weight in boys with normal sight of the same ages.

	Number (n)	Arithmetic average	Standard deviation	T Test	Significance
Boys VD	29	31.0	10.30	–2.3597	*
Boys NS	46	26.9	4.60		

Average height data are listed in the following tables.

TABLE 3
Average heights of boys and girls with visual disabilities

Group of with visual disabilities (VD)	Values in (cm)	
	7 – 8 years	9 – 10 years
Total	126.1	133.8
Girls	126.7	133.7
Boys	125.6	135.8

TABLE 4
Average heights of boys and girls with normal sight (NS)

Group of normal sight (NS)	Values in (cm)	
	7 – 8 years	9 – 10 years
Total	127.3	134.8
Girls	127.8	133.9
Boys	126.8	135.4

By our statistical verification of the H2 hypothesis, we could confirm the zero hypothesis in all cases. Hence it means that a population of 7–10 year old boys and girls with visual disabilities within the whole range of visual disabilities is comparable to the population of children with normal sight of the same ages.

Movement test “standing broad jump with legs together”.

Average performances of children with visual disabilities are listed in TABLE 5, 6.

TABLE 5
7–8 year old children with visual disabilities

Values in centimeters (cm)						
Group with visual disabilities (VD)	Total		Girls		Boys	
	B1	B – 3,4	B1	B – 3,4	B1	B – 3,4
Number (n)	10	7	4	4	6	3
Arithmetic average	65.7	112.0	70.0	101.0	62.8	126.7
Standard deviation	29.75	26.68	21.86	32.10	35.80	5.03

TABLE 6
9–10 year old children with visual disabilities

Values in centimeters (cm)						
Group with visual disabilities (VD)	Total		Girls		Boys	
	B1	B – 3,4	B1	B – 3,4	B1	B – 3,4
Number (n)	3	16	2	7	1	16
Arithmetic average	88.7	121.3	88.0	124.4	90.0	118.01
Standard deviation	1.15	18.98	0	23.22	0	16.01

Statistical verification of the hypotheses.

To verify the movement test "standing broad jump with legs together" we determined the zero hypothesis H3. Performances from this test were compared with those gained from the control tested group of children with normal sight from common elementary school. Further they were compared with those from the national study carried out by Moravec (1970).

Statistic testing of the H3 hypothesis on the significant level $\alpha = 0.05$ brought the following results:

First, let us consider 7–8 year old boys with visual disabilities (B–1 and B–3,4 categories) in comparison with the two sets of children with normal sight. In the B–1 category we refuse the zero hypothesis since the level of explosive strength differs in a statistically significant way from that for the both sets of children with normal sight. Therefore we adopt an alternative hypothesis as follows: the level of explosive strength is statistically lower in the B–1 group. In the B–3,4 category the zero hypothesis has been confirmed.

A similar comparison was carried out for older boys at the ages of 9–10 years. For both groups of children with visual disabilities (B–1 and B–3,4), we refuse the zero hypothesis since the level of explosive strength compared to that of the both groups of boys with normal sight differs in a statistically significant way. Again, we adopt the alternative hypothesis as follows: the level of explosive strength in both groups of children with visual disabilities is statistically lower than that of their equals in age who possess normal sight.

The similar method was applied in the case of 7–8 year old girls (B–1 and B–3,4 categories). On the significant level $\alpha = 0.05$ we refuse the zero hypothesis since the level of explosive strength of both categories in girls with visual disabilities differ in a statistically significant way from that of both groups of children with normal sight. Hence, we adopt the alternative hypothesis as follows: the level of explosive strength of both groups of 7–8 year old girls with visual disabilities is statistically lower than that of their equals in age who posses normal sight.

In the case of 9–10 year old girls, performances in both groups of girls with visual disabilities differ in a statistically significant way compared to both groups of girls with normal sight, so here also we adopt the above mentioned alternative hypothesis. To better illustrate this, we demonstrate the achieved performances in boys and girls trough the following figures 1 and 2.

Fig. 1
Boys

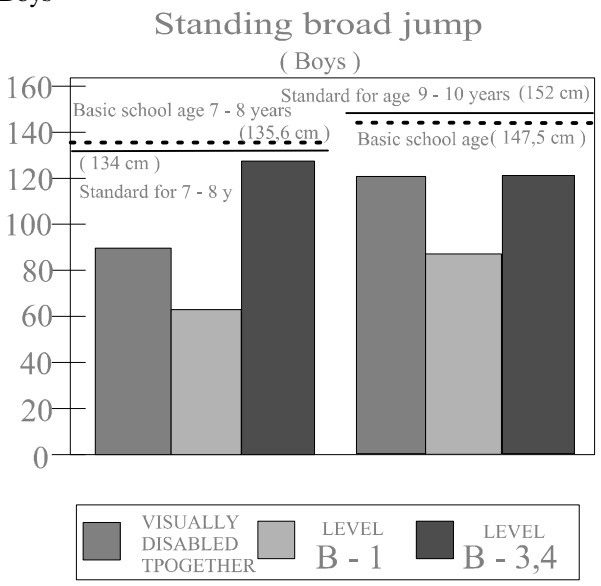
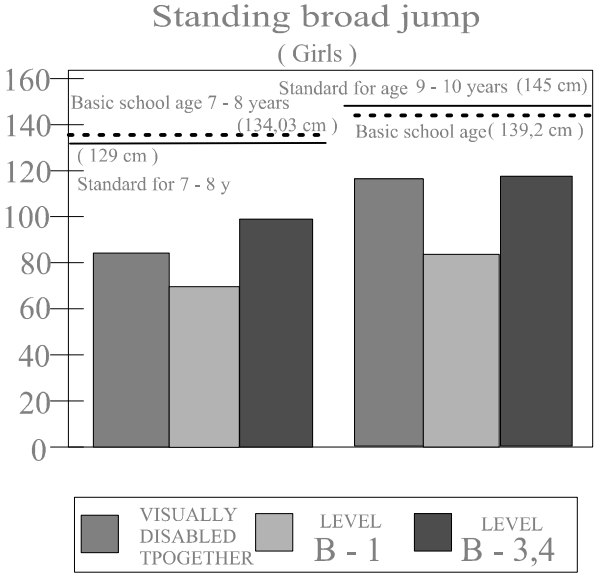


Fig. 2
Girls



Movement test: "Stick movement combination"

Average performances of children with visual disabilities are given in Tables 7 and 8.

TABLE 7
7–8 year old children with visual disabilities

Values in seconds (s)						
	Total		Girls		Boys	
	B1	B – 3,4	B1	B – 3,4	B1	B – 3,4
Number (n)	9	12	4	8	5	4
Arithmetic average	69.3	41.3	81.5	44.5	59.6	35.0
Standard deviation	26.53	27.86	36.92	34.35	10.92	3.74

TABLE 8
9–10 year old children with visual disabilities

Values in seconds (s)						
	Total		Girls		Boys	
	B1	B – 3,4	B1	B – 3,4	B1	B – 3,4
Number (n)	3	16	2	6	1	10
Arithmetic average	30.3	28.0	30.0	23.1	31.0	31.0
Standard deviation	6.02	7.60	8.48	8.29	0	5.65

Statistical verification of hypotheses

For verification of movement test "stick movement combination" we determined the H4 zero hypothesis. Performances in this test were again compared with those of the control study group of children with normal sight from general elementary school and with performances from research carried out by Teplý (1986).
Statistical testing of the H4 hypothesis on the significant level $\alpha = 0.05$ brought the following results:

For 7–8 year old boys with visual disabilities we refuse the zero hypothesis in both categories of visual disability. Therefore we adopt the alternative hypothesis: performances in movement test "stick movement combination" are in a statistically significant way lower, than those for the group of children with normal sight. For 9–10 year old boys the zero hypothesis has been confirmed. The sets, however, do not differ in a statistically significant way.

For 7–8 old girls with visual disabilities, as well as for those 9–10 years old, we refuse the zero hypothesis in both categories (B–1 and B–3,4) because the results show that children with visual disabilities differ in a statistically significant way from a population with normal sight. Again, the alternative hypothesis is adopted as follows: performances in the movement test "stick movement combination" are lower in a statistically significant way than in group of children with normal sight.

To better illustrate this, the achieved performances are presented in the following figures 3 and 4:

Fig. 3
Girls

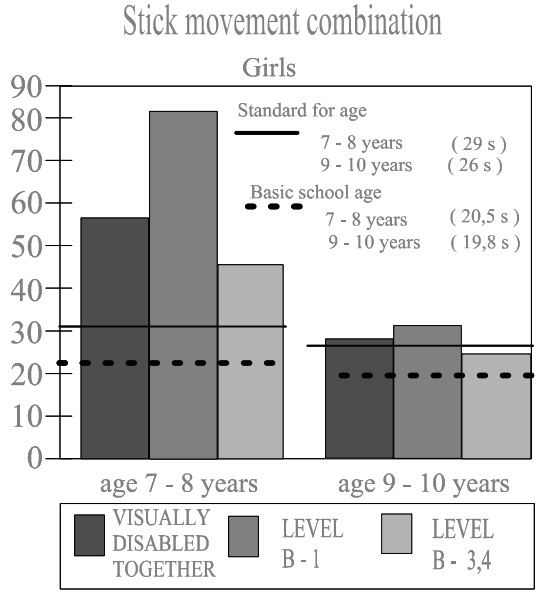
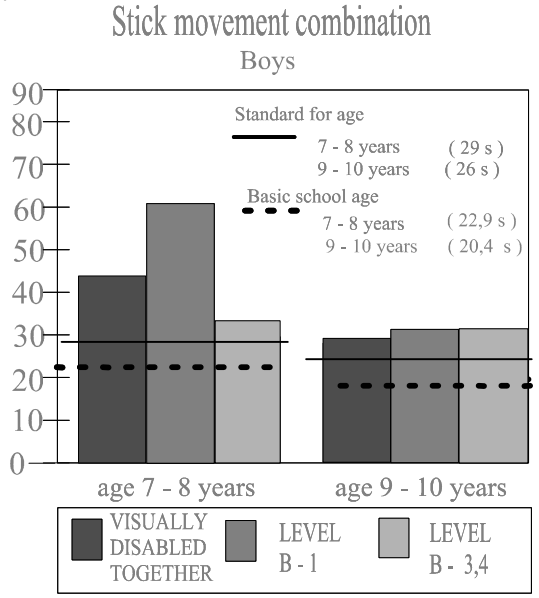


Fig. 4
Boys



CONCLUSIONS

A relatively little known field of motor competence in the case of children with visual disabilities led us to a long-term study of body, motor and social development of children with visual disabilities at the ages of 7–15 years. In our paper we have focused on early school-children, and on certain specific motor indicators. The aim was to evaluate children

with visual disabilities in all the above mentioned areas and to compare their results with the development trends in population in the same age with normal sight.

On the basis of the obtained data we can state that 7–10 year old girls with visual disabilities in both age categories and both categories by extent of disability are comparable in respect of height and weight to their equals in age with normal sight. A similar situation exists in the age categories with boys. The only exception is a group of 9–10 year old boys where the weight differs in a statistically significant way from that of boys of the same age with normal sight. On this basis we can conclude that morphological dispositions of children with visual disabilities are comparable to those of the population with normal sight.

Nevertheless, this is not true for psychomotor indicators, i.e. motor tests presented by us. In the case of standing broad jump the level of explosive strength of 7–8 year old boys with visual disabilities (B–1 and B–3,4 categories) differs in a statistically significant way from the boys of the same age with normal sight. A similar situation is in the category of older boys and girls. In the movement test "stick movement combination" we again obtained similar results for all categories of boys and girls with visual disabilities as in the case of standing broad jump. Both categories of girls and boys with visual disabilities differ in a statistically significant way from children of the same ages with normal sight. We assume that the reason of this is an insufficient development in some areas of motor system. We therefore recommend designating intervention programs to support development of those abilities and skills, development of which is most often delayed. Development of children with visual disabilities should be versatile and harmonious akin to those of children with normal sight.

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MOTORISCHE KOMPETENZ UND SEHBEHINDERUNG BEI DEN KINDERN IM ALTER 7 BIS 10 JAHRE

(Zusammenfassungsdes englischen Textes)

Die verhältnismäßig wenig untersuchte Problematik der motorischen Kompetenz bei Kindern mit einer Sehbehinderung führte uns zu einer langfristigen Untersuchung der körperlichen, motorischen und sozialen Entwicklung von sehbehinderten Kinder in einem Alter zwischen 7 und 15 Jahren. In unserem Beitrag konzentrierten wir uns auf die Altersgruppe des jüngeren Schulalters und auf einige motorische Kennziffern. Unser Ziel war die Beurteilung der Entwicklungstendenzen bei Kindern mit einer Sehbehinderung in allen oben genannten Bereichen und der Vergleich mit den Entwicklungstrends bei einer altersmäßig vergleichbaren Population ohne Sehbehinderung.

Aufgrund der ermittelten Tatsachen kann festgestellt werden, daß Mädchen zwischen 7 und 10 Jahren mit einer Sehsbehinderung in beiden Altersgruppen und mit beiden Behinderungsgraden mit gleichaltrigen Altersgenossen in Körpergröße und Körpergewicht vergleichbar sind. Ähnlich ist es auch in beiden Altersgruppen bei Jungen. Eine Ausnahme bildet nur eine Gruppe von Jungen zwischen 9 und10 Jahren, wo das Gewicht auf eine statistisch bedeutende Weise höher ist im Vergleich zu gleichaltrigen Jungen ohne Sehbehinderung. Aus diesen Tatsachen ergibt sich, daß die morphologischen Voraussetzungen bei Kindern mit einer Sehbehinderung mit der normal sehenden Population vergleichbar sind.

Dies bestätigt sich jedoch in psychomotorischen Kennziffern in den von uns präsentierten Beispielen der motorischen Tests nicht. Beim Weitsprung aus dem Stand bei blinden und schwachäugigen Jungen in einem Alter zwischen 7 und 8 Jahren (Kategorie B – 1 und B – 3,4) unterscheidet sich das Niveau der Explosivkraft statistisch bedeutend von der Explosivkraft

der gleichaltrigen Jungen ohne Sehbehinderung. Ähnlich ist es auch in der Kategorie älterer Jungen und in beiden Mädchen-Altersgruppen. Im Bewegungstest „Übung mit dem Stab“ sind wir in allen Altersgruppen blinder Mädchen und Jungen zu ähnlichen Ergebnissen wie beim Weitsprung aus dem Stand gekommen. Beide Altersgruppen der sehbehinderten Mädchen und Jungen unterscheiden sich statistisch bedeutend von ihren normal sehenden Altersgenossen. Wir nehmen an, daß der Grund für diesen Zustand eine unzureichende Entwicklung einiger Gebiete der Motorik ist. Auf Grund unserer Ermittlungen empfehlen wir, Interventionsprogramme zur Förderung der Entwicklung dieser Fähigkeiten und Fertigkeiten zu erstellen, bei denen die Entwicklung am meisten zurückgeblieben ist. Es handelt sich nämlich darum, daß sich auch Kinder mit einer Sehbehinderung allseitig und harmonisch entwickeln können.

Schlüsselwőrter: die Motorische Kompetenz, die Sehbehinderungn, der Schüller, die Grundschule.

MOTORICKÁ KOMPETENCE 7–10 LETÝCH DĚTÍ SE ZRAKOVOU VADOU

(Souhrn anglického textu)

Poměrně málo zkoumaná problematika motorické kompetence u dětí se zrakovým postižením nás vedla k dlouhodobému sledování tělesného, motorického a sociálního vývoje zrakově postižených dětí ve věku od 7 do 15 let. V našem příspěvku jsme se zaměřili na kategorii mladšího školního věku a na některé motorické ukazatele. Cílem bylo posouzení vývojových tendencí dětí se zrakovým postižením ve všech výše jmenovaných oblastech a srovnání s vývojovými trendy obdobně staré vidící populace.

Na základě zjištěných skutečností můžeme konstatovat, že dívky 7–10leté se zrakovým postižením obou věkových kategorií a obu stupňů postižení jsou výškově i hmotnostně srovnatelné se stejně starými vrstevníky. Obdobně je tomu i obou věkových kategorií chlapců. Výjimku tvoří pouze skupina 9 10letých hochů, kde je hmotnost statisticky významným způsobem vyšší v porovnání se stejně starými hochy vidícími. Na základě tohoto můžeme konstatovat, že morfologické předpoklady dětí se zrakovým postižením jsou srovnatelné s normálně vidící populací.

Toto se však nepotvrzuje v psychomotorických ukazatelích, námi prezentovaných příkladů motorických testů. U skoku do dálky z místa u nevidomých a slabozrakých hochů ve věku 7–8 let (kategorie B – 1 a B – 3,4) se úroveň explozivní výbušné síly statisticky významně liší od úrovně explozivní výbušné síly stejně starých vidících hochů. Obdobně je tomu tak i u kategorie starších hochů a u obou věkových kategorií dívek. V pohybovém testu „sestava s tyčí“ jsme opět u všech kategoriích nevidomých dívek i hochů dospěli k obdobným výsledkům jako u skoku do dálky z místa. Obě kategorie zrakově postižených dívek i hochů se statisticky významně liší od svých normálně vidících vrstevníků. Předpokládáme, že důvodem toho stavu je nedostatečný rozvoj některých oblastí motoriky. Proto doporučujeme na základě našich zjištění sestavit intervenční programy na podporu rozvoje těch schopností a dovedností, ve kterých dochází nejčastěji k opožďování vývoje. Jde totiž o to aby se i děti se zrakovým postižením rozvíjely všestranně a harmonicky.

Klíčová slova: motorická kompetence, zrakové postižení, žák, základní škola.

SCORING SKILLS PERFORMANCES OF THE TOP INTERNATIONAL MEN'S SITTING VOLLEYBALL TEAMS

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This survey attempts to establish the structure of scoring skills in sitting volleyball. The sample comprised 12 of the top international men' s sitting voleyball teams that took part in the World Sitting Volleyball Championship in Tehran in 1998. To evaluate the competition we used Volleyball Information System (VIS), version 1.50 and forms P-2, P-4. Statistical Match Analysis (SMA) was used for presenting the team performances in scoring skills: attack, block, serve and opponent error. The result of this study will allow the players, coaches, officials and others interested in sitting volleyball to get a closer look at this specific sporting activity for the disabled.

Keywords: competitive sport, sitting volleyball, volleyball scoring skills, physically disabled.

INTRODUCTION

As a high level competitive sport, sitting volleyball arrived on the international scene relatively late, in 1980. That year sitting volleyball became an official event at the Paralympic Games for the first time in Arnhem, The Netherlands. Medal winners at this turning-point tournament were The Netherlands, gold, Sweden, silver and Yugoslavia, bronze. Nowadays, there are several international top level sitting volleyball teams in four world zones: Arab / African, Asia / Oceania, Pan American and European. If we take a look at the development of elite sitting volleyball in regard to the zones and their rankings in international championships, it becomes evident that Europe has lost its top position, but remains a leading zone in men's sitting volleyball. Some national federations have established long term elite sitting volleyball development programmes which are supported by governments or privately by companies. Without long terms programmes and quality management, it is impossible for national team to stay at the top. Some federations develop national teams based on their club system and their national competition programmes, others train their national players year around in special camps. To become number one in the world of sitting volleyball, the team must create something new in play and training and must work hard and to a superior level.

Sitting volleyball is a team sport which originated in the Netherlands. Over 90 countries around the world now play the game. We follow the FIVB (Federation Internationale de Volleyball) rules of the game, with additions from the WOVD (World Organisation Volleyball for Disabled) rules and regulations for sitting volleyball. Some characteristics and facts: the playing court is a rectangle measuring 10 m × 6 m, the attack line is drawn 2 m back from the central line, the net, 0.80 m by 6.50 m is placed vertically over the centre line and is 1.15 m high for the men, players use hands for moving, sweeping on the playing court, buttocks must remain on the floor when playing the ball, block on the service is allowed, for official tournaments a classification on minimum disability is required.

Elite competitive sport is probably the most disputable part of the whole sport sphere regarding the physically disabled and their participation. The demonstration of power and abilities is common in sport generally and specifically in the sport for disabled including top sitting volleyball (Vute, 1994). Participants at the sport excellence level generally engage in sport to fulfill an intense personal desire to excel and to reach their personal limits. In doing so, they achieve high standards of performance accompanied by appropriate personal, physical, intellectual and emotional qualities. At this level of participation, there must be a willingness to accept the required external conditions imposed by coaches, officials and others (Steadward, 1992). Volleyball sport enables two very important processes, identification of an individual and integration into the collective. Satisfaction means complete identification with the team according to the needs, motives, interests, expectations, valuables and models. Satisfaction also means reward and amply repays the effort for all what one has done in their life as coach or player (Krevsel, 1997). Victory and the title of champion are becoming more and more important in the competition of people with physical disabilities. Emphasizing the importance of success is reflected in clear expectations of some benefits that are possible through sports activities (Vute, 1992). To study volleyball statistics we should be fully aware of

the following (Papageorgiou & Spitzley, 1996; Beal, Brassey & Brown, 1993): first, the need for a fundamental understanding of the available principles regarding volleyball analysis. There are many different tools that can be used and invented. Statistics go far beyond kills and aces; second, that understanding volleyball statistics can better prepare the volleyball coach to record and analyse his or her team's performance; third, that understanding volleyball statistics can help the coach decide on the most important skills to be measured; fourth, that if all the coaches and a staff understand volleyball statistics, the statistics can give direction to staff assignments and full advantage can be taken of available personnel.

THE MAIN AIM

The purpose of this study is to find out the structure of scoring skills in elite international men's sitting volleyball teams, therefore we intend to:

- analyse top sitting volleyball team performances: set score, points score and playing time,
- find out the structure of scoring skills (attack, block, serve, opponent error) of the teams ranking from 1st to 6th place,
- find out the structure of scoring skills (attack, block, serve, opponent error) of the teams ranking from 7th to 12th place,
- establish a model of scoring skills of the top international men's sitting volleyball teams.

METHODS

The study group consisted of the national sitting volleyball men's teams who qualified for the 7th World Sitting Volleyball Championship in Tehran, Iran in April 1998. The number of teams taking part in this Championship was 12, with 127 active players, including Australia (AUS, 11 active players, final rank XII.), Bosnia and Herzegovina (BIH, 12, III.), Egypt (EGY, 12, VII.), Finland (FIN, 10, II.), Germany (GER, 12, V.), Iran (IRI, 12, I.), Iraq (IRQ, 11, IX.), Japan (JPN, 8, XI.), Kazakhstan (KZK, 11,VIII.), the Netherlands (NED, 10, IV.), Norway (NOR, 10, VI.) and Slovenia (SLO, 8, X.). Teams ranking from 1st to 6th place were represented by 66 active players and teams ranking from 7th to 12th by 61 active players. Eligible for competitions in sitting volleyball at the World Championships are those athletes with disabilities defined as amputees and "les autres", which includes motor paresis or paralysis of limb(s), displasia or luxation of the coxae, total endoprothesis of knee or hip(s) and instability forward / backward of 1.5 cm of the knee.

The subject of this survey is the teams' performance in scoring skills: attack, block, serve and opponent error. Volleyball Information System (VIS), version 1.50 (Build 36), forms P – 2, P – 4 and Statistical Match Analysis (SMA) were used to present the results. Volleyball Information System (VIS), a computer system for match analysis, was developed by FIVB, with the main purpose to provide quality data on match results and on team and individual player statistics. Form P – 2 provides data on team performances: attack (total attempts, points scored, side-out), block (total attempts, points scored, side-out), serve (total attempts, points scored), opponent error (points scored, side-out), set score, points score and playing time. Form P – 4 provides match results and team ranking. Statistical Match Analysis (SMA) is the essential method of match analysis. The immense amount and diversity of playing actions require classification into categories. The most common classification takes into account tactical aspects which include basic skills of attack: hitting the ball into opponent's side, block: a play by one or more players attempting to stop a spike at the net, serve: the act of putting the ball in play and opponent error: team own faults which result in loss of service or a point to the opposing team, for example: four contacts, double fault, double contact, ball out, held ball, ball touches the net from the service. The data were collected with computers by specially trained volleyball officials, rating in two stages, score and error.

RESULTS AND DISCUSSION

Objective measurement, evaluation, analysis and interpretation of player and team performance are vital in scientific training and development of top class teams in modern volleyball. Sitting volleyball is inseparable part of this orientation. There are three main elements characterising modern top volleyball which are indispensable and decisive for the highest performance: velocity and variety of play, height of action above the net and perfection of skills. These elements are closely linked and form the so called "magic triangle". Without a high level of all three, there will not be a top result in international volleyball competitions. Weakness in one can hardly be compensated for by advantages in the other two. Best results may be expected when the three are balanced. If there is a disadvantage in one element, for instance in height of action above the net, one has to work very hard to compensate for this lack by extraordinary performance in one or both of the others. The same standards are set for sitting volleyball, given that jumps are not an element in this specific volleyball game.

Sitting volleyball top teams performances

In the Tehran World Sitting Volleyball Championship the 12 men's national teams were divided into two pools of 6 teams. In the preliminary round, each team played all others in their pool. The top 4 teams

from each pool advanced in a single elimination format to determine places one to eight. The remaining 4 teams played a single elimination format designed to determine places nine through twelve.

National teams which qualified for the 7th Sitting Volleyball Championship came from 3 of 4 zones which are divided by WOVD, World Organisation Volleyball for Disabled. There were two teams, from Japan and

TABLE 1
Performances of the teams ranking from 1st to 4th place

PLACE	I.	II.	III.	IV.
team	IRI	FIN	BIH	NED
No. of games	8	8	8	8
set score	24 : 0	18 : 11	23 : 4	16 : 10
points score	361 : 142	366 : 301	375 : 250	332 : 227
playing time	403 min (6.72 h)	583 min (9.72 h)	492 min (8.20 h)	461 min (7.68 h)
SCORING SKILLS	won P S–O TATT	won P S–O TATT	won P S–O TATT	won P S–O TATT
attack	119– 166– 852	121– 253– 1276	112– 184– 1081	111– 195– 1002
block	94 – 31 – 434	76 – 36 – 597	73 – 38 – 522	41 – 24 – 395
serve	35 – 0 – 620	30 – 0 – 771	47 – 0 – 691	50 – 0 – 650
opponent error	113 – 62	139 – 122	143 – 104	130 – 98
TOTAL TEAM	361– 277– 1906	366–401– 2626	375–326–2294	332–317–2047

P: points scored
S–O: side – out
TATT: total attempts

TABLE 2
Performances of the teams ranking from 5th to 8th place

PLACE	V.	VI.	VII.	VIII.
team	GER	NOR	EGY	KZK
No. of games	8	8	7 *(8)	7 *(8)
set score	18 : 9	13 : 13	6 : 15	6 : 17
points score	335 : 279	328 : 295	228 : 269	191 : 354
playing time	539 min (8.98 h)	584 min (9.73 h)	435 min (7.25 h)	422 min (7.03 h)
SCORING SKILLS		won P S–O TATT	won P S–O TATT	won P S–O TATT
attack	116– 258– 1169	109– 194– 1208	67 – 157 – 885	45 – 89 – 641
block	43 – 27 – 445	42 – 40 – 458	49 – 40 – 449	26 – 30 – 329
serve	36 – 0 – 719	70 – 0 – 667	22 – 0 – 524	30 – 0 – 421
opponent error	140 – 106	107 – 119	90 – 92	90 – 112
TOTAL TEAM	335–391–2333	328– 353– 2343	228– 289– 1858	191– 231– 1391

*(8) EGY : KZK, 3:0, no game

TABLE 3
Performances of the teams ranking from 9th to 12th place

PLACE	IX.	X.	XI.	XII.
team	IRQ	SLO	JPN	AUS
No. of games	7	7	7	7
set score	12 : 13	7 : 15	3 : 18	0 : 21
points score	311 : 277	188 : 264	146 : 288	55 : 315
playing time	479 min (7.98 h)	349 min (5.82 h)	323 min (5.38 h)	223 min (3.72 h)
SCORING SKILLS	won P S–O TATT	won P S–O TATT	won P S–O TATT	won P S–O TATT
attack	88 – 137 – 1100	58 – 132 – 771	33 – 93 – 708	6 – 31 – 337
block	46 – 38 – 481	30 – 24 – 273	21 – 8 – 198	2 – 19 – 166
serve	21 – 0 – 605	27 – 0 – 436	30 – 0 – 358	10 – 0 – 117
opponent error	156 – 121	73 – 81	62 – 101	37 – 60
TOTAL TEAM	311– 296– 2186	188– 237– 1480	146– 202– 1264	55– 110– 680

the host of Sydney 2000 Paralympic Games, Australia, that were playing at the tournament on such high international level, for the first time. After a long absence from international scene Iraqi team qualified to come to the tournament. The total number of matches played at the Championship was 46. Teams therefore played 7 or 8 matches depending on their tournament ranking. Total set score varied from the winners' 24 : 0 to a score of 0 : 21 for the last placed team. Scoring points also varied. Among medal winners we have positive point score, gold medallist 361 : 142 (+219), silver medallist 366 : 301 (+65) and bronze medallist 375 : 250 (+125). The tournament point score was negative for the last three teams in the tournament, the 10th team reached 188 : 264 (–76), the 11th team reached 146 : 288 (–142) and 12th team scored 55 : 315 (– 260).The longest playing time at the Championship was 584 min (9:73 h) for Norway for 8 matches. The last team at the tournament deviated from others mainly because of its inexperience and not yet having reached a competitive level for a top world event in sitting volleyball.

Scoring skills of the top sitting volleyball teams

The intention of this study is to find out the structure of scoring skills in elite sitting volleyball teams. The subject of survey was team performances in attack, block, serve and opponent error. Attack is a general term used to describe how the ball is played over the net. Spiking is the primary and most dynamic skill used to attack the ball and is usually the third contact in the three contact offence. The greatest difference, according to McGown (1994), between top international volleyball and the game that most of us teach is the velocity of the players as they are playing. At the top level, players hurl themselves around the court at sprint velocities. These players use techniques in which the momentum created by these high velocities is transferred to the ball during the attack. Blocking, like spiking, is a primary determinant of success. Good blocking involves timing and the ability to read the offensive hitter's intentions. In sitting volleyball every player, short or tall, can have an effective role as a blocker. Blocking an opponent's service is permitted in sitting volleyball. Experienced blockers can often turn the block into an attacking shot and possibly a winning point. Blocking is often the last skill to be perfected and is probably the most complex sitting volleyball skill. Besides putting the ball in play, the serve can be an effective way for a team to score points quickly. A good server can provide the momentum to boost his team to victory. The only measure of whether a serve is effective is whether it leads to the serving team scoring points. Errors are part of the top sitting volleyball as well. Stress contributes significantly to inconsistency in players' on-court performance. Attack error: players keep hitting the ball out of bounds or into the net. They seem to lack control of their bodies. Blockers often have a hard time keeping their hands firm and angled properly. Players get frustrated when they cannot serve the ball into play consistently. The common causes of faults, which result in loss of service (side – out) or a point to the opposing team, are: the ball touches the ground, the ball does not cross the top of the net between the antennae, the ball hits antennae, the ball is played more than three times in succession by one team, the ball is held, the ball lands outside the boundary lines, a player touches the net or antennae, a player lifts his buttocks at the moment he hits the ball, positional fault, rotational fault, delayed substitution, interfering with the ball while in the opponents' half of the court, player makes an attacking stroke while the ball is in the opponents' court, or a player receives a misconduct penalty.

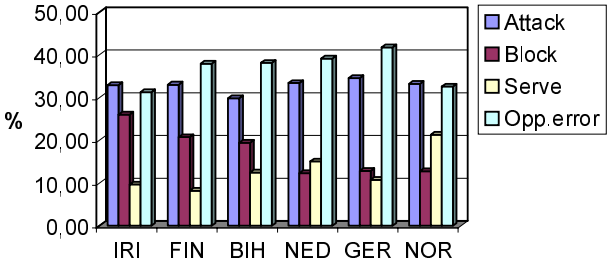
TABLE 4
Scoring skills of the teams ranking from 1st to 6th place

team / w points	I. IRI / 361	II. FIN / 366	III. BIH / 375
ATTACK	119	121	112
	32.96 %	33.06 %	29.87 %
BLOCK	94	76	73
	26.0 4%	20.77 %	19.47 %
SERVE	35	30	47
	9.69 %	8.19 %	12.53
OPP. ERROR	113	139	143
	31.30 %	37.98 %	38.13 %

team / w points	IV. NED / 332	V. GER / 335	VI. NOR / 328
ATTACK	111	116	109
	33.43 %	34.63 %	33.23 %
BLOCK	41	43	42
	12.35 %	12.84 %	12.80 %
SERVE	50	36	70
	15.06 %	10.75 %	21.34 %
OPP. ERROR	130	140	107
	39.16 %	41.79 %	32.62 %

w points: total winning points score

Fig. 1
Graphic presentation of the scoring skills of the teams ranking from 1st to 6st place



Scoring skills including attack, block, serve and opponent error show us the composition of those elements vital for sitting volleyball success at the top level. All the first six teams have a lot of experience and were medal winners at the biggest international championships like Continental, World and Paralympic, except for Bosnia and Herzegovina as a new country. However, Bosnia and Herzegovina have a sitting volleyball tradition from the former Yugoslavia, whose teams were on the scene from the very beginning. Percentage of attacks in the total winning points shows no big difference among the six best teams, the lowest score, 29.87 % attained by Bosnia and Herzegovina and the highest 34.63 % by Germany. The World Champions, Iran, have 32.96 %. Netherlands had the lowest percentage of point scoring blocks (12.35%) and Iran the highest (26.04%). Norway had the highest percentage of serves as a direct scoring element (21.34%) with Finland having the lowest among the top 6. Points from opponent error was 31.30 %, the lowest, to Iran and the highest, 41.79 %, to Germany. Iran shows the highest percentage among the top six teams in gaining points by blocking and also the lowest score in gaining points from opponent error. There seems to be an important corelation between active and passive points collection. Active and dynamic approach to attacking, blocking and serving is the key to success.

TABLE 5
Scoring skills of the teams ranking from 7th to 12th place

team / w points	VII. EGY / 228	VIII. KZK/ 191	IX. IRQ / 311
ATTACK	67	45	88
	29.39 %	23.56 %	28.29 %
BLOCK	49	26	46
	21.49 %	13.61 %	14.79 %
SERVE	22	30	21
	9.65 %	15.71 %	6.75 %
OPP. ERROR	90	90	156
	39.47 %	47.12 %	50.16 %
team / w points	X. SLO / 188	XI. JPN / 146	XII. AUS / 55
ATTACK	58	33	6
	30.85 %	22.60 %	10.91 %
BLOCK	30	21	2
	15.96 %	14.38 %	3.64 %
SERVE	27	30	10
	14.36 %	20.55 %	18.18 %
OPP. ERROR	73	62	37
	38.83 %	42.47 %	67.27 %

w points: total winning points score

The table of scoring skills among teams ranking from 7th to 12th clearly shows a surprisingly low level for the last team. An inexperienced team, struggling with the basic elements of sitting volleyball, used the privilege of wild card invitation. The reason for this team's attendance was that it will be the host of Sydney 2000 Paralympic games. Getting points through passive participation is therefore a surprise only in the first moment. To be good means to be active in the mastering of sitting volleyball's technical, tactical and psychological elements. Slovenia got high scores in this group for attack skills, with 30.85 %, Egypt for blocking points with 21.49 % and Japan for serving points with 20.55 % in winning points structure.

Fig. 2
Graphic presentation of the scoring skills of the teams ranking from 7th to 12th place

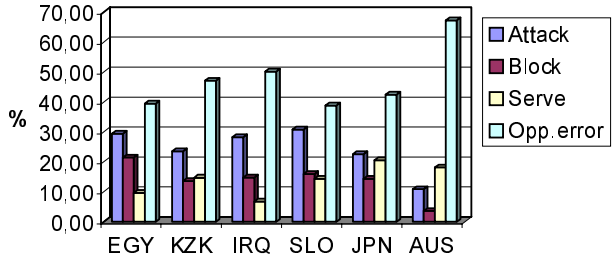
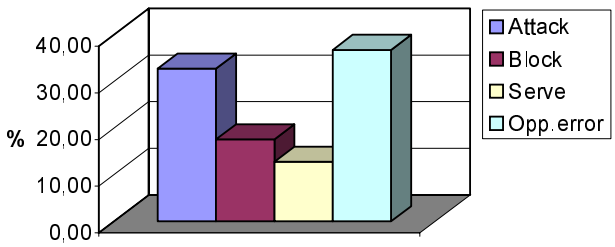


TABLE 6
Scoring skills of the "winning group", teams ranking from 1st to 6th place

	teams 1–6 total winning pt. score: 2097	teams 1–6 total winning pt. score: 2097	teams 1–6 total winning pt. score: 2097	teams 1–6 total winning pt. score: 2097
attack winning points	688 32.81 %			
block winning points		339 17.60 %		
serve winning points			268 12.78 %	
opponent error				772 36.81 %

Fig. 3
Graphic presentation of the scoring skills of the "winning group", teams ranking from 1st to 6st place



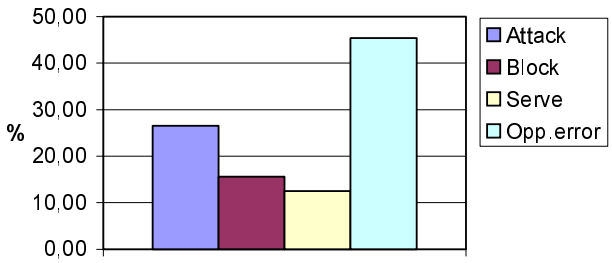
This presentation of the scoring skills of the "winning group", as we may call teams ranking from first to sixth place, shows us the order of individual scoring skills: attack 32. 81 %, block 17.60 % and serve 12.78 %

as active winning points and opponent error the highest at 36.81 %, as a passive way of collecting points. Good team can force weaker opponent to make an error in play.

TABLE 7
Scoring skills of the "losing group", teams ranking from 7th to 12th place

	teams 7–12 total winning pt. score: 1119	teams 7–12 total winning pt. score: 1119	teams 7–12 total winning pt. score: 1119	teams 7–12 total winning pt. score: 1119
attack winning points	297 26.54 %			
block winning points		174 15.54 %		
serve winning points			140 12.51 %	
opponent error				508 45.40 %

Fig. 4
Graphic presentation of the scoring skills of the "losing group", teams ranking from 7th to 12th place



The so called "losing group", teams ranking from the seventh to twelfth place have the same scoring points structure as the "winning group", but with obviously lower percentage in active scoring in attack actions, blocking and serving, while opponents error score is higher than in the other group with 45.40 % to 36. 81 % in favor of lower ranking teams. Besides other factors lower ranking teams play more games with each others which also increase points from opponent error. To avoid an error, players should use errors to prompt themselves on what to do in the next play. Confidence is built through success in practices and competition and recognition of those successes.The importance of establishing a positive environment is crucial for all, especially for those teams wanting to learn from mistakes and make progress.

Model of scoring skills of top sitting volleyball teams

An analysis of both groups, "winning and losing", shows us the position of an individual scoring skill in the whole scoring skills structure. Attack winning points: "winning group" 32.81 %, "losing group" 26.54 %, block winning points: "winning group" 17.60 %, "losing group" 15.54 %, serve winning points: "winning group" 12.78 %, "losing group" 12.51 %, opponent error points: "winning group" 36.81 %, "losing group" 45.40 %. The established ranking order of collecting winning points: opponent error (rank 1), attack (rank 2), block (rank 3) and serve (rank 4) represents a model of skills of top sitting volleyball teams. The high percentage of opponent error shows the complexity of the sitting volleyball game, in which besides scoring skills, the playing system has an important role as well as the level of tournament, importance of the game and how serious the opponent players' approach is. Opponent error varied from four contacts to positional fault, rotational fault, to player misconduct penalty. Active approach to attacking, blocking and serving is, we believe, the key to success. As a reminder, in sitting volleyball the players in the attacking area are allowed to block the serve from the opposite team. The quality gap between first and last ranking teams at the Championship is evident in scoring skills structure, Iran (1st place): attack (32.96%), block (26.04%), serve (9.69%), and opponent error (31.30%), Australia (12th place): attack (10.91%), block (3.64%), serve (18.18%) and opponent error (67.27%). Rookie Australian team, invited (not qualified) as the host of Sydney 2000 Paralympic games, should start to gain their international experience at a lower level than World Championship competition. According to WOVD rules, in sitting volleyball, athletes with minimal disability are eligible for official competition. Minimal disability is required to avoid a situation where able bodied athletes will take part in world championships for the disabled. Minimal disability classification covers four areas: amputees (minimal disability examples: amputation of the first two fingers of both hands, amputation in Lisfranc joint on one foot), "les outres" (minimal disability examples: shortening on one upper limb of more than 33 %, motor paresis or total paralysis of upper limb, joint mobility specific problems), cerebral palsy (minimal disability examples: hemiplegics, monoplegics, minimal athetoids) and special cases (examples: severe circulation defect of lower limb(s), instability forward / backward of 1.5 cm the knee, luxation of humeroscapular joint). A curiosity of the competition were teams from Iran (1st place), Bosnia and Herzegovina (3rd place) and Iraq (9th place) with complete amputee teams. Effects of the wars and especially land mines need no further explanation. The other teams had mixed ability players, but also a clear majority of amputees. Sitting volleyball appears to be the most suitable ball game for amputees. On the other hand, the team from Egypt (7th place) consisted exclusively of polio players, presumably because of their strong national sport organisation.

CONCLUSION

The attempt to find out the structure of scoring skills in top sitting volleyball teams by analysing the points obtained through attack, block, serve and opponent error, leads us to the conclusion that all these sitting volleyball elements are similarly distributed among all participating national teams. Differences in the quality of teams' performances did not change the overall distribution of points, despite the enormous gap between some teams. Results show that the scoring skills in top sitting volleyball teams were as follows: teams ranking from 1st to 6th place: attack 32.81 %, block 17.60 %, serve 12.78 % and opponent error 36.81 %, teams ranking from 7th to 12th place: attack 26.54 %, block 15.54 %, serve 12.51 %, opponent error 45.40 %. Gathering information on volleyball for the disabled at the top level is the first step towards monitoring and analysing this specific game in detail. From now on, with an established scoring point structure for sitting volleyball, opponent error (rank 1), attack (rank 2), block (rank 3), serve (rank 4), doors are open to further investigation including comparison with top level able bodied volleyball, which is always a big challenge and inspiration. We are aware that Statistical Match Analysis (SMA) cannot completely reflect the entire performance of a team. There are so many factors of performance that cannot be grasped or evaluated by SMA, for instance, actions without the ball are difficult to include in SMA. The results of actions are dependent on opponents and team mates, psychological factors, etc. We believe that this survey means a step forward to better understanding sitting volleyball and could help coaches, players, teachers, officials and others to make their volleyball orientated efforts more efficient. Objective measurement, evaluation, analysis and interpretation of player and team performance are indispensable in scientific training and development of top class teams in modern sitting volleyball. This scoring point structure was established for the first time in top level international sitting volleyball competition.

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WIE DIE BESTEN INTERNATIONALEN MANNSCHAFTEN IM SITTING VOLLEYBALL DIE ZUM ERWERB VON PUNKTERGEBNISSEN NOTWENDIGEN FERTIGKEITEN REALISIEREN

(Zusammenfassung des englischen Textes)

Diese Übersicht ist ein Versuch eines Aufbaus einer Struktur von Fertigkeiten, die zum Erwerb von Punktergebnissen im Sitting Volleyball nötig sind. Die Stichprobe umfaßte die 12 besten internationalen Mannschaften, die an der Sitting Volleyball-Weltmeisterschaft in Teheran 1998 teilnahmen. Bei der Bewertung des Wettbewerbs bedienten wir uns des Informationssystems Volleyball Information System (VIS), Version 1.50 und Form P-2, P-4. Die statistische Analyse des Wettkampfs (SMA) wurde für die Präsentierung der Leistungen der einzelnen Mannschaften und ihrer Realisierung der einzelnen, für den Gewinn eines Punktes notwendigen Fertigkeiten verwendet: Sturm, Block, Service und die Ausnutzung des Fehlers des Gegenspielers. Die Ergebnisse dieser Studie ermöglichen den Spielern, Trainern, leitenden Angestellten und allen, die sich für das Sitting Volleyball interessieren, sich mit dieser Sportart für Körperbehinderte näher vertraut zu machen.

Schlüsselwörter: Wettbewerbssporte, Sitting Volleyball, zum Erwerb von Punktergebnissen notwendige Fertigkeiten, Körperbehinderte.

PŘÍLEŽITOSTI KE SKÓROVÁNÍ A SCHOPNOST JEJICH VYUŽITÍ U VRCHOLOVÝCH MEZINÁRODNÍCH DRUŽSTEV V SITTING VOLEJBALU MUŽŮ

(Souhrn anglického textu)

Tento přehled je pokusem o vybudování struktury v dovednostech potřebných ke skórování v sitting volejbalu. Namátkový průzkum zahrnoval 12 nejlepších mezinárodních družstev, která se zúčastnila Mistrovství

světa v sitting volejbalu mužů v Teheránu v roce 1998. K hodnocení soutěže jsme použili informační systém Volleyball Information System (VIS), verzi 1.50 a formy P-2, P-4. Statistická analýza zápasu (SMA) byla užita k prezentaci výkonů jednotlivých mužstev a jejich využití jednotlivých příležitostí ke skórování: útoku, bloku, podání a využití protihráčovy chyby. Výsledky této studie umožní hráčům, trenérům, vedoucím pracovníkům a všem, kdo se zajímají o sitting volejbal, seznámit se podrobněji s tímto sportem pro tělesně postižené.

Klíčová slova: soutěživé sporty, sitting volejbal, schopnost skórovat, tělesně postižení.

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