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Original empirical article

COMPARISON AND ANALYSES OF DIFFERENCES IN FLEXIBILITY AMONG TOP-LEVEL MALE AND FEMALE HANDBALL PLAYERS OF DIFFERENT AGES

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Igor Gruić, Katarina Ohnjec, Dinko Vuleta

Faculty of Kinesiology University of Zagreb, Croatia

Abstract. *A battery comprised of 10 tests estimating global (sit and reach) and topologically defined flexibility (over-arm flip, hip flexion, extension and abduction), was assessed on the sample of subjects represented by a 38 male (24 junior and 14 senior) handball players and 34 female (18 junior and 16 senior) handball players, with the aim of determining the differences in general and local flexibility, with regard to the competition age of the subjects. The results of the analyses of differences (t-test) showed that statistically significant differences between junior and senior male team handball players were determined in the variables estimating flexibility of the shoulders and related body zone (MFLIP – over-arm flip), hamstrings (MFLPLL and MFLPLD) and flexibility of m. quadriceps and part of pelvic region (MFLZLL – hip extension of the left leg while lying face down, and MFLZLD – hip extension of the right leg while lying face down). Statistically significant differences were noted between junior and senior female handball players in the variables estimating flexibility of the lower back with related body zone (MFLSAR – seat and reach), hamstrings (MFLPLL – hip flexion of the left leg while lying in a supine position, and MFLPLD - hip flexion of the right leg while lying in a supine position).*

Key words: *flexibility, handball, age, differences.*

INTRODUCTION

Flexibility as a basic motor ability is mostly explained in terms of free movements with maximal amplitudes in particular joint/angular body systems. Performance efficiency of typical movement structures in the majority of sports is determined by the flexibility of joints and the strength of muscles. In team handball the optimal level of

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Corresponding author: Igor Gruić
Faculty of Kinesiology, University of Zagreb, Horvaćanski zavoj 15, 10 000 Zagreb, Croatia • Tel: + 385 1 365 87 54 • Fax: + 385 1 36 34 146 • E-mail: igruic@kif.hr

flexibility implies 1) the possibility of maximal usage/manifestation of other motor abilities, and 2) the improvement of technical performance of elements that can assure an advantage over one's opponent. The specific nature of handball as a game requires additional improvement of dynamic flexibility, which is supposed to be implemented in different operators in each training cell, usually conducted at the beginning of a training session or competition as part of direct sport preparation. In long term sport preparation, the methods for the improvement of flexibility have to be applied in concordance with the most sensitive periods/phases of athletes' development.

Integral diagnostic procedures consist of the measurement and evaluation of the basic anthropological status of an individual, and specific abilities/characteristics and knowledge responsible for successful performance of technical-tactical elements in handball. Diagnostic procedures provide answers to questions about actual status; they initiate changes, motivate progress and finally confirm it.

The results of numerous diagnostic procedures conducted on male handball (Kuleš & Šimenc, 1983; Milanović, Vuleta & Šimenc, 1997; Vuleta 1997) and female player samples which differed in age and quality (Čavala, Rogulj & Srhoj, 2002; Rogulj et al., 2005), based on the application of a sample of variables, presented the level and status of basic motor abilities dominant for success in handball (according to the hierarchical model outlined in Milanovic, Vuleta & Šimenc, 1997). A smaller number of investigations aimed at determining the state and level of flexibility for male and female handball players is also explained by the fact that the used sample of variables comprised only the one touch - toe astride test (MFLPRR). In this study, as in the latest diagnostic procedures, this principle has been changed out of the necessity of using more tests to explain the observed space.

The interpretation of the results achieved in the tests of flexibility should be aimed at determining the relations between flexibility and the performance of elements of the handball technique. Shooting performance, unconditioned by position and modality, activates joints with a certain time-space order and at a certain pace. Biomechanical analyses of different kinetic and kinematic parameters should not be conducted without anatomic observation through mioelectric/bioelectric parameters. Basic muscle groups which are most active in the performance of handball techniques are muscles extensors – m. pectoralis major, m.deltoideus, m triceps brachii, forearm muscles (m. extensor carpi radialis longus et brevis, m. extensor digitorum, m. extensor digiti minimi, m. extensor carpi ulnaris, m. anconeus), m. quadriceps femoris, m. gastrocnemius and m. soleus, and muscles flexors – m. biceps brahii, forearm muscles (m. flexor carpi radialis, m. flexor carpi ulnaris, m. flexor digitorum supraficialis, m. flexor digitorum profundus, m. policis longus), m. rectus abdominalis, m. biceps femoris, m. semitendinosus (according to Vuleta, Milanović & Gruić, 2003; in Jonat, 1981).

Optimal flexibility of the lumbar spine zone (the back) is a precondition for the efficient performance of all shooting techniques due to the ability of a well-timed performance of pre-throwing and after-throwing rotations, counter-rotations and torsions (as the main gathering part of the performed ‘kinetic chain'). Improved flexibility of the lumbar spine enables adequate situational adaptation and the modification of basic motor shooting stereotypes into variants of shooting performances from different altitudes and with different levels of body deflection (bending). Optimal flexibility in the shoulders is also a precondition of the previously described performance. Jump shooting requires the additional, mostly unilateral, ability of enhanced adduction and flexion of the swing leg, during the swing and during blocking.

METHODS

The participants

The participants numbered 34 female and 38 male professional handball players, subdivided into four groups, i.e. 16 senior female players from the Croatian national team (the diagnostics were carried out in Kostrena, Croatia, 2005), 18 young (17-18 years old) female players from the Croatian national team (the diagnostics were carried out in Pula, Croatia, 2006), 15 senior male players from HC 'Medvešćak-Infosystem', Zagreb (the diagnostics were carried out in Zagreb, Croatia, 2005), and 24 junior (18 years) female players from the Croatian national team (the diagnostics were carried out in Pula, Croatia, 2006).

Instruments

The sample of variables consisted of 5 tests estimating the levels of flexibility of different topologically defined regions of the body (Table 1).

Table 1. Sample of variables

Test	Test description	Object of measurement
MFLSAR	"sit and reach"	flexibility of the lumbar spine zone
MFLIP	over flip with stick	flexibility of the shoulder zone
MFLPLK	hip flexion of the leg while lying in a supine position	flexibility of the back of the upper legs
MFLZLP	hip extension of the leg while lying face down	flexibility of the front of the upper legs and lower pelvic region
MFLOLB	abduction while lying on the side	flexibility of adductors and abductors of the upper legs

Procedure

The data were entered into Statistica 7.0 for Windows. Descriptive parameters were calculated for each observed variable. The differences between the subgroups of the sample of subjects were analyzed using the t-test for independent samples.

THE RESULTS

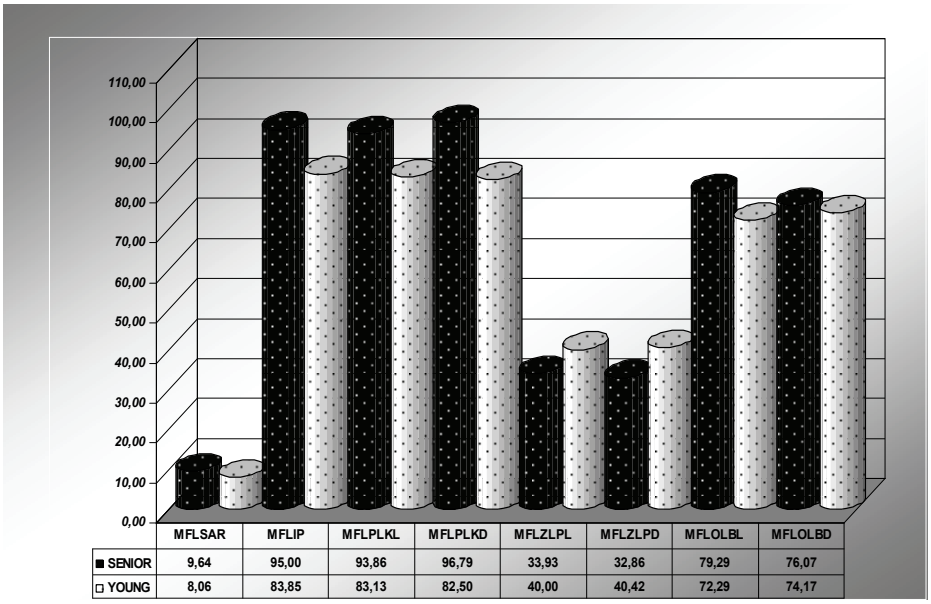
The central and dispersive parameters of the studied subgroups of handball players reveal some differences (Table 2). The means of the subgroups are presented graphically in graph 1 and graph 2.

The process of determining the differences between the male and female subgroups was carried out by means of the t-test (Table 3). The results of the analysis indicate a statistically significant difference between the senior and junior male handball players in the tests used to estimate flexibility of the arm and arm zone (MFLIP), flexibility of the back of the upper legs (MFLPLK), and flexibility of the front of the upper legs and lower pelvic region (MFLZLP).

Table 2. Descriptive parameters

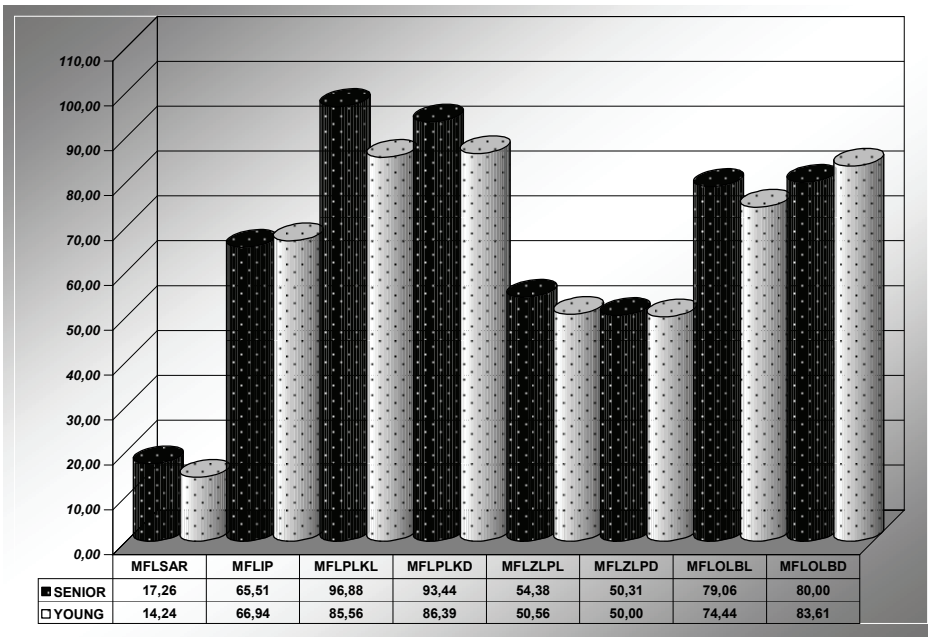
	Seniors m (1)			Juniors m (2)			Seniors f (3)			Juniors f (4)		
	N	AS	SD	N	AS	SD	N	AS	SD	N	AS	SD
MFLSAR	14	9.64	11.13	24	8.06	9.10	16	17.26	3.82	18	14.24	3.19
MFLIP	14	95.00	17.50	24	83.85	13.73	16	65.51	18.73	18	66.94	11.03
MFLPLKL	14	93.86	10.34	24	83.13	10.61	16	96.88	11.24	18	85.56	11.10
MFLPLKD	14	96.79	12.20	24	82.50	9.33	16	93.44	9.08	18	86.39	7.44
MFLZLPL	14	33.93	7.02	24	40.00	4.89	16	54.38	9.64	18	50.56	7.45
MFLZLPD	14	32.86	6.42	24	40.42	5.50	16	50.31	11.18	18	50.00	8.74
MFLOLBL	14	79.29	12.85	24	72.29	8.47	16	79.06	8.98	18	74.44	10.56
MFLOLBD	14	76.07	11.83	24	74.17	8.93	16	80.00	8.76	18	83.61	8.01

*results in variables MFLPLK, MFLZLP, MFLOLB are presented for the left and right leg (L, D)



Graph 1. Topological comparison of flexibility between senior and junior male handball player

The results of the t-test analysis indicate a statistically significant difference between the senior and junior female handball players in tests used to estimate the flexibility of the lumbar spine zone (the back) (MFLSAR), and flexibility of the back of the upper leg (MFLPLK).



Graph 2. Topological comparison of flexibility between senior and junior female handball players

Table 3. T-test analysis of the differences in flexibility of male and female senior and junior handball players

T-test				
	Male		Female	
	t-value	p	t-value	p
MFLSAR	0.47	0.64	2.51	0.02
MFLIP	2.16	0.04	-0.28	0.78
MFLPLKL	3.04	0.00	2.95	0.01
MFLPLKD	3.99	0.00	2.49	0.02
MFLZLPL	-3.33	0.00	1.30	0.20
MFLZLPD	-3.84	0.00	0.09	0.93
MFLOLBL	1.99	0.05	1.36	0.18
MFLOLBD	0.55	0.58	-1.26	0.22

DISCUSSION

Statistically significant differences in terms of flexibility between the senior and junior male handball players were determined in the tests used to estimate the flexibility of the arm and arm zone (MFLIP; $p<.05$), flexibility of the back of the upper legs (MFLPLK; $p<.01$), and flexibility of the front of the upper legs and lower pelvic region (MFLZLP; $p<.01$). The variable MFLIP is inversely scaled, i.e. its lower values mean better results and *vice versa*. One out of the many determinants that is most important for

the interpretation is enlarged body mass, so it could be assumed to be the main reason for decreased flexibility among the senior compared to the junior male subgroup. The seniors are more flexible in the back of their upper legs, while at the same time, the juniors are more flexible in the front of their upper legs and lower pelvic region. The continuity of the application of operators for the improvement of static and dynamic (but mostly static) flexibility during entire sport careers of national team players, and the stability of the performance of motor stereotypes of handball techniques as well, puts seniors in a better position with regard to the optimization of the relation between phylogenetically "older" muscle groups of the back of the upper legs and phylogenetically "younger" muscle groups of the front of the upper legs. The process of formation of new motor stereotypes, in a spectrally defined variety, could offer some additional requirements for the enhancement of flexibility of the front of the upper legs.

Statistically significant differences between the senior and junior female handball players were established in the tests used to estimate flexibility of the lumbar spine zone (the back) (MFLSAR; $p<.05$), and the flexibility of the back of the upper legs (MFLPLK; $p<.05$). In both variables the seniors achieved better results. The number of repetitions of specific operators is supposed to be the underlying cause, but a new question arises: how come there are no differences in flexibility of the front of the upper legs, or flexibility of the arms zone, especially if compared to the results obtained for the male handball players? The fact that junior female handball players took part in senior competitions earlier than young male players can offer some explanations. In the female population, the differences are mostly caused by an earlier start in the process of adaptation.

CONCLUSIONS

Plans and programs for the improvement of basic motor abilities in handball are target-oriented towards hierarchically defined abilities which have shown the greatest impact on, contribution to and influence on success in the game of handball. Flexibility as a basic motor ability was not analyzed to an extent which could explain real contributions to the performance of different elements of team handball techniques, nor to offer an insight into specific relations to other motor abilities. Injuries are mostly the cause and motive for more intensive studies of flexibility. The relevance of new knowledge in the field of top-level sport must not be constrained by tradition to an extent which would be an obstacle to the implementation of new operators which would introduce flexibility into prevention programs or the treatment of convalescents. The unilateral nature of techniques in handball may purport previously given arguments based mostly on the relation between strength and flexibility. Misbalances in flexibility between the left and right side of the body are usually the first symptoms of inadequate training programs. There are certain regularities regarding playing positions, but based on studies focusing on the unilateral manifestations of flexibility, and questions that have arisen based on the finding of this paper and the answers that were given, practical issues and problems of proper planning and programming of the training process in top level handball could be resolved.

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UTVRĐIVANJE RAZLIKA U FLEKSIBILNOSTI VRHUNSKIH RUKOMETAŠICA I RUKOMETAŠA RAZLIČITE DOBI

Igor Gruić, Katarina Ohnjec, Dinko Vuleta

Na uzorku ispitanika od 38 rukometaša (24 kadeta i 14 seniora) i 34 rukometašice (18 kadetkinja i 16 seniorki) primijenjena je baterija od 10 standardnih testova za procjenu opće (sjed i dohvat) i topološki definirane fleksibilnosti (iskret palicom, prednoženja, zanoženja i odnoženja) s ciljem utvrđivanja razlika u općoj i lokalnoj fleksibilnosti u odnosu na natjecateljsku dob. Rezultati provedene analize razlika (t-test) ukazuju na postojanje statistički značajnih razlika između rukometaša seniora i kadeta utvrđene su u testovima za procjenu fleksibilnosti ruku i ramenog pojasa (MFLIP – iskret palicom), fleksibilnosti stražnje strane natkoljenice (MFLPLL i MFLPLD) te fleksibilnosti prednjeg dijela natkoljenice i dijela zdjeličnog pojasa (MFLZLL – zanoženje lijevom nogom iz ležanja na prsima i MFLZLD – zanoženje desnom nogom iz ležanja na prsima). Statistički značajne razlike između rukometašica seniorskog i kadetskog uzrasta u varijablama za procjenu fleksibilnosti lumbalnog dijela leđa s pripadajućim pojasom (MFLSAR - sjed i dohvat) te fleksibilnosti stražnje strane natkoljenice (MFLPLL – prednoženje lijevom nogom iz ležanja na leđima i MFLPLD – prednoženje desnom nogom iz ležanja na leđima).

Ključne reči: *fleksibilnost, rukomet, dob, razlike.*