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CORRELATION BETWEEN THE MOTOR ABILITIES AND COMPETITIVE PERFORMANCE OF SLOVENIAN HANDBALL GOALKEEPERS

POVEZANOST GIBALNIH SPOSOBNOSTI IN TEKMOVALNE USPEŠNOSTI PRI SLOVENSKIH ROKOMETNIH VRATARJIH

ABSTRACT

The objective of the present research was to analyse the relations between selected motor abilities and the competitive performance of team handball goalkeepers. The sample consisted of 46 male goalkeepers who were members of first and second division Slovenian handball league clubs (age: 24.2 ± 5.2 years, height: 185.6 ± 4.9 cm, body weight: 88.2 ± 9.6 kg). Motor abilities were measured with seven motor tests assessing the level of strength, agility and flexibility. Independent handball professionals evaluated the goalkeepers' competitive efficiency using values from 1 (very bad) to 5 (excellent). The correlation between motor abilities and competitive efficiency was assessed with Pearson's correlation coefficient. Only the "heavy ball motor test" correlated statistically significant with competitive performance ($p=0.00$). The results show that those goalkeepers who were able to express a higher level of explosive arm strength appeared to be more effective in the handball game. As there were no other motor tests correlating with competitive efficiency, it is possible that the goalkeepers have these abilities on a similar level or the tests did not have sufficiently high sensitivity to predict the performance level. It is also possible that competitive efficiency correlates most with other characteristics not included in the present study (perceptual skills, reaction times, experience, age...).

Key words: team handball goalkeepers, basic motor tests, competitive efficiency

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IZVLEČEK

Povezanost gibalnih sposobnosti in tekmovalne uspešnosti rokometnih vratarjev je dokaj neraziskano področje, zato je bil glavni cilj pričujoče raziskave analizirati morebitne povezave. Vzorec preizkušancev je zajemal 46 rokometnih vratarjev, ki so bili člani prve ali druge slovenske rokometne lige (stari $24,2 \pm 5,2$ let, visoki $185,6 \pm 4,9$ cm in teški $88,2 \pm 9,6$ kg). S 7 gibalnimi testi so bile izmerjene moč, koordinacija (agilnost) in gibljivost. Tekmovalna uspešnost vratarjev je bila ocenjena z ocenami od 1 (zelo slabo) do 5 (odlično) s strani treh neodvisnih rokometnih strokovnjakov. Povezanost med rezultati gibalnih testov in oceno tekmovalne uspešnosti je bila izračunana s Pearsonovim koeficientom korelacije. Rezultati so pokazali, da je z oceno tekmovalne uspešnosti statistično značilno povezan le test 'sunek teške žoge' ($p=0,00$). Vratarji, ki so bili sposobni izraziti večjo eksplozivno moč rok, so dobili tudi višjo oceno tekmovalne uspešnosti. Na podlagi ugotovitev bi lahko predvidevali, da so imeli vratarji našega vzorca razvitost merjenih gibalnih sposobnosti na podobnem nivoju oziroma izbrani osnovni gibalni testi niso bili dovolj občutljivi, da bi ločili boljše in slabše vratarje. Prav tako je mogoče, da je tekmovalna uspešnost najbolj povezana z dejavniki, ki jih nismo obravnavali (percepcija, reakcijski čas, izkušnje, starost...).

Ključne besede: rokometni vratarji, osnovni gibalni testi, tekmovalna uspešnost

INTRODUCTION

The correlation between motor abilities and success in sport has received much attention in recent years. The question concerning which characteristics determine a top athlete is an eternal dilemma. Team handball is a dynamic sport where the playing positions and roles are divided on the basis of the players' skills, abilities and characteristics (Šibila, 2004). The position of goalkeeper is the most specific and probably the most exposed playing position. His primary activity is to save opponents' shots in the goalkeeping area. When saving the ball a goalkeeper performs many actions such as moving to the left and right in anticipation of the ball's location, moving to the front, jumping, moving downwards, lifting his arms and legs etc. which all require a certain level of motor abilities.

There is a lack of literature analysing the motor abilities of team handball goalkeepers in correlation with their competitive performance. Most research studies only concentrated on examining the differences between handball players in different playing positions. For example, it was found that playing positions differ from each other the most in their anthropometric characteristics (Chaouachi, Brughelli, Levin, Boudhina, Cronin, & Chamari, 2009; Šibila & Pori, 2009; Sporiš, Vuleta, Vuleta, & Milanović, 2010; Milanese, Piscitelli, Lampis, & Zancanaro, 2011). The available literature includes some sources that discuss the goalkeeper's specific role from the aspect of the motor abilities needed for this playing position (Gruić & Vuleta, 2009; Sporiš et al., 2010); goalkeepers were found to be slower runners. Oxyzoglou, Hatzimanouil, Kanioglou & Papadopoulou (2008) revealed that the studied goalkeepers had a highly developed level of pelvis flexibility and a well-developed level of explosive strength compared to other players. Further, some researchers have concluded that abilities between positions in elite handball players appear to be very similar, with the abilities of specific agility and explosiveness having the biggest impact on players' performances in general (Chaouachi et al., 2009). Another analysis showed that goalkeepers underperformed in all motor abilities compared to players in other positions (Christodoulidis et al., 2009).

All playing positions demand highly developed motor abilities which are specific to each playing position. This is probably due to the fact that differences occur in the volume and intensity of large-scale cyclic movements and the frequency of acyclic activities for players in different playing positions (Šibila, Vuleta, & Pori, 2004). Some researchers concluded that the most important abilities in competitive team handball are muscle strength, speed and endurance (Marques, 2010). Gorostiaga, Granados, Ibanez, Gonzales-Badillo and Izquierdo (2006) stated that a high level of force, power (explosive strength) and throwing velocity determined competitive success. Also the results of other studies have shown that explosive strength in the upper and lower limbs seemed to be one of the key requirements in top team handball (Chelly, Hermassi, & Shephard, 2010).

In the present study, we concentrated on strength, coordination (agility) and flexibility. One of the subcomponents of strength could be named power (explosive strength, according to Santtila, Kyrolainen, & Hakkinen, 2009), which is characterised by tests that involve rapidly projecting objects or the entire body in a single voluntary effort (Knapik, Sharp, Darakjy, Jones, Hauret, & Jones, 2006). As goalkeepers make many movements of that kind (throws, quick starts, sudden jumps, short sprints etc.), we focused on that kind of motor tests. Further, coordination shows the ability to efficiently resolve space-related problems, which gives the goalkeeper the ability to respond quickly to incoming shots. Saving shots demands the activation of the entire body and represents a combination of complex motor structures performed with maximum speed. One

of the basic movements dominating a goalkeeper's situational activity is side-stepping (Rogulj & Papić, 2005) and so that kind of movement was included in the test battery. Finally, in team handball the optimal level of flexibility implies either the possibility of the maximal manifestation of other motor abilities or an improvement of the technical performance of elements that can provide an advantage over one's opponent (Gruić, Ohnjec, & Vuleta, 2011). The goalkeeper's flexibility should be highly developed, particularly in the hips, because it is necessary for repulsing, mainly in cases where the lower limbs are used (Oxyzoglou et al., 2008). In addition, a higher level of flexibility might not only contribute to a better competition performance but also help prevent injuries (Rubini, Costa, & Gomes, 2007). The abovementioned facts shaped the formation of the test battery of seven basic motor tests. Evaluations of a handball goalkeeper's performance are normally made when only considering balls received in relation to balls saved by the player (Prudente, Garganta, & Anguera, 2010), but in our case this was established on the basis of experts' opinions.

Previous studies have shown that high performance in team sports largely depends on the motor abilities of all players according to their position in the team (Oxyzoglou et al., 2008), but in the selection process goalkeepers are usually recruited on the basis of their increased height or weight, poor motor skills or on the desire of children to play in that position (Šibila, Pori, & Imperl, 2008). To our knowledge, no attention has been paid to the selection of motor abilities which could determine a good handball goalkeeper. Therefore, the purpose of the present study is to describe and examine the relations between the motor abilities and competition performance of Slovenian handball goalkeepers.

MATERIALS AND METHODS

Participants

The sample consisted of 46 male goalkeepers who were members of first and second division Slovenian handball league clubs (age: 24.2 ± 5.2 years, height: 185.6 ± 4.9 cm, body weight: 88.2 ± 9.6 kg). The sample represents 63% of the whole population of Slovenian elite handball goalkeepers.

Variables

Motor abilities were measured with seven motor tests, assessing the levels of strength, coordination (agility) and flexibility. We used the following tests: heavy ball throw test (HBT) (Šibila, 1995); standing long jump test (SLJ) (Šturm, 1977); jumps (Bosco, 1999) – squat jump (SJ), counter movement jump (CMJ), drop jump (DJ); stepping sideways (SS) (Šturm, 1977) and hip abduction (HA) (Šturm, 1977). All measures were made by properly qualified personnel in December 2010. HBT was performed with one arm from a standing position. SLJ required propelling the body forward as far as possible; a similar action, except in a vertical direction was performed in the SJ, CMJ and DJ tests. When performing the SJ test the performer is to jump as high as possible from the position where their knees are bent at 90 degrees, in the CMJ test it is required to start with straight legs and perform a natural flexion before take-off. In the DJ test the performer drops down from a specified height (45 cm) and then jumps immediately upwards as high as possible. The SS test requires sideways movements (lateral steps) over a distance of 6 m (4 times) while in the HA test the performer has to lift one leg while lying with his back to the wall. Independent handball professionals evaluated the temporary competitive efficiency (CE) of the

goalkeepers, using values from 1 to 5 (1-very bad, 2-sufficient, 3-good, 4-very good, 5-excellent). Each goalkeeper got one score for his technical skills and one for his competitive performance. The average values of both represent the competitive performance in general.

Statistical methods

The SPSS statistical package was used for the statistical data analyses. The concordance of experts' values was calculated using Kendall's coefficient of concordance (W). Basic statistics for variables were computed. The correlation between motor abilities and competitive efficiency was assessed with Pearson's correlation coefficient. A probability level of 0.05 or less was taken to indicate statistical significance.

RESULTS

Basic statistical characteristics of the variables are presented in Table 1. Kendall's coefficient of concordance (W) among the values of the three independent handball experts was statistically significant ($p=0.01$).

Table 1. Basic statistical characteristics of all variables.

Variable	Unit	X	SD
Heavy ball throw (HBT)	m	23,62	3,25
Standing long jump (SLJ)	cm	244,95	15,48
Squat jump (SJ)	cm	33,52	3,58
Counter movement jump (CMJ)	cm	35,70	3,35
Drop jump (DJ)	cm	33,20	5,41
Stepping sideways (SS)	second	7,80	0,46
Hip abduction (HA)	degree	66,11	10,53
Competitive efficiency (CE)	point	3,41	1,18

Key: X - average value; SD - standard deviation

Arm strength seems to have the highest correlation with competitive efficiency in our case (Table 2). Only the heavy ball throw test (HBT), measuring explosive arm strength, correlated statistically significantly with competitive performance ($p=0.00$).

Table 2. Correlation of all variables

Variable	HBT	SLJ	SJ	CMJ	DJ	SS	HA
Heavy ball throw (HBT)	1						
Standing long jump (SLJ)	0,32*	1					
Squat jump (SJ)	0,24	0,37*	1				
Counter movement jump (CMJ)	0,23	0,50**	0,70**	1			
Drop jump (DJ)	0,06	0,52**	0,47**	0,55**	1		
Side stepping (SS)	-0,25	-0,31*	-0,23	-0,27	-0,30*	1	
Hip abduction (HA)	0,06	0,36*	0,03	0,23	0,28	-0,23	1
Competitive efficiency (CE)	0,50**	0,15	0,16	0,02	0,09	-0,10	0,06

Key: * $p \leq 0,05$; ** $p \leq 0,01$

DISCUSSION AND CONCLUSIONS

The results show that goalkeepers who could express arm movements of high intensity appear to have greater competitive efficiency. Throwing a handball is the type of task which demands maximal exertion, as measured in HBT. It is important to know that a goalkeeper also has an important role when he acts outside his area. This is most often seen at the beginning of a counter-attack, when he has to pass the ball to the best positioned team mate on the court (Šibila, Justin, Pori, Kajtna and Pori, 2010). The skill of throwing is one of the most important skills in handball (van Muijen, Joris, Kemper, & Schenau, 1991) and found to be a very important aspect for success (Gorostiaga, Granados, Ibanez, & Izquierdo, 2005). It is crucial not just for shots against the goal but also for long passes (Skoufas, Stefanidis, Michailidis, Hatzikotoulas, Kotzamanidou, & Bassa, 2003). It could be concluded that goalkeepers with a high level of arm strength can throw the ball at a higher velocity, which could lead to a faster attack on the opponent's goal. It has been found that muscle strength has a greater influence on ball velocity (van Muijen et al., 1991) and this could also be shown in our case. Chelly, Hermasi and Shephard (2010) also found that upper limb strength contributes to greater throwing velocity. Even if the velocity of the ball has been found to be the lowest with goalkeepers (Manchado, Ferragut, Abalades, Rodriguez, Alcará, & Vila, 2011), in our case it distinguishes more and less successful goalkeepers. Nevertheless, there is a lack of literature which can support our results. Šibila et al. (2010) found that only results in the HBT test significantly distinguish elite goalkeepers from low-level ones. The results may suggest the need for coaches to include upper limb strength and power programmes when improving the throwing velocity of goalkeepers, which could result in better competitive efficiency.

The lack of relations between the other explosive strength tests and competitive efficiency can be explained by the fact that the results in measured leg strength tests were represented only with the measured length (in SLJ) or height (in SJ, CMJ and DJ) in cm. There is a rapid velocity increase in the final phase of movement (before saving the shot), which is caused by the lower leg extension and contraction of the muscles of the frontal side of the thigh (Rogulj & Papić, 2005). Therefore, when defending the goal it is very important not just how far the goalkeeper jumps but even more how fast he can develop the maximum force. Rapid movements of the body and body parts are important in saving shots. If one goalkeeper is able to develop the maximum force quickly, meaning to project the entire body in the direction of the shot, he could be more successful than one who actually jumps the same length or height but where a slower maximum force is developing. Further analysis should include more data, especially measures of maximum force development.

We also expected a significant relationship between agility and flexibility with competitive performance but this did not show in our case. Coordinated movement at maximum speed is required in the side-stepping test which represents the kind of movement used when defending shots from longer distances. It is the most common movement used by goalkeepers to save the ball (Guitierrez-Davila, Rojas, Ortega, Campos, & Parraga, 2011), but in our case it seems to hold no importance for competitive efficiency. Only the results of Šibila et al. (2010) can in some way support our findings; there was no difference in the results for the agility or flexibility tests between goalkeepers of different competition levels.

While we did not find any other significant correlation between the motor tests and competitive efficiency, it is possible that these abilities are on a similar level among all the subjects or the tests did not have sufficiently high sensitivity to predict the performance level. It cannot be concluded

that these abilities are not important for goalkeepers; it simply did not distinguish between more and less successful goalkeepers in our case.

The strength of the present study is the large sample of national elite handball goalkeepers and the novelty of analysing the correlation between their motor abilities and competitive performance. Some limitations are worth noting. The study is based on experts' opinions about the goalkeepers' competitive efficiency. In future work, more objective measures could provide an alternative to those data. Further, we should consider taking some morphological characteristics and measures of maximum force into account. Finally, we suggest using a selection of more specific handball motor tests. Perhaps competitive efficiency correlates most with other characteristics not included in the present study.

In conclusion, these results only allow us to assume that the explosive strength of the arms contributes to a better competitive performance. Our results can only provide evidence regarding the importance of explosive movements with the upper limbs for the better evaluation of the competitive efficiency of handball goalkeepers. It is possible that there are many other characteristics which could make a greater contribution to competitive efficiency, but were not included in the present study. As body height, limb length and body mass are well known to have a positive effect on explosive strength it could be important to take them into account, along with more specific handball motor tests, perception tests, training experience, influence of age, personality traits etc. Data concerning a handball player's position-related model characteristics are very important from the aspect of achieving top results. This information contributes to understanding the specificity of individual playing positions and consequently leads to a more precise selection of players and planning of the training process. Programmes should be targeted towards those abilities which demonstrate the biggest influence on the success of handball goalkeepers. Top-level goalkeepers should have a high level of their motor abilities so gained information could be of use for further individualisation and careful planning of the training process. The specific playing position of a goalkeeper requires special training and it should not be neglected in favour of other positions.

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