

# SOME METRIC CHARACTERISTICS OF TESTS TO ASSESS BALL SPEED DURING OVERARM THROW PERFORMANCE

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## SUMMARY

The aim of the study was to determine metric characteristics of the 2 tests for evaluation handball ball speed during over arm throw of handball ball. Research was conducted on a sample of 50 students of the Faculty of kinesiology, average age of 20.4 years. Beside measurements of body height and body weight, speed of ball flight after over arm throw from sitting position (distance 4 meters) was assessed with radar gun. The tests of over arm throw were performed with a blocked and a free hand which does not perform a throw. Results show satisfactory reliability, sensitivity and validity of all tests. The homogeneity of tests was not good considering that the positive trend of results was observed. This is a consequence of respondent adaptation to the technique of over arm throw performance. Factor analysis extracted a latent dimension that may be called a factor of the ball speed during overarm throw performance. Respondents achieved significantly better results in the test RS because of biomechanical freer movement. This also confirmed the pragmatic validity of the tests. The tests are best for use in sports like handball, water polo, tennis, volleyball, baseball or throwing disciplines in athletics because of the similarity of overarm performance and technical elements of the chosen sport. The advantages of tests are fast performance, easy execution and good metric characteristics and the defects poor homogeneity and necessity for a radar gun.

**Key words:** arm and shoulder, explosive power, metric characteristics, overarm throw, radar gun, assessment.

## INTRODUCTION AND OBJECTIVES

Explosive power is the motor ability whose importance is unquestionable in the creation of top athletic performance of many teams and individual sports (Van den Tillaar et al, 2004; Gorostiaga et al, 2005; Falvi et al, 2006; Cronin et al, 2005). Hence, it is important to find the reliable measuring instruments that will give the instructors of the training process the best feedback information about this ability (Cronin-Owen, 2004).

Scientists in the field of sport are looking for this ability in relation with its manifesta-

tion, but also on its topological region the needed force for the outcome is produced from (Van den Tillaar et al, 2004; Kotzamanidis et al, 2003). Tests to evaluate the explosive power while the ball is being thrown are presented in this study. Van den Tillaar (2004) pays great attention to the throwing velocity of the object especially in sports like baseball, volleyball, javelin, or water polo. Furtheron, he tests the impact of various training programs on the outcome of the above mentioned ability. It seems that different types of force may affect the throwing speed of the object. And so, Van den Tillaar (2004) establishes high correlation between maximal iso-

metric strength and throwing velocity of the ball, while Kotzamanidis et al. (2003) prove, by the help of the students of kinesiology, the impact of training with external straining of the upper extremities on the throwing velocity of the ball. Hoffman et al. (2009) have come to the similar conclusions. Their sample includes the university players of American football. They have proved the significant impact of the maximal strength of arms and shoulder muscles on two-hand medicine ball forward throw.

Different anthropometric characteristics that can exert influence on this type of motor performance are being studied together with the ways of improving the speed of the throwing velocity of the object. So, Izquierdo et al. (2002) consider that the difference in the explosive power with the athletes of different sports and disciplines can give us just a partial explanation by the structure and distribution of muscle fibers, muscle mechanics and training system. Mayhew et al. (1993) have proved the influence of power and of body weight on the way of throwing the ball from a seated position with the university players of American football.

In accordance with the previous observations this study tested the explosive power of arms and shoulder belt in one-arm throw of the handball ball. For the purposes of this research two simple tests were made, according to the authors, to give a good qualitative description of this ability. The aim of this study is to determine the measurement characteristics of the newly constructed tests.

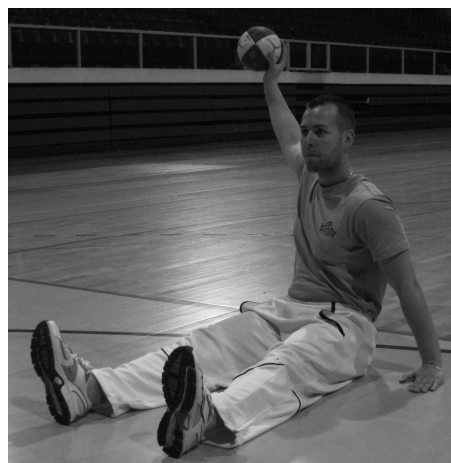
## MATERIALS AND METHODS

The study was conducted on a sample of 50 first year students (age:  $20 \pm 4$ y) of the Faculty of Kinesiology, University of Split. The procedure was explained to the students. They all agreed to participate in testing voluntarily. All of them were of a good psycho-physical health. Body height (BH) of the students was measured by anthropometer, body weight (BW) by a digital scale. During the measuring time the subjects were barefooted. The ball velocity was measured by Speedster Radar Gun made by Bushnell. Handball ball no. 3

(weight 380 gr., volume 58 cm) was used in testing. Newly constructed tests will be presented in the following part of the paper.

### PICTURE 1

#### *RP Test*



*RP - throw with the opposite hand on the floor - the student is in a sitting position (with legs slightly apart, at the angle of  $45^\circ$ ) 4.5 m away from the target dimensions 50 # 50 cm (lower edge of the target was 75 cm above the ground). The target was placed on the safety net behind which a surveyor with a radar gun was. Each student performs 3 hits to the target, when the hand, not running the throw, is placed on the floor.*

### PICTURE 2

#### *RS Test*



*RS - throw from the opposite free hand* - the student is in a sitting position (with legs slightly apart, at the angle of 45°) 4.5 m away from the target dimensions 50 # 50 cm (lower edge of the target was 75 cm away from the ground). The target was placed on the safety net behind which a surveyor with a radar gun is. Each student performs 3 hits at the target, when the hand, not running the throw, is freely placed in front of the body enabling the student to involve rotating muscles of the trunk.

## RESULTS

### Reliability

Correlation matrix between the particles in all tests together with two indicators of reliability tests, inter-item correlations and Crombach alpha coefficients were analyzed for the purpose of determining the reliability. The

TABLE 1.

*Correlation between RP test particles*

VAR	RP1	RP2	RP3
RP1	1.000	<b>0.851</b>	<b>0.811</b>
RP2	<b>0.851</b>	1.000	<b>0.858</b>
RP3	<b>0.811</b>	<b>0.858</b>	1.000

TABLE 2.

*Correlation between RS test particles*

VAR	RS1	RS2	RS3
RS1	1.000	<b>0.934</b>	<b>0.928</b>
RS2	<b>0.934</b>	1,000	<b>0.934</b>
RS3	<b>0.928</b>	<b>0.934</b>	1,000

TABLE 3.

*Inter-item correlations and Crombach alpha coefficients of RP and RS tests*

VARIABLES	II r	Crombach alpha ( $\alpha$ )
RP	0.84	0.93
RS	0.93	0.97

results are presented in Tables 1, 2 and 3. Significant correlations between 3 measured particles in both tests, as well as the Crombach alpha coefficients high value indicate the good reliability. Out of these results we can deter-

mine that the instrument has satisfactory reliability, and that the error in measuring has been reduced to minimum.

### Homogeneity

Table 4 presents the results of analysis of variance for each test with the calculated values F and with the significance level p. It is clear that statistically significant differences between the measured particles in all tests exist. This leads us to the unsatisfactory homogeneity of the measuring instruments. After examining the average values of the individual measured particles trend towards better results, due to inhomogeneous measuring instruments, is evident. This trend is the consequence of adjustments of the students to the technique of throwing. It is to expect that with every new attempt of throw will be ever more rational, and the object will fly faster (Sertić et al 2005; Foretić et al 2009).

TABLE 4.

*Analyses of variance for both tests*

VARIABLES	F	P
RP	10.07	<b>0.00</b>
RS	4.74	<b>0.01</b>

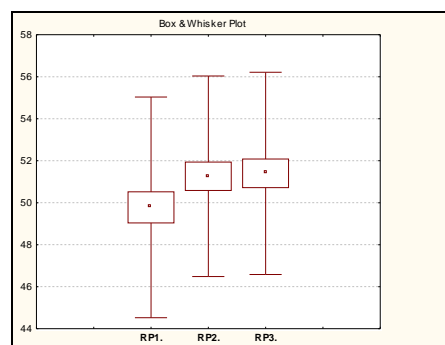
TABLE 5.

*Mean results in each measurement particles*

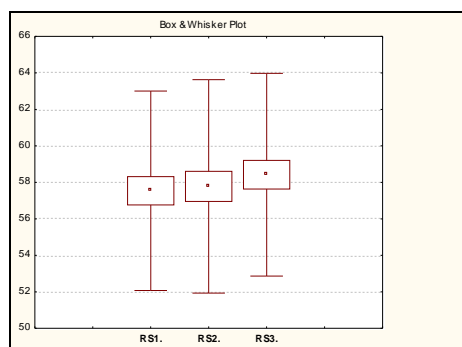
VARIABLES	1. particle	2. particle	3. particle
RP	49.78	51.26	51.40
RS	57.54	57.78	58.42

DIAGRAM 1

*Analyses of variance in Test RP*



## DIAGRAM 2

*Analyses of variance in Test RS**Sensitivity*

The results of measuring of 3 particles have been summed up by using the average arithmetic means to meet the needs of this study. The sensitivity of the tests is presented in Table 6. It is clear that there is no significant difference between obtained and theoretical normal distribution of the results. Because a single obtained K-S value of the test doesn't go beyond border line of it, hence we can assume that the measuring instruments do good distinction among the students and give satisfactory feedback to the criterion of sensitivity.

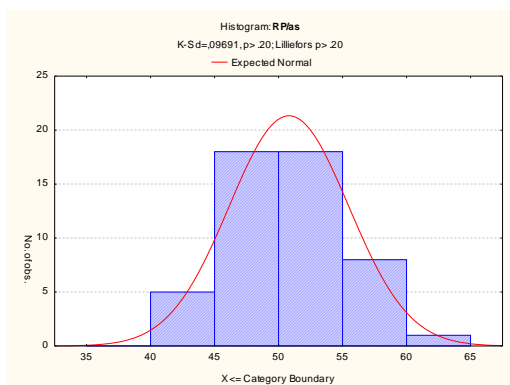
TABLE 6.

*Descriptive statistics*

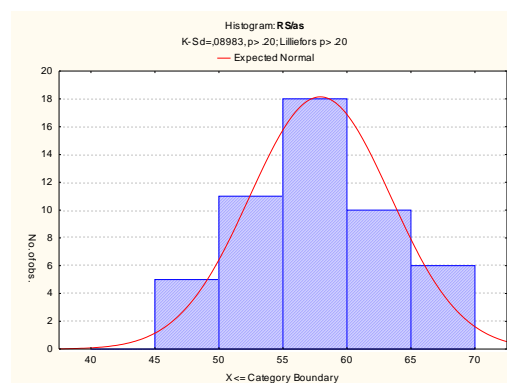
VAR	N	X±SD	MIN	MAX	KS test
RP	50	50.8±4.68	42.0	63.3	0.09
RS	50	57.9±5.50	47.0	69.7	0.08

The maximum theoretical value of KS test for N = 50 is 0.23 for p=0.01

## HISTOGRAM 1.

*Distribution of the results / RP*

## HISTOGRAM 2.

*Distribution of the results / RS**Factor validity*

The results of factor analysis are presented in Table 7. Two measuring instruments have been included in the analysis. One latent dimension has been allocated from the 2nd manifested variable because, according to the author, it defines the explosive power of arms and shoulders. The factor variance is high, 1.88. The common factor projection of both tests shows that the tests measure the same motor dimension. Although authors think this is explosive power of arms and shoulders test should be compared with relevant number of instruments that measure mentioned dimension.

TABLE 7.

*Factor analyses results*

VARIABLES	Factor
RP/as	<b>0.970439</b>
RS/as	<b>0.970439</b>
Expl.Var	1.883503
Prp.Totl	0.941752

Legend: **Factor** - significant factor in the Guttman-Kaiser criterion, **Expl.Var** - eigenvalue, **Prp.Totl** - amount of explained variance of all variables.

*Pragmatic validity*

Pragmatic validity of a certain test shows how much, i.e., with what amount of certainty we can predict success in a practical activity based on the results of this test. It can be determined in many ways, and is directly related to the research aim that is being conducted. In

general, if the test has met the purpose, i.e., achieved, then the aim of the research has been reached and the pragmatic validity of the test has been proved (Dizdar, 2006). In the field of kinesiology researches are frequent trying to determine which test defines better the specific capability. Thus, this study also tries to determine whether there are differences between the tests that should assess the same motor ability - the explosive power of the upper extremities. Variance analysis has been made for this purpose. From the Table 8 the existence of statistically significant difference between these two tests is evident. After examining the results of descriptive statistics (Table 9) it is evident that the average values of the RS test are for 7.1 km/s higher than the values of the RP test. Literature reviews reveal that Foretić et al (2010) were engaged in the similar issues. They found out that by opening a kinetic chain by the sweep and the use of multiple muscle groups the students achieve greater force. If we analyze more carefully kinetic characteristics of the tests, it is obvious that the values of the RP test limit movement during the performance. In the previously mentioned test, only the forearm, upper arms, shoulders and chest muscles perform the throw. In comparison to this, in performing the RS test the movement is freer, and the trunk muscles, especially the rotational muscles, are included in performance together with the above mentioned muscles. This is why the students achieve better results in the RS test. Pragmatic validity of the tests has been confirmed because the use of the tests depends on the topological region that we want to test.

TABLE 8.  
*ANOVA between RS and RP tests*

VARIABLES	F	p
RP - RS	<b>48.42</b>	<b>0.00</b>

TABLE 9.  
*Descriptive statistical indicators*

VAR	N	AS±SD
TOTAL/as	100	54.36±6.20
RP/as	50	50.80±4.68
RS/as	50	57.90±5.50

## CONCLUSION

The blast is the manifestation of explosive power that is present in many sports and sport disciplines. Regardless of whether it is the ball throwing or any other apparatus, flight object speed always depends on the explosive force of one who deals with the object. Hence, it's very important to give to this motoric dimension the objective evaluation. The tests of evaluation should have qualitative metric characteristics so that the results could be properly used and analyzed. In this study two tests have been presented together with their metric characteristics.

All tests have shown relevant reliability. Homogeneity is not good enough because in every new particle in measuring a positive trend has been noted. It is probably due to the students' adaptation to the technique of throwing. The regular distribution points out that there isn't significant difference between obtained and theoretical normal distribution results. So, one can conclude that the measuring instruments differ the students rather well and are reliable. One latent dimension has been obtained by the factor analysis that, according to the author, can be named the factor of the ball speed during overarm throw performance. Pragmatically value has been tested by calculated variance analysis of the two tests. Due to biomechanical more free movement the students have shown statistically far better results performing RS tests. It has been confirmed that the tests are factory and pragmatically valid. Achieved data may serve to all the professionals who are interested in the speed of the flying object, its explosive force and its throw in general.

In general, the tests are the most qualitative to be applied in such sports as handball, water polo, tennis, volleyball, basketball, throwing disciplines in athletics because all of them have some similarities in performing the technical element of the chosen sport. The advantages of tests are speed and simplicity in performing together with good metrical characteristics, while the negative side is the bad homogeneity and the need for radar gun. At the end it's important to point out that in the further researches it would be good to compare similar tests from the different kinetically dynamic

(standing position, from the run, and from the jump). Furtheron, it would be necessary to examine up described phenomenon among the athletes of different disciplines and sports since this study has been done on the sample of Kinesiology Faculty students.

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## NEKE METRIJSKE KARAKTERISTIKE TESTOVA ZA PROCJENU BRZINE LETA LOPTE TOKOM JEDNORUČNOG IZBAČAJA

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Eksplzivna snaga motorička je sposobnost čija je važnost neosporna u kreiranju vrhunskog sportskog postignuća mnogih kolektivnih i individualnih sportova (Van den Tillaar i sur, 2004; Gorostiaga i sur, 2005; Falvo i sur, 2006; Cronin i sur, 2005) pa je važno pronaći pouzdane mjerne instrumente koji će upravljačima trenažnog procesa dati najbolju povratnu informaciju o ovoj sposobnosti (Cronin-Owen, 2004). Shodno spomenutom, u radu se ispitivala brzina leta lopte prilikom jednoručnog izbačaja rukometne lopte. Za potrebe istraživanja konstrisana su 2 jednostavna testa koja bi prema mišljenjima autora mogli kvalitetno opisati ovu sposobnost. Cilj rada je utvrditi mjerne karakteristike novokonstruiranih testova. Istraživanje je provedeno na uzorku od 50 studenata, polaznika prve godine preddiplomskog studija Kineziološkog fakulteta u Splitu, prosječne dobi 20,4 godine. Izmjerene su osnovne antropometrijske karakteristike tjelesna visina i tjelesna težina kao i brzina udarca radarskim pištoljem Speedster Radar Gun, američkog proizvođača Bushnell. Za potrebe testiranja korištena je seniorska rukometna lopta. Testovi su se izvodili sa blokiranom rukom i slobodnom rukom koja ne izvodi izbačaj, iz sjeda, na udaljenosti 4 metra od radarskog pištolja. Zadovoljavajuća pouzdanost utvrđena

je značajnim korelacijama između 3 čestice mjerenja kod oba testa kao i visokim vrijednostima Crombach alpha koeficijenata. Statistički značajne razlike između čestica mjerenja u svim testovima upućuju na nezadovoljavajuću homogenost mjernih instrumenata. Uvidom u prosječne vrijednosti rezultata pojedinih čestica mjerenja vidljiv je trend ka boljim rezultatima što je karakteristika nehomogenih mjernih instrumenata. Trend je posljedica prilagođavanja ispitanika na tehniku izvođenja samog izbačaja. Obzirom da nema značajne razlike između dobijene i teorijske normalne distribucije rezultata te da niti jedna dobijena vrijednost K-S testa ne prelazi graničnu vrijednost zaključeno je da mjerni instrumenti dobro razlikuju ispitanike te zadovoljavaju kriterij osjetljivosti. Faktorskom analizom utvrđena je faktorska valjanost testa. Varijanca faktora je visoka i iznosi 1,88. Projekcija na zajednički faktor oba testa nam govori da testovi mjere istu motoričku dimenziju. Iako je pretpostavka autora da se u ovom slučaju radi o eksplozivnoj snazi ruku i ramenog pojasa trebalo bi test usporediti sa većim brojem provjerenih mjernih instrumenata koji mjere spomenutu dimenziju. Pragmatička valjanost testirana je izračunavanjem analize varijance dvaju testova koja je pokazala da postoji statistički značajna razlika između ova dva testa. Uvidom u re-

zultate deskriptivne statistike uočeno je da su prosječne vrijednosti rezultata testa RS za čak 7,1 km/s veće od rezultata testa RP. Zbog biomehanički slobodnijeg pokreta ispitanici su prilikom izvođenja testa RS postizali statistički značajno bolje rezultate. Testovi su faktorski i pragmatično valjani. Dobijeni podaci mogu poslužiti svim ekspertima kojih intrigira brzina leta objekta, eksplozivna snaga ili izbačaj generalno. Testovi su najkvalitetniji za primjenu u sportovima kao rukomet, vaterpolo, tenis, odbojka, bejzbol ili bacačke discipline u atletici

zbog sličnosti izvođenja tehničkom elementu izabranog sporta. Prednosti testova su brzina i jednostavnost izvođenja te dobre metrijske karakteristike dok je mana loša homogenost i potrebitost radar pištolja. U budućim istraživanjima bilo bi dobro upoređivati slične testove različite kinetičke dinamike (stojeći položaj, iz trka, iz skoka) kod sportista različitih disciplina i sportova obzirom da je ovaj rad izveden na uzorku studenata kineziološkog fakulteta.

**Ključne riječi:** eksplozivna snaga, izbačaj, metrijske karakteristike, radar pištolj, ruke i rameni pojas, testovi.