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RELIABILITA A PREDIKČNÍ VALIDITA MOTORICKÝCH TESTŮ POUŽÍVANÝCH V DISCIPLINĚ BĚH NA 100 M PŘEKÁŘEK ŽEN

RELIABILITY AND PREDICTION VALIDITY OF MOTOR TESTS USED IN 100M HURDLES WOMAN

V. Prukner & I. Machová

Palacký University Olomouc, Faculty of Physical Culture, Department of Sport

ABSTRACT

The aim of this study is to analyse the reliability and prediction validity of a battery of motor tests used in 100m Hurdles woman. Seven control tests were analyzed and used for a prediction of performance and training improvement and to evaluate their importance for a future hurdles performance. Best athletes (woman, 100m hurdles runners) from Ostrava (Vítkovice, Poruba), Třinec, Opava and Olomouc have been asked to undergo the testing. Based on the results of stepwise method we can conclude that key tests in the whole battery are 120m run and standing long jump. The result of the multi-regress analyzes shows that only these two tests can predict the performance on women´s 100m hurdles.

Keywords: reliability; prediction validity; 100m hurdles woman; control test set; hurdles performance

SOUHRN

Cílem této studie je analyzovat reliabilitu a predikční validitu testové sestavy motorických testů nejčastěji využívaných v kontrolním testování při tréninku běhu na 100 m překážek žen. Bylo analyzováno sedm testů používaných pro predikci sportovní výkonnosti překážkářek. Testování se zúčastnily nejlepší překážkářky z oddílů Ostrava (Vítkovice, Poruba), Třinec, Opava a Olomouc. Na základě výsledků regresní krokové analýzy bylo zjištěno, že klíčovými testy pro predikci budoucí překážkářské výkonosti jsou testy běh na 120 m a skok do dálky z místa.

Klíčová slova: reliabilita; predikční validita; běh na 100 m překážek žen; sestava kontrolních testů; překážkářská výkonnost

Introduction

An aerobic capacity, economy of running, muscle evaluation, index of body height and length of lower limb belong among main determinants used for effective prediction of sports performance in athletics (Mackenzie, 2001; Jarver, 1997; Gambetta, & Hill, 1981). Perič (2006) says that it is possible during the performance to find the main points and values, which have an effect at the performance and describe them (such as speed ability, take off ability and so on). This is a reason, why for a result model we have used a regression analyses (prediction). The criterion measures were used for prediction of result and prediction validity.

Hurdles runners performance is depended at a few factors. Čilík (2009) stress on these seven factors:

– three speed factors as Ability of acceleration (110m hurdles, 100m hurdles), *Maximum speed, Speed-endurance ability* (more at 200-400m hurdles),
– four ability factors as *Skipping preparedness, Joint movement, Hurdles over take technique, Prediction of rhythmic movement.*

Similar factors mentioned Edward, & Wallace Jr. (1998) and Bowerman, & Freeman (2009), but they divided them into three categories as general conditioning (aerobic endurance, mobility, etc.),

special conditioning (speed endurance, special mobility, etc.) and competition-specific conditioning (hurdles technique, sprint technique, etc.).

Testing helps athletes and coaches asses athletic talent and identify physical abilities, areas in need of improvement and to reach the maximum performance in chosen discipline. Testing should be done regularly by control measurements and tests. Baseline measurements can be used to establish starting points against which achievable goals can be set and testing at regular intervals can help athletes progress in reaching those goals.

The amount of used tests is great, different coaches used a different tests, usually they used the ones with which they have the best experience as an ideal predictors of athletics performance. It seems a good idea to analyzed control testing of best woman´s 100m hurdles runners in the Czech Republic We would like to define the most used tests and to show the ones which have the best prediction validity for woman´s 100m hurdles.

In literature we can discover different approaches to testing of elite athletes, Powers & Howley (2007) described for sprinters and hurdles runners a regular testing with these tests according to ATP-CP measurements:

1) Margaria – Kalamen power test: The athlete sprints to the steps (from a line 6m far) and up the flight of steps taking three steps at a time landing on the 3rd, 6th and 9th steps. The stopwatch stop when the athlete's foot lands on the 3rd step and 9th step and records the time (Power [kg·m·s^{-1}] = weight of athlete [kg] ⋆ vertical distance 3-9step [m] ⋆ 9,8/Time [s].
2) Vertical jump test
3) Standing long jump
4) Oxygen deficit initiation phase: An earlier onset of aerobic ATP production with less lactate formation for the trained person. Measured at Spiro ergometer with the analyses of expiration.
5) Fast component („alactacid") recovery oxygen: Persons with the higher capacity of ATP-CP system has bigger fast component ratio to slow component of recovery oxygen (oxygen debt).

Next authors for example Mackenzie (2001) point out 101 motoric tests used for testing of hurdles runners. The question is which of these tests are best and most accurate for prediction of woman´s hurdles performance?

In coach practice are for performance testing of hurdles runners preferred test with the maximal speed as run for 50m, 60m, 30m with flying start, acceleration tests (10m, 20m, shuttle 4×10m), speed endurance (120m, 150m, 200m), explosive leg power (standing long jump, vertical jump, six step jump, ten step jump), flexibility tests (deep forward bend, sit and reach test, side straddle).

Training groups from Ostrava (Vítkovice, Poruba), Třinec, Opava and Olomouc from the Czech Republic were asked to participate at this project. These training groups have a good performance in woman´s 100m hurdles. The main aim was to analyze the control tests used for a prediction of performance and training improvement and to evaluate their importance for a future hurdles performance. To realize all tests in test battery is economically and time consuming for coaches. The question is, if all tests in test battery have the same importance for evaluation of performance and if it is possible to reduce the number of tests in the test battery with the same percentage of prediction of sports performance.

Goals

The main aim is to analyze the battery of motoric tests used for control measurements of woman´s 100m hurdles and to state their level of importance as possible predictors of evaluation of the future performance.

Partial aims:
• To state a basic statistical parameters of performance in evaluation of motoric tests.
• To evaluate the reliability (stability) of used motoric tests with one year difference.
• To state key tests in the test battery, which are important for prediction of future hurdles performance.

Methods

Participants

At this project participated 29 woman, 100m hurdles runners, age 18-26. All participants are involved in hurdles training for minimum 5 years. For stability review of battery test 29 participants repeated test with one year period. The level of participants sport performance is described in the supplement 1. All participants signed informed consent (supplement 2).

Project

Entry measurements were done during years 2009-2014. From the primary number of participants was excluded hurdles runner who doesn't have all tests absolved or one´s who doesn't have performance on 100m hurdles in test year (due to injury for example). The test measurement was done at the end of preparation period I., and time of 100m hurdles was taken from competition with the period distance 6-8 months from the control testing.

Used motoric tests:

1. Running 30m flat out with flying start – best to use electronic equipment. Set the 30m distance with enough space before and after the photo-cameras lines, cameras are 30m apart and start line should be at least 10m before the first photo-camera. Electronic time measurement with 0,01s accuracy.
2. 50m run from standing or three point start position – participant runs 50m with the maximal speed, start is realized on examiner´s sign, test is measured with 0,1s accuracy.
3. Standing long jump – standing position with legs slightly apart, then jump is realized with the maximum power. Test measurement is realized with 1cm accuracy.
4. Ten jump test – from a standing position take off from one leg to other leg ten steps (jumps) with the best result, last jump is realized to both legs position. Test measurement is realized with 1cm accuracy.
5. 50m sprint jump test – horizontal jumps realized on 50m distance with the most speed (evaluate the speed of jumps). Result is counted as: $K = s/t \star s/n$.

   s = distance (m), t = time (s), n = number of jumps

   Participant should realize the distance as fast as possible with the smallest number of jumps (for example: 50m, 7.5s, 20 jumps). The result should be the highest number.
6. 120m sprint – participant run 120m with the maximum speed from the standing position. Test is measured with 0.1s accuracy.
7. 100m hurdles – test is realized on competition distance with the maximal speed. The high of hurdles is 84 cm (women) and 76.2cm juniors. Result is electronically with 0.01s accuracy.

Statistical analysis

The statistical analysis was done by computer program Statistica 10. Kolmogorov-Smirnov test (K-S test) of probability distribution showed a normal distribution of data. For a metrical samples with a normal distribution (scale of measurement – intervals, ratio) we used a parametric statistical methods. Simple correlation analyzes (Pearson correlation – r_{tk}) was used for reference of a level of correlation relationship of the individual motoric tests and a criterion (performance at 100m hurdles run), for evaluation of multiple correlation (whole test battery) was used multiply correlation coefficient – R. A stepwise regression statistical method with the dependent variable was used for calculation of multiple regress analyses – best performance on 100m hurdles and independent variables-individual test from a test battery which was realized at the end of training preparation period I. Time difference between entry (test battery) and exit data (performance on 100m hurdles) was 6-8 months. A coefficient of long term stability (r_{stab}) was calculated as pair correlation function of test and retest. Time difference for a long term stability of the tests was one year. Level of statistical significance was implied on 5% ($\alpha = 0.05$).

Results

Individual test out of test battery have a significant correlation according our stated criterion. The highest value of correlation shows: positive – 30m flying and 120m run and negative – standing long jump.

Tabulka 1./ Table 1.
Hodnocení korelačního koeficientu individuálních motorických testů vzhledem ke kritériu (nejlepší výkon v běhu na 100 m překážek) – časový odstup 6 – 8 měsíců./ Evaluation of correlation coefficient of individual motoric tests to criterion (best performance at 100m hurdles run) – time difference 6-8 months.

Battery tests	R_{tk} – correlation Female (n = 29)
50m from the standing position (s)	+0.791⋆⋆
30m flying (s)	+0.837⋆⋆
Standing long jump (cm)	–0.811⋆⋆
10jump (m)	–0.768⋆⋆
50m jumping run	–0.516⋆
120m run(s)	+0.904⋆⋆

Note. ⋆ Correlation is significant at the 0.05 level; ⋆⋆ Correlation is significant at the 0.01 level.

Tabulka 2./ Table 2.
Reliabilita individuálních motorických testů (hodnoceno metodou test-retest) – časový odstup mezi jednotlivými měřeními – 12 měsíců./ Reliability of individual motoric tests (evaluated by test–retest) – time distance between individual measurements 12 months.

Battery tests	$R_{tt'}$ – correlation Female (n = 29)
50m from the standing position (s)	+0.973⋆⋆
30m flying (s)	+0.934⋆⋆
Standing long jump (cm)	+0.952⋆⋆
10jump (m)	+0.955⋆⋆
50 m jumping run	+0.567⋆⋆
120 m run (s)	+0.982⋆⋆

Note. ⋆ Correlation is significant at the 0.05 level ; ⋆⋆ Correlation is significant at the 0.01 level

From the results above we receive expected information. All reliability tests with the one year difference between test – retest shows a high stability of measurements for a selected group of woman's 100m hurdles runners (best from the Czech Republic). The level of reliability of individual tests ($r_{tt'}$) is between 0,93-0.97, only test on 50m jumping run has lower level of reliability ($r_{tt'} = 0.567$).

Our main aim was to evaluate the relationship of the whole test battery according the criterion (100m hurdles performance). We can conclude that individual motoric tests used as a field tests shows foundation for putting them into the test battery of control tests for prediction of performance on women´s 100m hurdles runners because the value of multiple correlation of these tests reach the high value of correlation. Multiple correlation of the test battery according to the performance on woman´s 100m hurdles is $R = 0.957$ ($p < 0.01$). The results help to explain 91-92% of variance of our criterion (women´s 100m hurdles).

The results of step analyzes of the whole test battery are even more interesting. We can use a method of step wise regression for reduction of the number of test in the test battery (to have tests with the highest prediction value). In the previous works of (Hebák & Hustopecký, 1987; Loužecký, 1990) were used these phenomena:

1. firstly we put the variable with the highest value of correlation coefficient;
2. next is taken the variable which theoretically heighten the most a theoretical sum of quadrats and if this heightening is statistically significant on level α;
3. is investigate the influence of sooner placed variable in a case, if this variable was places as second (reverse order);

4. this method is carried on until the heightening of increased which is done by a next variable will not be statistically significant. Due to the F-test is in each step evaluate a possibility to exclude sooner included variables.

Tabulka 3./ Table 3.
Výsledky regresní analýzy použitých motorických testů k závisle proměnné./ The results of regression analyses of used motoric tests with the dependent variable.

Variable in equation	n	OR	p-value.
Standing long jump	29	–0.337⋆⋆	0,0025
120 m run	29	0.662⋆⋆	0,0001

Note. Linear regression analysis, method stepwise: OR – odds ratio; ⋆⋆ – $p < 0.01$; ⋆⋆.
$R^2 = 0.872$ (adjust $R^2 = 0{,}862$); $R = 0{,}934$.

On the above mentioned results of stepwise method we can conclude that key tests in the whole battery are 120m run and standing long jump. The result of the multi-regress analyzes shows that only these two tests can predict the performance on women´s 100m hurdles. If the statistical results of control test shows 91-92% of disperse stated criterion women´s 100m hurdles, the results of two key tests shows 86-87% disperse of stated criterion.

Discussion

In our article we have analyzed the motoric tests which are the most often used in tests batteries for control measurements of women´s 100m hurdler runners from the chosen Czech athletics clubs. The number of tests point out that the most of the coaches use tests intuitively at the basis of their experience with the coaching of women´s 100m hurdles. We have chosen tests which have been used the most by coaches and international authors and evaluate them as the most reliable for future prediction of performance on women´s 100m hurdles. These tests we have used as predictors and we have evaluated their relationship to our criterion – which was the best performance for women´s 100m hurdles. We have expected the high level of dependence among used tests and criterion. We have been interested if used tests are used rightfully (justly) and if there is a way to reduce the number of test in battery while the prediction stay high. This reduction of tests will lead to the simplification and economization of the whole process of control measurements. In different words to distinguished which tests are essential and which can be reduced.

According to our findings there is a possibility to reduce 6 individual tests in a battery to two key tests. These tests are 120m run and standing long jump. The results of multi-regression analyzes shows for these two tests a minimum of distortion of the predicted result of sport performance in comparison with the whole test battery. The 120m run tests shows the level of maximum speed, most of all speed endurance which is an important variable for hurdles runners in last third of the 100m hurdles run. The standing long jump test shows the level of explosive leg power. Surprisingly the test 50m jumping run, which intuitively shows at the ability of fast and effective take off, doesn't show as a key test. The problem could be in evaluation of this test with is done by the coefficient, this can distort the result of the predict validity against the other tests which are recorded in metric values.

Strength and limitations of the study

The strong part of this study are objective methods (the results of motoric tests) not only a subjective evaluation of participants. The weak part is number of participant´s n = 29 who have finished the whole project both measurements (first and with 1 year difference).

Conclusion

During the physical education practice are the motoric tests used quite often and not all tests have accurately stated the level of validity and reliability. In this article we wanted to show a possibility to reduce the number of tests used during the control measurements – in our case for women´s 100m hurdles runners. Out of the results we can recommend to do such analyzes for more used tests batteries (for different sports, disciplines or just as evaluation of basic fitness). The results of these analyzes

should give us a better and accurate measures and prediction of future performance and selection for centers for talented youth and more economic process of the talent´s selection.

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Příloha 1./ Supplement 1.

Výsledky motorických testů a hodnot nejlepších výkonů v běhu na 100 m překážek./ Results of motoric tests and the value of the best performance on 100m hurdles.

Inicials	100 m hurdles 84cm (Juniors 76cm)	50 m standing	Standing long jump	30 m flying	10 jump	50m jump run	run 120m
1.	14,93	6,9	218	3,58	26,24	15,5	15,4
2.	14,74	6,8	227	3,44	27,95	17,4	15,6
3.	14,68	6,9	238	3,43	28,53	15,6	15,4
4.	15,36	7,1	215	3,60	23,81	13,7	16,2
5.	15,61	7,0	220	3,72	23,88	14,5	16,3
6.	15,50	6,8	225	3,63	23,90	14,4	16,3
7.	13,60	6,0	257	3,20	30,45	18	14,8
8.	13,32	6,0	265	3,16	30,65	14,9	14,6
9.	13,78	6,7	259	3,49	25,98	15,7	15,0
10.	13,83	6,5	245	3,54	27,00	13,9	14,8
11.	13,75	6,5	255	3,52	26,00	13,9	14,8
12.	15,80	7,9	205	3,89	23,40	14,1	16,9
13.	15,74	7,0	237	3,72	24,23	13,9	16,4
14.	14,99	6,7	226	3,54	26,30	13,0	15,7
15.	15,05	6,6	242	3,47	27,47	15,6	15,4
16.	14,99	6,7	242	3,48	26,90	15,8	15,6
17.	14,87	6,6	246	3,48	28,35	16,7	15,4
18.	14,41	6,8	236	3,42	26,78	15,2	15,4
19.	14,33	6,8	223	3,56	26,32	14,8	15,3
20.	14,18	6,5	244	3,49	26,23	15,9	14,8
21.	14,19	6,5	254	3,48	26,93	16,5	15,4
22.	13,67	6,6	254	3,43	28,50	16,9	15,4
23.	15,83	7,2	215	3,78	22,10	12,6	17,4
24.	15,93	7,1	218	3,74	22,73	13,5	17,0
25.	15,56	7,0	218	3,69	22,37	13,3	16,7
26.	16,01	7,1	227	3,77	23,30	13,8	17,0
27.	14,45	6,9	258	3,51	27,21	14,5	15,9
28.	15,20	6,8	237	3,6	26,58	13,9	16,8
29.	14,41	6,7	252	3,41	24,00	13,3	15,4

Příloha 2./ Supplement 2.

Informovaný souhlas./ Informed consent.

Informovaný souhlas

Název studie (projektu):
Reliabilita a predikční validita motorických testů používaných v disciplině běh na 100 m překážek žen.

Jméno:
Datum narození:
Účastník byl do studie zařazen pod číslem:

1. Já, níže podepsaný(á) souhlasím s mou účastí ve studii. Je mi více než 18 let.
2. Byl(a) jsem podrobně informován(a) o cíli studie, o jejích postupech, a o tom, co se ode mě očekává. Beru na vědomí, že prováděná studie je výzkumnou činností.
3. Porozuměl(a) jsem tomu, že svou účast ve studii mohu kdykoliv přerušit či odstoupit. Moje účast ve studii je dobrovolná.
4. Při zařazení do studie budou moje osobní data uchována s plnou ochranou důvěrnosti dle platných zákonů ČR. Je zaručena ochrana důvěrnosti mých osobních dat. Při vlastním provádění studie mohou být osobní údaje poskytnuty jiným než výše uvedeným subjektům pouze bez identifikačních údajů, tzn. anonymní data pod číselným kódem. Rovněž pro výzkumné a vědecké účely mohou být moje osobní údaje poskytnuty pouze bez identifikačních údajů (anonymní data) nebo s mým výslovným souhlasem.
5. Porozuměl jsem tomu, že mé jméno se nebude nikdy vyskytovat v referátech o této studii. Já naopak nebudu proti použití výsledků z této studie.

Podpis účastníka: Podpis výzkumníka pověřeného touto studií:

Datum: Datum:

Mgr. Vítězslav Prukner, Ph.D.
Department of Sport
Faculty of Physical Culture, Palacky University in Olomouc, Czech Republic
Tř. Míru 115
771 11 Olomouc
vitezslav.prukner@upol.cz