RELIABILITY AND FACTORIAL VALIDITY OF THE CYCLING TESTS AMONG SCHOOL POPULATION

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Abstract
The purpose of this study was to assess the reliability and validity of the newly constructed bike tests among non-selected school population. The total of 30 non-selected primary school pupils (mean age = 13 ± 0.6 years; mean height = 162.35 ± 9.63 cm; mean body mass = 54.47 ± 13.08 kg) participated in this study without previous involvement in any training process. A total of six tests have been used. Three standardized tests for schools long jump from a place (LJP), bend gap (BG), raising trunk (RT) and three cycling tests cycling acceleration (CA), cycling polygon (CP), 1000 m time trial (C1000). Reliability coefficients for cycling tests CA α = 0.904, α = 0.978 CP. From a total of six tests, factor analysis resulted in two significant factors. The first factor explains 41.97% of the total variance and is defined as the cycling factor. The correlation coefficients of tests with the first factor CA =- 0.869, CP =- 0.849, and LJP = 0.692. The second factor explains 22.437% of the total variance and stands for the flexibility with the correlation between BG and other factors of 0.858. The results indicate that the tests are reliable and valid.

***Key words**: cycling tests, children, reliability, cross, bike*

Introduction

Cycling moto-cross (BMX) is ideal for mastering the techniques of riding a bike, so the whole training of young athletes should be related to a BMX. The research dealing with BMX (Zabala et al., 2008) is related to a professional sport in the subjects aged 19.4 years who have been in training process for 8-12 years. Mountain biking (MTB) is a discipline that takes place in the natural environment, in most cases through the woods. Research in MTB (Gregory, Johns, & Walls, 2007) deals with comparing the results of laboratory research (VO2max) and time needed to master the specific trip on the field that means on the bike race. The subjects in this study were professional cyclists aged 25.1 years. Cyclo-cros is a discipline in which running and cycling are being alternated. Races are generally held in combination of asphalt and grassy areas. In places where you cannot ride a bike, the bike is worn on the shoulder and run. Cyclo-cros (White, Dressendorfer, Muller, & Ferguson, 2003) explores the issue of training which compares running to running with cycling among the female population. Piste cycling is specific because it needs special bikes that have a direct transmission with no brakes (when turning the wheel the pedals turn too). Battista, Foster, Andrew, Wright, Lucia, et al. (2008) examines high intensity exercise for increasing the ability among the subjects aged 24.4 years. There is a considerable amount of research in road cycling, and it is interesting to look at the characteristics of the individual authors who have been studying it in order to obtain a guiding principle for programming the training process from the earliest age all the way to the top sports art. Research carried out (Lounana, Campion, Noakes, & Medelli, 2006) among 26 professional cyclists aged 25.1 years includes: data on height and weight, body mass index (BMI), and maximum and minimum values of heartbeat rate compared to the pulse. The maximum receipt of oxygen (VO2max) tells us about the high aerobic capacity, which is here to 70.9 ml · kg−1· min−1 and the maximum watts (Wmax), which is in on average 433.9 talks about power. We can conclude from the research that (VO2max and Wmax) are modal values to which we should strive for at training programming for top road cycling. In the study (Vogt, Heinrich, Schumacher, Blum, Roecker, et al., 2006) we can find information about subjects aged 27.3 years, such as height and weight and there are also interesting data on the strength which is expressed to a maximum of 390 watts. The author also gives us information about the values of heartbeat rate and strength of the lactate threshold, which is based on 4 mili mole. Also, the value of the load 4 million + 1 million per pier, which can be very useful to us when planning and programming training. Compared to top athletes, 12 of them active men in the study (Green, McLester, Crews, Wickwire, Pritchett et al. 2006), have a significantly lower VO2max, which here is 52.2 in contrast to 70.9 among top cyclists. The difference separates the top athletes from amateurs. The information that the author also gives us is the percentage of fat, then the percentage of VO2max at 4 million piers that we use in the training programming process, and information about the load on the scale Borgovoj 4 million wharf. When choosing the test that which will be used to estimate a characteristic the researchers have aspiration for simplicity and applicability in practice and therefore (Swain, Parrott, Bennett, Branch, & Dowling, 2004) has applied the 6-minute test for assessment of VO2max (Vanhatalo, Doust, & Burnley, 2006) and used a full 3-min test to assess the critical power (W). In field tests (Vogt et al., 2006) uses the SRM Training system to gain power, heartbeat rate, cadence, speed and distance, and Gregory et al. (2007) uses 15.5 km field test that he later puts into relation with laboratory tests (VO2). Belgian researcher Bourgois, Coorevits, Danneels, Witvrouw, Cambier et al. (2004) tests the validity of the assessment of aerobic threshold using the Conconi test, comparing the pulse and blood lactate concentration. McNaughton, Roberts, & Bentley (2006) finds a link between the progressive tests, the 3 minute (GXT3min) and the 5 minute (GXT5min), with the 30-minute (TT) test with a complete SRM, while (Paton & Hopkins, 2001) uses two simple tests, 1 km and 4 km on bicycle ergometer for assessment of strength. Most studies in cycling are generally done with the top cyclists on expensive laboratory equipment, while research dealing with the problem of training and tests selection for children are generally scarce in the literature. One of the reasons is that the top sports results in cycling are achieved in mature age (about 25 years), and the laboratory equipment is not suitable for research on children. A survey conducted by Carrel, Sledge, Ventura, Clark, & Peterson (2008) deals with overweight children, while the training procedures or choice of tests for children are mostly unexplored. For these reasons this paper focuses on non-selected school population that is precisely on the reliability and validity of tests that can be applied in everyday practice and that they do not require expensive laboratory equipment.

Methods

Subjects

The total of 30 non-selected primary school pupils (mean age = 13 ± 0.6 years; mean height = 162.35 ± 9.63 cm; mean body mass = 54.47 ± 13.08 kg) who have not been in the training process yet complete the study. For each participant a testing protocol was kept, in which, besides the main results, the basic anthropometric parameters (height and body mass) were recorded too. The study had the approval of the Ethical Committee of the Faculty of Kinesiology, Zagreb, Croatia, according to the revised Declaration of Helsinki.

The Experimental Approach

Testing of students in the Croatian educational system and that part of education related to teaching physical education refers to the functional motor and anthropometric variables. In this study, the three school standard tests of motor areas were used, which were tested in the hall: LJP - a long jump from place to measure the explosive force, BG - bend gap to measure flexibility, RT - raising the trunk that measures repetitive force, and three newly designed test from cycling: CA - cycling acceleration, CP – cycling polygon, C1000 - 1000 meter time trial. Cycling tests are performed on an open asphalt surface on a medium quality bicycle that satisfies the needs of the MTB (frame - aluminium, equipment - Shimano pedals-classical (without the cycling system), 26-inch wheels, tires scott, number of gears 21 (3 front, 7 rear). The tests on a bicycle are performed in the conventional equipment for teaching physical education (sport shoes, jersey and a T-shirt). During the testing it is not allowed to wear cycling equipment (jersey and shoes) only the use of helmets is obligatory while speed shifting is allowed.

Procedure

The measurement was conducted in academic year 2008/2009, in March when the weather conditions satisfied the conditions for external testing (minimum of 15 degrees Fahrenheit and in the day with no wind) from the early morning at 10 am and ending at 1 pm. The subjects consumed the last meal two hours before the testing. The complete testing was performed in one day, first testing three motor tests indoors or in the gym. The first test is LJP - a long jump from a place (measured 3 times in a row), and BG – bend gap measured 3 times in a row, and RT - raising the trunk - only once, a break between each test (30 minutes) is a sequence of waiting for all 30 students to perform a task. After the motor test anthropometry is measured body height and body weight. Tests LJP, BG, RT are standardized school tests for the Republic of Croatia and are described in (Findak, 1996) applied kinesiology in education. After a 30 minutes break, the students switch to cycling tests which are performed outdoors. First, the extent CA - cycling acceleration - 3 times in a row, and CP - cycling polygon - 3 times in a row and finally C1000 - 1000 meter time trial - just once.

Cycling polygon (CP): Location of the task: This task is performed on a flat asphalt surface (school playground), length 30 meters. Description of performing the task: The initial position of the subject: The subject is on a bike on the start line, the front wheel is behind the starting line. One foot rests on the pedal that is in a horizontal position with the ground and another foot is on the ground, the choice of foot is arbitrary, but the seat height on a bicycle seat allows the sitting in such a position. The first two cones are placed to the left of the subject. Description of bicycle training ground: path long 30m, marked with 7 cones in a way that they are separated from each other 5m along the center line, with the first two cones placed on the central line, the third one 2m right from the center line, the fourth 2m left from the center line, fifth 2m right from the center line and the last two cone straight along the center line. At the seventh cone is also the finish line. Task performance: After the timekeeper's signal the subject masters the training ground by driving slalom around set cones at the maximum speed (without removing the foot from the pedal) all the way to the finish line, the first two cones passing from the left, the third cone from the right side, the fourth cone from the left, fifth cone from the right and sixth and seventh from the left. The test ends when the subject's front wheel crosses the finish line. This task is repeated 3 times in a row.

If the subject knocks the cone down, he continues driving, and if he misses it, he starts again. Transfer to a bicycle is arbitrary. Position of examiner: The examiner stands at the finish line, gives signal to the subject to start a task and stops the time when the subject has passed the line. Result: The time passed from start to finish. The first number is the seconds while the decimals represent hundredths. Purpose: The purpose of the test is to assess the degree of mastering cycling techniques.

Cycling acceleration (CA): Location of the task: This task is performed on a flat paved surface 30 meters in length. Description of performing the task: The initial position of the subject: the subject is standing on the starting line on a bicycle in the way that his front part of the wheel is behind the starting line. One foot rests on the pedal that is in a horizontal position, and another on the ground. Task performance: After the timekeeper's signal the subject masters the 30m long straight track at top speed until the front wheel crosses the finish line. This task is repeated 3 times in a row. The subject is not allowed to sit on the bike seat during task performance. Transfer to a bicycle is arbitrary. Final position: The test ends when the subject's front wheel crosses the finish line. Position of examiner: The examiner stands at the finish line, gives signal to the subject to start a task and stops the time when the subject has passed the line. Result: The time passed from start to finish. The first number is the seconds while the decimals represent hundredths. Purpose: The purpose of the test is to evaluate explosive power.

1000 m time trial (C1000): Place the task: This task is performed on a flat asphalt surface 1000 meters long. Description of performing the task: The initial position of the subject: The subject is standing at the starting line on a bicycle in the way that his front part of the wheel is behind the starting line. One foot rests on the pedal and another one on the ground. Task performance: After the timekeeper's signal the subject masters the 1000m long straight track at top speed until the front wheel crosses the finish line. The task is done only once. Transfer to a bicycle is arbitrary and subject is allowed to sit on the seat while performing the task. Final position: The test ends when the subject's front wheel crosses the finish line. Position of examiner: One examiner is standing on the start line and he gives the sign to the subject to start a task and the second examiner is standing on the finish line and he measures the time of arrival of the subject to the finish line. The examiners are coordinated in terms of timing, in the way that the finish line examiner knows the exact starting time of the subject. Result: The time passed from start to finish. The time is marked in seconds. Purpose: The purpose of the test is to evaluate functional abilities.

Statistical Analysis

For statistical analysis the basic statistical parameters (Mean) arithmetic center and standard deviation (SD) are used. Kolmogorov-Smirnov test was used to test the normality of distribution. Reliability was calculated by Cronbach's alpha (alpha) and interclass correlation coefficient (ICC). Factor in determining the validity of the newly constructed tests intercorelation matrix is factorized to the first principal component of factor analysis. The number of significant factors was determined by Kaiser-Guttman criterion with a value of 1.0 or greater, the structure of the matrix determines the validity factor and Structural validity is determined by the highest correlation with the resulting factors.

Results

All variables showed normal distribution. The average value of all derivative attempts shows statistically insignificant degree of variation (Table 1). Reliability coefficient in Table 1. is not calculated for variables C1000 and RT because the tests were measured only once.

Table 1 Descriptive Indicators and Coefficients of Reliability (Cronbach Alpha - Alpha, Intercorrelation - ICC)

	Mean	SD	ICC	alpha
LJP	185.20	19.32	0.834	0.924
BG	56.88	11.10	0.954	0.983
CA	6.44	0.79	0.777	0.904
CP	13.29	1.84	0.94	0.978
C 1000	132.33	9.85		
RT	41.30	6.47		

LJP- long jump from a place; BG – bend gap; RT - raising trunk; CA – cycling acceleration; CP - cycling polygon; C1000-1000 m time trial

Table 2 Intercorrelation Matrix for All Tests

	LJP	BG	RT	CA	CP	C1000
LJP	1.00	0.08	0.20	-0.47	*-0.44	*-0.41
BG	0.08	1.00	0.20	0.34	*0.41	-0.00
RT	0.20	0.20	1.00	-0.27	*-0.37	-0.17
CA	*-0.47	0.34	-0.27	1.00	*0.71	0.32
CP	*-0.44	*0.41	*-0.37	*0.71	1.00	0.13
C1000	*-0.41	-0.00	-0.17	0.32	0.13	1.00

* Statistical significance p <0.05; LJP- long jump from a place; BG – bend gap; RT - raising trunk; CA – cycling acceleration; CP - cycling polygon; C1000-1000 m time

Statistically significant correlation coefficients (Table 2) were obtained between study tests, and the highest ratio between CA and CP (r = 0.708). The main components of the factor analysis extracted two significant components.

Table 3 Main Components

	Eigenval	% total Variance	Cumul. Eigenval	Cumul. %
1*	2.518	41.970	2.518	41.970
2*	1.346	22.437	3.864	64.407
3	0.947	15.781	4.811	80.188
4	0.646	10.772	5.458	90.960
5	0.331	5.522	5.789	96.482
6	0.211	3.518	6.000	100.000

* Statistically significant components
Eigenval - the main component % Total Variance - the percentage of variance

The first component extracts by 41.97%, other 22.43% of the total variance (Table 3), together components explain 64.40%. Correlation with the first factor was high and ranged from 0.32 to 0.86. The highest correlation coefficients was obtained with the first variable CA, CP, and LJP, while the second factor with high variable BG 0.85 (Table 4).

Table 4 Correlation Tests with Main Components

	Factor 1	Factor 2
LJP	0.692	0.355
BG	-0.321	0.858
RT	0.466	0.472
CA	-0.869	0.181
CP	-0.849	0.268
C1000	-0.492	-0.395

LJP- long jump from a place; BG – bend gap; RT - raising trunk; CA – cycling acceleration; CP - cycling polygon; C1000-1000 m time trial.

Discussion

Looking at the results of non-selected primary school pupils who were not involved in the training process, we have obtained the data that confirms that the proposed tests in the field of cycling fully meet the parameters of reliability and validity and can be used as guiding values for the non-selected school population. For all the tests basic statistical parameters, arithmetic center, standard deviation and coefficient of reliability and validity were calculated. Very little variation within all three attempts at each test whether on standardized school tests (LJP and BG) or cycling tests (CA and CP) confirmed a very high degree of reliability, as demonstrated by the Cronbach alpha coefficient, which ranges in the interval 0.904 to 0.978, a intercorelative coefficient ranges in the interval from 0.77 to 0.94 (Table 1). An interesting fact that we have got from the performance of the tests themselves tells us that in the first attempt the subjects achieved the lowest value, and then the value increases in accordance with the number of attempts. When applying the tests in practice we should take only a result of the first measurement in order to avoid the effect of motor learning of each test. In the C1000 and RT tests the coefficients of reliability were not given because they are maximal tests and are performed only once. When we compare the results of the tests (LJP, BG and RT), which are standardized for the school population in Croatia (Findak, 1996), we got that our subjects in the LJP test are average because our results are in the range of RC and the average value was 185.20 (RC average is 185-199), in the test BG are above the average with the average score of 56.88 (average RC is 48-52) and also above the average in the RT test with a score 41.30 (average RC is 33-37). From these results we conclude that subjects would also achieve average and above average results have in the cycling tests (CA, CP, and C1000) in comparison with a population. The data obtained from the correlation tables define the statistical significance of the relationship between LJP and CA test (-0.472), CP (-0.440) and C1000 (-0.406) (the negative sign in the cycling tests occurs because the cycling tests are actually weather variables and a weaker value of the test is a better test result). Test LJP here proved to be the most complex test in the field tests that are standardized for the population of Croatia. Statistically significant correlation between the test CP and BG (0.406), RT (-0.372), CU (0.708), proves to us that the CP test has represented unveiled cycling tests in the best way. Very high correlation was obtained between the two cycling tests CA and CP (0.708) and points to the fact that the two cycling test are very similar. From a total of six tests, factor analysis resulted in two significant factors that explain together 64.407% of the total variance. The first factor explains 41.970% of the variance and can be defined as cycling factor because the correlation between the first factor and cycling tests is very high and is in CA (-0.869) and CP (-0.849). The first factor also has a high correlation with the test LJP (0.692) which confirms the connection between cycling tests with the test that is standardized for the school population in Croatia and confirms the thesis that designed tests are valid for non-selected school population. The second factor explains 22.43% of the variance and has the highest correlation with the test BG (0.858), but this is the only test of this factor that has a high correlation coefficient and in this case we can speak only about the secondary factor which also in this case represents the flexibility as separate ability. From these results we conclude that designed cycling tests are reliable and valid and that they are freed from errors while measuring and that they are good at measuring of cycling skills for which they are constructed. Tests such as these do not require expensive laboratory equipment and are easy to use. They are easy to master by non-selected pupils and each teacher of physical education can simply and easily use this test in practice. Tests can be used to assess the state of mastering cycling techniques as well as control tests to check the bicycle training program.

Literature

Battista, R.A., Foster, C., Andrew, J., Wright, G., Lucia, A., & Porcari, J.P. (2008). Physiologic responses during indoor cycling. *Journal of Strength and Conditioning Research, 22*, 1236–1241.

Bourgois, J., Coorevits, P., Danneels, L., Witvrouw, E., Cambier, D., & Vrijens J. (2004). Validity of the heart rate deflection point as a predictor of lactate threshold concepts during cycling. *Journal of Strength and Conditioning Research, 18*(3), 498–503.

Carrel, A.L., Sledge, J.S., Ventura, S.J., Clark, R.R., Peterson, S.E., Eickhoff, J.C., et al. (2008). Measuring aerobic cycling power as an assessment of childhood fitness. *Journal of Strength and Conditioning Research, 22*(1), 192–195.

Findak, V. (1996). *Applied kinesiology in Education*. Zagreb: Faculty of Physical Education.
Green, J.M., McLester, J.R., Crews, T.R., Wickwire, P.J., Pritchett, R.C., & Lomax, R.G. (2006). RPE Association with lactate and heart rate during high-intensity interval cycling. *Medicine and Science in Sports and Exercise, 38*(1), 167–172.
Gregory, J., Johns, D.P., & Walls, J.T. (2007). Relative vs. absolute physiological measures as predictors of mountain bike cross-country race performance. *Journal of Strength and Conditioning Research, 21*(1), 17–22.
Lounana, J., Campion, F., Noakes, T. D., & Medelli, J. (2007). Relationship between %HRmax, %HR reserve, %VO2max, and %VO2 reserve in elite cyclists. *Medicine and Sci. in Sports and Exercise, 39*(2), 350–357.
McNaughton, L.R., Roberts, S., & Bentley, D.J. (2006). The relationship among peak power output, lactate threshold, and short-distance cycling performance: Effects of incremental exercise test design. *Journal of Strength and Conditioning Research, 20*(1), 157–161.
Paton, C.D., & Hopkins, W.G. (2001). Tests of cycling performance. *Sports Medicine, 31*, 489–496.
Swain, D.P., Parrott, J.A., Bennett, A.R., Branch, J.D., & Dowling, E.A. (2004). Validation of a new method for estimating VO2max based on VO2 reserve. *Medicine and Sci in Sp and Exercise, 36*(8), 1421–1426.
Vanhatalo, A., Doust, J.H., & Burnley, M. (2007). Determination of critical power using a 3-min all-out cycling test. *Medicine and Science in Sports and Exercise, 39*(3), 548–555.
Vogt, S., Heinrich, L., Schumacher, Y.O., Blum, A., Roecker, K., Dickhuth, H.H., et al. (2006). Power output during stage racing in professional road cycling. *Medicine and Sci in Sports and Exercise, 38*(1), 147–151.
White, L.J., Dressendorfer, R.H., Muller, S.M., & Ferguson, M.A. (2003). Effectiveness of cycle cross-training between competitive seasons in female distance runners. *Journal of Strength and Conditioning Research, 17*(2), 319–323.
Zabala, M., Requena, B., Sánchez-Muñoz, C., González-Badillo, J.J., García, I., Oöpik, V., et al. (2008). Effects of sodium bicarbonate ingestion on performance and perceptual responses in a laboratory-simulated BMX cycling qualification series. *Journal of Strength and Conditioning Research, 22*(5), 1645–1653.

POUZDANOST I FAKTORSKA VALJANOST TESTA BICIKLIZMA U ŠKOLSKOJ POPULACIJI

Sažetak

Svrha ovog istraživanja je bilo utvrđivanje pouzdanosti i valjanosti novokonstruiranog biciklističkog testa u neselektiranoj školskoj populaciji. Ukupno 30 neselektiranih učenika osnovne škole (prosječnog uzrasta 13.0 g ± 0.6; prosječne visine 162.35 ± 9.63 cm; prosječne mase 54.47 ± 13.08 kg) sudjelovalo je u ovom istraživanju i prethodno nisu bili uključeni ni u kakav trenažni process. Ukupno je korišteno 6 testova. Tri standardna testa za škole: skok u dalj s mjesta (LJP), pretklon raskoračno (BG), podizanje trupa (RT); kao i tri biciklistička testa: ubrzavanje (CA), polygon (CP) i vožnaj 1000 m 8C1000). Koeficijenti pouzdanosti za biciklističke testove su bili: CA - α = 0.904, CP - α = 0.978. Od ukupno šest testova, faktorska analiza je špokazala dva faktora. Prvi objašnjava 41.97 % totalne varijance i definiran je biciklističkim testovima. Korelacije testova s tim faktorom bile su: CA =- 0.869, CP =- 0.849, i LJP = 0.692. Drugi faktor objašnjava 22.44 % zajedničke varijance i opisuje fleksibilnost u rasponu od BG i ostalih dimenzija od 0.858. Rezultati pokazuju das u testovi pouzdani i valjani.

Ključne riječi: *biciklistički test, djeca, pouzdanost, kros, bicikli*

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