RELIABILITY OF A NEW LOWER-EXTREMITY MOTOR COORDINATION TEST

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Abstract
Introduction. Motor coordination is a basic motor ability necessary for daily life, which also allows athletes to win a sports rivalry and patients to assess their recovery progress after therapy and rehabilitation. The aim of the present study was to assess the reliability of a new lower-extremity rate of movements test and testing apparatus. ***Material and methods.*** The study sample consisted of 92 students aged 19.21 ± 3.55 years, with body height of 171.2 ± 15.11 cm and body mass of 66.01 ± 12.32 kg. The study used a test-retest method. ***Results.*** The correlation between the test and the retest was $r_s = 0.79$ ($p < 0.001$) for the right leg, and $r_s = 0.78$ ($p < 0.001$) for the left leg. In both cases a positive linear correlation was observed ($r_s > 0$). ***Conclusions.*** The results of the study showed that the new rate of movements electronic testing apparatus was highly valid and reliable. Its technical possibilities eliminate errors that might have occurred earlier during manual counting of the performed cycles of movements.

Key words: testing methodology, data interpretation, motor coordination, test reliability

Introduction

Simple exercise tests measuring athletes' and patients' progress are often used in sport and kinesiotherapy. In sport, the use of motor coordination tests allows developing training loads, adjusting training schedule, and arranging biological renewal programs for athletes. In rehabilitation, the tests can be used to assess patients' progress towards regaining full abilities. Motor tests contribute to the recognition of athletes' movement potential and help determine their capabilities of practicing particular sports. In motor rehabilitation, like in sport, an individual therapeutic (training) approach to each patient (athlete) offers a possibility of healthy recovery for the patient.

Fleishman [1, 2] and Fleishman & Quaintance [3] designed and described a battery of 52 tests of motor abilities, which – with various modifications – have still been used effectively to date. Their simple performance procedures and low costs make these tests applicable in various conditions, e.g. in gyms, rehabilitation rooms, or hospital wards.

The present-day dynamic development of sciences encourages upgrades of these extremely useful tests. Antosiak-Cyrak and her research team are currently working on a modernized version of Fleishman's speed of lower leg movement tests, whose original purpose was to measure the speed with which movements of the lower legs were executed.

At present tapping tests can measure one's ability of executing a high rate of movement of the lower extremities, which is an important component of motor coordination skills. The ability consists of executing lower leg movements with a maximal frequency and it depends on the performance of nerve centers, controlling antagonistic muscle groups and enabling quick transitions between inhibition and activation and vice versa, i.e. on the efficacy of nervous processes [4].

The rate of movements test can be performed with the legs or the arms. There have been many modifications of Fleishman's test, e.g. different testing times (10s, 15s, 20s); testing instruments (T-bars – Lafayette Foot Tapper no. 327338, Fitronic instruments, LEMOCOT test foam pad), and test names, e.g. Foot Tapping Test (FTT), foot tapping speed test, FiTRO Tapping Check (system serves for testing the tapping frequency of upper and lower limbs), or Lower Extremity Motor Coordination Test (LEMOCOT).

The application of the modified Fleishman's test for measuring the performance of the lower legs follows different characteristics in sport and physical rehabilitation.

- In sport and physical education, the test is used to assess the dynamic asymmetry of the legs to determine differences between the performance of the left and the right legs as an effect of versatile training as well as to establish the size of differences between the dominant and non-dominant legs for sport injury prevention [5-12].

- In motor rehabilitation the Foot Tapping Test (FTT) is used to assess the motor fitness of patients with cervical compressive myelopathy [13, 14]; to determine the effects of pharmacological therapy in patients with Parkinson's [15]; with apraxia [16-18]. The LEMOCOT test is used in rehabilitation of the elderly with lower-extremity impairments [19] and for assessment of recovery speed after surgeries [20].

The aim of the present paper was to determine the reliability of a new tool testing the rate of movements of the lower extremities.

Material and methods

The testing procedure was officially approved by the Bioethical Committee of the Poznan University of Medical Sciences. The study sample consisted of students of the Tourism and Recreation and Physiotherapy majors. Professional athletes were excluded from the study. The students attended their obligatory, curricular, swimming classes (once a week) and did not participate in any other sport classes. The sample consisted of 92 students (aged 19.21 ± 3.55 years, with body height of 171.2 ± 15.11 cm and body mass of 66.01 ± 12.32 kg.

The usability of authors' own new apparatus for measuring the motor coordination of the legs was assessed [21]. The subject performed a rate of movements test, which can be applied in all conditions during physical education classes or sport training sessions. The comparison between the test results of the left legs and the right legs allowed the assessment of the lateralization degree of the legs. The present study made also use of authors' own optoelectronic measuring apparatus for administration and control of tests, registration of movements, and precise recording of test results displayed simultaneously on the computer screen (fig. 1 and 2).

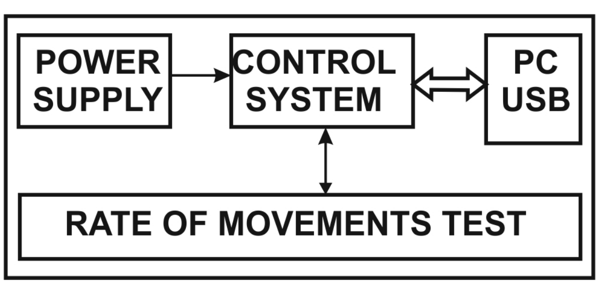

Figure 1. Block diagram of the testing apparatus – the power source, data control system, connect to a PC, the platform picking stimuli caused by the foot of subjects

Performing movements with the maximal frequency depends on the efficiency of nerve centers controlling antagonistic muscle groups responsible for quick transitions from motor activation to inhibition and vice versa. The movement rate is measured by recording the maximal number of movements performed by a given muscle group in a specified time. This skill is to a large extent grounded in the functions of the central nervous system, and it is hardly receptive to training. It is manifested in soccer players by their abilities to perform quick feints and shots.

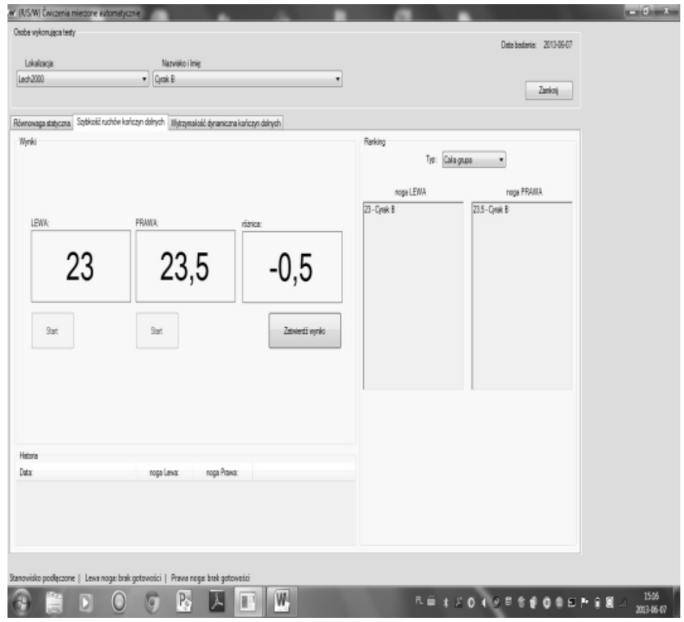

Figure 2. Screenshot

The rate of movements test (fig. 3) consists of shifting one's foot over a 15-cm-high bar within 20 sec. The subject sits on a chair with his arms along the torso and hands resting on the chair. The bar is placed along the symmetry axis of the chair. A movement cycle consists of moving the foot over the bar, touching the ground and returning the foot to its original position. During the test the other foot is positioned outside the detection area. The test lasts 20 seconds. The time measurement commences by lifting the foot, and stops after the test is completed. Only fully completed cycles made with each foot are counted. The subject must touch both halves of the detection area alternately. The result is given to the nearest half-cycle in counting time (number of cycles/execution time). The more full cycles are performed, the better the test result.

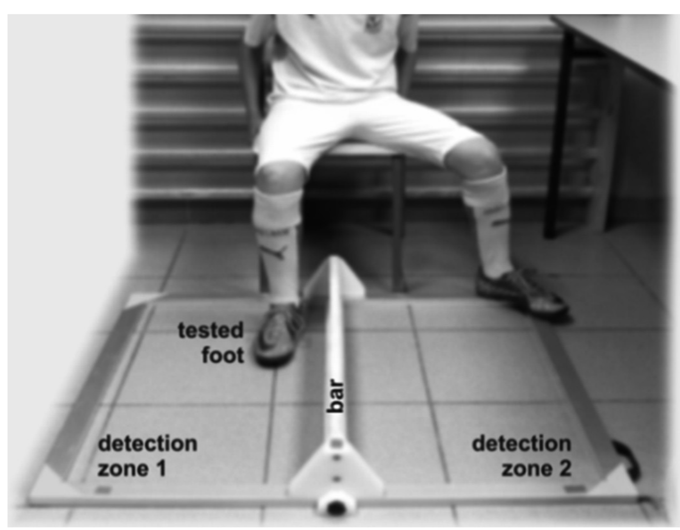

Figure 3. Station for testing the rate of movement

Each test using new research equipment should be subject to reliability assessment. The test results should be checked for their dependence on temporary, accidental, changes (undesired) as well as for their stability and duration (desired). To determine the reliability of the apparatus the test-retest method was used for measurement of absolute stability [22]. The test content and procedure was the same, but it was performed twice. The period between the measurements was from 4 to 7 days.

All methods assessing test reliability have some flaws. In the case of the test-retest method it is its variability in time. Thus the times of measurement and procedures must be strictly adhered to. The coefficient of correlation indicates the strength of correlation between both measurements. The closer the coefficient is to 1, the stronger the correlation between the test and the re-test. The magnitude of effects was quantitatively assessed according to Cohen [23, 24] as follows: trivial (0-0.19), small (0.20-0.49), medium (0.50-0.79) and large (0.80 and greater). The statistical significance of the test, as the most informative indicator, was set at $p < 0.05$.

Statistical analysis was carried out using the Statistica version 10. The following statistical tests were used: Wilcoxon's test and Spearman's rank correlation coefficient (r_s).

Results

A slight improvement of results was noted for the right and the left leg. For the left legs the difference was only slightly significant (Wilcoxon's test $Z = 2.4$; $p = 0.017$). For the right legs the difference was statistically non-significant ($Z = 1.8$; $p = 0.075$). For the right leg (fig. 4) the test-retest difference was 0.39 of a movement, cycle, and for the left leg – 0.5 of a movement cycle (fig. 5). The coefficient of variability in both legs was between 9.03 and 11.46, which indicates a low variability of the test. In both test measurements the right leg attained better results: 27.4 cycles in the test and 27.8 cycles in the retest. The left leg attained 26.1 cycles in the test, and 26.5 in the retest. The percent difference, i.e. the left leg's score as a percentage of the right leg's score, between the test and the retest was not statistically significant (fig. 6).

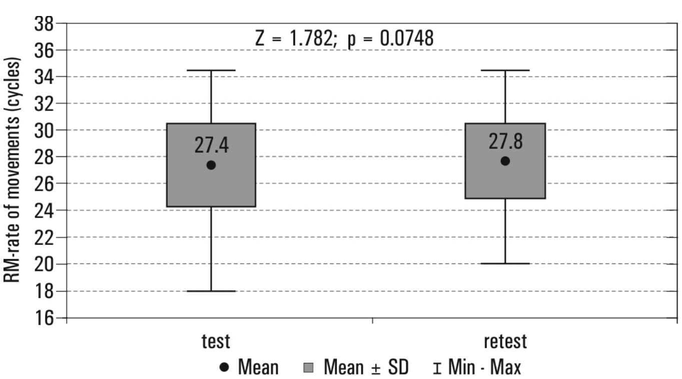

Figure 4. Statistical analysis of test-retest results of the right legs

Figures 7 and 8 show the test-retest differences for the right and the left legs. In the right leg test the participants mostly attained better results in the retest – 53.3% (fig. 7, left side). The improvement ranged from 6.5 to 0.5 movement cycles. Only 9.8 % of subject attained the same results for the test and retest, whereas 37% scored lower on their retest than on their test: from 0.5 to 3.5 movement cycles (fig. 7, right side).

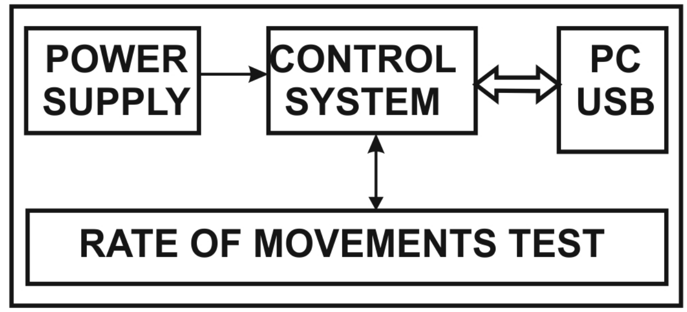

Figure 5. Statistical analysis of test-retest results of the left legs

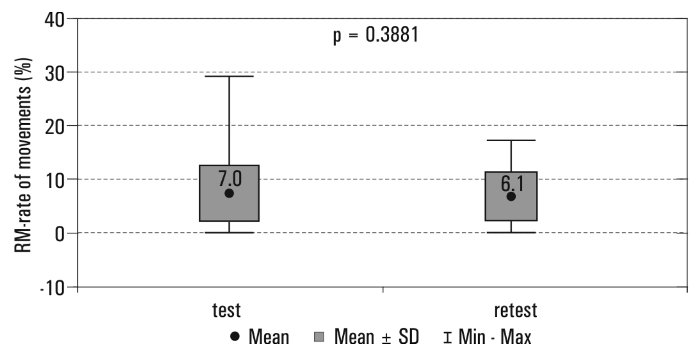

Figure 6. Statistical analysis of percent left/right test-retest differences (% in the diagram indicates the percent result of the left leg as lower from the result of the right leg, i.e. 100%)

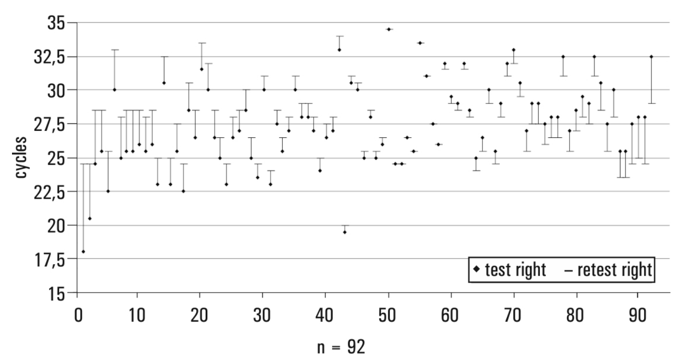

Figure 7. The right leg – differences between test and retest results (from better retest to better test results)

Very similar results were attained in the test with the left leg (fig. 8). 55.4% of subject attained better results in their retest. The improvement ranged from 5.5 to 0.5 movement cycles. 7.6% subject attained the same results in the test and the retest, whereas 37% scored lower in the retest, from 0.5 to 2.5 cycles.

The correlation coefficient between the test and the retest for the right leg amounted to $r_s = 0.79$ ($p < 0.001$, fig. 9), and for the left leg to $r_s = 0.78$ ($p < 0.001$, fig. 10). In the case of both legs a positive linear correlation was attained ($r_s > 0$). Number of points in figures 9 and 10 is smaller than the number of subjects, because some values were in the same place.

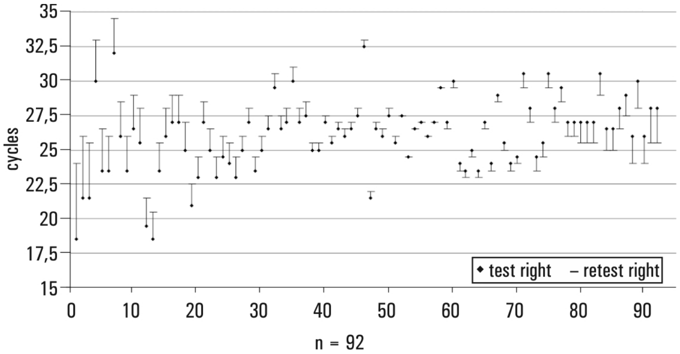

Figure 8. The left leg – differences between test and retest results (from better retest to better test results)

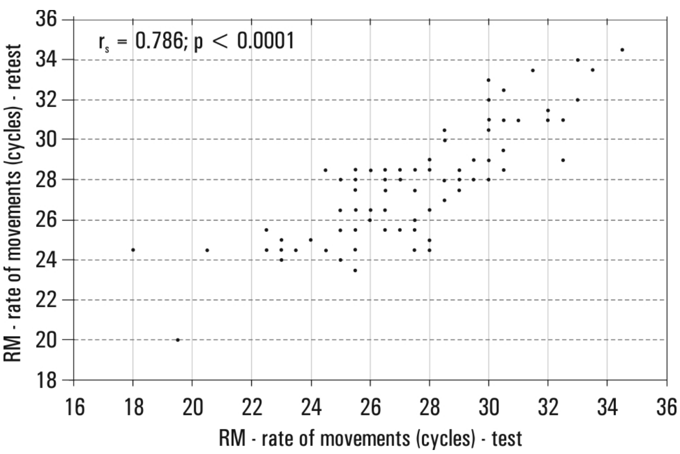

Figure 9. Analysis of reliability of the rate of movements test. Correlation coefficient (r_s) for the right legs

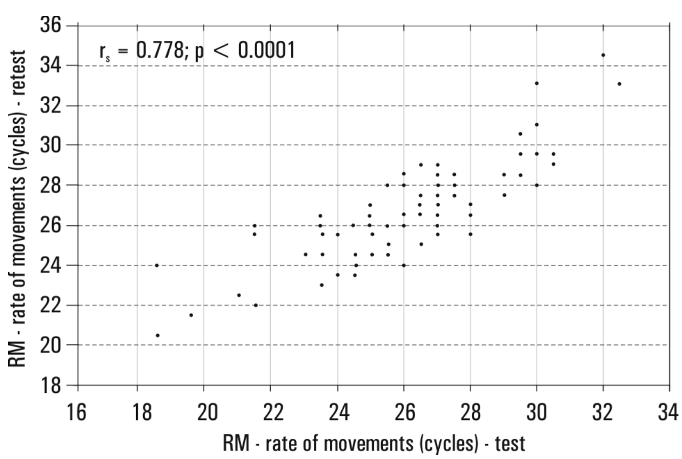

Figure 10. Analysis of reliability of the rate of movements test. Correlation coefficient (r_s) for the left legs

Discussion

A slight, statistically significant test-retest difference was noted for the right legs, which in test-retest validations were not infrequent. Brzeziński [25, 26] explains it by the factors of memory and learning. During the retest the subject already know the testing procedure, which may lead to an improvement in their test results. The obtained results also indicate that the learning factor affects the right legs earlier than the left legs.

The testing procedure had been designed very carefully, and all possible factors which could have affected the test results had been eliminated. However, this did not prevent the variability in the rate of movements. The high coefficient of correlation points to the usability of the test in motor coordination research. Similarly, Weber writes about the correlation as a tool to evaluate tests reliability and validity [29].

The results of this study met the requirements of these two trials (the Wilcoxon differences and the Spearman correlation) [19, 28]. The resulting relationship test-retest also met the requirements described by Cohen [23, 24]. The results can therefore be considered reliable.

Although one should always remember that, as pointed out by other authors who use the method of test-retest: constantly monitor the operation of measuring devices, and often calibrate it [27, 29].

There were no situations in which after performing a test and a retest a participant would have obtained completely different results. The experiment revealed an improvement in the results, which rather exposes the flaws in the test-retest method than in the usability of the new measurement tool.

Conclusions

The results showed that the new test proved medium valid by Cohen and reliable (0.78-0.79). This is the upper limit of reliability, according to Cohen (0,50-0,79). The technical possibilities of the apparatus eliminate errors that might have been generated during stopwatch measurements, i.e. by visual counting of the number of movement cycles. This accurate testing apparatus will allow preparation of standards for assessment of results of high movement rates test using a modified Fleishman's test, which is our next research project.

It is therefore promoted the introduction of modern electronic devices working in tandem with the computer to research the various features of human motor skills. They provide the accuracy, reliability and relevance of the results and the ability to archive electronically. This tool provides a quick research process and ease of obtaining statistical results.

It has another advantage important from a psychological point of view; subjected to tests of motor skills are often young people, and applying of methods with the use of modern equipment will be encouraging them to participate in the study.

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