Adaptation of Ruffier’s test for assessment of heart workability of students with health problems

Drogomeretsky V.V., Kopeikina E.N., Kondenkov V.L., Iermakov S.S.
Belgorod National Research University, Russia

Abstract

Purpose: to check up experimentally adapted test for assessment of heart workability of students with health problems. In the research girl students and boy students of 18-20 years age (n=487) participated. The procedure of test was as follows: during 45 seconds students fulfilled torso rising from lying on back position. During this procedure pulse was measured three times. Total time of test fulfillment was 2 minutes. For working out the scale for the received results’ interpretation we assessed new version of Ruffier’s test for validity. For this purpose 487 absolutely healthy tested students fulfilled, first, adapted test. Then, after complete recreation (in 20 minutes) they fulfilled commonly accepted test with squatting.

Results: it was found that with the help of adapted test it is possible to objectively assess heart workability of students. Correlation analysis of the received results showed average correlation (r=0.73).

Conclusions: application of adapted Ruffier’s test permits to assess heart workability of students with health problems.

Keywords: students, adapted, test, Ruffier, correlation analysis, heart workability.

Introduction

Modern health condition of future specialists is characterized as negative with tendency to worsening. Many studies of recent years have been registering increase of first year students’ with health problems quantity. It is very noticeable in division of students for practical physical culture classes [16; 49, 68]. Annual analysis of applicants’ health shows unfavorable dynamic of increasing first year students’ with different disorders in cardio-vascular, digestive, urogenital, nervous and other organism’s systems quantity. As per different data in special health groups (SHG – group of students with health problems) from 10.45% to 35.34% students were enlisted. In next years of study increment of these indicators is observed, which is characterized by progressing old diseases and emersion of new ones [8, 10, 13, 14]. The researches show that this quantity increases with every year. It results from emersion of new health problems and development of earlier registered [1, 3, 5, 15]. In 15.2-42.5% of students disorders in bone-muscular system were found.

Negative tendencies of students’ health worsening require seeking new directions of these problems’ solution. Among them there are:

- Increase of motivation component of sports practicing [25, 36] considering students’ reactions to physical loads [46];
- Optimization of physical loads’ volumes for students, considering their individual fitness [26, 40, 41, 65];
- Reduction of environmental and harmful habits’ negative influence [50, 51];
- Application of modern and new training methods [61, 63];
- Organization of proper pedagogic control in trainings of students with different fitness [28, 47];
- Raising of health criteria, considering psychological factors’ influence [48, 52] and health culture formation [71];
- Implementation of physical education pedagogic technologies in the process of training of students with different nosologies [22, 54, 59, 62];
- Application of health related students’ trainings with sport competition elements [57];
- Individual approach in choice of strategy, tactic and methodological provisioning of physical rehabilitation for students with pathologies [45, 67];
- Important criterion of the listed above approaches to students’ health improvement is students’ workability. Among approaches to increase students’ workability we can name:

- Weakening of chronic fatigue under different loads [39, 43];
- Determination of motor and sports rank places in students’ leisure hierarchy [42];
- Adaptation to physical loads [37].

With every passing years reduction of physical condition and functional fitness is observed in students. Generalization of medical examination results showed that many universities have own specific features: prevalence of bone-muscular system’s diseases. It was found that in Sankt Petersburg universities such diseases are 43%; in Ryazan – more than 19%; in Homel – less than 17%; in Ulyanovsk it does not exceed 15% [20]. Some scientists found that osteoarthritis (OA) of knee joint cover 20% of world population [32, 33, 53].

Physical education of people with such problems has a number of distinctive features [23, 24, 30, 38]. It reflects in organization and fulfillment of practical classes in university conditions. As specialists note [27, 30, 31, 35] knee pain when ascending staircase or walking on even inclined surfaces is an evident factor, limiting physical activity with OA of knee joint. It is proved also be the data of other scientists [64, 69, 70]. The authors found that it is tiresome for people with lower limbs’ OA to fulfill ordinary movements, because joint changes can
block transition of potential and kinetic energy of mass centers during walking. Some scientists resume that it is purposeful to develop methods of harmless physical loads for persons with Knee joint OA [34, 55, 56]. It means that additional studies, considering universities’ specificities are required.

**Hypothesis** was built on assumption that adapted Ruffier’s test with torso rising from lying position during 45 seconds will be valid in respect to commonly accepted squatting during 45 seconds. It will permit to specialists to completely assess heart workability of students with lower limbs OA.

The purpose of the work is to check up experimentally adapted test for assessment of heart workability of students with lower limbs OA and substantiate it.

**Material and methods**

*Participants:* in the research girl students and boy students of 18-20 years age from main health group (without health problems) (n=487) participated. All participants were familiarized with “Helsinki declaration of world health protection organization” and gave written consent for participation in experiments [72].

*Organization of the research:* Ruffier’s test is used for the following: assessment of heart workability before sport trainings; working out training programs; assessment of sport training programs’ effectiveness; assessment of person’s physical fitness by his/her cardiovascular system’s reaction to physical load.

At present time several functional tests with squatting are known. Martinet’s test implies 20 squatting during 30 sec.; Ruffier’s test assesses heart functional reserves with 30 squatting during 45 seconds. All they imply bending and unbending of lower limbs. But such exercises are difficult for most of persons with lower limbs’ OA. That is why adapted variant of Ruffier’s test, especially for students with lower limbs OA, was worked out.

According to adapted Ruffier’s test students shall be in lying position in relaxed state. His pulse is counted for 15 seconds (P1). Then student fulfills 30 torso risings from lying on back position. Arms are crossed on chest with hands on shoulders. Legs are fixed and bent in knees under angle 80-90°. When rising torso it is necessary to touch elbows by knees, when descending legs – lie on back completely. For exact dozing of rising frequency we used metronome with frequency 80 beat/min. Every torso movement corresponded to one strike of metronome.

After test’s finishing the tested took lying position and his pulse was measured during first 15 seconds (P2) and last 15 seconds (P3) in the first minute of rest.

Coefficient was calculated by the following formula:

$$C = \frac{4 \times (P1 + P2 + P3) - 200}{10}$$

For working out interpretation scale of the received results we assessed new variant of Ruffier’s test for validity. For this purpose 487 absolutely healthy students fulfilled,
first, adapted test. Then, after complete restoration (in 20 minutes) they fulfilled commonly accepted test with squatting.

Statistical analysis was fulfilled with the help of SPSS 22 program.

Results

For working out interpretation scale of the received results for students with lower limbs OA we fulfilled correlation analysis of the received data. These data were analyzed for finding statistical correlations in this sample. In fig. 1 there are presented the received results. Analysis of the obtained data shows regularity in heart beats rate distribution in both versions of Ruffier’s test. Alongside with it we formed correlation field (see fig.2). Analysis of this field showed direct positive correlation in the studied data. We found that with higher value of one attribute the value of other also increases. With reduction of one attribute the other also decreases. Thus, we can note average correlation between two samples (r=0.73).

The received data permitted to develop the following interpretation scale for adapted Ruffier’s test results for persons with lower limbs OA:

The results are interpreted in the following way [18].

- Less than 0 – athletic heart;
- 0.1-5 – “excellent” (very good heart);
- 5.1-10 – “good” (good heart);
- 10.1-15.0 – “satisfactory” (moderate heart deficiency);
- 15.1-20 – “bad” (strong heart deficiency).

Finally, it should be noted that the fulfilled research of students hearts workability permitted to prove validity of the worked out adapted Ruffier’s test. The collected by that time empiric material proves that with the help of adapted Ruffier’s test specialists can objectively and with high quality assess heart workability of students with lower limbs OA.

Fig.2. Correlation field of heart beats rate registration results in commonly accepted Ruffier’s test P1, P2, P3) and in adapted version (P1a, P2a, P3a).
Discussion
Annual observations of physical education specialists find that there is a significant quantity of students with chronic diseases of joint-ligament apparatus, in particular lower limbs OA [6, 17, 60, 66]. This category has a number of significant limitations in respect to physical loads and requirements to physical activity [7, 11, 12, 19]. Nevertheless, it is very important for these persons to sustain physical activity for ensuring normal functioning of organism’s important systems. For this purpose it is necessary to develop special methodic and programs of physical education [9, 21, 58]. When choosing load it is necessary to know initial potentials and realize systemic control over them during long time [2, 4, 20, 44]. Widely used for this purpose Ruffier’s test is intended for people with healthy lower limbs. Application of developed by us adapted version of Ruffier’s test permits for specialists to assess at high quality heart workability of students with lower limbs OA. Analysis of cardio-vascular workability of students with lower limbs OA permitted for us to prove validity of the worked out adapted Ruffier’s test. The results permit to assume that application of this adapted test is possible for different age groups as well as for people without lower limbs OA.

Conclusions
The worked out by us adapted version of Ruffier’s test has potentials for wide application by specialists in physical culture and sports. This variant of the test permits for physical culture pedagogues to completely assess heart workability of students with lower limbs OA, as well as of students without health problems.

Conflict of interests
The author declares that there is no conflict of interests.

References
1. Balisheva NV. Ukreplenie zodor’va studentok, imeiushchikh narushenii serdечно-сосудистой системы, sredstvami dozirovannoj ozdorovitel’noj khod’by i bega. Kand. Diss. [Health improvement of girl students, who have cardio-vascular system problems, by means of dozed health related walks and run]. Cand. Diss.], Sankt Petersburg; 2010. (in Russian)
2. Bogoeva MD. Postroenie processa fizicheskogo vosпитания studentov special’noj medicinskoi gruppy s ograniennyimi vozmozhnostiamy serdечно-сосудистой sistemy. Kand. Diss. [Building of physical education process of special health group students with cardio vascular system’s limited potentials]. Cand. Diss.] Sankt Petersburg; 2011. (in Russian)
3. Bocharova VI. Integracija sredstv pilatesa i step-aerobiki dlja oboespecheniia rabotosposobnosti studentov: dissertacija. Kand. Diss. [Integration of pilates and step-aerobic means for ensuring students’ workability: dissertation. Cand. Diss.], Sankt Petersburg; 2013. (in Russian)
4. Goginava SE. Sochetanie sredstv aerobnoj i anaeobnoj napravennosti na zaniatiiakh po fizicheskoj kul’ure v vuz. Kand. Diss. [Combining of aerobic and anaerobic means at physical culture lessons in HE]. Cand. Diss.], Tambov; 2014. (in Russian)
5. Gorelov AA, Kondakov VL, Belikova ZhA. About necessity of use of Hatha Yoga exercises for correction of deformation of students’ spine of special medical groups with violations of posture. Physical education of students, 2013; 17(2): 35-44. doi:10.6084/m9.figshare.156378
6. Gorelov AA, Kondakov VL, Usatov AN, Usatov VN. O roli dvigatel’noj aktivnosti studentov gumanitarnykh vuzov i sposobakh ee povysheniia [On role of humanitarians’ students’ motor activity and means of its intensification]. Uchenye zapiski universiteta im. P.F. Lesgafta, 2009; 1(47):28-33. (in Russian)
7. Gorelov AA, Kondakov VL, Usatov AN. Tekhnologii regulirovaniia dvigatel’noj aktivnosti studentov v prossese povsednevnoj i obrazovatel’noj deiatel’nosti [Technology of students’ motor functioning regulation in everyday and educational activity]. Vestnik sportivnoj nauki, 2010;5:47-49. (in Russian)
8. Grachev AS. Tekhnologia uluchshenija funkcionirovanija zritel’nogo analizatora slabovidushchikh studentov sredstvami sportivnykh i podvizhnikh igr. Kand. Diss. [Technology of visual analyzer functioning improvement for students with eyesight problems by means of sport and outdoors games. Cand. Diss.], Sankt Petersburg; 2013. (in Russian)
9. Drogomeretsky VV. Korrekciia narushenii sustavno-sviazochnogo aparata studentov special’nykh medicinskikh gruppy sredstvami ozdorovitel’nogo plavaniia. Kand. Diss. [Correction of special health group students’ ligament-joint apparatus disorders by means of health related swimming. Cand. Diss.], Sankt Petersburg; 2012. (in Russian)
10. Drogomeretsky VV, Kondakov VL, Gorelov AA. Application of improving swimming to the correction of joint and ligament students. Physical education of students, 2013; 17(5): 46-54. doi:10.6084/m9.figshare.771046
11. Drogomeretsky VV, Kondakov VL, Gorelov AA. Korrekciia sustavno-sviazochnogo aparata sredstvami plavaniia [Correction of ligament-joint apparatus by swimming]. LAP LAMBERT Academic Publishing; 2016. (in Russian)
12. Drogomeretsky VV, Kondakov VL. Ocenka sostoiania sustavno-sviazochnogo aparata studentov [Assessment of students’ ligament-joint apparatus condition]. Ekonomicheskie i gumanitarnye issledovaniia regionov, 2011;6:45-51. (in Russian)
13. Kondakov VL, Kopeikina EN, Balisheva NV, Usatov AN, Skrug DA. Causes of declining interest of students to employment physical education and sports. Physical education of students, 2015; 19(1): 17-21. doi:10.15561/20755279.2015.0103
14. Kondakov VL, Belikova ZhA, Rumba OG. Korrekciia narushenii osanki sredstvami khatkha-jogi [Correction of posture disorders by Hatha Yoga means], LAP LAMBERT Academic Publishing; 2016. (in Russian)
15. Kondakov VL. Sistennye mehanizmy konstruktirovaniia fizkul’turno-ozdorovitel’nykh tekhnologii v obrazovatel’nom prostranstve sovremennogo vuz. Dokt. Diss. [Systemic mechanisms of health related physical culture technologies building in educational space of modern HE]. Doct. Diss], Sankt Petersburg; 2013. (in Russian)
16. Kopeikina EN. Postroenie processa fizicheskogo vosпитания studentov s narusheniami v sostoyanii dykhatel’noj sistemy. Kand. Diss. [Building of physical education process for girl students with respiratory system disorders. Cand. Diss.,
30. Cho Y, Kim M, Lee W. Effect of proprioceptive training on foot posture, lower limb alignment, and knee adduction moment in patients with degenerative knee osteoarthritis: a randomized controlled trial. *Journal of Physical Therapy Science*. 2015;27(2):371-4.

31. de Rooij M, van der Leeden M, Heymans MW, Holla JFM, Hakkinen A, Lems WF, et al. Prognosis of Pain and Physical Functioning in Patients With Knee Osteoarthritis: A Systematic Review and Meta-Analysis: Knee OA Pain and Functioning Prognosis. *Arthritis Care & Research*. 2016;68(4):481–92.

32. De Souza Campos Fernandes R, Nogueira MP. Effects of prescribed physical activity in patients with advanced osteoarthritis of the knee. *Revista Brasileira de Medicina do Esporte*. 2016;22(4):302-305.

33. Esculier JF, Bouyer LJ, Roy JS. The Effects of a Multimodal Rehabilitation Program on Symptoms and Ground-Reaction Forces in Runners With Patellofemoral Pain Syndrome. *Journal of Sport Rehabilitation*. 2016;25(1):23-30.

34. Fukutani N, Iijima H, Aoyama T, Yamamoto Y, Hiraoka M, Miyanobu K, et al. Knee pain during activities of daily living and its relationship with physical activity in patients with early and severe knee osteoarthritis. *Clinical Rheumatology*. 2016;35(9):2307–16.

35. Gaskov AV, Kuzmin VA, Kudryavtsev DM, Iermakov SS. Successfulness of general and special physical qualities’ development on different stage of students-boxers’ training. *Physical Education of Students*. 2016;20(1):4–11.

36. Goodwin D, Howe PD. Framing Cross-Cultural Ethical Practice in Adaptive Physical Activity. *Quest*. 2016;68(1):43-54.

37. Gorelov AA, Kondakov VL, Usatov AN. To the question about the use of independent physical training in educational space of modern higher institute. *Physical education of students*, 2013; 17(1): 17-26. doi:10.6084/m9.figshare.156351

38. Hayes MJ, Osmotherly PG, Taylor JA, Smith DR, Ho A. The effect of loupes on neck pain and disability among dental hygienists. *Work-a Journal of Prevention Assessment & Rehabilitation*. 2016;53(4):755-62.

39. Iermakov SS, Arziutov GN, Jagiello W. Quick training of students to judo techniques. *Archives of Budo*. 2016;12:15–24.

40. Iermakov SS, Podrigalo LV, Jagiello W. Hand-grip strength as an indicator for predicting the success in martial arts athletes. *Archives of Budo*. 2016;12:179–86.

41. Ilchenko S.S. Motor and sport components in hierarchy of non physical culture profile pedagogic specialties students leisure. *Pedagogics, psychology, medical-biological problems of physical training and sports*. 2015;5:33-37. doi:10.15561/18189172.2016.0505

42. Iljin VN, Alwani AR. Ubiquity and formation of chronic fatigue in qualified sportmen. *Pedagogics, psychology, medical-biological problems of physical training and sports*, 2016;5:33-37. doi:10.15561/18189172.2016.0505

43. Konev VN, Voloshina LN, Balysheva NV, Kopeikina EN, Skrug DA. Correction of the state of cardiovascular system of undergraduates by means of dosed constitutional walking and jogging. *Research Journal of Medical Sciences*. 2015;9 (3):95-98.

44. Kotelyskiy VI. Integrative technology of massage manipulations in physical rehabilitation of students with backbone pathology. *Pedagogics, psychology, medical-biological problems of physical training and sports*, 2016; 20(3): 31-40. doi:10.15561/18189172.2016.0305

45. Kozina ZL, Iermakov SS, Kadutskaya LA, Sobyanin FI,
Krzeminski M, Sobko I N, Ryepko OA. Comparative characteristic of correlation between pulse subjective indicators of girl students’ and school girls’ reaction to physical load. *Physical education of students*, 2016; 20(4): 24-34. doi:10.15561/20755279.2016.0403

47. Kretschmann Rolf. Comparison of 9th grade students’ physical activity levels during recess and regular class periods using objective measurement. *Pedagogics, psychology, medical-biological problems of physical training and sports*, 2016; 20(4): 59-63. doi:10.15561/18189172.2016.0409

48. Kudryavtsev MD, Kopylov YuA, Kuzmin VA, Ionova OM, Yermakova TS. Personality oriented system of strengthening of students’ physical, psychic and social-moral health. *Physical education of students*, 2016; 20(3): 43-52. doi:10.15561/20755279.2016.0308

49. Kudryavtsev MD, Kramida IE, Iermakov SS, Osipov AYu. Development dynamic of healthy life style personality component in relatively healthy students. *Physical education of students*, 2016; 20(6): 26-33. doi:10.15561/20755279.2016.0603

50. Kudryavtsev MD, Kramida IE, Iermakov SS. Influence of studying in higher educational establishment on students’ harmful computer habits. *Physical education of students*, 2016; 20(5): 17-23. doi:10.15561/20755279.2016.0503

51. Kudryavtsev MD, Kramida IE, Kuzmin VA, Iermakov SS, Cieslicka Miroslawa, Stankiewicz Blazej. Influence of study in hee on ubiquity and strength of students’ computer gambling. *Physical education of students*, 2016; 20(3): 13-22. doi:10.15561/20755279.2016.0302

52. LeBlanc VR, McConnell MM, Monteiro SD. Predictable chaos: a review of the effects of emotions on attention, memory and decision making. *Advances in Health Sciences Education*. 2015;20(1):265-82.

53. Lene Krenk, Gertrud Laura Sorensen, Henrik Kehlet, Poul Jennum Heart rate response during sleep in elderly patients after fast-track hip and knee arthroplasty. *Sleep and Biological Rhythms*, 2015;13(3):229–234.

54. Leo J, Goodwin D. Simulating Others’ Realities: Insiders Reflect on Disability Simulations. *Adapted Physical Activity Quarterly*. 2016;33(2):156-75.

55. Liu S-H, Driban JB, Eaton CB, McAlindon TE, Harrold LR, Lapane KL. Objectively Measured Physical Activity and Symptoms change in Knee Osteoarthritis. *The American Journal of Medicine*. 2016;129(5):497–505.

56. Longpre HS, Acker SM, Maly MR. Muscle activation and knee biomechanics during squatting and lunging after lower extremity fatigue in healthy young women. *Journal of Electromyography and Kinesiology*. 2015;25(1):40-6.

57. Lochbaum MR, Jean-Noel J, Cetinkalp ZK, Vallejo-Reyes FA, Mena-Campbell J. 2 x 2 Achievement goals profiles in chilean competitive and recreational athletes: a first look. *Pedagogics Psychology Medical-Biological Problems of Physical Training and Sports*. 2016;20(1):41-6. doi:10.15561/18189172.2016.0106

58. McNell O., Pile K. My knees can tell the weather: Effective management of osteoarthritis. *Medicine Today*, 2011;12(1): 28-39.

59. Moraros J, Islam A, Yu S, Banow R, Schindelka B. Flipping for success: evaluating the effectiveness of a novel teaching approach in a graduate level setting. *Bmc Medical Education*. 2015;15.

60. O’Dwyer, T.O’Shea, F., Wilson, F. Decreased health-related physical fitness in adults with ankylosing spondylitis: A cross-sectional controlled study. *Physiotherapy (United Kingdom)*, 2016;102(2): 202-209.

61. Osipov AYu, Kudryavtsev MD, Kramida IE, Iermakov SS, Kuzmin VA, Sidorov LK. Modern methodic of power cardio training in students’ physical education. *Physical education of students*, 2016; 20(6): 34-39. doi:10.15561/20755279.2016.0604

62. Paz AL, Doniz LG, Garcia SO, Canosa JLS, Couto CM. Respiratory Muscle Strength in Chronic Stroke Survivors and Its Relation With the 6-Minute Walk Test. *Archives of Physical Medicine and Rehabilitation*. 2016;97(2):266-72.

63. Podrigalo LV, Iermakov SS, Alekseev AF, Rovnaya OA. Studying of interconnects of morphological functional indicators of students, who practice martial arts. *Physical education of students*, 2016; 20(1): 64-70. doi:10.15561/20755279.2016.0109

64. Queen RM, Sparling TL, Schmitt D. Hip, Knee, and Ankle Osteoarthritis Negatively Affects Mechanical Energy Exchange. *Clinical Orthopaedics and Related Research*. 2016;474(9):2055–63.

65. Ross JA, Shipp EM, Trueblood AB, Bhattacharya A. Ergonomics and Beyond: Understanding How Chemical and Heat Exposures and Physical Exertions at Work Affect Functional Ability, Injury, and Long-Term Health. *Human Factors*. 2016;58(5):777-95.

66. Senter C, Appelle N, Behera SK. Prescribing exercise for women. *Current Reviews in Musculoskeletal Medicine*. 2013;6(2):164–72.

67. Arezes P, Baptista J, Barroso M, Carneiro P, Cordeiro P, Costa N, et al., editors. Occupational Safety and Hygiene IV [Internet]. CRC Press; 2016 [cited 2017 Jan 14]. Available from: http://www.crcnetbase.com/doi/book/10.1201/b21172.

68. Skurikhina NV, Kudryavtsev MD, Kuzmin VA, Iermakov SS. Fitness yoga as modern technology of special health groups’ student’s psycho-physical condition and psychosocial health strengthening. *Physical education of students*, 2016; 20(2): 24-31. doi:10.15561/20755279.2016.0204

69. Smith BE, Hendrick P, Logan P, Patelofemoral pain: Challenging current practice - A case report. *Manual Therapy*. 2016;22:216-9.

70. Straker LS, Vannatta CN, Waldron K. Treatment Strategies for the Master Athlete With Known Arthritis of the Hip and Knee. *Topics in Geriatric Rehabilitation*. 2016;32(1):39-54.

71. Su J, Zhang S, Yang L, Li XH, Inc DEP. Research on the Effect of Physical Fitness Evaluation Model for Physical Exercise Evaluation. 2016. 2nd International Conference on Modern Education and Social Science (Mess 2016). 2016:797-801.

72. WMA Declaration of Helsinki - Ethical Principles for Medical Research Involving Human Subjects [Online] Available from: [Accessed 15th April 2016]. http://www.wma.net/en/30publications/10policies/b3/
Cite this article as: Drogomeretsky VV, Kopeikina EN, Kondakov VL, Iermakov SS. Adaptation of Ruffler’s test for assessment of heart workability of students with health problems. Pedagogics, psychology, medical-biological problems of physical training and sports, 2017;1:4–10. doi: 10.15561/18189172.2017.0101

The electronic version of this article is the complete one and can be found online at: http://www.sportpedagogy.org.ua/index.php/PPS/issue/archive

This is an Open Access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited (http://creativecommons.org/licenses/by/4.0/deed.en).

Received: 11.01.2017
Accepted: 25.01.2017; Published: 24.01.2017