Journal of Physical Education and Sport ® (JPES), 15(3), Art 90, pp. 598 - 602, 2015
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Evaluation´s options of diurnal variation of physical performance of university students: a pilot study

DOMINIKA VANČOVÁ[1]; PAVOL PIVOVARNIČEK[2]; JANA MIŇOVÁ[3]; VÁCLAV BUNC[4]; ĽUDMILA JANČOKOVÁ[5]
[1,2,3,5] Department of Physical Education and Sports, Faculty of Arts, Matej Bel University, Slovak republic
[4] Faculty of Physical Education and Sport, Charles University, Czech Republic

Published online: September 28, 2015
(Accepted for publication september 17, 2015)

DOI:10.7752/jpes.2015.03090;

Abstract:
The aim of the pilot study was to verify the evaluation´s methods of differences of the morning and the evening performance of university students. We used three parameters for evaluation: reaction time to various directions (RT), tapping frequency of lower limbs (TF) and jump abilities (JA). The experimental ensemble consisted of university students (n = 18, age = 21.0±1.6 years) attending various study programmes at Matej Bel University in Banská Bystrica. The reaction time (RT) was measured by the device FiTRO Agility Check (FiTRONiC, Bratislava, Slovak Republic). The tapping frequency (TF) was measured by the device FiTROtapping (FiTRONiC, Bratislava, Slovak Republic). Jump abilities (JA) were measured by the test Countermovement jump (CMJ) by the device Myotest PRO (Myotest, Switzerland). We do not detect significant difference in any indicator when we compare the morning and the evening performance because the effect size level was small in RT, TF and also in JA. The effect size value was in RT ES = 0.19, in TF – ES = 0.28 and in JA – ES = 0.15. The limit of the methods was shown in time- consuming of laboratory measurements. The evaluation of larger samples of students will require longer realization of mentioned measurements.
Key words: chronotype, evening performance, morning performance.

Introduction

The diurnal rhythms and their impact on sports performance during the day present the sphere of sports chronobiology which is examined in detail. The diurnal rhythms are the part of circadian rhythms. The circadian rhythms last according to many researches approximately 24 hours (Aschoff, 1990, 1995 and 1998, Arendt, 1998, Zeman, 2009) and are divided in two phases: the first phase (lasting from 3.00 AM to 3.00 PM) and the second phase (lasting from 3.00PM to 3.00 AM). Mentioned phases are characterized by variations of biochemical, physiological and psychological processes including exogenous sports performance. According to the mentioned variations we distinguish the human typology whose organism prefers one part of the day. The morning type of human-being (the morning chronotype) is a type who is more active mainly in the morning. The morning chronotype is able to show and perform maximal physical performance during these morning hours. This type is also known under the term "lark" because this type wakes up early in the morning and goes to bed early in the evening. The evening type of human, the evening chronotype, is more active in the second part of the day (in the afternoon or in the evening). The evening chronotype is known under the term "owl" which is characterized by getting up later in the morning and this human´s type needs to go to bed in late evening hours or in hours after the midnight. Literature presents one more chronotype – neither type (intermediate, neutral), whose performance and the other characteristics are in balance and this type does not prefer any specific part of the day. Horne & Ostberg (1976), Reilly et al. (2007), Harada et al. (2011), Muro et al. (2011), Roenneberg (2012), Waterhouse, Fukuda & Morita (2012) etc. agree with mentioned chronotypes´ classification. Horne & Ostberg (1976) presented the questionnaire thanks to which we can identify the chronotype to general population.

Nowadays, there are available lots of results which are interested in the sphere of exogenous rhythms. Schlank & Pupiš (2007) examined performance´s variations of speed- strength abilities during the day of the ski jumper. The authors denoted that the ski jumper achieved the highest performance at 12.00 (noon). Rošková & Demjan (2011) examined psychological and physical performance of female university students (n = 24) at 8.00 AM, 11.00 AM, 2.00 PM and at 5.00 PM. The maximal performance was achieved at 5.00 PM. Paugschová & Ondráček (2011) examined the diurnal rhythm of speed and strength abilities of female students attending secondary school (n = 10) at 9.00 AM, 12.00 (noon), 3.00 PM and at 6.00 PM. The strength predispositions showed maximal values at 9.00 AM and at 6.00 PM, and speed predispositions showed maximal values at 12.00 (noon). In the next researches authors presented the researches in which they examined the relationship between

Corresponding Author DOMINIKA VANČOVÁ, E-mail: dominika.dancova@umb.sk

the chronotype and diurnal performance. Edwards et al. (2005), Kunorozva, Roden & Rae (2014) examined the impact of the chronotype on diurnal performance of professional cyclists. Authors denoted that the cyclists belonged to the morning chronotype according to the Horne & Ostberg´ chronotype questionnaire and their performance was better in the morning when comparing with the evening performance. Very interesting results of cyclists´ testing were brought by Atkinson et al. (2005). Their research showed that the athletes belonged to the morning chronotypes but their sports performance was better not in the morning as they predicted but in the evening hours. Rae, Stephenson & Roden (2015) also examined the relationship between the chronotype (identified by chronotype´s questionnaire) and sports performance. Results expressly showed that professional swimmers of the morning chronotypes achieved better results in morning trainings and professional swimmers of the evening and neither chronotypes achieved better performance and lower fatigue in the evening hours.

A number of methods are used in researches which are interested in chronotypes´ problem and a lot of methods are often presented without clear verification of their informative value. For reproducible evaluation is necessary to verify the use of applicable methods.

In present study we verify the usage of evaluation´s methods of the morning and the evening performance differences of university students on three parameters – reaction time to various distinctions, tapping frequency of lower limbs and jump abilities.

Material & methods

Characteristics of the group

The experimental ensemble consisted of university students (n = 18, age = 21.0±1.6 years) who were during the academic year 2014/2015 students of the first and the second level of university studies. They attended various study programmes and study fields on faculties at Matej Bel University in Banská Bystrica, Slovak Republic. Students of study programmes connected with the physical education and sports were not included because these types of students used to have time - moving stereotype. Women and men participated on the research. The results do not have to be evaluated separately for men and separately for women because we do not compare interindividual characteristics. The minimal criterion for student to be included in the evaluation was to participate on four morning and four evening measurements from five morning and five evening possible measurements which were realized.

Organizing

The research was realized during the week from Monday (on 26th of January) to Friday (on 30th of January) in academic year 2014/2015 in Diagnostic Laboratory at Department of Physical Education and Sports situated at Matej Bel University, Faculty of Arts in Banská Bystrica in standard conditions. The diurnal performance was examined in the morning during time interval lasting from 8.30 AM to 10.00 AM and in the evening during time interval lasting from 4.30 PM to 6.00 PM. Total number of the morning and the evening measurements was five from which we calculated students´ diurnal- mean performance in the morning and students´ diurnal-mean performance in the evening. The diurnal performance was denoted through three performance´s parameters: reaction time to various directions, tapping frequency and jump abilities. Before each measurement in the morning we also examined the length of sleep, subjective feelings and the quality of sleep of students. Students agreed with publication of their data on scientific aim and use. The research was approved by the Ethical Committee of Matej Bel University in Banská Bystrica, Slovak Republic.

Measuring procedure

The reaction time was measued through the device FiTRO Agility Check (FiTRONiC, Bratislava, Slovak Republic) consisted of four contact mats fixed and situated on the floor. Mats were placed into the shape of square (with external side 1.2 m) and were connected with computer. Before the measurement each students took up standing position in the middle of the mats. The mats had to be touched by students in accordance with the location of a stimulus in one of the corners of a screen. Students had to touch, as fast as possible, with either the left or the right foot, one of four mats located outside each of the four corners according to the screen´s signal. The computer´s screen was situated in front of the mats in distance of 3 m and according to the localization they had to make a move (front right, front left, rear right, rear left). Left mats had to be touched by left lower limb and right mats had to be touched by right lower limb. Students still took up standing position after each mat´s touch by particular lower limb and waited for the next signal. We used as a signal blue circle on white background. The result of one measurement was reaction time in milliseconds (ms) which was calculated as a mean of 20 visual signals generated randomly in time interval 500-3000 ms on the computer´s screen to four directions according to mats placement (rear left, rear right, front left, front right). The measurement was realized twice and into the evaluation we noticed the better one from two realized experiments.

The tapping frequency was measured by the device FiTROtapping (FiTRONiC, Bratislava, Slovak Republic) consisted of two contact mats fixed and placed on the floor and they were connected to the computer by interface. Before the test each student took up standing position behind the mats. The main task of the student

was to touch alternately right and left mat by left and right lower limb, as fast as possible (do maximal contacts with mats), during 6 seconds. The result of one measurement of tapping frequency of lower limbs was the number of contacts of both lower limbs on mats of the device FiTROtapping (FiTRONIC, Bratislava, Slovak Republic) lasting 6 seconds. The measurement was realized twice. We noticed the better one from two realized experiments.

Jump abilities were measured by test: Countermovement jump (CMJ) through the device Myotest PRO (Myotest, Switzerland). The result of one measurement was the mean height of the three best vertical jumps from five consecutive realized vertical jumps in cm with accuracy of 0.1 cm. Students realized training tests on all devices before the measurements.

Data Analyses

In present study we used within periphrastic characteristics of descriptive statistics arithmetic mean (x) from position measures and standard deviation (SD) from variability measures. We used coefficient effect size to detect the significance of differences between the morning and the evening performance in all examined parameters. The effect size was calculated according to the relationship $ES = |z|/\sqrt{n}$ (Corder & Foreman, 2009) and it was interpreted as: small effect = 0.10, medium effect = 0.30, and large effect = 0.50 (Cohen, 1988). The „z" value was calculated from Wilcoxon Signed Ranks Test. The statistical analysis was realized by software IBM® SPSS® Statistics V19 (Statistical Package for the Social Sciences).

Results

We detected the differences between the mean morning and the mean evening performance in three chosen parameters of university students´ sample: reaction time to various distinctions, tapping frequency of lower limbs and jumb abilities in countermovement jump test. The morning and the evening performance presented in table 1 are calculated as the mean performance of all university students from particular measurements which they passed in the morning and in the evening during examined period. The evaluation consists of each student´s performance who minimally participated on four morning and four evening measurements from five morning and five evening possible measurements which were realized during the examined period.

We did not detect any significant differences in our study when we compared the morning and the evening performance (table 1).

Table 1 Evaluation of differences between the mean morning and the mean evening performance of university students (n = 18) in parameters: reaction time to various distinctions (in milliseconds- ms), tapping frequency of lower limbs (a number of contacts on mats of FiTROtapping device during 6 seconds), and jump abilities (vertical jump height in Countermovement jump in centimetres- cm).

Parameter	MMP	MEP	Effect size (ES)	
	Mean±SD	Mean±SD	ES value	ES level
Reaction time	705.1±120.0	686.2±104.1	0.19	small
Tapping frequency	59.2±7.1	60.5±7.0	0.28	small
Jump abilities	28.4±6.4	28.7±6.2	0.15	small

MMP – mean morning performance, MEP – mean evening performance

Discussion

Diurnal performance which is presented in various tests of physical performance can be important indicator when athletes, general population and in our case university students plan difficult activities during the day. Eventual performance´s differences in various day phases can show the time interval in which can exist the precondition of more effective realization of several activities for example physical- including sport or psychological.

Štulajter (2007) detected in his researches which are interested in diurnal variations of physical performance of young soccer players that they achieved and showed better performance in the morning hours with culminate point 9 AM and also in late afternoon hours. Chtourou et al. (2012) detected that soccer players achieved and showed higher performance ($p < 0.05$) in late afternoon hours when comparing with the morning performance in test of repeated sprints, in Wintgate and endurance YoYo tests. Atkinson et al. (2005) detected higher evening performance of cyclists (n = 8, age = 24.9±3.5 years) who belonged to the morning chronotype when comparing with the morning performance. Barbosa & Albuquerque (2008) made a research in which they examined training effect on long-term explicit memory of undergraduates who were classified as morning, intermediate, or evening chronotypes. The students who trained in the afternoon achieved better performance. The authors presented that the long-term explicit memory performance was not affected or depended by

chronotype or time –of- day. Brown, Neft & LaJambe (2008) divided athletes (n = 16, age = 19.6±1.5 years) in three groups: the morning chronotypes, the intermediate (neither) chronotypes nor the evening chronotypes. The athletes´ performance was examined in the morning hours from 5 AM to 7AM and in late afternoon hours from 4.30 PM to 6 PM. The authors did not detect any significant difference in athletes´ performance according to chronotype´s typology from the point of view of time- of – day and they stated that the results of athletes were influenced by training and time- stereotypes.

The results of our study focus on methods´ verifying of variations´ detection of the morning and the evening performance of university students (n = 18) in three parameters. The results´ interpretation from the point of view of the morning and the evening performance´s comparison is limited due to the low number of university students, but on the other hand it is inevitable. The aim of the pilot studies is not to generalize the results by statistical hypothesis and tests according to the research made by Leon, Davis, & Kraemer (2011). Our results were not evaluated by any statistical test because of the low number of university students (n = 18). However, we used the value „z" (calculated from Wilcoxon Signed Ranks Test) to evaluate the differences of the morning and the evening performance, but the results were interpreted only by effect size coefficient. The requirement of five (resp. more) examined days is inevitable when detecting the morning and the evening performance. Single morning and single evening measurement is very sensitive on influence of disturbing factors as quality of sleep, current concentration, what can significantly distort results. According to our results, we can state that our sample of university students did not showed any significant differences between the morning and the evening diurnal performance. There exists significant detection from the point of view of methods´ verification – all three methods of variations´ detection of diurnal performance showed similar result. It means that each method can be used separately. Of course, it will be necessary to verify them on larger samples which will participate on repeated measurements if we want to generalize the results. The significant fact of our study is also the detection of time-limitation of laboratory measurements. When the research is participated by larger samples it is very necessary to accept the fact that the morning and the evening time interval is limited. We recommend two steps to resolve the time problem. Firstly, to provide a higher number of diagnostic devices and equipment and higher number of examiners if personal, material and space conditions are allowed and secondly, to plan and realize measurements longer. In the future there will be necessary to examine also endogenous variations as cortisol level, level of melatonin and core body temperature. We also plan to identify the chronotype (to which chronotype our sample of university students belong to) and to examine and explore the relationship between the chronotype and sports performance.

Conclusion

Diurnal performance can be significant indicator for planning sports and physical activities of general population, including university students. Our study refers on the significance of examination´s problem of diurnal variations of university students´ physical abilities on the basis of the fact that their physical performance is not significant in specific time of day- their performance is balanced. When we want to formulate some conclusions we have to be very careful because of the low number of university students (n = 18). On the other hand, the results present next material of examination of diurnal variations of physical performance. There exists significant detection from the point of view of methods´ verification – all three methods of variations´ detection of diurnal performance showed similar results and each one can be used separately. The benefits of the pilot study are also knowledge and experience with realization of laboratory measurements with the usage of three methods to detect and examine the morning and the evening physical performance. We recommend providing a higher number of diagnostic devices (equipment), higher number of examiners and to plan and realize measurements longer when the research will consist of larger sample of university students.

Acknowledgements

This project was supported by VEGA 1/0795/15

References

Arendt, J. (1998). Biological rhythms: the science of chronobiology. *Journal of the Royal College of Physicians of London*, 32, 27-35.

Aschoff, J. (1990). Interdependence between locomotor activity and duration of wakefulness in humans during isolation. Experientia, 46, 870-871.

Aschoff, J. (1995). Changing gears in the human circadian mechanism. *Wiener medizinische Wochenschrift*, 145, 393-396.

Aschoff, J. (1998). Circadian parameters as individual characteristics. *Journal of biological rhythms*, 13, 123-131.

Atkinson, G., Todd, C., Reilly, T., & Waterhouse, J. (2005). Diurnal variation in cycling performance: influence of warm-up. *Journal of sports sciences*, 23, 321-329.

Barbosa, F. F., & Albuquerque, F. S. (2008). Effect of the time-of-day of training on explicit memory. *Brazilian journal of medical and biological research*, 41, 477-481.

Brown, F. M., Neft, E. E. & LaJambe, C. M. (2008). Collegiate rowing crew performance varies by morningness-eveningness. *Journal of Strength and Conditioning research / National Strength & Conditioning Association*, 22, 1894-1900.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd edn). New York: Academic Press.

Corder, G. W., & Foreman, D. I. (2009). Nonparametric Statistics for Non-Statisticians: A Step-by-Step Approach. New Jersey: John Wiley & Sons.

Chtourou, H., Hammouda, O., Souissi, H., Chamari, K., Chaouachi, A. & Souissi, N. (2012). Diurnal variations in physical performances related to football in young soccer players. *Asian Journal of Sports Medicine*, 3, 139-144.

Edwards, B. J., Edwards, W., Waterhouse, J., Atkinson, G., & Reilly, T. (2012). Can cycling performance in an early morning, laboratory-based cycle time-trial be improved by morning exercise the day before? *International journal of sports medicine*, 26, 651-656.

Harada, T., Kobayashi, R., Wada, K., Nishihara, R., Kondo, A., Akimitsu, O., ... & Takeuchi, H. (2011). Effect of birth season on circadian typology appearing in Japanese young children aged 2 to 12 years disappears in older students aged 18 to 25 years. *Chronobiology international*, 28, 638-642.

Horne, J. A., & Ostberg, O. (1976). A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. *International journal of chronobiology*, 4, 97-110.

Kunorozva, L., Roden, L. C., & Rae, D. E. (2014). Perception of effort in morning-type cyclists is lower when exercising in the morning. *Journal of sports sciences,* 32, 917-925.

Muro, A., Gomà-i-Freixanet, M., Adan, A., & Cladellas, R. (2011). Circadian typology, age, and the alternative five-factor personality model in an adult women sample. *Chronobiology international*, 28, 690-696.

Paugschová, B., & Ondráček, J. (2011). Denné zmeny rýchlostných a silových schopností študentiek 1. ročníka gymnázia [Daily changes of speed and strength abilities of female students of the first year at grammar school. In Slovak.]. In Rošková, M. (Ed.) *Acta Facultatis Humanisticae Universitatis Matthiae Belii Neosoliensis* (p. 113–128). Banská Bystrica: FHV UMB.

Rae, D. E., Stephenson, K. J., & Roden L. C. (2015). Factors to consider when assessing diurnal variation in sports performance: the influence of chronotype and habitual training time-of-day. *European journal of applied physiology*, [Epub ahead of print].

Reilly, T., Atkinson, G., Edwards, B., Waterhouse, J., Farrelly, K., & Fairhurst, E. (2007). Diurnal variation in temperature, mental and physical performance, and tasks specifically related to football(soccer). *Chronobiology international*, 24, 507-519.

Ronneberg, T. (2012). What is chronotype? *Sleep and biological rhythms*, 10, 75-76.

Rošková, M., & Demjan, M. (2011). Zmeny v úrovni psychickej a pohybovej výkonnosti v priebehu denného rytmu [Level´s changes in psychological and physical performance in daily rhythm process. In Slovak.]. In Rošková, M. (Ed.) *Acta Facultatis Humanisticae Universitatis Matthiae Belii Neosoliensis* (p. 139-149). Banská Bystrica: FHV UMB.

Schlank, P., & Pupiš, M. (2007). Biorytmické zmeny rýchlostno-silových schopností skokana na lyžiach [Biorhythmical changes of a ski jumper´s speed–strength abilities. In Slovak.]. In Hajer, M. (Ed.) *Kvalita života I.* (p. 179-185). Ústí nad Labem: Universita Jána Evangelisty Purkyne, Ústav zdravotnických studií.

Štulajter, I. (2007). Vplyvy biorytmov na vybrané pohybové schopnosti vo futbale [Impacts of biothythms on selected motor skills in soccer. In Slovak.]. Banská Bystrica: FHV UMB.

Waterhouse, J., Fukuda, Y., & Morita T. (2012). Daily rhythms of the sleep-wake cycle. *Journal of physiological anthropology*,13, 31-35.

Zeman, M. (2009). Začíname ich fungovaniu rozumieť [Getting understand their funtion. In Slovak.]. *Žurnál*, 3, 66-67.