UNIVERSITY OF BELGRADE
FACULTY OF SPORT AND PHYSICAL EDUCATION
Belgrade 25. 05. 2020.

TO TEACHING-SCIENTIFIC COUNCIL

Teaching-Scientific Council of the University of Belgrade - Faculty of Sport and Physical Education at the 8th session held on February 27th, 2020 in accordance with Article 41 of the Statute of the Faculty and Article 40 of the Rulebook on Doctoral Academic Studies at the University of Belgrade - Faculty of Sports and Physical Education (02-No. 1696/18-1 from September 14th, 2018), and at the proposal of the Council of Doctoral Academic Studies, it adopted the decision to form the committee for scientific background evaluation of the doctoral dissertation written by Danica Janićijević under the title:

"MECHANICAL CAPACITIES OF THE DIFFERENT MUSCLE GROUPS ASSESSED USING "TWO-VELOCITY" METHOD (ПРОЦЕНА МЕХАНИЧКИХ СВОЈСТАВА РАЗЛИЧИТИХ МИШИЋНИХ ГРУПА ПРИМЕНОМ МЕТОДЕ „ДВЕ БРЗИНЕ")".

The committee was formed from the following members:
1. Dr. Dragan Mirkov, full professor, University of Belgrade, Faculty of Sport and Physical Education, chair;
 3. Dr. Dejan Suzović, full professor, University of Belgrade, Faculty of Sport and Physical Education, member;
 4. Dr. Amador García-Ramos, assistant professor, University of Granada, Faculty of Sport Science, member.

After evaluating the final version of the doctoral dissertation, biography, and bibliography of the candidate, Committee is handing into the Teaching-Scientific Council following

REPORT
ON SCIENTIFIC BACKGROUND EVALUATION OF THE DOCTORAL DISSERTATION

INTRODUCTION

Candidate Danica Janićijević handed over her final version of the doctoral dissertation under the title **"MECHANICAL CAPACITIES OF THE DIFFERENT MUSCLE GROUPS ASSESSED USING "TWO-VELOCITY" METHOD (ПРОЦЕНА МЕХАНИЧКИХ**

СВОЈСТАВА РАЗЛИЧИТИХ МИШИЋНИХ ГРУПА ПРИМЕНОМ МЕТОДЕ „ДВЕ БРЗИНЕ")" to the faculty archive on 06th of March 2020. (02-99/19-12). Based on the decision of the Teaching-Scientific Council of the Faculty of sport and physical education which was held on the 28th of January 2020 (Number 02-99/19-3) committee was formed to analyze and evaluate the project of the Danica Janićijević's doctoral dissertation (Student's ID 5007/2016). Therefore, it can be concluded that the process of writing a doctoral dissertation lasted in accordance with the project goals and academic standards. The final version of the dissertation was handed out with a volume of 75 pages.

BIOGRAPHY OF THE CANDIDATE

Personal data

Danica Janićijević was born on the 29th of October 1991 in Belgrade, Republic of Serbia.

Education

She finished elementary school "Dragojlo Dudić" and "VI Grammar school". After finishing Grammar school, she started studying Bachelor studies on the Faculty of sport and physical education (University of Belgrade) in the school year 2010/2011 and finished it with the highest grades in the generation (average grade: 9.39). Afterward, she finished Master studies in the school year 2015/2016 with the average grade 9.44. In the same year she enrolled in a doctoral program, where she passed all exams with the average grade 9.92.

Pedagogical and other professional skills

During her professional career she worked as a volleyball coach, as a coach and co-owner in the sport school "Sportomanija", and in several elementary schools as a professor of physical education. Currently, she is working as a research assistant on the Faculty of sport and physical education in the University of Belgrade on the project financed by Ministry of science, education and technological development of Republic of Serbia called "Muscle and neural factors of human movement and their adaptive changes" (#175037). She conducted research stay at Catholic University of the Most Holy Concepcion, Faculty of education, Concepcion (2 months), and at the University of Granada, Faculty of Sport Sciences, Department of Physical Education and Sport, Granada, Spain (one month). Besides this she is an author of more than 10 papers published in international journals (indexed in WOS) and various publications in national journals and scientific conferences. Additionally, she has

been a reviewer for the International Journal of Sports Physiology and Performance and Peer J.

SCIENTIFIC PRODUCTION AND COMPETENCE OF THE CANDIDATE

1. Scientific papers published in the journals indexed in WOS (M21-M23) - 11
2. Scientific papers published in the leading national journals (M51) - 1
3. Scientific papers published in the books of proceedings (M33) – 3
4. Scientific papers published in the conference book of abstracts (M34) – 1

List of the scientific papers in which Danica Janićijević was an author or a co-author:

Scientific papers published in the journals indexed in WOS (M21)

1. **Janicijevic, D.,** García-Ramos, A. Knezevic, O., Mirkov, D. Feasibility of the two-point method for assessing the force-velocity relationship during lower-body and upper-body isokinetic tests, Journal of Sports Sciences. In press. DOI: 10.1080/02640414.2019.1636523 (8 points)

2. **Janicijevic, D.,** Knezevic, O., Mirkov, D., Pérez-Castilla, A., Petrovic, M., Samozino, P., García-Ramos, A. Assessment of the force-velocity relationship during vertical jumps: influence of the starting position, analysis procedures and a number of loads, European Journal of sport science. In press. DOI: 10.1080/17461391.2019.1645886 (8 points)

3. Torrejón, A., **Janicijevic, D.,** Haff, G. G., & García-Ramos, A. (2019). Acute effects of different set configurations during a strength-oriented resistance training session on barbell velocity and the force-velocity relationship in resistance-trained males and females. European Journal of Applied Physiology, 119(6):1409-1417. DOI: 10.1007/s00421-019-04131-8 (8 points)

4. Garcia-Ramos, A., Barbosa, P., Ulloa-Diaz, D.L., Rodriguez-Perea, A., Martinez-Garcia, D., Guede R. F., Hinojosa-Riveros, H., Chirosa-Ríos, L. J., Cuevas-Aburto, J., **Janicijevic, D.,** Johnatan Weakley. Reliability and validity of different methods of estimating the one-repetition maximum during the free-weight prone bench pull exercise. Journal of Sports Sciences. In press. DOI: 10.1080/02640414.2019.1626071 (8 points)

5. **Danica Janicijevic,** Jorge Miguel Gonzales Hernandez, Yaodong Gu, Amador Garcia Ramos, Differences in the magnitude and reliability of velocity variables collected during 3 variants of the bench press exercise, Journal of Sports Sciences. In press. (8 points)

Scientific papers published in the journals indexed in WOS (M22)

1. Claudino Sá, E., Ricarte Medeiros, A., Santana Ferreira, A., Garcia-Ramos, A., **Janicijevic, D.,** Boullosa, D. Validity of the iLOAD® App for resistance training monitoring, Peer Journal. In press. DOI: 10.7717/peerj.7372 (5 points)

2. Garcia-Ramos, A., Ulloa-Diaz, D.L., Barbosa, P., Rodriguez-Perea, A., Martinez-Garcia, D., Quidel, M., Guede R. F., Cuevas-Aburto, J., **Janicijevic, D.,** Johnatan Weakley. Assessment of the load-velocity profile in the free-weight prone bench pull exercise through different velocity variables and regression models, Peer Journal. In press. DOI: 10.1371/journal.pone.0212085 (5 points)

3. Amador Garcia-Ramos, **Danica Janicijevic**, Jorge M González-Hernández, Justin W. L. Keogh, Jonathon Weakley. Reliability of the velocity achieved during the last repetition of sets to failure and its association with the velocity of the 1-repetition maximum, Peer J. In press. (5 points)

Scientific papers published in the journals indexed in WOS (M23)

1. **Janicijevic, D.,** Knezevic, O., Mirkov, D., Pérez-Castilla, A., Petrovic, M., García-Ramos, A. Magnitude and reliability of mechanical outputs obtained during loaded squat jumps performed from different knee angles, Sports Biomechanics. In press. DOI: 10.1080/14763141.2019.1618390 (3 points)

2. **Danica Janicijevic,** Olivera Knezevic, Dragan Mirkov, Alejandro Perez Castilla, Milos Petrovic, Amador Garcia Ramos, The force-velocity relationship obtained during the squat jump exercise is meaningfully influenced by the initial knee angle, Sports Biomechanics, In press. DOI: 10.1080/14763141.2020.1727559, 2020. (3 points)

3. Amador Garcia-Ramos and **Danica Janicijevic**. Potential benefits of multicenter reliability studies in sports science: A practical guide for its implementation. Isokinetic and exercise science. In press. (3 points)

Scientific papers published in the leading national journals (M51)

1. Ђурић, С., Јанићијевић, Д., Мајсторовић, Н., Илић, Д., (2015): Постурални статус одбојкашица узраста 12-16 година, Физичка култура **69**(2): 110-118. (3 points)

Scientific papers published in the books of proceedings (M33):

1. **Janicijevic, D.,** Garcia-Ramos, A., Knezevic, O., Petrovic, M., Mirkov, D. (2018) International Scientific Conference: Force-velocity relationship of lower-body muscles

during horizontal jumps- preliminary study. Book of proceedings Fis communications. p.p. 155-159. (1 point)

2. **Janicijevic, D.,** Knezevic, O., Garcia-Ramos, A., Petrovic, M., Anicic, Z., Mirkov, D. (2018) International Scientific Conference: Feasibility of the two-velocity method to discriminate between muscle groups and subjects with different physical activity levels. Book of abstracts. Physiotherapy in sports, recreation and wellness. p.p.24-25. (1 point)

3. García-Ramos, A., **Janicijevic, D.,** Pérez-Castilla, A., Petrovic, M., Knezevic, O. Mirkov, D. (2018). Reliability of the force-velocity relationship during the squat jump exercise: effect of the knee angle, measurement method and number of loads. XI International Symposium in Strength Training. Comunicación oral. Ámbito Internacional. Madrid, España. (1 point)

Scientific papers published in the conference book of abstracts (M34)

1. Ilic, D., Cvjetkovic, D., **Janicijevic, D.** (2014) Physical status of preschool and younger school age children, International Scientific Conference: Effects of physical Activity Application to Anthropological Status with Children, Youth, and Adults, Book of abstracts, Faculty of sport and physical education, pp. 80-81. (0.5 point)

2. Ilic, D., Skripan, G., **Janicijevic, D.** (2015) Postural status analysis of female volleyball players 11-14 age, International Scientific Conference: Effects of physical Activity Application to Anthropological Status with Children, Youth, and Adults, Book of abstracts, Faculty of sport and physical education, pp. 114-115. (0.5 point)

3. **Janicijevic, D.,** Mijailovic, M., Ilic, D. (2015) Foot status among young school age girls. International Scientific Conference: Effects of physical Activity Application to Anthropological Status with Children, Youth, and Adults, Book of abstracts, Faculty of sport and physical education, pp. 108-109. (0.5 point)

Up to date Danica Janićijević reached following level of scentific competence: M21 - (5 x 8) + M22 - (3 x 5) + M23 (3 x 3) + M51 – (1 x 2) + M33 - (3 x 1) + M34 – (3 x 0.5) = 40 + 15 + 12 + 3 + 3 + 1.5 = 70.5 poins. Regarding her international scientific index, candidate has a scientific production on the level of WOS IF = M21- (2.549 + 2.376 + 3.055 + 2.549 + 2.549) + M22 - (2.353 + 2.353 + 2.353) + M23 - (0.94 + 0.94 + 0.452) = 13.078 + 7.059 + 2.332 = 22.469 points of international scientific influence (Average index of international scientific influence per publication = 2.042).

From the all published scientific papers, the following two are directly associated with the scope of the doctoral dissertation:

1. **Janicijevic, D.,** García-Ramos, A. Knezevic, O., Mirkov, D. Feasibility of the two-point method for assessing the force-velocity relationship during lower-body and upper-body isokinetic tests, Journal of Sports Sciences. In press. DOI: 10.1080/02640414.2019.1636523

2. **Janicijevic, D.,** Knezevic, O., Garcia-Ramos, A., Petrovic, M., Anicic, Z., Mirkov, D. (2018) International Scientific Conference: Feasibility of the two-velocity method to discriminate between muscle groups and subjects with different physical activity levels. Book of abstracts. Physiotherapy in sports, recreation and wellness. p.p.24-25.

SCOPE AND AIM OF THE DISSERTATION (Originality of the idea for science development, practical application and developing the scientific thought in general)

The scope of the dissertation is the assessment of the maximal muscular capacities (force – F, velocity – V and power – P) using isokinetic dynamometry. Tests that have been utilized until now do not allow discerning between muscle capacities at once. Because of this, it was necessary to develop a more efficient and fatigue-free procedure. **The general aim of the dissertation** was to validate the „two-point" method and explore its sensibility to discriminate between different muscle groups and different populations. Also, the possibility of generalizing the results from one to other muscle groups was evaluated.

Isokinetic dynamometry has wide application and has been used for decades, however, standardized procedures/testing protocols have not been established for different groups of subjects. Its application started when Perrine and Hislop proposed the concept of isokinetic dynamometry in 1967. Defining protocol of the isokinetic testing consists of contraction mode used during a test, range of movement, angular velocities during a test, etc. A variety of testing protocols does not allow comparing the results and defining specific protocols for different populations. Besides, when the protocol is defined, muscle testing under low angular velocities allow obtaining results which dominantly reveal maximal force, while using fast angular velocities dominantly reveal maximal power. Previous studies showed that muscle power should be assessed using higher velocities, which is out of range of isokinetic devices. Also, the routine isokinetic test (i.e., force output recorded against a predetermined velocity) cannot reveal the maximal velocity capacity because (I) the velocity cannot be voluntarily changed during the movement, and (II) the maximal velocity of the muscles is considerably higher than the velocities determined by isokinetic devices. Therefore, it would be of value to develop a testing procedure that can provide more precise information about the maximal capacities of the muscles to produce force (F_0), velocity (v_0), and power (P_{max}). More, the most common testing protocol consists of measuring velocities during consecutive

contractions against at least two angular velocities which prolong the testing procedure even more.

For the abovementioned reasons, a procedure based on the force-velocity relationship modeling has been proposed, which was done using linear regression models in the previous research. Although it has been well known that the force-velocity relationship follows hyperbolic shape if the isometric force is excluded from the regression, the relationship follows linear shape, and therefore "two-velocity" has been allowed (i.e., modelling force-velocity relationship applying two different angular velocities and related forces). Linear modelling of the force-velocity relationship is valid, reliable and sensitive within multi-joint movements. "Two-velocity" method could be characterized as a more efficient and fatigue-free testing procedure, and it could reveal all muscle mechanical capacities at once. Besides this, it is needed to explore if the force-velocity parameters could be generalized between different muscle groups, given that the previous studies found inconsistent results.

MAIN HYPOTHESES

Based on the detailed literature review, following hypothesis have been set up: **(1)** isokinetic force-velocity relationship will be linear, **(2)** no differences will be found between parameters of the force-velocity relationship modeled using "multiple-point" and "two-point" methods, **(3)** force-velocity relationship can discriminate between different muscle groups and subjects of different training levels, and **(4)** parameters of different muscle groups will present low positive correlations. **The first hypothesis** has been confirmed since it has been shown that the isokinetic force-velocity relationship is linear with no differences between linear and polynomial models. **The second hypothesis** has been partially confirmed since the validity of the parameters of maximal force was high, however, validity was lower for other parameters. **The third and fourth hypotheses** have been confirmed since the "two-velocity" method has shown to be sensitive to discriminate between different muscles (of the same and subjects of different training levels) while the parameters could not be generalized across muscle groups.

BASIC DATA ABOUT DOCTORAL DISSERTATION

The final version of the dissertation is presented on 75 pages, A4 format, using the English alphabet and English language, with 5 tables, 13 figures, 3 pictures and 155 bibliographic units. The dissertation has been presented through the following chapters and subchapters:

Table of Content:

INTRODUCTION

The candidate starts the introduction pointing out the importance of testing muscle mechanical capacities and the possibility of using isokinetic dynamometry for these purposes. Isokinetic dynamometry is widely applied for testing muscle capacities of the single-joint movements; however, regular procedures could be time-consuming, and therefore, the candidate proposes the utilization of the "two-velocity" method which can increase testing efficiency.

THEORETICAL APPROACH TO THE PROBLEM AND PREVIOUS RESEARCH

In the continuation, the candidate is defining and emphasizing the importance of knowing someone`s maximal muscle capacities (i.e., force: 2.1; power: 2.2; and velocity: 2.3), while in the other chapters describes most common tests for assessing those capacities (3.1-3.3) and

discusses their nature. In the extension of the third chapter the candidate discusses the force-velocity relationship, its shape, and the possibility of its modelling using the "two-velocity" method within single-joint movements, and finally provides the review of the studies that have explored the same topic, but within multi-joint movements.

In chapter 4 she focuses on the possibility of simplifying and standardizing the isokinetic testing procedure. Reviewing the literature, it has been established that two most common angular velocities during isokinetic testing were 60 and 180 °/s and that is why candidate proposes the utilization of these two angular velocities for modelling of the force-velocity relationship using the "two-velocity" model (i.e., measuring forces within mentioned angular velocities). Further, she describes parts of the isokinetic dynamometer and typically derived variables. At the very end of the fourth chapter, it outlines the shortcomings of the previous studies that investigated the isokinetic testing procedures.

In the fifth chapter she defines the scope and general and specific aims of the study, while in the sixth one, hypotheses have been defined. Chapter seven was reserved for the report about the first study in which 22 subjects participated intending to explore the shape of the isokinetic force-velocity relationship within the knee and elbow flexion and extension movements. Afterward, the validity of the parameters has been explored (maximal values of the theoretical force, velocity, and power, as well as the slope of the relationship). Also, its sensitivity to discriminate between different muscle groups and its generalizability has been explored.

The second research study was presented in chapter 8th. Forty subjects have participated in this study with the main goal to explore whether the "two-point" method is sensitive enough to discriminate between subjects of different physical activity levels. Finally, the ninth chapter brings the conclusions and importance of the conducted research, while in the remaining chapters necessary documents such as ethics committee approval, the questionnaire used to assess the levels of regular physical activity habits, etc., were provided.

RESULTS

Mean values and standard deviations were used for presenting descriptive data. Shapiro-Wilk test was used for exploring the normality of the data. Pearson's correlation coefficient was used to assess the strength of the connection between force and velocity data, while for assessing the validity of the "two-velocity" method standard error of estimate, effect size and t-test were used. ANOVA was implemented for assessing the sensitivity of the "two-velocity" method. In the second study, in addition to ANOVA, "Magnitude Based Inference"

was applied, a statistical procedure which should allow overcoming the problems related to the conservative defining 0.05 as the level of statistical significance. Descriptive data are shown in tables 3 and 4, regression models in figures 7 and 11, while the differences between parameters in figures 9, 12 and 13. Results regarding the correlations between the same parameters of the force-velocity relationships (between different muscle groups) and parameters of maximal and isometric force are shown in tables 2, 3 and 5, as well as in figures 8 and 10. Summing up, the results showed high values of Pearson`s r for regression models for all muscle groups, as well as that it is possible to model isokinetic force-velocity relationships by applying the "two-point" method. The validity of the force parameter was high, while the validity of the other parameters was compromised as a consequence of the low validity of the maximal theoretical velocity parameter (the maximal theoretical power and slope of the force-velocity relationships depended directly from the maximal theoretical velocity parameter). The proposed "two-velocity" method can discriminate between muscle groups as well as between subjects of different physical activity levels. A low correlation coefficient between the same parameters of the different muscle groups indicates that it is not possible to generalize results from one to other muscle groups.

DISCUSSION

The discussion was divided into two different parts and it can be found in the first and the second study, respectively. Specifically, discussion of the first study can be found in the subchapter 7.4., while discussion of the second study could be found in the subchapter 8.4. At the beginning of both discussions, the candidate firstly emphasized the main findings of the study, and in the following paragraphs she responded and discussed hypotheses. Therefore, in the discussion of the first study, in the first paragraph she compares the findings regarding the shape of the force-velocity relationship with the findings from previous studies. In the second paragraph she discusses the validity of the force-velocity relationship parameters; in the third one about the possibility of the "two-point" method to discriminate between different muscle groups; and in forth one about the possibility of generalizing those parameters. In the fifth paragraph, she discusses possibilities to use the parameter of maximal theoretical force to predict maximal isometric force, and the last one to propose directions for the future studies, and shortcomings of the current study. In the discussion of the second study, in the paragraph which follows main findings, she discusses the possibility of the "two-velocity" method to discriminate between antagonistic muscle groups in the knee (second paragraph), hip (third paragraph), elbow (fourth paragraph) and shoulder joint (fifth paragraph), and finally, about

the possibility of generalizing results of the same parameters between muscle groups (sixth paragraph).

CONCLUSION

The candidate repeated the main findings of the dissertation and reported practical values of the dissertation (how utilization of the "two-velocity" method could contribute to the simplification of the isokinetic testing). It can be concluded that the candidate deducted scientifically valid conclusions.

PRACTICAL APPLICATION

Practical application is portrayed in the proposal of the simpler procedure for maximal muscle capacities assessment. Namely, the "two-point" method could simplify procedures of the isokinetic testing and reveal information about muscle capacities using only two angular velocities. Also, this method could be applied to the males and females, as well as in subjects of different training levels which widens the practical applicability of the proposed method.

REFERENCES

References were presented in the volume of 155 bibliographic units, mainly written in English (except 3 bibliographic units: two written in Serbian and one on Portuguese). The reference list contains three references authored by the candidate that is not directly related to the isokinetic testing. A review of the reference list suggests that the literature used is actual and referent to write this dissertation.

CONCLUSION AND COMMITTEE PROPOSAL

Candidate Danica Janićijević has fulfilled all legal requirements for acquiring the right to defend her doctoral dissertation. Her scientific background and professional work in the field of physical education and sport are clearly defining her as an adequate candidate. Regarding her future work she plans to continue her research in human biomechanics and related topics.

Teaching-Scientific Council of the University of Belgrade - Faculty of Sport and Physical Education at the 8th session held on February 27th, 2020 in accordance with Article 41 of the Statute of the Faculty and Article 40 of the Rulebook on Doctoral Academic Studies at the University of Belgrade - Faculty of Sports and Physical Education (02-No. 1696/18-1

from September 14th, 2018), and at the proposal of the Council of Doctoral Academic Studies, it adopted the decision to form the committee for scientific background evaluation of the doctoral dissertation written by Danica Janićijević.

The committee has a uniform opinion that the present doctoral dissertation is original and independent scientific work of the author, as well as that it has significant value in the area of muscle function testing using isokinetic devices. With this dissertation Danica Janićijević presented herself as a devoted young researcher who has a good theoretical background in the area of isokinetic dynamometry, as well as practical knowledge necessary for successful independent scientific work.
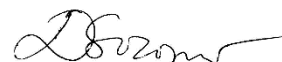
Based on the qualitative and quantitative analysis of the candidate's professional, scientific and practical work, the committee has a uniform opinion that Danica Janićijević has fulfilled all legal and scientific requirements for the defence of the doctoral dissertation, therefore, we are suggesting Teaching-Scientific Council to accept the Committee report about positively assessed doctoral dissertation named **"MECHANICAL CAPACITIES OF THE DIFFERENT MUSCLE GROUPS ASSESSED USING "TWO-VELOCITY" METHOD (ПРОЦЕНА МЕХАНИЧКИХ СВОЈСТАВА РАЗЛИЧИТИХ МИШИЋНИХ ГРУПА ПРИМЕНОМ МЕТОДЕ „ДВЕ БРЗИНЕ")"** and, in accordance with legal rights, to direct it further to Social-Humanistic Scientific Council of University of Belgrade for assessment and acceptance.

In Belgrade, 25.05.2020.

1. Dr. Dragan Mirkov, Professor
Faculty of Sport and Physical Education,
University of Belgrade

2. Dr. Dejan Suzovic, Professor
Faculty of Sport and Physical Education,
University of Belgrade

4. Dr. Amador García Ramos, Assistant Professor
Faculty of sport sciences,
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