Montenegrin Journal of Sports Science and Medicine

www.mjssm.me

ISSN 1800-8755

Vol. 6 September 2017 No. 2

Montenegrin Journal of Sports Science and Medicine

Index Coverage
Web of Science Core Collection (Emerging Sources Citation Index); Scopus; DOAJ; Index Copernicus; EBSCO Publishing Inc.; ERIH PLUS; Open Academic Journals Index; Google Scholar; SJIF Scientific journal Impact Factor; SafetyLit; Genamics Journal Seek; Ulrich's; Academic Journals Database; InfoBase; J-Gate; OALib; Global Impact Factor; ROAD; UTS: Library; Geisel Guides; Electronic Journal Library; Journal Locator; BU Libraries; SMEXE; Journal Impact Factor; CiteFactor; Hinari; Scientific Indexing Services; UNB Libraries; UB Leipzig; Geisel Library; Dowling College Library; EZB; OUM; Universia; UW-Madison Libraries; Kubon & Sagner; UB Online Library; OCLC World Cat; Impact Factor PL; State Library NSW

Proofreading Service
Terry Troy Jackson

Prepress
Boris Šundić

Print
AP Print | Podgorica

Print Run
1500

CRNOGORSKA SPORTSKA AKADEMIJA • MONTENEGRIN SPORTS ACADEMY •

UCG
Univerzitet Crne Gore

• Fakultet za sport i fizičko vaspitanje • Univerzitet Crne Gore

ISSN 1800-8755 eISSN 1800-8763

MONTENEGRIN JOURNAL OF SPORTS SCIENCE AND MEDICINE

International Scientific Journal

Vol. 6(2017), No.2 (1-88)

TABLE OF CONTENTS

Full-text available free of charge at http://www.mjssm.me/

Dear Readers,

Even though our Journal in 2015 and 2016 achieved the greatest success, and entered two strongest index databases (Web of Science and Scopus), we believe that the turning point, that is, the point from which our Journal would continue to grow faster and to develop more, was entering the year 2017 when we reformed the editorial board of the Journal, and introduced a significant number of young people who are, we are sure, the new driving force, who will lead our Journal to the goal that we set in the forthcoming five-year mandate period, to make it a solid leader in the region and recognized by all relevant authors in the field of sports science and medicine around the world.

We have to admit that the work in the last period tripled to say the least, and it was not easy to organize a new team with a significant number of young people to be immediately effective as it was the previous one, so in the first quarter of 2017 we were little late with the review process and we hereby publicly apologize to all authors who have had to wait a little longer than usual. However, very quickly everything clicked into its place, and a new, rejuvenated team works exactly as intended. Therefore we would like to thank the executive editor Selcuk Akpinar, PhD; the assistant editors: Mehmet Uygur, PhD; Catalina Casaru, PhD; Predrag Bozic, PhD and all members of the editorial board and reviewers who on voluntary basis contributed to publishing 10 scientific papers in each of the individual issues in 2017 (March and September).

Also, great gratitude goes to the Montenegrin Sports Academy, Faculty for Sport and Physical Education, and the University of Montenegro, that is, to the Rector, professor Radmila Vojvodic, who from the beginning of her first mandate, selflessly helped our Journal and she is one of the main "culprits" that this Journal progressed so much in a very short period of time. Also, from time to time, Montenegrin relevant ministries provide their support so we would like to thank the Ministry of Science and Ministry of Education, which if were not able to help financially, always wholeheartedly provided moral support, for which we are especially grateful.

Finally, we would like to thank our authors, who have chosen precisely our Journal to publish their scientific papers, and we would like to invite them to continue our cooperation to our mutual satisfaction, since we intend to develop our journal as "open access" Journal, free of any claims against the authors, because we believe that to be the best way we can achieve our basic idea for which we have established this Journal, and that is to promote science and scientific achievements and its availability to all interested users without any restrictions.

Thank you for reading us and we hope you will find this issue of MJSSM informative enough.

Editors-in-Chief,
Prof. Dusko Bjelica, PhD
Assist. Prof. Stevo Popovic, PhD

Medical Students' Awareness of the Links between Physical Activity and Health

Sandra Mandic[1], Hamish Wilson[2], Monika Clark-Grill[2] and Diana O'Neill[3]

Affiliations: [1]University of Otago, Active Living Laboratory, School of Physical Education, Sport and Exercise Sciences, Dunedin, New Zealand, [2]University of Otago, Dunedin School of Medicine, Dunedin, New Zealand, [3]Ministry of Health, Wellington, New Zealand

Correspondence: Sandra Mandic, University of Otago, School of Physical Education, Sport and Exercise Sciences, PO Box 56, Dunedin, New Zealand. E-mail: sandra.mandic@otago.ac.nz

ABSTRACT The effectiveness of physicians in providing advice to patients about physical activity (PA) is influenced by their own understanding of the links between PA and health, as well as by their own PA habits. This study involved pre-clinical medical students in New Zealand, examining their baseline knowledge, skills, and attitudes towards advising patients about PA, as well as eliciting their personal exercise habits. A total of 234 students (age 20.9±2.9 years; 46% males; participation rate: 99%) completed a paper questionnaire assessing their awareness of current PA guidelines, the benefits of PA, their attitudes toward PA advising, perceived competence and importance of PA-advising skills, and personal PA habits. Data were analysed using descriptive statistics. Most students were aware of the benefits of PA and were regularly active. Students perceived PA advising as a high priority in general practice (79%) but only 37% felt confident in their ability to provide PA advice. At this point in their training, students considered PA advice to be important (4.7±0.8 out of 6), yet perceived themselves to be only moderately competent in providing patient-oriented exercise prescriptions (3.1±0.8 out of 6). However, students who had regular exercise felt more confident in providing PA advice (3.0±0.9 vs. 3.3±0.9, p=0.009). In conclusion, medical students were generally active and had a good understanding of the links between PA and health, but were lacking skills for PA advising. Competence and skills in PA counselling need to be further developed within clinical training as part of an overall curriculum strategy.

KEY WORDS Medical Students, Education, Physical Activity, Exercise Advising.

@MJSSMontenegro
MEDICAL STUDENTS AWARENESS
http://mjssm.me/?sekcija=article&artid=136

Introduction

Physical inactivity is one of the major public health problems in the 21st century (Blair, 2009). Challenges in public health associated with sedentary lifestyles and the emerging multiple benefits of regular exercise (Giannuzzi et al., 2003) indicate the importance of preparing future physicians to use exercise as a medical therapeutic option and to provide patient-oriented exercise prescriptions. Furthermore, exercise has intrinsic benefits for students in terms of their own health and wellbeing (Dyrbye, Satele, & Shanafelt, 2016). Although physicians can be effective in increasing patients' health-promoting behaviours, including exercise (Elley, Kerse, Arroll, & Robinson, 2003; Harsha, Saywell, Thygerson, & Panozzo, 1996; Swinburn, Walter, Arroll, Tilyard, & Russell, 1998), less than half of physicians provide physical activity (PA) screening (Sherman & Hershman, 1993; Walsh, Swangard, Davis, & McPhee, 1999) and less than one third of patients report receiving advice about PA within the previous year (Croteau, Schofield, & McLean, 2006; Eakin, Brown, Marshall, Mummery, & Larsen, 2004; Wee, McCarthy, Davis, & Phillips, 1999). Physicians' beliefs (Sherman & Hershman, 1993), knowledge (Rogers et al., 2006), and attitudes toward PA advising (Rogers et al., 2002), their confidence and prior training in PA advising, and their personal lifestyle (Frank, Hedgecock, & Elon, 2004; Frank, Rothenberg, Lewis, & Belodoff, 2000) are the main factors associated with an increased likelihood of physicians' providing PA advice. Limited data from previous studies suggest less than moderate competence and confidence in providing PA advice among medical students (Connaughton, Weiler, &

Accepted after revision: February 03 2017 | First published online: September 01 2017

Conflict of interest: None declared.

Connaughton, 2001; Vallance, Wylie, & MacDonald, 2009) and residents (Rogers et al., 2002). Conducted during an introductory study module on lifestyle factors that influence health, this study evaluated the baseline knowledge, skills, and attitudes toward PA advising, as well as the personal PA habits of third-year medical students.

Methods

Participants

All third-year medical students at the Dunedin School of Medicine, University of Otago, (Dunedin, New Zealand, n=237) were offered the opportunity to participate; 234 students (99%) completed a survey in April 2009. Each participant voluntarily provided written informed consent before participating. Ethics approval was obtained from the University of Otago Human Ethics Committee.

Study design

Students completed a 15- to 20-minute paper-based questionnaire during tutorial classroom time.

Outcome Measures

Basic demographic data collected included age, gender, ethnicity, cultural background, and self-reported height and weight.

Assessment of knowledge, skills, and attitudes. Knowledge, skills, and attitudes toward exercise advising were assessed using several questionnaires. Awareness of current physical activity guidelines, publicly available resources on exercise prescription, 'Green Prescription' initiative, and the benefits of exercise were measured using 5-point Likert scales (1 [strongly disagree] to 5 [strongly agree]). The Green Prescription health initiative is a primary health care referral programme in New Zealand (Ministry of Health, 2016). Available since 1998, primary care physicians can refer inactive patients with stable medical conditions to local physical activity providers for free telephone follow-up, one on one, or group support to assist with lifestyle changes (Ministry of Health, 2016). The Green Prescription Initiative was transferred from Sport and Recreation New Zealand (SPARC) to the Ministry of Health in July 2009.

Perceived competence and importance of skills in advising patients about PA were assessed using a validated Exercise and Physical Activity Competence Questionnaire (Connaughton et al., 2001). This questionnaire assessed students' perception of the importance of, and their competence in, performing physical examination, determining maximal heart rate, body mass index, and daily nutritional needs, calculating training heart rate and designing an exercise prescription. The questionnaire contained 12 statements using a 6-point Likert-type scale (for competence: 1 = not competent to 6 = very competent; for importance: 1 = not important to 6 = very important).

The questionnaire assessing beliefs and attitudes toward personal exercise habits as well as exercise advising was modelled on previous work (Abramson, Stein, Schaufele, Frates, & Rogan, 2000; Keats, Culos-Reed, & Courneya, 2007). As a part of this questionnaire, students were asked to put themselves in the role of a primary care physician and identify their potential motivations for advising patients about PA, to demonstrate their knowledge of current exercise recommendations, and to identify other health professionals that could assist in providing PA advice.

Assessment of PA Habits. Students' PA habits were assessed using the New Zealand Physical Activity Questionnaire – short form (Sport and Recreation New Zealand (SPARC), 2004). The questionnaire consists of seven questions related to the frequency and duration of brisk walking as well as other moderate and vigorous physical activities in the previous seven days. Questionnaire data were used to calculate if students met current minimal PA guidelines for adults (at least 150 minutes of moderate intensity PA or at least 75 minutes of vigorous intensity PA in the previous week) (Haskell et al., 2007). The last question referred to stages of change toward adopting regular PA habits. In addition, students were asked to identify their own motivations and barriers to performing regular PA.

Statistical analysis

Baseline characteristics were described using descriptive statistics. Data are reported as mean ± SD or frequency (percentage). A P-value less than 0.05 was considered statistically significant. Data were analysed using SPSS statistical software.

Results

Demographic characteristics

A total of 234 third-year medical students (age 20.9±2.9 years; 46% males; body mass index 22.7±2.8) completed a set of questionnaires (participation rate: 99%). Detailed demographic characteristics are presented in Table 1.

Awareness and knowledge of PA guidelines

Nearly half the students (43%) were aware of the current New Zealand Physical Activity guidelines for healthy adults (Table 2). Only 2% of students were aware of the current American College of Sports Medicine (ACSM)

UDC 796.012:613-057.875

TABLE 1 Demographic Characteristics

	Study sample (n=234)
Gender [n(%)]	
Males	106 (46)
Females	126 (54)
Age (years)	20.9 ± 2.9
Height (cm)	171 ± 9
Weight (kg)	67 ± 11
Body mass index (kg/m^2)	22.7 ± 2.8
Ethnicity* [n(%)]	
NZ European	153 (65)
Māori	15 (6)
Chinese	33 (14)
Other	66 (28)
Country of origin† [n(%)]	
New Zealand	122 (57)
Malaysia	25 (12)
China	16 (7)
Other	52 (22)

Legend: *Some participants selected belonging to 2 or more ethnic groups; †Other countries of origin include England, Korea, Australia, Brunei, Taiwan, South Africa, South Arabia, and others. Data are missing for 19 participants.

guidelines for exercise in individuals with chronic diseases. The majority of students were aware of the Green Prescription initiative in New Zealand and various benefits of exercise (Table 2).

Only 19% of students correctly identified a recommended combination of duration, intensity, and frequency of activity to achieve the current minimal exercise recommendations for healthy adults (30 minutes of moderate intensity exercise 5 days per week, equivalent to 150 minutes per week).

TABLE 2 Knowledge of Physical Activity Guidelines, Attitudes towards Physical Activity Advising and Benefits of Physical Activity

	Average score	**Strongly disagree**				**Strongly agree**
	(out of 5)	1	2	3	4	5
Physical Activity Guidelines and Initiatives						
I am aware of the current New Zealand guidelines for physical activity in healthy adults.	3.1 ± 1.1	19 (8)	55 (24)	58 (25)	88 (38)	12 (5)
I am aware of the current American College of Sports Medicine guidelines for physical activity in individuals with chronic diseases.	1.4 ± 0.6	166 (71)	54 (23)	9 (4)	4 (2)	0 (0)
I am aware of "Green Prescription" Initiative in New Zealand.	4.2 ± 0.9	7 (3)	5 (2)	26 (11)	89 (38)	106 (46)
Physical Activity Advising						
I am confident in my ability to advise patients about physical activity.	3.2 ± 0.9	4 (2)	47 (20)	96 (41)	74 (32)	12 (5)
I perceive exercise advising as having a high priority in general practice.	4.4 ± 4.0	1 (0.4)	11 (5)	36 (16)	108(47)	74 (32)
Exercise advising impacts patients' quality of life.	4.1 ± 0.7	1 (0.4)	2 (1)	40 (17)	116(50)	74 (32)
Benefits of Physical Activity						
Some physical activity is better than none.	4.8 ± 0.5	1 (0.4)	1 (0.4)	1 (0.4)	32 (14)	198 (85)
For most health outcomes, additional benefits occur as the amount of physical activity increases through higher intensity, greater frequency, and/or longer duration.	3.9 ± 0.9	4 (2)	13 (6)	46 (20)	114(49)	56 (24)
Both aerobic (endurance) and muscle-strengthening (resistance) physical activity are beneficial.	4.4 ± 0.8	1 (0.4)	5 (2)	18 (8)	87 (38)	121 (52)
Health benefits from regular physical activity occur for children and adolescents, young and middle-aged adults, older adults, and those in every studied racial and ethnic group.	4.7 ± 0.6	0 (0)	3 (1)	5 (2)	55 (24)	169 (73)
The benefits of physical activity far outweigh the possibility of adverse outcomes.	4.2 ± 0.8	2 (1)	4 (2)	39 (17)	99 (43)	89 (38)
Adults with chronic conditions obtain important health benefits from regular physical activity.	4.0 ± 0.8	2 (1)	4 (2)	55 (24)	100(43)	71 (31)
When adults with chronic conditions do activity according to their abilities, physical activity is safe.	4.3 ± 0.8	1 (0.4)	4 (1.7)	28 (12)	99 (43)	100 (43)
Older adults and people with chronic conditions and symptoms should consult their health-care provider about the types and amounts of activity appropriate for them.	4.6 ± 0.7	1 (0.4)	4 (2)	11 (5)	57 (25)	160 (69)

Legend: Categorical data presented as [n(%)].

PA advising: Attitudes and competence

The majority of students perceived PA advising to have a high priority in general practice (79%) that would impact patients' quality of life (82%) (Table 2). Only one third of these students felt confident in their ability to provide PA advice (37%). Overall, most medical students perceived exercise-related prescription to be important (average score: 4.7±0.8 out of 6), yet they perceived themselves only moderately competent in providing PA advice (average score: 3.1±0.8 out of 6) (Table 3, Figure 1).

TABLE 3 Perceived Competence and Importance of Physical Activity Advising

	Average score	**Minimally competent /important**	**Moderately competent /important**	**Very competent /important**
	(Out of 6)	1-2	3-4	5-6
Competence		Minimally competent	Moderately competent	Very competent
I feel competent to conduct a physical exam on a healthy adult to approve that person to begin a physical activity program.	2.4 ± 1.1	138 (59)	89 (38)	7 (3)
I feel competent to determine the maximum heart rate for a healthy adult.	2.9 ± 1.5	102 (44)	89 (38)	43 (18)
I feel competent to determine the daily caloric and nutritional needs of a healthy adult.	2.9 ± 1.2	85 (36)	130 (56)	19 (8)
I feel competent to determine the body mass index for a healthy adult.	5.8 ± 0.5	1 (0.4)	4 (2)	229 (98)
I feel competent to calculate the aerobic training heart rate for a healthy adult.	2.5 ± 1.3	134 (58)	76 (33)	23 (10)
I feel competent to design a physical activity prescription including frequency, duration and intensity for a healthy adult	2.3 ± 1.2	151 (65)	69 (30)	14 (6)
Average perceived competence	3.1 ± 0.8			
Importance		Minimally important	Moderately important	Very important
It is important to be able to conduct a physical exam on a healthy adult to approve that person to begin a physical activity program.	5.0 ± 1.2	18 (8)	36 (15)	180 (77)
It is important to be able to determine the maximum heart rate for a healthy adult.	4.3 ± 1.2	25 (11)	105 (45)	104 (44)
It is important to be able to determine the daily caloric and nutritional needs of a healthy adult.	4.9 ± 1.0	7 (3)	66 (28)	161 (69)
It is important to be able to determine the body mass index for a healthy adult.	5.2 ± 1.0	4 (2)	41 (18)	188 (81)
It is important to be able to calculate the aerobic training heart rate for a healthy adult.	4.2 ± 1.2	17 (7)	124 (53)	93 (40)
It is important to be able to design a physical activity prescription including frequency, duration and intensity for a healthy adult.	4.9 ± 1.2	15 (6)	50 (21)	169 (72)
Average perceived importance	4.7 ± 0.8			

Legend: Categorical data presented as [n(%)]; Data were originally collected using a 6-point Likert-scale. Items were collapsed into 3 categories (e.g., minimally competent/important [1 and 2], moderately competent/important [3 and 4], and highly competent/important [5 and 6].

When students were asked to imagine themselves working as primary care physicians in five years, the majority stated that they would counsel patients about PA for improving cardiovascular fitness (97%), disease prevention (97%), weight control (96%), psychological benefits (90%), and musculoskeletal health (80%) (Figure 3).

For more specific exercise advice, nearly half of the students would refer patients to a personal trainer (49%), physiotherapist (44%), and/or Green Prescription support (42%). A smaller percentage of students would seek advice from an exercise physiologist (21%) and sports medicine doctor (12%). Very few students would refer patients to a nurse/nurse practitioner (2%), other medical doctor (1%), or other professional (2%) for exercise advice.

Personal PA habits

Most students (79%) were physically active and engaged in >300 minutes of moderate intensity PA in a previous week. Only 7% of students did not meet minimal PA guidelines for healthy adults (minimum 150 minutes of moderate intensity PA in a previous week). Half of the students (51%) were regularly active in the maintenance stage. On average, students reported engaging in 30 minutes of moderate intensity PA or 20 minutes of vigorous intensity PA on 4.6±2.1 days per week.

The total amount of weekly PA was similar between male and female students (males: 744±706 minutes; females: 658±558 minutes, p=0.303), even though female students engaged in less moderate intensity PA in comparison to their male counterparts. Female students reported meeting minimal PA recommendations more frequently in comparison to male students (4.9±2.1 vs. 4.2±2.1 days per week, p=0.010). Self-reported PA in the previous week was no different when data were analysed according to ethnicity (NZ European versus others) or country of origin (New Zealand versus others) (data not presented).

UDC 796.012:613-057.875

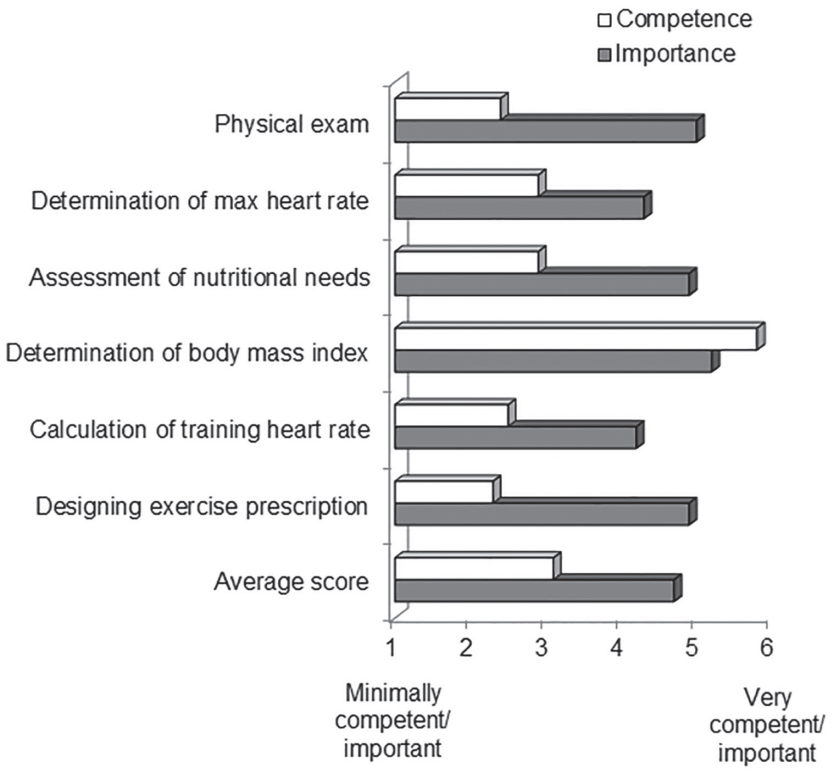


FIGURE 1 Perceived competence in and importance of providing patient-oriented exercise prescription

Motivations and barriers

Approximately two thirds of students participated in PA to improve their cardiovascular fitness (71%), general health/disease prevention (72%), musculoskeletal health (61%), weight control (60%), physical appearance (71%) and psychological benefits (61%) (Figure 2). In comparison to their male peers, female students were more likely to participate in PA for general health/disease prevention (80% vs. 63%, p=0.003), weight control (81% vs. 33%, p<0.001) and psychological benefits (67% vs. 54%, p=0.043), and less likely to aim at improving musculoskeletal health (53% vs. 70%, p=0.007). The main barriers to students' participation in exercise were lack of time (84%) and lack of motivation (61%) with no significant difference between male versus female students (lack of time, males: 80%, females: 88%, p=0.077; lack of motivation, males: 56%, females: 66%, p=0.107).

Personal PA habits and PA advising

Regularly active students in the maintenance stage felt more confident in providing PA advice (3.0±0.9 vs. 3.3±0.9, p=0.009) and perceived a greater impact of PA advising on patients' quality of life (4.0±0.7 vs. 3.3±0.9, p=0.009) in comparison to their less active peers. Regularly active students felt more competent to determine daily caloric and nutritional needs (3.2±1.2 vs. 2.7±1.2, p=0.008), and design a detailed exercise prescription for a healthy adult (2.4±1.3 vs. 2.0±1.2, p=0.012). However, no difference between the groups was found for the overall perception of the importance (4.8±0.8 vs. 4.7±0.7, p=0.195) or competence (3.2±0.8 vs. 3.1±0.8, p=0.385) in providing exercise-related prescriptions.

Discussion

Main findings of the present study are: 1) third year medical students were aware of the current PA guidelines for healthy adults and multiple benefits of PA but were lacking specific knowledge and awareness of the PA guidelines for clinical populations; 2) although the majority of students perceived PA advising to be a high priority in general practice with a positive impact on patients' quality of life, students were lacking confidence and competence in offering client-oriented PA advice; and 3) regularly active students felt more confident but were not more competent in providing exercise-related prescriptions.

Despite their positive attitude toward PA advising, third-year medical students were lacking competence in offering patient-centred exercise prescriptions. Several previous studies examined the competence for prescribing exercise among medical students and resident physicians. Deans and directors of medical schools perceived that 58% of graduating medical students were competent in conducting a patient evaluation for approving the patient to begin an exercise program, but only 10% could design a specific exercise program (Connaughton et al., 2001). In contrast, only 29% of resident physicians felt successful in getting their patients to start exercising and only 28% felt confident in their skills to prescribe exercise for patients (Rogers et al., 2002). Consistent with a previous study (Vallance et al., 2009), these pre-clinical medical students reported

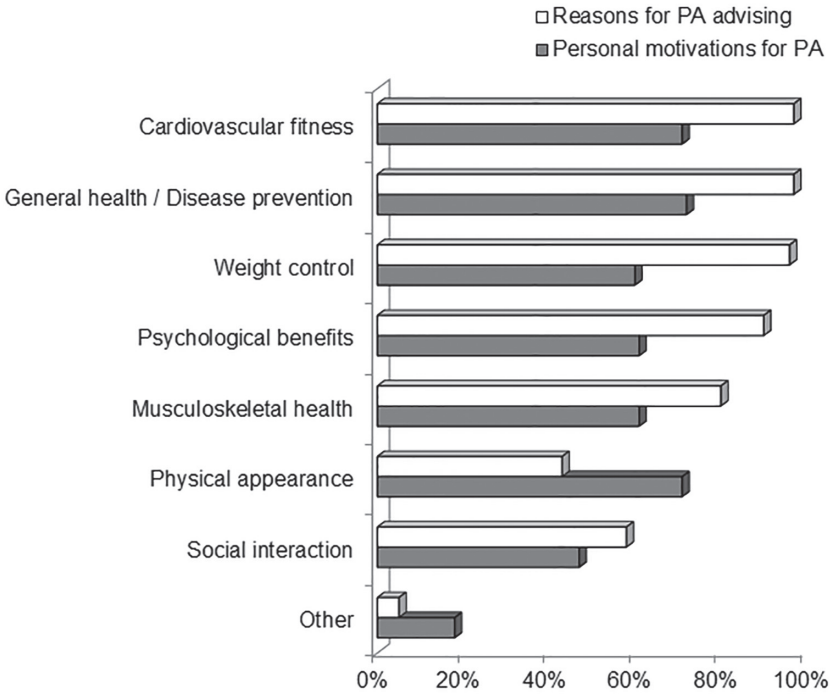


FIGURE 2 Reasons for physical activity advising and personal motivations for engaging in physical activity. PA - physical activity

less than moderate competence for prescribing exercise. In addition, previous studies reported that physicians' confidence in PA-advising skills was significantly influenced by prior training (Rogers et al., 2002). Therefore, it is essential to provide opportunities for medical students to develop effective skills in PA advising as a part of their undergraduate training.

Among multiple factors that contribute to infrequent PA-advising rates, physicians' lifestyles affect both the frequency and quality of the PA advising in their clinical practice (Frank et al., 2004; Frank et al., 2000). Previous studies reported that nearly three quarters of physicians are insufficiently active (Gaertner, Firor, & Edouard, 1991; Gupta & Fan, 2009) and almost two thirds of medical residents have less than average fitness (Rogers et al., 2006). A more positive attitude toward health promotion and disease prevention was a significant predictor of fitness among first year medical students (Liang et al., 1993). In the present study, most third year medical students reported meeting minimal PA recommendations in the previous week and half of students were regularly active in the maintenance stage. Despite the main barriers of lack of time and lack of motivation, medical students in the present study were generally physically active. A previous study found that medical students who were achieving the minimum levels of recommended PA perceived higher competence in prescribing patient-oriented exercise prescription (Vallance et al., 2009). In the present study, regularly active medical students felt more confident in providing PA advice and perceived a greater impact of PA advising on patients' quality of life. However, these students did not feel more competent in providing patient-oriented exercise prescriptions in comparison with their less active peers. Similar findings were observed when the results were compared between students who self-reported achieving minimal PA recommendations in the previous week versus those who did not. Therefore, promoting PA among medical students may contribute to improving their confidence in providing PA advice.

With the lack of time for lifestyle advising in primary care practices, future doctors also need to become more aware of other health professionals, such as exercise physiologists, physiotherapists and physical activity providers who can assist them in providing more comprehensive PA advice for their patients. Almost half of the students in the present study would refer patients to a personal trainer, physiotherapist, and/or Green Prescription support, but notably, only one fifth of students would refer their patients to an exercise physiologist. Providing medical students an opportunity to interact with different exercise professionals during their medical training may be an effective way of raising students' awareness of their therapeutic roles and the support they can provide.

The present study adds further evidence that it is essential to raise medical students' awareness and specific knowledge of the current PA guidelines for healthy individuals and clinical populations, to develop their competence and effective skills for PA advising, to raise awareness of the existence of other health professionals who can provide specific PA advice, and to encourage students to be physically active. Increasing PA levels is helpful in many medical conditions. Therefore, taking an exercise history should be a standard feature of routine medical assessment. To achieve these goals, the curriculum on PA assessment and PA advising needs to be comprehensively planned and delivered within undergraduate medical training.

UDC 796.012:613-057.875

Study limitations

The limitations of this study include its cross-sectional design, assessment of students in one medical school, self-reporting of PA habits, and surveying third-year medical students before their exposure to specific training on PA advising. The cross-sectional design prevents claims about causality. Results reported here may not generalizable to other geographic and cultural settings. Although self-reported data on PA may lead to misclassification bias, self-report is a common and convenient strategy (Biddle, Gorely, Pearson, & Bull, 2011) and a validated questionnaire was used. Knowledge, attitudes, and competence in PA advising and personal PA habits may be different for medical students at later stages of medical training and after exposure to more specific PA-related curricula. Future studies need to examine the outcomes of specific teaching approaches to PA advising on students' attitudes, knowledge, and confidence in providing patient-oriented exercise prescriptions. Similarly, studies need to examine whether such training influences the subsequent rates of PA advising by future physicians in specialist and general practice. In addition, a university culture which encourages PA might also contribute to medical students' greater competence in PA advising.

Conclusion

Pre-clinical medical students in New Zealand were generally active and had a good understanding of the links between PA and health, but were lacking specific knowledge and skills for PA advising. This was more pronounced among less active students. Future curricula on the benefits of PA should focus on these particular areas and further encourage PA among medical students.

Acknowledgments

The authors would like to thank Sarah Jutel for administrative support and Sport and Recreation New Zealand (SPARC) for funding the project.

Conflicts of Interest

The authors have no conflicts of interest. Diana O'Neill worked as a Senior Health Advisor for SPARC at the time of study design and data collection.

REFERENCES

Abramson, S., Stein, J., Schaufele, M., Frates, E., & Rogan, S. (2000). Personal exercise habits and counseling practices of primary care physicians: a national survey. *Clinical Journal of Sport Medicine*, 10(1), 40-48.

Biddle, S. J., Gorely, T., Pearson, N., & Bull, F. C. (2011). An assessment of self-reported physical activity instruments in young people for population surveillance: Project ALPHA. *International Journal of Behavioral Nutrition and Physical Activity*, 8, 1-9.

Blair, S. N. (2009). Physical inactivity: the biggest public health problem of the 21st century. *British Journal of Sports Medicine*, 43(1), 1-2.

Connaughton, A. V., Weiler, R. M., & Connaughton, D. P. (2001). Graduating medical students' exercise prescription competence as perceived by deans and directors of medical education in the United States: implications for Healthy People 2010. *Public Health Reports*, 116(3), 226-234.

Croteau, K., Schofield, G., & McLean, G. (2006). Physical activity advice in the primary care setting: results of a population study in New Zealand. *Australian and New Zealand Journal of Public Health*, 30(3), 262-267.

Dyrbye, L. N., Satele, D., & Shanafelt, T. D. (in press). Healthy Exercise Habits Are Associated With Lower Risk of Burnout and Higher Quality of Life Among U.S. Medical Students. *Academic Medicine*. doi:10.1097/ACM.0000000000001540

Eakin, E. G., Brown, W. J., Marshall, A. L., Mummery, K., & Larsen, E. (2004). Physical activity promotion in primary care: bridging the gap between research and practice. *American Journal of Preventive Medicine*, 27(4), 297-303.

Elley, C. R., Kerse, N., Arroll, B., & Robinson, E. (2003). Effectiveness of counselling patients on physical activity in general practice: cluster randomised controlled trial. *British Medical Journal*, 326(7393), 793.

Frank, E., Hedgecock, J., & Elon, L. K. (2004). Personal health promotion at US medical schools: a quantitative study and qualitative description of deans' and students' perceptions. *BMC Medical Education*, 4(1), 29.

Frank, E., Rothenberg, R., Lewis, C., & Belodoff, B. F. (2000). Correlates of physicians' prevention-related practices. Findings from the Women Physicians' Health Study. *Archives of Family Medicine*, 9(4), 359-367.

Gaertner, P. H., Firor, W. B., & Edouard, L. (1991). Physical inactivity among physicians. *Canadian Medical Association Journal*, 144(10), 1253-1256.

Giannuzzi, P., Mezzani, A., Saner, H., Bjornstad, H., Fioretti, P., Mendes, M., . . . Veress, G. (2003). Physical activity for primary and secondary prevention. Position paper of the Working Group on Cardiac Rehabilitation and Exercise Physiology of the European Society of Cardiology. *European Journal of Cardiovascular Prevention & Rehabilitation*, 10(5), 319-327.

Gupta, K., & Fan, L. (2009). Doctors: fighting fit or couch potatoes? *British Journal of Sports Medicine*, 43(2), 153-154.

Harsha, D. M., Saywell, R. M., Jr., Thygerson, S., & Panozzo, J. (1996). Physician factors affecting patient willingness to comply with exercise recommendations. *Clinical Journal of Sport Medicine*, 6(2), 112-118.

Haskell, W. L., Lee, I. M., Pate, R. R., Powell, K. E., Blair, S. N., Franklin, B. A., . . . American Heart, A. (2007).

Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Circulation*, 116(9), 1081-1093.

Keats, M. R., Culos-Reed, S. N., & Courneya, K. S. (2007). An examination of the beliefs, attitudes and counselling practices of paediatric oncologists toward physical activity: A provincial survey. *Paediatric Child Health*, 12(4), 289-293.

Liang, M. T., Dombrowski, H. T., Allen, T. W., Chang, C. O., Andriulli, J., Bastianelli, M., . . . Norris, S. D. (1993). Do medical students' knowledge and attitudes about health and exercise affect their physical fitness? *The Journal of the American Osteopathic Association*, 93(10), 1020-1024, 1028-1032.

Ministry of Health. (2016). *Green Prescriptions*. Retrieved from http://www.health.govt.nz/our-work/preventative-health-wellness/physical-activity/green-prescriptions

Rogers, L. Q., Bailey, J. E., Gutin, B., Johnson, K. C., Levine, M. A., Milan, F., . . . Sherman, S. E. (2002). Teaching resident physicians to provide exercise counseling: a needs assessment. *Academic Medicine*, 77(8), 841-844.

Rogers, L. Q., Gutin, B., Humphries, M. C., Lemmon, C. R., Waller, J. L., Baranowski, T., & Saunders, R. (2006). Evaluation of internal medicine residents as exercise role models and associations with self-reported counseling behavior, confidence, and perceived success. *Teaching and Learning in Medicine*, 18(3), 215-221.

Sherman, S. E., & Hershman, W. Y. (1993). Exercise counseling: how do general internists do? *Journal of General Internal Medicine*, 8(5), 243-248.

Sport and Recreation New Zealand (SPARC). (2004). *The New Zealand Physical Activity Questionnaires: Report on the validation and use of the NZPAQ-LF and NZPAQ-SF self-report physical activity survey instruments*. Wellington.

Swinburn, B. A., Walter, L. G., Arroll, B., Tilyard, M. W., & Russell, D. G. (1998). The green prescription study: a randomized controlled trial of written exercise advice provided by general practitioners. *American Journal of Public Health*, 88(2), 288-291.

Vallance, J. K., Wylie, M., & MacDonald, R. (2009). Medical students' self-perceived competence and prescription of patient-centered physical activity. *Preventive Medicine*, 48(2), 164-166.

Walsh, J. M., Swangard, D. M., Davis, T., & McPhee, S. J. (1999). Exercise counseling by primary care physicians in the era of managed care. *American Journal of Preventive Medicine*, 16(4), 307-313.

Wee, C. C., McCarthy, E. P., Davis, R. B., & Phillips, R. S. (1999). Physician counseling about exercise. *JAMA*, 282(16), 1583-1588.

UDC 796.012:613-057.875

ORIGINAL SCIENTIFIC PAPER

Characteristics of Professional and Non-Professional Football Players – An Eight-Year Follow-Up of Three Age Cohorts

Stig Arve Sæther[1]

Affiliations: [1]Norwegian University of Science and Technology, Department of Sociology and Political Science, NTNU, Trondheim, Norway

Correspondence: Stig Arve Sæther, Norwegian University of Science and Technology, Department of Sociology and Political Science, NTNU, Dragvoll, 7491 Trondheim, Norway. E-mail: stigarve@ntnu.no

ABSTRACT Identification of the most talented youth players is regarded as a key part of the talent development process in football. The basis for the criteria is naturally affected by the characteristics of the early-detected talented players. Nonetheless, earlier research has found limited evidenced for different criteria in this process. This study has examined whether professional and non-professional football players showed differences in player and coach characteristics as talented youth-level players eight years earlier. A total of 103 players selected for Norwegian youth national teams (age cohorts 1991–1993) participated in this study. Based on player and coach characteristics, the results showed that non-professional players had the most playing time and felt more successful in comparison to the professional players. The professional players, however, reported higher ambitions and a higher number of weekly-organized training sessions. No differences between the professional and non-professional players showed in terms of their relationship to their coaches were found. The study concludes that we need more research on identification criteria to be able to predict which abilities and skills should be sought in the identification process for youth-level players. As in earlier research, this study also found a poor relationship between youth performance and senior performance.

KEY WORDS Talent, Youth, Skills, Football, Identification.

@MJSSMontenegro
CHARACTERISTICS OF PROFESSIONAL AND NON-PROFESSIONAL FOOTBALL PLAYERS
http://mjssm.me/?sekcija=article&artid=137

Introduction

Talent selection and identification have been significant issues in sport science research. Most studies have focused on finding the skills and abilities of the most talented players and, as a consequence, predict the future top-level players (Rees et al., 2016). Nonetheless, the talent identification process in both professional and amateur clubs has mainly been affected by several well-established assumptions about what characterizes a talented football player. These include the notions that talent is hereditary, that it is domain-specific, that a trained eye can identify talent at an early age, and that such early indicators predict future success (Durand-Bush & Salmela, 2001). Furthermore, these assumptions may lead to certain expectations about the characteristics of talented players and their path to elite-level football. Naturally one might expect the most talented players to be characterized by an extraordinary skill level in comparison to their peers, getting more playing time, enjoying competitions and experiencing greater success, having a sole focus on football as their main sport, being more ambitious, and training more in both organized and self-organized arenas.

A considerable amount of research has been undertaken into finding early indicators that predict future success. Because of the complexity of talent development and the potential factors affecting each other (Williams & Reilly, 2000), the ideal pathway to a professional career is difficult to describe. Many of these player characteristics have been confirmed in empirical studies, even if many of the assumptions need further confirmation to be used to identify the future top-level players.

Studies have found match-play performance to be closely connected to the selection for full-time scholarships

Accepted after revision: February 03 2017 | First published online: September 01 2017

Conflict of interest: None declared.

at elite player residential programmes (O'Connor, Larkin, & Williams, 2016). Playing time has also been found to be closely related to the coaches' assessment of the players' abilities (Sæther, Aspvik, & Høigaard, submitted), even though some studies have found academy players overvalue their own skills (Nerland & Sæther, 2016). This would indicate that these players are comfortable in the competition settings during matches. As a result of their early success and feedback that identifies them as talented, the talented players are also expected to be solely focused on their main sport, potentially increasing the difference in skills compared to less talented peers and, furthermore, increasing the players' ambitions (Sæther, 2013) to become potential professional players. With regard to the number of sports in which players had participated, results from earlier studies indicate that there were no differences between players obtaining a senior professional contract and non-professional players (Haugaasen, Toering, & Jordet, 2014b), as was also shown in other similar studies (Ford et al., 2012). Later research has also shown that the amount of training cannot be taken as a predictor of future success since players obtaining a senior professional contract were not found to train more than non-professional players in their youth (Haugaasen, Toering, & Jordet, 2014a).

However, this notion of a continual positive circle of progression in the players' development has some major shortcomings. The relationship between early selection to youth-level national teams and selection later in youth has been found to be weak (Sæther, 2015), indicating difficulties in predicting future performance at an early age. This would suggest that despite the positive circles that the players experience, sooner or later they are faced with obstacles that potentially affect their development. A well-known explanation for the lack of relationship between skills is the fact that early-selected players are characterized by an early birth month, a feature related to the advantage of being born early in the year, an effect called "the relative age effect". This effect has been widely confirmed among youth-level players (Helsen et al., 2012; Sæther, 2015, 2016).

The most important reason for which the talent identification process is vital in the development of talented players is the environmental and contextual elements that surround the players are found to be essential factors associated with the success of talented athletes (Carlson, 1991; Hall, Kerr, Kozub, & Finnie, 2006; Stambulova, 2007). There is an expectation that competitive environments lead to winning the most matches because of the often-high degree of players selected by the top-level clubs. However, such a focus on winning could have a negative effect on the players' development if the focus on a mastery climate (according to achievement goal theory) is not also included, since performance climate often promotes interpersonal competition, achieving results, and public recognition of the demonstration of skills (Ames, 1992). Some studies have suggested that introducing mastery-oriented criteria while simultaneously maintaining performance-oriented criteria will lead to an positive and effective motivational strategy that is equal to that entailed in focusing entirely on mastery criteria (Ommundsen & Roberts, 1999). It is important to stress that many of the participants in this study are not only at the development stage, but that they also compete in adult competitive football where the performance and competitive element is stronger (Ommundsen & Roberts, 1999). High personal pressure, especially from coaches, is one of the main challenges that may affect the development of youth football academy players (Richardson, Gilbourne, & Littlewood, 2004).

Such competitive environments are expected to select the best players at all times, giving them the most playing time, and again affecting the players' assessment of their own skills. The identified players, especially by top-level clubs, are given obvious advantages in this selection system (Ashworth & Heyndels, 2007) even though there are many obstacles in this process (Larsen, Alfermann, Henriksen, & Christensen, 2013). These environments are often characterized by high expectations, which might indicate that players may experience considerable personal pressure, especially from coaches. Several researchers have underlined the importance of high quality coach-athlete relationships in order to reduce stress, and to improve the performance and enjoyment of competitive experiences (Kristiansen & Roberts, 2010). Similarly, Rodahl and colleagues (Rodahl, Giske, Peters, & Høigaard, 2015) highlight the quality of the coach-athlete relationship as a significant factor in enhancing mental toughness, which may subsequently increase the athlete's ability to cope with stress (Nicholls, 2011). The coach is of great importance for the development of young players (Carlson, 1991), and coaches' understanding of player development impacts the players' progression (Gagné, 2000; Martindale, Collins, & Abraham, 2007).

Well-established development environments for youth-level players are expected to provide talented players with feedback on their training in both the short- and long-term. An essential part of the theory of "deliberate practice", which has been indicated as a prerequisite for the development of expertise, is that feedback must be given at each training session (Ericsson, Krampe, & Tesch-Römer, 1993). The content of this feedback must be seen as important, where feedback should be expected to be constructive and balancing the amount of praise and criticism. Earlier studies have highlighted that feedback during exercise is a common strategy recognized by most coaches (Potrac, Jones, & Cushion, 2007) even though little feedback is given after exercise, potentially affecting the players' ability to reflect on their own skills (Partington & Cushion, 2013). Previous research also shows that the content of the feedback is essential for the players' further motivation and development (Cushion, Ford, & Williams, 2010; Ford, Yates, & Williams, 2010).

The most talented players selected for national youth teams are naturally expected to be the most likely to be future professional football players. Even so, most talented players never become professional players, despite their early-detected talent. Thus, the search for early indicators continues, hallmarking professional players early in their youth. The aim of the present study was to investigate player and coach characteristics for players

UDC 796.332:159.928

aged 14 to 16 who were selected for Norwegian age-specific national teams in 2007. The second aim was to compare the players who, in 2015 (eight years later) had gone on to play the game professionally as opposed to non-professional players. The use of future performance based on earlier data has been used as an appropriate way of collecting data (Höner & Feichtinger, 2016).

Methods

Participants

The participants were drawn from three age cohorts of Norwegian players selected for a national youth team in June 2007. The players were born between 1991 and 1993, and represented U16, U15, and U14 teams.

Measures

Player characteristics. The questions used to assess player characteristics were single item questions intended to measure a range of topics labelled as player characteristics. Birth month was reported according to the four birth quartiles (January–March, etc.), and background was the number of sports the players were engaged in or have played and the ambitions they had according to the categories: international, national, first division, etc. The estimated weekly amount of training sessions (organized and self-organized) was allocated to the categories: never, 1 day, 2–3 days, 4–5 days, etc. Playing time was categorized as: all matches, most matches, some matches, and few matches. The final questions asked the players to respond to the statements, "I often succeed", and "I like to compete", and their answers were rated using a Likert scale that ranged from 1= fits well, 7= fits badly.

*Coach characteristics***.** The questions used to assess the coach characteristics were single item questions intended to measure a range of topics labelled as coach characteristics. Using a Likert scale for their responses, ranging from 1= fits well, 7= fits badly, the players were asked four questions about their coach. These questions were: "I often get praise from my coach", "I often get criticism from my coach when I am not succeeding", "only the best players get playing time", and "it is most important to win matches".

Procedures

The data were collected using a questionnaire among players selected for a national youth team. Before answering the questionnaire all the participants were informed about the purpose of the study, that their participation was voluntary, that the survey was anonymous, and that all information would be treated confidentially. All players were provided with an information letter to be given to their parents. The study (ethics clearance) was in accordance with, and approved by the Norwegian Social Science Data Services.

Statistical Analysis

All analyses were conducted using SPSS version 21.0. Means and standard deviations were calculated for player characteristics and the coach-athlete relationship. Student's T-test was used to identify the differences between professional and non-professional players according to player characteristics and coach characteristics. The significance level (alpha) was set to .05.

TABLE 1 T-test, Comparing the Professional and the Non-Professional Players in 2015

Variables	Scale	Professional Mean	Non-Professional Mean	N
%		48	52	103
Player Characteristics				
Birth month	1-4 [a]	1.8	2.0	111
Self-organized training (day/week)	1-5 [b]	2.9	3.4	103
Organized training (day/week)	1-5 [b]	3.1	**2.1***	78
Ambitions	1-5 [c]	2.1	**2.7***	102
Sporting background		2.5	2.5	103
I often succeed	1-4 [d]	1.7	**1.4***	77
Like to compete	1-7 [e]	1.6	1.9	102
Playing time	1-5 [f]	1.3	1.1	77
Coach relationship				
Coach praise	1-7 [g]	2.3	2.2	103
Coach criticism	1-7 [g]	3.6	3.0	103
Most important to win	1-7 [g]	2.2	2.5	100
Only the best players play	1-7 [g]	3.0	3.0	101

Legend: *P < 0.05 – reference "Professional"; a 1= January-March, 4 = October–December; b 1= Never, 5 = 6–7 days a week; c 1= Internationally, 5= 5–6 division; d 1= Very well, 4= Very bad; e 1= Fits well, 7= Fits badly; f 1= All matches, 4= Few matches; g 1= Fits well, 7= Fits badly.

Results

The results showed that the professional and non-professional players were characterized by some similarities and some significant differences. The non-professional players trained close to (<0.082) significantly more self-organized ways, whereas the professional players trained significantly more in organized settings. The professional players had significantly higher ambitions, even though the non-professional players significantly felt they often succeed and, close to significantly (<0.083), had more playing time compared to the professional players. Furthermore, there were small differences in birth month, the number of sports they had participated in, and their fondness of competitions.

The players' relationships with their coaches seemed quite similar in terms of praise, although the professional players reported close to significantly (<0.056) less criticism from their coaches. Overall, both groups of players reported more praise than criticism. There was found to be no difference between their coaches' focus on the importance of winning matches and that only the best players got to play matches. Even so, according to the players the coaches had a higher focus on winning than letting only the best players play (mean 3.0 vs 2.35).

Discussion

This study examined players and their coaches' characteristics among a group of talented players aged 14–16 years, dividing the players between professional and non-professional players in an 8-year follow-up. Somewhat surprisingly, the professional players did not stand out from among as many of the variables as one could expect, in terms of their own characteristics or the characteristics of their coaches.

Most surprisingly, the non-professional players, almost significantly had more playing time, indicating that these players were regarded as more talented than the professional players. Earlier studies have found connections between the players' perception of their own skills and their playing time (Sæther et al., submitted). The results from this study could be seen as confirmation of this relationship since the non-professional players also experienced significantly (<0.05) more success in comparison to the professional players. Even if the relationship between skills at youth level and senior level is one of the most common assumptions (Durand-Bush & Salmela, 2001), the results from this study indicate that this relationship is not that strong, as earlier studies have also highlighted (Rees et al., 2016). Even if one could expect the relative age effect to be present in such high performance groups (Helsen et al., 2012), the effect was not significantly different between the professional and non-professional players. An obvious explanation could be that these groups of players have already been affected by this effect (Sæther, 2015), and both groups had mean values approximately in the second quartile. Both groups were thereby affected by the relative age effect, but they did not differ as groups.

According to the theory of deliberate practice, the players with the highest degree of deliberate practice will develop the best skills, assuming the players receive feedback from expert coaches, which is a prerequisite for the training to be described as deliberate practice (Ericsson et al., 1993). Since the professional players in this study trained significantly more in organized setting than the non-professional players, this assumption could partly be confirmed. However, the non-professional players trained close to significantly more in self-organized settings, indicating that these players compensate with self-organized training. However, a recent study found no differences in training amount when comparing players that had obtained a senior professional contract with non-professional players did, indicating that this is a poor predictor of future success (Haugaasen et al., 2014a). From the players' overall training amount, one could argue that the main difference is the type of training (professional versus non-professional) is important, not the amount.

Talented football players are obliged to have great ambitions in regards to their football careers, which is also confirmed by the professional players in this study, being significantly more ambitious. Based on the fact that the non-professional players had the greatest amount of playing time and considered themselves to be more successful than the professional players, one could expect the non-professional players to be the most ambitious. An obvious explanation could be that the professional players were, in fact, more ambitious, and that this could be one reason as to why they became professional players. An earlier study examined the ambitions of talented players and found them to be very ambitious (Sæther, 2013), although that study did not compare professional and non-professional players. This player' ambition could be expected to be accompanied by a sole focus on their main sport, but, at the time of the study, no differences were found in terms of the number of sports they had participated in. This was also confirmed by an earlier study (Haugaasen et al., 2014a).

Based on previous studies on coach characteristics, one could expect the professional players to have a closer relationship with their coach, compared to the non-professional players. The players' relationships with their coaches seemed quite similar since, overall, both groups reported more praise than criticism. However, an essential difference was that the professional players reported close to significantly less criticism from their coaches. Earlier studies have highlighted the potentially adverse effect of both too much feedback (Potrac et al., 2007) or a lack of feedback to the players (Partington & Cushion, 2013). Previous research also shows that the content of the feedback is essential for the players' further motivation and development (Cushion et al., 2010; Ford et al., 2010).

UDC 796.332:159.928

Even though the participants of this study were quite young, being part of a high-performance environment one could expect the focus on winning matches to be essential. However, the results showed no differences between the professional and non-professional players in terms of the focus on winning matches and only letting the best players play in the matches. Even so, according to the players, the coaches had a higher focus on results (winning) than on only giving attention to the best players (best players play). Pressure from coaches is a major challenge for youth-level players (Richardson et al., 2004). The coaches' focus in this respect would, of course, be of vital importance, potentially affecting the players' development.

In summary, these results could indicate that some of the player' characteristics are more essential in talent development than the coach-athlete relationship and the environment of which they are a part. It would, of course, be a mistake to draw such a conclusion. Even if the players did not differ in their relationship to their coach, this could indicate that they were given a proper environment to develop as footballers. Since the non-professional players appeared to be considered more talented because of their playing time and their feelings of success compared to the professional players, one could expect these players to become professionals. The higher ambitions of the professional players could indicate that they were willing to give more to become professional players, and perhaps here lies the puzzle. We obviously need more research evidence to be able to test that hypothesis and to find potential indicators to identify youth-level players.

In essence, this study only provides a snapshot of the players' characteristics, their coach relationship, and the environment they have been a part of. Talent development process must be seen as a long-term process, which is highlighted by this study, showing that the players need to be in an environment emphasizing development, to be able to achieve their potential goal of becoming a professional football player. This study cannot make any assertions about the characteristics of either the players or their coach relationship during the eight-year period. It can only indicate that there could be a relationship between the players' characteristics and their coach-athlete relationship, and them becoming professional or non-professional players. However, the results do indicate that the players assumed to be the most talented according to playing time and the players own assessment of their own success were not the players most lightly to end up as professional players. The two common characteristics of the players who became professional was their higher amount of organized training and their higher ambitions. Further studies need to be carried out to confirm these findings.

Declaration of Conflicting Interests

The author(s) declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

REFERENCES

Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology, 84*(3), 261–271.

Ashworth, J., & Heyndels, B. (2007). Selection bias and peer effects in team sports: The effect of age grouping on earnings of German soccer players. *Journal of Sports Economics,* 8, 355–377.

Carlson, R. (1991). *Vågen til landslaget. En retrospektiv studie av framgångsrika ungdomar i sju idrotter*. Stockholm, Sweden: Högskolan för lärarutbildning.

Cushion, C., Ford, P. R., & Williams, M. A. (2010). Coach behaviours and practice structures in youth soccer: Implications for talent development. *J Sports Sci, 30*(15), 1631–1641.

Durand-Bush, N., & Salmela, J. H. (2001). The development of talent in sport. In R. N. Singer, H. A. Hausenblau & C. M. Janelle (Eds.), *Handbook of sport psychology*. New York: Wiley.

Ericsson, K. A., Krampe, R., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100*, 363–406.

Ford, P. R., Carling, C., Garces, M., Marques, M., Miguel, C., Farrant, A., . . . Williams, M. (2012). The developmental activities of elite soccer players aged under-16 years from Brazil, England, France, Ghana, Mexico, Portugal and Sweden. *J Sports Sci, 30*(15), 1653–1663. doi:10.1080/02640414.2012.701762

Ford, P. R., Yates, I., & Williams, M. A. (2010). An analysis of practice activities and instructional behaviours used by youth soccer coaches during practice. *J Sports Sci, 28*(5), 483–495.

Gagné, F. (2000). Understanding the complex choreography of talent development through DMFT-based analysis. In K. A. Heller, F. J. Mönks, R. J. Sternberg & R. Subotnik (Eds.), *International handbook for research on giftedness and talent* (pp. 67–79). Oxford, UK: Pergamon Press.

Hall, H. K., Kerr, A. K., Kozub, S. A., & Finnie, S. B. (2006). Motivational antecedents of obligatory exercise: The influence of achievement goals and multidimensional perfectionism. *Psychology of Sport and Exercise, 8*, 297–316.

Haugaasen, M., Toering, T., & Jordet, G. (2014a). From childhood to senior professional football: A multi-level approach to elite youth football players' engagement in football-spesific activities. *Psychology of Sport & Exercise, 15*(4), 336–344.

Haugaasen, M., Toering, T., & Jordet, G. (2014b). From childhood to senior professional football: Elite youth

player´engagement in non-football activities. *J Sports Sci, 32*(20), 1–10.
Helsen, W. F., Baker, J., Michiels, S., Schorer, J., Van Winckel, J. V., & Williams, M. (2012). The relative age effect in European professional soccer: Did ten years of research make any difference? *J Sports Sci, 30*(15), 1665–1671.
Höner, O., & Feichtinger, P. (2016). Psychological talent predictors in early adolescence and their empirical relationship with current and future performance in soccer. *Psychology of Sport and Exercise, 25*, 17–26.
Kristiansen, E., & Roberts, G. C. (2010). Young elite athletes and social support: Coping with competitive and organizational stress in "Olympic" competition. *Scandinavian Journal of Medicine & Science in Sports, 20*, 686–695.
Larsen, C. H., Alfermann, D., Henriksen, K., & Christensen, M. K. (2013). Successfull talent development in soccer: The characteristics of the environment. *Sport Exercise Performance, 2*, 190–206.
Martindale, R. J. J., Collins, D., & Abraham, A. (2007). Effective talent development: The elite coach perspective in UK sport. *Journal of Applied Sport Psycjology,* 19, 187–206.
Nerland, E., & Sæther, S. A. (2016). Norwegian football academy players – Players self-assessed competence, perfectionism, goal orientations and motivational climate. *Sport Mont Journal, 2*, 7–11.
Nicholls, A. R. (2011). Mental toughness and coping in sport. In D. F. Gucciardi & S. Gordon (Eds.), *Mental tougness in sport* (pp. 30–46). New York: Routledge.
O´Connor, D., Larkin, P., & Williams, A. M. (2016). Talent identification and selection in elite youth football: An Australian context. *European Journal of Sport Science, 16*(7), 837–844.
Ommundsen, Y., & Roberts, G. C. (1999). Effect of motivational climate profiles in motivational indices in team sport. *Scandinavian Journal of Medicine & Science in Sports, 9*, 389–397.
Partington, M., & Cushion, C. (2013). An investergaiton of the practice activities and coaching behaviours of professional top- level yuoth soccer coaches. *Scandinavian Journal of Medicine and Science*, 23, 3, 374–382.
Potrac, P., Jones, R., & Cushion, C. (2007). Understanding power and coach's role in proffesional English soccer: A preliminary investergaition of coach behavior. *Soccer and society*, 8, 1, 33–49.
Rees, T., Hardy, L., Güllich, A., Abernethy, B., Côté, J., Woodman, T., . . . Warr, C. (2016). The great British medalists project: A review of current knowledge on the development of the world's best sporting talent. *Sports Medicine, 46*(8), 1041–1058. doi:10.1007/s40279-016-0476-2
Richardson, D., Gilbourne, S., & Littlewood, M. (2004). Developing support mechanisms for elite young players in a professional football academy: Creative reflections in action research. *European Sport Management Quarterly,* (4), 195–214.
Rodahl, S., Giske, R., Peters, D. M., & Høigaard, R. (2015). Satisfaction with the coach and mental toughness in elite male ice hockey players. *Journal of Sport Behavior, 38*, 419–431.
Stambulova, N. (2007). *The transition from junior to senior sports: A summary of six Swedish studies.* Paper presented at the Book of abstracts. The 12th European Congress of Sport Psychology, Halkidiki: Fepsac.
Sæther, S. A. (2013). Høye ambisjoner og riktig studievalg–eneste vei til en fotballkarriere. *Idrottsforum*. Downloaded from; http://idrottsforum.org/saether130213/
Sæther, S. A. (2015). Selecting players for youth national teams — A question of birth month and reselection? *Science & Sports, 30*(6), 314–320. doi:http://dx.doi.org/10.1016/j.scispo.2015.04.005
Sæther, S. A. (2016). Presence of the relative age effect and its eccect on playing time among under-20 players in the Norwegian premier league Tippeligaen — A four-year follow up. *Montenegrin Journal of sports science and medicine,* (1), 11–15.
Sæther, S. A., Aspvik, N. P., & Høigaard, R. (Submitted). Norwegian football academy players - players' characteristics, stress and coach-athlete relationship.
Williams, A. M., & Reilly, T. (2000). Talent identification and development in soccer. *J Sports Sci, 18*(9), 657–667.

UDC 796.332:159.928

ORIGINAL SCIENTIFIC PAPER

Swim Speed Tests as a Method for Differentiating the Profiles of Young Swimmers

Klara Šiljeg[1], Joško Sindik[2] and Goran Leko[3]

Affiliations: [1]University of Zagreb, Faculty of Kinesiology, Croatia, [2]Institute for Anthropological Research, Croatia, [3]University of Zagreb, Faculty of Kinesiology, Croatia

Correspondence: Klara Šiljeg, University of Zagreb, Faculty of Kinesiology, Croatia, Horvaćanski zavoj 15, 10000 Zagreb, Croatia. E-mail: kklara.siljeg@gmail.com

ABSTRACT Swimming tests are used in every training cycle and seasons with purpose of estimating swimming performance and evaluate certain training types. The focus of this study is an attempt to distinguish between the potential short-distance and longer-distance swimmers, as well as the swimmers who could have desirable profiles for particular swimming styles. For this purpose, several aims are given: () to determine the latent dimensions of the performances in swimming tests, conducted on various distances and performed using different swimming styles; 2) to determine the correlations between speeds on various distances using different swimming styles; 3) to determine the differences in various distance speeds at the same swimmers ; 4) to determine the profiles of swimmers, based on the various distance speeds (4). Male swimmers (N=68), aged 14 to 16 from five Zagreb clubs were tested. Four swimming tests were used to measure speed (25-m freestyle, backstroke, breaststroke, butterfly), five swimming tests measured speed endurance (50-m freestyle, 100-m freestyle, backstroke, breaststroke, butterfly), while only one test measured endurance (800-m freestyle). The results revealed two interpretable and highly reliable latent dimensions of swimming tests. Factor analysis of the scores in swimming tests differentiated the variables of swimming tests that describe breaststrokes and other strokes. Most of the scores in the swimming tests are positively correlated (in range 0.25–0.85), while no differences in various distance speeds among the same swimmers are found. The results indicate the importance of using swimming tests, especially in breaststrokes styles, because of their specific motor structure.

KEY WORDS Breaststroke, Swimming Styles, Various Distances.

@MJSSMontenegro
SWIM SPEED TESTS
http://mjssm.me/?sekcija=article&artid=138

Introduction

The key to success does not lie in training hard, but in training purposefully and carefully (Olbrecht, 2000). The purpose of this research is to emphasize the importance of testing the swimmers by using specific swimming tests. These tests are direct indicators of the current status of the swimmers and serve for possible changes (corrections) in the training process, as well as the orientation for directing a swimmer to train with a particular swimming technique.

Swimming tests and the role of the coach

The goal of a successful coach is to improve the performance of his swimmers, and coaches are aware that a training program has great influence on final swimming performance (Richards, 1999; Costa, 2016). Therefore, swimming coaches use the swimming tests (ST) to evaluate basic speed, stroke mechanics, starts and turning ability, the physiological factors of basic and specific endurance, anaerobic power and capacity, muscle power and flexibility and, finally, the psychological factors of motivation and stress management (Smith, Noris & Hogg, 2002; Costa, 2016). All of that has a certain impact on the final results in swimming

Accepted after revision: February 03 2017 | First published online: September 01 2017

Conflict of interest: None declared.

performance. To control training tasks or to obtain insight into a current state of a competing swimmer, testing during training is conducted daily. With testing, a coach can predict future competitive performance and provide recommendations for continued directional training (Smith et al., 2002).

Young swimmers

Swimmers from 14 to 16 years old conducted training in all zones of intensity, mostly in the aerobic zone, and all swimming techniques (Thorton, 2012; Vorontsov, 2002). Many scientists suggest that male swimmers' specialization begins at 13 to 16 years old (Vorontsov, 2002; Sokolovas, 2006). Timely and quality specialization would result in a longer retention of swimmers in competitive swimming and enable the full development of their potentials. It is often the case that junior swimmers are equally successful in more than one discipline, especially in swimming associations that have the smallest number of competing swimmers (Šiljeg, 2012); the same author suggests that knowing the connection between specific control tests and success in certain swimming techniques would lower the possibility of mistakes when directing a swimmer towards a certain discipline.

Specifics of swimming techniques and young swimmers

The anthropometric characteristics, the motor structure, and energy expenditure are quite different in four techniques (Barbosa et al., 2006; Leko, Šiljeg & Zoretić, 2011). For example, a more propulsive force is made by the motion of the hand in freestyle and backstroke (Brooks, Lance & Sawhill, 2000; Maglischo, 2003) or by undulating the body like in butterfly (Maglischo, 2003), but in the breaststroke (BS) the kick is more essential for power and efficiency (Strzała et al., 2012; Maglischo, 2003; Sweetenham, 2003). Freestyle, backstroke, and butterfly strokes require much greater mobility and range of motion because of the high demand for rotation in the shoulder joint (Bishop, Cree, Read, Chavda, Edwards & Turner, 2013). Nuber, Jobe, Perry and Moynes (1986) provided supporting evidence to the notion of less rotational requirement in the breaststroke.

Injuries are also different according to different swim technique. Freestyle and butterfly swimmers are frequently associated with impingement syndrome in shoulders because of the repetitive nature of rotation, but this injury is not frequent in breaststroke swimmers (Nuber et al., 1986; Maglischo, 2003). In breaststroke swimmers, hip adductors, and knee joint injuries were significantly more common than in non-breaststroke swimmers (Keskinen, Eriksson & Komi, 1980; Grote, Lincol & Gamble, 2004). The above-mentioned expresses the controlled important especially in this critical forming age when interests are changing, and personal crisis occurs, creating the question whether to continue swimming or not (Šiljeg, 2012). Numerous authors have reported that the high prediction of swimming performance has had on specific ST in the water (Šiljeg, 2012; Latt et al., 2010; Arrelano, 2004). Hence, the ST in this research has been performed to measure: swimming speed (on the distance of 25 m for all four techniques), speed endurance (on the distance of 50 m, only for the freestyle and on the distance of 100 m in all four techniques) and endurance (on the distance of 800 m, only for the freestyle).

The focus of this study is an attempt to distinguish between the potential short-distance and a longer-distance swimmers, as well as the swimmers who could have desirable profiles for particular swimming styles. The various swimming strokes are quite different in terms of the patterns of muscle recruitment, the force and power produced, as well as the energy required for a given swimming speed (Nelson, Pyne & Sweetenham, 1991). Control of progress with timely and valid specialization would ensure the maximum utilization of the genetic potential of any swimmer (Vorontsov, 2002). A breaststroker usually does not find his/her optimal swimming style spontaneously (Soons, Colman & Persin, 2003). However, instructional intervention could significantly improve the technique and performance in certain techniques, according to Havriluk (2006). Therefore, the training process should be tailored to the individual needs of certain swimmers, according to their technique of swimming.

In order to apply the knowledge obtained by ST for improving orientation (choosing the most convenient swimming technique for each swimmer), as well as to adjust the training process to the individual specifics of each swimmer, several goals of our study were defined: first, to determine the latent dimensions of the performances in ST, conducted on various distances and performed using different swimming techniques; second, to determine the correlations between speeds on various distances using different swimming styles; third, to determine the differences in various distance speeds of the same swimmers; fourth, to determine the profiles of swimmers, based on the latent dimensions revealed.

Methods

Participants

A total of 68 male swimmers aged 14 to 16 from five Zagreb clubs were tested. All were participating in training programs in Zagreb swimming clubs. All participants were in good health, and they had been involved in swimming training process for the previous six years. They train six times per week, with the length of training of 2 hours. The testing was undertaken at swimming pools in Zagreb in a 25-m pool. Measurements were done in accordance with ethical principles, and all the tests were conducted by the same person. The testing procedure is standardized for all swimmers.

Materials and Procedure

Swimmers were tested in specific motor skills. Four ST were used to measure speed (25-m freestyle, backstroke, breaststroke and butterfly), five ST measured speed endurance (50-m freestyle, 100-m freestyle, backstroke, breaststroke and butterfly), while only one test measured endurance (800-m freestyle) (Šiljeg, 2012). The 25-m, 50-m and 800-m ST were used in the assessment of swimming speed applying the technique. The task was performed in the water at the starter's signal by pushing off from the wall. The result was measured with an Omega electronic device with one-hundredth-of-a-second accuracy. The 100-m results were taken at official swimming competitions in a 25-m length pool in the period of one month during the testing. Tests in the water were carried out in two phases, with a break of two days between testing for adequate recovery swimmers. The first phase consisted of the tests of speed (25 m) and speed endurance (50 m). Since the measuring was performed electronically, the swimmers first performed ST 25 m for all the techniques in the order: butterfly, backstroke, breaststroke and freestyle. The interval between each 25-m swimming section of was 6 minutes. After this phase, the swimmers swam a maximum of 50-m freestyle (Šiljeg, 2012). After a two-day break, the swimmers performed ST 800-m with freestyle technique (Šiljeg, 2012).

Statistical analysis

The basic descriptive indicators for certain ST were calculated (means and standard deviations). Next, the latent dimensions on the standardized scores in ST (Z-scores) were determined, by using Principal Component Analysis (hereinafter PCA) with Varimax rotation, with the criteria of the interpretability of components obtained, along with the Guttman-Kaiser criterion and the Scree Plot. All ST were included in PCA for the first time and in the second PCA only chosen ST were. Cronbach alpha coefficients are used to determine internal consistency reliability of the latent dimensions obtained. The differences in certain swimming speeds in the same swimmers are determined using the nonparametric Friedman test. K-means cluster analysis is used in the taxonomization of standardized swimming speeds on various distances, using different swimming styles. For all the analyses, IBM SPSS 24.0 package was used. All differences and correlations are commented on the levels less than $p<0.05$ and $p<0.01$.

Results

The results showed that two principal components (PCs) were obtained. The second PC describes the breaststroke swimming style only (on the distances 25 and 100 m), while the first PC describes the correlations between all other swimming styles, on various distances (Table 1). In Table 2, there is a similar situation as in Table 1. For the results without tests of endurance (800-m freestyle), two PCs were obtained. One describes breaststroke swimmers, while the other (first) describes the correlations between all other swimming styles in both distances.

TABLE 1 Factor structure (Principal component analysis with Varimax rotation) of standardized swimming speeds on various distances with descriptive statistics

Swimming styles	Component		Communalities	Mean	Std. Dev.
	1	2			
25-m free	**.803**	.307	.739	13.5	0.6
25-m breast		**.933**	.874	18.5	1.2
25-m back	**.843**		.713	15.9	1.1
25-m fly	**.832**	.306	.786	15.3	1.2
50-m free	**.740**	.362	.678	28.8	1.5
800-m free	**.636**	.352	.528	647.9	48.2
100-m free	**.876**		.839	59.1	3.5
100-m back	**.871**		.758	69.1	6.0
100-m breast		**.858**	.818	77.7	5.3
100-m fly	.824		.724	69.8	6.7
Reliability (Cronbach's alpha)	0.938	0.846			
Variance explained (%)	52.91	21.67			
Eigenvalues	5.29	2.17			

Legend: Bold – saturations in variables that define certain principal component.

The correlations between standardized speeds of the swimmers on various distances using different swimming styles confirm the fact that breaststroke style is relatively "isolated" from different swimming styles (Table 3); it is in lower correlation with other styles. The sizes of all correlations range from very low to high. The highest correlations are found between the scores in ST for the same style (discipline) in various distances. The lowest statistically significant correlation is between the 100-m breaststroke and 25-m backstroke. Quite different motor structure and length of swimming are the main reasons for the low correlation. The highest size of significant (positive) correlations between different disciplines is among the 100-m fly and 100-m freestyle.

TABLE 2 Factor structure (Principal Component Analysis with Varimax rotation) of standardized swimming speeds on the distances of 100 metres and 25 metres

Swimming styles	Component		Communalities
	1	2	
25-m free	**.813**	.329	.769
25-m brest		**.938**	.884
25-m back	**.863**		.744
25-m fly	**.840**	.327	.812
100-m free	**.856**		.802
100-m back	**.878**		.772
100-m breast		**.873**	.846
100-m fly	**.827**		.736
Reliability (Cronbach's alpha)	0.935	0.846	
Variance explained (%)	54.82	24.72	
Eigenvalues	4.39	1.98	

Legend: Bold – saturations in variables that define certain principal component

It can be explained by using the same motor structure of hand (full-scale "S" stroke). Among freestyle techniques, the highest correlation is found between ST on the distances 25-m and 100-m freestyle. Between 50-m freestyle and 100-m freestyle, the correlation is similarly high as the correlations between 25-m and 100-m freestyle. The lowest correlation is found between 25-m freestyle and 800-m freestyle. Although it is the same technique, the lowest correlation can be explained by using different energy expenditure, according to lengthwise discipline.

TABLE 3 Correlations between standardized speeds of the swimmers on various distances using different swimming styles

	25m free	25m back	25m	25m breast	50m free	800m free	100m free	100m back	100m breast	100m fly
25-m free	1	.657**	.748**	.346**	.652**	.499**	.791**	.666**	.481**	.674**
25-m back		1	.708**	.115	.554**	.374**	.616**	.798**	.253*	.568**
25-m fly			1	.363**	.674**	.534**	.733**	.633**	.471**	.848**
25-m breast				1	.377**	.295*	.267*	.107	.733**	.216
50-m free					1	.646**	.765**	.581**	.427**	.607**
800-m free						1	.699**	.524**	.414**	.579**
100-m free							1	.741**	.466**	.778**
100-m back								1	.348**	.618**
100-m breast									1	.413**
100-m fly										1

Legend: **significant at a level of p< .01; *significant at a level of p< .05

Table 4 provides an insight into the differences between standardized (z-score) speeds of the swimmers on various distances using freestyle only. There are no relative differences in the median speed between the same swimmers who are swimming with the same style (freestyle) on different distances.

TABLE 4 Differences between standardized (z-score) speeds of the swimmers on various distances using free style only (paired samples)

Distance	25m free	50m free	800m free	100m free	Friedman test (p)
Median	.047	-.135	-.049	-.058	.757

Table 5 provides an insight in the taxonomization of the standardized (z-score) speeds of the swimmers on various distances using all styles. The fourth cluster represents the swimmers who are the slowest, while the largest distance is found from the second cluster, where the swimmers are the fastest. The first and third clusters could not be similarly unambiguously explained, reflecting the interaction between swimming distances and styles. These two clusters are therefore very close.

TABLE 5 Cluster analysis of the standardized (z-score) speeds of the swimmers on various distances using all styles

	Cluster			
	1	2	3	4
25-m free	0.152	**-0.933**	0.735	2.502
25-m back	-0.077	**-0.792**	1.155	1.815
25-m breast	0.524	**-0.579**	-0.482	1.461
25-m fly	0.175	**-0.940**	0.701	2.477
100-m free	-0.049	**-0.739**	0.774	2.786
100-m back	-0.117	**-0.712**	1.047	2.054
100-m breast	0.433	**-0.676**	-0.292	2.260
100-m fly	0.088	**-0.793**	0.728	2.070
Number of Cases	29	23	13	3

Legend: Bold – scores for the fastest group.

Discussion

The results revealed that factor analysis without the test endurance and with it obtained two PCs. One principal component (in both cases) describes breaststroke (BS) swimmers, while the other one describes the correlations between all other swimming styles in various distances. This result can be explained by specifics of BS technique. BS is quite different than other strokes in certain anthropometric characteristics. Moreover, they are different according to their use of muscle categories, and the percentage of muscle usage while swimming BS in comparison to other swimming techniques. BS is the oldest, slowest, and most energy demanding of all swimming techniques (Barbosa et al, 2006). BS is the ancestor of butterfly and freestyle. BS is the appropriate technique to maintain on the water but it can be hard to learn, except for children who are "natural breaststroke swimmers". It is the least efficient of the four competitive strokes; swimmers encounter more frontal resistance in it than in any of the others (Hannula, 2003). The differences between BS and other strokes can be observed in the first movement after the swimmer leaves the wall. Their arms start first (in contrast with other strokes) and then kick during the latter part of the arm stroke. A single kick occurs during each stroke cycle. In BS, the movement of the arms and legs are symmetrical and they are carried out under the water. They simultaneously stroke with both hands and they have distinctive kick of the legs. Hand movement is diverse in comparison to other strokes in the propulsive phase and does not make a complete "S" stroke and does not have the last stroke phase (phase upsweep). Because of the specific simultaneous leg and hand work, swimmers have large deviation in a velocity during one stroke cycle. This is one of the reasons that BS is the slowest and most demanding technique. Even though a large propulsive force is created during the propulsive phase, there is a certain slow movement of the body going forward while preparing to kick with the legs. BS has the greatest intra-cyclic velocity variations of the four competitive strokes due to the underwater recoveries and the relatively long glide times (Seifert, Leblanc, Herault, Komar, Button & Chollet, 2011; Leblanc, Seifert & Chollet, 2009; Miyashita, 1974;). During these periods, the resistive forces are much greater than propulsive forces. With some swimmers, BS completely loses speed and they stop going forward while swimmers in the other competitive stroke lose only about one third of their forward velocity during recovery period in stroke cycles (Maglischo, 2003); the same author emphasizes that BS swimmers must create a much greater force than swimmers using other techniques, simply by accelerating their body forward to the competing velocity during the stroke cycle.

According to Montgomery and Chambers (2009), the BS has a certain degree of flexibility in the ankle, knee and hip that allows legs and feet to hold or grab more water while kicking. The legs are symmetrical and bent in the knee, at the same time and in the form of a triangle, with the feet turn outwards. What has been stated shows that, other than flexibility (Russel, 2015; Montgomery & Chambers, 2009), a swimmer must have strong legs in order to produce a strong kick (Kippenhan, 2001; Strzala et al.,2012).

They have a specific way of breathing. Swimmers take a breath with every stroke cycle by raising the head and torso upwards and forwards. Extra force is used in the relaxation phase of the hand because, in the propulsive phase, it is going through the water and it begins to create extra resistance, which slows down the body when going forward. The structure of one's legs and feet may also play a role in becoming a good breaststroker, described by others as "walking like a duck" (Bixler, 2005).

Everything mentioned confirms that the BS technique is relatively "isolated" from different swimming styles. Consequently, the results that indicate the low correlation of BS technique with other styles on various distances were not unexpected. The lowest statistically significant correlation is found between 100-m BS and 25-m backstroke. This finding can be explained with completely different motor structures, body position and

way of breathing in these two techniques, as well as with different energy exposure according to the length of duration of the ST. Because of all of these specific characteristics, many coaches say, "Breaststrokers are born not made" (Montgomery & Chambers, 2009).

No relative differences in median speed between the same swimmers who are swimming on different distances in freestyle are found. The results of one swimmer to various distances lie in one direction, if it is swum with an even pace and at full power. This is the basis for calculating critical speed: swimming velocity at about maximal lactate steady state, expressed as yards or metres per second. When results are standardized, then it is expected that the differences of each swimmer in relation to the other swimmers on the Z scale are approximately the same (no significant difference). That was expected because specialization for swimmers in lengthwise swimming and technique begins at approximately the age of 16. In this research we observed swimmers aged 14 to 16 and all had a training process that contains a lot of aerobic training and a lot of mixed swimming (Šiljeg, 2012). After the specialization of the swimmers in lengthwise distance, there is a change in the slope which improves the results of the individual distance and then an occurrence of statistical significant differences could be expected.

The advantage of this research is that all the swimmers from Zagreb swimming clubs are measured. Therefore, the sample of young swimmers is very representative of the population of Zagreb (Croatian) swimmers. Their achievements revealed unique work in all four swimming techniques, which could reflect coaches' good work in all clubs. Furthermore, there is no specialization among swimmers in freestyle swimming on various distances. Specific (specialized) training from an early age is not an indispensable precondition for later success; moreover, early participation in specific training programmes correlated negatively with long-term senior success (Vaeyens, Gullich, Chelsea, Warr & Philippaerts, 2009).

The main shortcoming of the research is that the age range in the tested sample of swimmers is very large (3 years). Anderson, Hopkins, Roberts & Pyne (2006) indicated a high variability in swimmers responses and results according to age. However, tested swimmers are undergoing a phase of accelerated growth and development, with possible large individual variations (Mišigoj, 2008), and it would be better if the swimmers in the same age could be observed separately.

For future studies, the authors suggest testing each age separately (Costa, 2016) as well as adding tests that control just legs (swimming with kickboard) and just hand work (swimming with pull-buoy). Furthermore, it would be interesting to do the testing in all phases (general, preparation, competition and relaxation) of the training process.

Practical implications of this research indicate that progress in the BS discipline is only controlled by the tests done while swimming BS. It is very important to apply a different practice program, which includes much work in BS technique if the improvement of the performance in BS discipline is to be accomplished. According to some research, leg work is the most responsible for propulsion swimming in the BS technique and must be the most represented in the training process of swimmers BS techniques (Maglischo, 2003). Swimmers' BS techniques in daily practice must have leg work three times more than in other techniques (Oxford et al., 2010). Considering swimmers age, it is necessary to apply specialization according to lengthwise swimming, especially among 16-year-old swimmers (Costa, Marinho, Reis, Silva, Bragada & Barbosa, 2010).

Conclusions

The results revealed two interpretable and highly reliable latent dimensions of ST. Factor analysis of the ST differentiated the variables of ST that describe breaststrokes (BS) and other strokes (OS). Most of ST were positively correlated (in range 0.25–0.85), while no differences in various distance speeds among the same swimmers are found. However, the correlations found between BS and OS are the lowest. Cluster analysis revealed clear profiles of the swimmers who are the slowest and those who are the fastest. However, the first and third clusters could not be similarly unambiguously explained, reflecting the interaction between swimming distances and styles (with the particular role of breaststroke swimming style). The results indicate the importance of using ST, especially in BS techniques, by developing different practice programs, which include specific approaches in BS technique training.

REFERENCES

Anderson, M.E., Hopkins, W.G., Roberts, A.D., & Pyne, D.B. (2006). Monitoring seasonal ad long-term changes in test performance in elite swimmers. *European Journal of Sport Science*, 6, 145-154.

Arellano, R. (2004). Applying biomechanical testing to swimming training. Seminario Europeo de Entrenadores de Natacion - Madrid. Retrieved August 5, 2015, from http://homepage.mac.com/natacion/SwimmingScience/page4/page57/files/2004ArellanoEuroSem.pdf

Barbosa, T.M., Fernandes, R., Keskinen, K.L., Colaço, P., Cardoso, C., Silva, J., & Vilas-Boas, J.P. (2006). Evaluation of the energy expenditure in competitive swimming strokes. *Sports Medicine,* 27(11), 894-899.

Bixler, B.S. (2005). Resistance and propulsion. In: J.M. Stager, & D.A. Tanner (Eds.): Swimming. *Handbook*

of Sports Medicine and Science, 96. Massachusetts: Blackwell Science Ltd.
Brooks, R.W., Lance, C.C., & Sawhill, J.A. (2000). Kicking is not a significant source of propulsion. The biomechanical interaction of lift and propulsion forces during swimming. *Medical Science of Sports Exercise*, 32(5), Supplement abstract 910.
Costa, M.J. (2016). *Longitudinal interventions in elite swimming: relationship between energetics, biomechanics and performance.* Doctoral Dissertation. Retrieved September 20, 2016 from http://repositorio.utad.pt//handle/10348/5875.
Costa, M.J., Marinho, D.A., Reis, V.M., Silva, A.J., Bragada, J.A., & Barbosa, T.M. (2010). Stability and prediction of 100 m Breaststroke performance during the elite swimmers career. In P.L. Kjendlie, R.K. Stallman, & J. Cabri (Eds.). Proceedings of the *XIth International Symposium on Biomechanics and Medicine in Swimming.* Norway, pp. 272-273.
Grote, K, Lincoln, T.L., & Gamble J.G. (2004). Hip adductor injury in competitive swimmers. *The American Journal of Sports Medicine,* 32, 104–108.
Hannula, D. (2003). *Coaching swimming successfully*. Champaign IL: Human Kinetics.
Havriluk, R. (2006). Magnitude of the effect of an instructional intervention on swimming technique and performance. In J. P. Vilas-Boas, F. Alves, A. Marques (Eds.), Biomechanics and Medicine in Swimming X. *Portuguese Journal of Sport Sciences*, 6(S2), 218-220.
Keskinen, K., Eriksson, E., & Komi, P. (1980). Breaststroke swimmer's knee: Abiomechanical and arthroscopic study. *The American Journal of Sports Medicine,* 8, 228–231.
Latt, E., Jurimae, J., Maestu, J., Purge, P., Ramson, R., Haljaste, K., Keskinen, K.L., Rodrigez, F.A., & Jurimae, T. (2010). Physiological, biomechanical and anthropometrical predictors of sprint swimming performance in adolescent swimmers. *Journal of Sports Science and Medicine*, 9, 398-404.
Leblanc, H., Seifert, L., & Chollet, D. (2009). Arm–leg coordination in recreational and competitive breaststroke swimmers. *Journal of Science and Medicine in Sport*, 12, 352–356.
Leko, G., Šiljeg, K., & Zoretić, D. (2011). Predictors on performance in swimming strokes. *5th ISN International Sports Medicine and Sports Science Conference*. Kuala Lumpur.
Kippenhan, B.C. (2001). Influence of lower extremity joint motions of the effectiveness of the kick in breaststroke swimming. In: J.R. Blackwel, & R.H. Sanders (Eds.) Proceedings of swim sessions: *XIX International Symposium on Biomechanics in Sports,* 48-52. San Francisco, CA.
Maglischo, E.W. (2003). *Swimming fastest*. California, London, Toronto: Mayfield Publishing Company Mountain.
Mišigoj-Duraković, M. (2008). *Kinantropologija. Biološki aspekti tjelesnog vježbanja.* Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.
Montgomery, J., & Chambers, M. (2009). *Mastering swimming*. Champaign IL: Human Kinetics.
Miyashita, M. (1974). Method of calculating mechanical power in swimming the breast stroke. *Research Quarterly*, 45(2), 128-137.
Nelson, B., Pyne, D., & Sweetenham, B. (1991). *National talent identification and development program for swimming.* Paper presented as the 1999 ASCTA Convention. Western Australian Institute of Sport. Retrieved September 11, 2011, from http://www.wasa.asn.au/html/coaching/rtf/tid-ascta.rtf.
Nuber, G.W., Jobe, F.W., Perry, J., Moynes, D.R., & Antonelli, D. (1986). Fine wire electromyography analysis of muscles of the shoulder during swimming. *The American Journal of Sports Medicine,*14, 7–11.
Olbrecht, J. (2000). *The Science of Winning*. Luton, England: Swimshop.
Oxford, S. W., James, R., Price, M., & Payton, C. (2010). Coordination changes during a maximal effort 100m short-course breaststroke swim. *XIth International Symposium for Biomechanics and Medicine in Swimming*, Oslo: Norwegian School of Sport Sciences.
Richards, R. (1999). *Talent identification and development*. ASCTA Convention. Australia.
Russel, M. (2015). Butterfly Technique. In S. Riewald, S. & Rodeo (Eds). *Science of Swimming Faster,* 87-96. Champaign: Human Kinetics.
Seifert, L., Leblanc, H., Herault, R., Komar, J., Button, C., & Chollet, D. (2011). Inter-individual variability in the upper-lower limb breaststroke coordination. *Human Movement Science*, 3, 550-565.
Smith, D. J., Norris, S., & Hogg, J., M. (2002). Performance Evaluation of Swimmers. *Sports Medicine*, 32(9), 539-554.
Soons, B., Silva, A., Colman, V., & Persyn, U. (2003). Specific movement variables important for performance in different breaststroke styles. In J.C. Chatard (Ed.) *IX. International Symposium for Biomechanics and Medicine in Swimming, 295.* St. Etienne: Publications de l'Université de St. Etienne.
Sokolovas, G. (2006). Analysis of swimming's all-time top 100 times. In: J.P. Vilas-Boas, F., & Alves, A. Marques (Ed). Xth *International Symposium on Biomechanics and Medicine in Swimming*, 315-317. Porto: University of Porto.
Strzała, M., Krężałek, P., Kaca, M., Głąb ,G., Ostrowski, A., Stanula, A., & Tyka, A. (2012). Swimming Speed of The Breaststroke Kick. *Journal of Human Kinetics,* 35, 133–139.
Sweetenham, B. & Atkinson, J. (2003). *Championship swim training*. Champaign IL: Human Kinetics.
Šiljeg, K. (2012). *Povezanost antropoloških karakteristika i specifičnih plivačkih sposobnosti s uspješnošću u plivanju.* Doctoral Dissertation. Zagreb: Kineziološki fakultet.
Thorton, N. (2012). Trends and techniques in breaststroke. In: D. Hannula, N., & Thorton, (Eds). *The swim coaching Bible*, pp. 184-198. Champaign IL: Human Kinetics.

Vaeyens, R., Güllich, A., Chelsea, R., Warr, C.R., & Philippaerts, R. (2009). Talent identification and promotion programmes of Olympic athletes. *Journal of Sports Sciences*, 27(13), 1367-1380.

Vorontsov, A.R. (2002). *Multi-year training of young athlete as potential modifier of growth and development (Analysis of some biological concepts).* Sport Medicine in Aquatic Sports – the XXI Century, FINA World Sport Medicine.

ORIGINAL SCIENTIFIC PAPER

Examining Attitudes of Physical Education Teacher Education Program Students Toward the Teaching Profession

Gunay Yildizer[1], Caner Ozboke[1], Ramazan Tascioglu[1] and Ilker Yilmaz[1]

Affiliations: [1]Anadolu University, Faculty of Sport Sciences, Department of Physical Education and Sport Teaching, Eskişehir, Turkey

Correspondence: Gunay Yildizer, Anadolu University, Faculty of Sport Sciences, 2 Eylül Campus, Department of Physical Education and Sport Teaching, Tepebaşı/Eskişehir. E-mail: gunayyildizer@gmail.com

ABSTRACT The purpose of this study was to investigate attitudes of pre-service teachers toward the teaching profession with respect to their gender, grade level, whether participants regularly participate in physical activities, and whether pre-service students have a teacher-parent in their family. Research was conducted on 469 pre-service physical education teachers (Mage=21.35, SDage= 2.49), 188 female (Mage=20.89, SDage= 2.30) and 281 male (Mage=21.66, SDage= 2.57) students from five different universities in Turkey. In this study the "Attitude Scale for the Profession of Physical Education Teaching" was used. It has two factors: "concern for profession" (CP) and "affection for profession" (AP). Independent sample t-test results indicated that there were no significant differences with respect to gender or having a teacher-parent in both factors and total attitude points ($p > 0.05$). Pre-service physical education teachers who participate in physical activity had significantly higher points in AP and the total scale in comparison to those who do not participate in physical activity ($p < 0.05$). ANOVA results indicated that based on grade level there were significant differences in CP and total attitude ($p < 0.05$). Students' concern about employment may be associated with differences in attitude scores between grade levels. The positive effect of physical activity participation and their professional teaching education on stress resilience might also be an important factor for increasing positive attitudes toward the teaching profession.

KEY WORDS Attitudes toward Profession, Physical Education and Sport, Pre-service Teacher.

@MJSSMontenegro
ATTITUDES TOWARD THE TEACHING PROFESSION
http://mjssm.me/?sekcija=article&artid=139

Introduction

Personal or community development and change in one's desired course with respect to culture, knowledge, abilities and attitudes are only achievable through education (Demirhan, 2006). Teachers, students, and education programs are the essential components of the educational process (Sönmez, 2014). Teachers might be seen as the core of these components as they are responsible for guiding students to achieve the desired outcome according to the education program. Demirtaş, Cömert and Özer (2011) indicated that the teaching profession has decisive and directive roles beyond the other factors such as physical environment and other components in the educational process.

As stated in the literature, the effectiveness of the teaching profession is dependent on three crucial factors (i) profession choices of pre-service teachers, (ii) quality of teacher training, and (iii) teachers' personal beliefs towards the teaching profession (Şişman, 1999). The belief system is diversified from other factors that affect the quality of education, as it is deeply resistant to change (Kagan, 1992). However, studies have elucidated how belief system of teachers have been formed (Tsangaridou, 2006). Literature has theoretically demonstrated that the belief system of teachers is formed in three consecutive periods; (i) during their experiences in school, (ii) from life experiences, (iii) during their professional teacher education program in university (Pajares, 1992).

Accepted after revision: November 28 2016 | First published online: September 01 2017

Conflict of interest: None declared.

Kullinna, Brusseau, Ferry, and Cothran (2010) emphasized the belief system of teachers as "When beliefs function to make a decision or call for action, they become important and a group of beliefs clustered around a situation or object becomes an attitude that is prone to action". Attitudes can be defined as individual's mental, emotional, and behavioural forms of expected behaviour to an environmental object, social issue or experience. In line with these definitions, Kırel (2011) explained attitude as "personal feelings, ideas and adopting particular behaviours to other people, situations or objects". Teachers attitudes can lead their decisions and may affect teacher's behaviours in this way (Pajares, 1992). Considering the ways attitude towards teaching take form and influence teaching behaviors, it is important to understand pre-service teachers' attitudes. In this perspective, how pre-service teachers are restructuring belief system and attitudes in order to adopt appropriate instructional practices are key. Early educational experiences during childhood (Rovegno, 2003), early field experiences as a teacher (Woods, Goc Karp, & Escamilla, 2000) are important factors to consider.

Studies that examine pre-service teachers' attitudes toward the teaching profession have analysed different variables. Terzi and Tezci (2007) specified that pre-service teachers have a positive attitude towards their profession. In some studies, female pre-service teachers have demonstrated higher attitude scores than male pre-service teachers have (Pehlivan, 2010; Sağlam, 2008; Terzi & Tezci, 2007) yet there were no significant differences between genders in other studies (Özder, Konedralı, & Zeki, 2010). The years spent in a bachelor program as an indicator of educational experience was also considered while examining differences in pre-service physical education teachers' attitudes. Research demonstrated that program messages are incorporated into pre-service teachers' belief system about teaching physical education related to content, teaching effectiveness, and planning (Matanin & Collier, 2003). Therefore, years spent in a teacher education program becomes a critical issue in terms of attitudes. To illustrate, Ünlü (2013) reported that attitude scores of Turkish pre-service physical education students linearly decreased from the first year to the last year of their education.

In contrast, previous studies with pre-service teachers suggest that culturally based assumptions regarding sport and physical education were important factors as pre-service teachers progressed through their professional development (Rovegno, 2003). The physical education teacher education program is in the context of sport. Considering that most physical educators and pre-service physical education teachers share athletic backgrounds, it is important to investigate effectiveness this common sport culture on attitudes toward teaching. However, there is limited literature on this variable. Similar to physical education culture, having a teacher-parent in the family is another cultural background that might be shared by pre-service teachers (Pehlivan, 2008). However, there is an insufficient body of literature investigating the effects of this variable on attitudes in the physical education context.

To date, comprehending factors associated with positive attitudes toward teaching has been vital in order to improve the quality of teaching. The purpose of this study was to examine the pre-service physical education teachers' self-reported attitudes toward the teaching profession by gender (men and women), grade levels (1st, 2nd, 3rd and 4th), regular physical activity participation (yes/no), and whether they have a teacher-parent in their family or not (yes/no). Therefore, based on previous literature we hypothesized that (1) there is no significant difference between attitude points of male and female pre-service physical education teachers, (2) there are significant differences among pre-service teachers from different grades, (3) there are significant differences between pre-service teachers who regularly participate in physical activities and ones who do not, and finally (4) there are significant differences between pre-service teachers who have a teacher-parent in their family and who do not.

Methods

Participants

The participants of this study were 478 pre-service physical education teachers from five different universities in Turkey. Nine of them was excluded from the study because of inaccurate or incomplete filling of the instrument. Therefore, the study was completed with 469 participants; 281 males (Mage=21.66, SDage=2.57) and 188 females (Mage=20.89, SDage=2.30) pre-service physical education teachers completed the study: 180 participants were in the 1st grade, 134 participants were in the 2nd grade, 105 participants were in the 3rd grade, and 50 participants were in the 4th grade. Demographic information about the participants is shown in Table 1.

Design of the Study

A descriptive survey model was implemented in this study. Data were collected by the same researchers in all data collection centres. Gender, grade level, physical activity participation status (yes/no) and having a teacher-parent in the family (yes/no) were the independent variables and coded as categorical variable. In contrast, attitude scores in both AP, CP, and total scale were dependent variables. Physical activity participation was coded as a categorical variable, not as the physical activity level. This is a limitation of this study.

Instruments

Demographic measures are obtained by self-reported age, grade level, physical activity participation status, and having a teacher-parent in the family.

UDC 796.015.3-057.875

TABLE 1 Demographic information of participants

	Frequency	%
Gender		
Female	188	40.1
Male	281	59.9
Total	469	100
Grade Level		
1st	180	38.4
2nd	134	28.6
3rd	105	22.4
4th	50	10.7
Total	469	100
Physical Activity Status		
Yes	324	69.1
No	145	30.9
Total	469	100
Teacher in the Family		
Yes	151	32.2
No	318	67.8
Total	469	100

Attitudes toward teaching profession were assessed using 23-item 5-point Likert-type scale developed and validated by Ünlü (2011). This scale consists of two subscales. Affection for the profession (AP) is assessed with 13 positive items and Concern for Profession (CP) is assessed with 10 negative items which indicate that lower scores in this subscale emphasize higher concern levels. In Ünlü's (2011) study both exploratory and confirmatory factor analyses conducted to check the validity of the instrument, and it was validated with satisfactory values. Moreover, internal consistency values were assessed with Cronbach's alpha values and revealed 0.90 for AP, for 0.86 CP and 0.88 total scale, respectively, in the original research. In our study, Cronbach alpha values were found 0.76 for AP, 0.85 for CP and 0.86 for total scale. Cronbach Alpha values, which were greater than 0.70, show that scale has high-level internal consistency and that it distinguishes item in high and medium levels (Tabachnick & Fidell, 2013).

Data Collection Procedures

To conduct the study, ethical approval was obtained by the Anadolu University Ethics Committee. Secondly, researchers contacted the heads of Physical Education and Sport Teaching departments from five different universities, and they all chose to support this study. Two researchers visited these universities, explained the purpose of the study, and collected data from pre-service physical education who wanted to participate.

Data Analysis

Data analysis was conducted on 469 surveys. This number is sufficient according to Nunnally's (1978) recommendations on required sample size for survey studies. It highlighted that required sample size is 10 for each item in the survey. Therefore, the sample size in this study is sufficient.

Before conducting analysis, variables were examined to meet assumptions of the parametric tests. Statistics of variables showed that skewness and kurtosis values were between the range of -0.60 to -0.53, -0.77 to 0.22 and -0.71 to -0.26 for total attitude score, AP, and CP respectively. These values met the ±1.50 criterion (Tabachnick & Fidell, 2013). Independent sample t-tests were separately conducted to understand differences between the independent variables "gender", "physical activity participation" and "having a teacher-parent in the family". In addition to t-tests, one-way ANOVA was conducted to understand the differences between grade levels in terms of their attitude scores. IBM SPSS 22.0 (Chicago, IL) was used to conduct analyses. The significance level was determined to be 0.05.

Results

Independent samples t-test results indicated that there were no significant differences between male and female pre-service physical education teachers in the AP subscale [Male (M= 4.18, SD= 0.50), Female (M= 4.22, SD= 0.48), t (467)= -0.72, p= 0.467], the CP subscale [Male (M= 3.85, SD= 0.81), Female (M= 3.92, SD= 0.78), t (467)= -0.88, p= 0.378], and the total attitude point [Male (M= 4.04, SD= 0.54), Female (M= 4.08, SD= 0.53), t (467)= -0.94, p= 0.344]. Although there were no significant differences between genders, descriptive statistics indicated that female pre-service physical education teachers had greater scores in the AP and CP subscales in comparison to their male counterparts. Similarly, female participants had greater total attitude points in comparison to male participants (Table 2).

TABLE 2 Independent t-test results with respect to gender variable

Gender	Affection for Profession		Concern for Profession		Total Attitude Score	
	Mean± SD	p	Mean± SD	p	Mean± SD	p
Male	4.18± 0.50	0.467	3.85± 0.81	0.378	4.04± 0.54	0.344
Female	4.22± 0.48		3.92± 0.78		4.08± 0.53	

Legend: p>0.05

One-way ANOVA results indicated that the grade level variable was a significant factor for attitudes toward the profession among pre-service physical education teachers. In other words, ANOVA results indicated that there were significant differences in total attitude points [F (3, 465)= 5.20, p= 0.002] and CP subscale [F (3, 465)= 7.09, p= 0.000] but not in AP [F (3, 465)= 1.70, p= 0.165] among pre-service PE teachers from different grade levels. Tukey post-hoc test was employed to understand differences among groups and results are shown in Figure 1. First-year students (M= 4.17, SD= 0.49) had significantly higher total attitude points in comparison to third-year [(M= 3.96, SD= 0.51), p=0.009] and fourth-year students [(M= 3.91, SD= 0.61), p=0.011]. Secondly, first-year students (M= 4.08, SD= 0.68) had significantly higher scores in the CP subscale in comparison to second-year [(M= 3.78, SD= 0.81), p=0.002], third-year [(M= 3.73, SD= 0.81), p=0.006] and fourth-year students [(M= 3.66, SD= 0.93), p=0.005]. Finally, there were no significant differences between first-year (M= 4.24, SD= 0.48), second-year (M= 4.22, SD= 0.50), third-year (M= 4.14, SD= 0.47), and fourth-year students (M= 4.10, SD= 0.49) for the AP subscale.

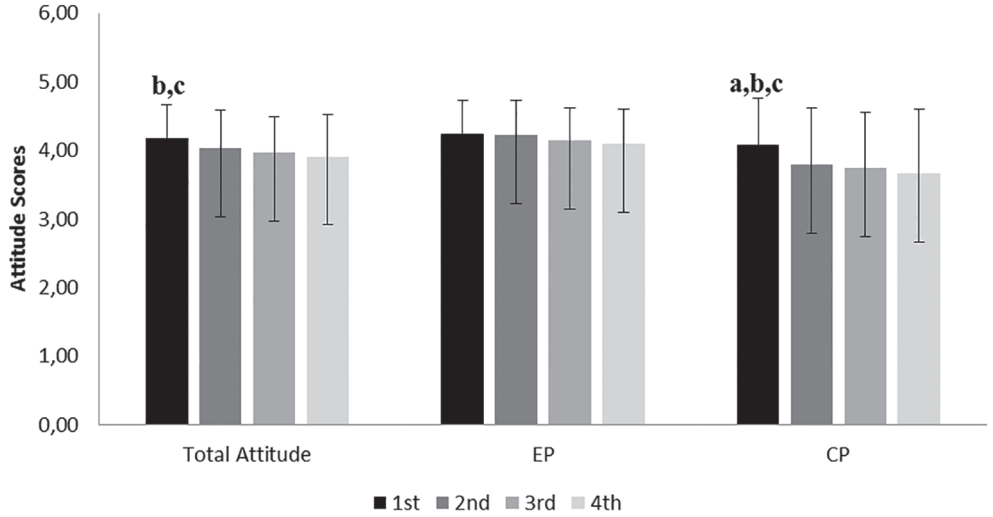


FIGURE 1 Attitude scores according to year of study (a: Difference between 1st and 2nd; b: Difference between 1st and 3rd; c: Difference between 1st and 4th)

A total of 151 participants reported that they have a teacher parent in the family, and 318 reported they do not have teacher-parent in the family. Independent samples t-test results indicated that there were no significant differences between these two groups in AP [t (467)= -1.13, p= 0.257] and CP [t (467)= -0.31, p= 0.752] subscales and total attitude score [t (467)= -0.79, p= 0.430]. Descriptive statistics and t-test results are shown in Table 3.

TABLE 3 Independent t-test results with respect to teacher in family variable

Teacher in Family	Affection for Profession		Concern for Profession		Total Attitude Score	
	Mean± SD	p	Mean± SD	p	Mean± SD	p
Yes	4.16± 0.50	0.257	3.86± 0.83	0.752	4.03± 0.57	0.430
No	4.21± 0.48		3.88± 0.77		4.07± 0.51	

Legend: p>0.05

As previously emphasized, physical activity culture is a key factor for attitude variables in physical education context; 324 of the participants reported that they regularly participate in physical activities and 145 of them reported that they do not participate regularly in any physical activity. Independent samples t-test results showed that participants who regularly participate in physical activities had significantly higher scores in comparison to those who do not participate in physical activity AP [Active (M= 4.25, SD= 0.49), Non-Active (M= 4.09, SD= 0.46), t (467)= 3.30, p= 0.001] and total attitude scores [Active (M= 4.09, SD= 0.53), Non-Active (M= 3.98, SD= 0.54), t (467)= 2.05, p= 0.041], but not in CP [Active (M= 3.89, SD= 0.78), Non-Active (M= 3.84, SD= 0.83), t (467)= 0.54, p= 0.583] (Table 4).

UDC 796.015.3-057.875

TABLE 4 Independent t-test results with respect to participation in physical activity variable

Physical Activity	Affection for Profession		Concern for Profession		Total Attitude Score	
	Mean± SD	p	Mean± SD	p	Mean± SD	p
Yes	4.25± 0.49	0.001*	3.89± 0.78	0.583	4.09± 0.53	0.041*
No	4.09± 0.46		3.84± 0.83		3.98± 0.54	

Legend: * – p<0.05

Discussion

In this study, pre-service PE teachers' attitudes towards teaching were examined with respect to gender, grade level, physical activity participation, and having a teacher-parent in the family. The first null hypothesis of the study was not rejected as there are no significant differences between male and female pre-service PE teachers. In all subscales of the questionnaire, males and females have reported similar attitude scores towards teaching. Descriptive statistics indicated that female pre-service PE teachers have higher affection, total attitude score and lower concerns for profession comparing to male counterparts. These results are in line with previous literature (Bedel, 2008; Pehlivan, 2010). Doğan & Çoban (2009) explained that teaching profession was perceived as female profession and females are more willing to become a teacher in Turkish culture. On the contrary; Güneyli & Arslan (2009) has demonstrated that gender is detrimental variable for attitudes toward teaching. A possible explanation to insignificant attitude scores between genders may be attributed to the specific domain. Most of the physical education teachers have professional athletic background, and Pajares (1992) indicated that life experiences are one of the crucial factors for the shaping belief system of teachers. Sandıkçı and Öncü (2013) reported that despite the similar results of attitude scores among teachers from various departments, PE teachers were the only group for which there is no main gender effect on teaching efficacy.

Our results indicated that the total attitude and effectiveness for teaching profession scores linearly decreased, whereas concern for the profession was linearly increase with respect to students' grades, thus indicating that first-year students have the highest scores in total attitude and affection subscales and the lowest concern level for the profession. The significant differences were observed between first- and third-, first- and fourth-year students for total attitude scores and first- and second-, first- and third-, first- and fourth-year students for concern for profession scores. Pehlivan (2010) also reported that positive attitudes toward teaching are decreasing in the middle and latest levels of the educational process among pre-service PE teachers. A possible explanation could be related to post-graduation stress, which indicates high concern for finding an appropriate job related to individuals' education (Doğan & Çoban, 2009). Moreover, it has been reported that negative beliefs about the teaching profession may lead to negative attitudes toward it among pre-service teachers (Inman & Marlow, 2004).

The results of our study indicated that having a teacher-parent in a family does not make a difference in attitude scores on any subscale in comparison to those who do not have teacher-parent in their family. As Rovegno (2003), suggested that teachers transfer early educational experiences during childhood to the educational process in professional life; teacher parents might have an effect on these experiences. To illustrate, Archer et al. (2012) reported that the family habitat and social capital of the family is effective on children's science aspiration and potential future participation among a 10-14 years old English population. Insufficient information on how parents in the teaching profession shape attitudes toward the academic life of children does not allow the comprehension of how teachers transfer their family background to attitudes related to teaching.

Participants who regularly participate in physical activity reported that they have significantly higher affection in the profession and total attitude score in comparison to those who do not. It was expected that the regular physical activity participation would increase the positive attitudes toward physical education teaching among pre-service PE teachers. In line with our results, Pehlivan (2010) reported the regular participation in sport has positive effect on attitudes toward the teaching profession among pre-service teachers. A possible explanation may be attributed to occupational stress. It is a well-established fact that physical activity reduces stress levels and improves mental health among adults and college-aged individuals (Wu, Tao, Zhang, Zhang, & Tao, 2015). Gerber, Jonsdottir, Lindwall, and Ahlborg (2014) suggested that physical activity participation is associated with resilience to occupational stress. Thus, decreased level of stress related to occupation may be effective on positive attitudes towards teaching profession among pre-service PE teachers. More specifically, literature has demonstrated that physical activity participation is one of the major strategies for coping with stress for teachers (Austin, Shah, & Muncer, 2005).

Our study has some methodological limitations. The physical activity level was obtained by self-report as a categorical variable, and this may have led to social-desirability bias. Moreover, future studies are needed to determine how family background and physical activity level rather than participation status affect the attitudes toward teaching among pre-service PE teachers. Finally, the sample sizes with respect to grade levels were distributed unequally because of the central teacher assignment exam, which takes place in the last year

of teacher education. Therefore, fourth-year students are generally out of faculties to prepare for this exam. Future studies in the Turkish context should consider these factors to be a limitation.

In conclusion, although female pre-service teachers have more positive attitude scores toward the teaching profession than their male counterparts do, there were no significant differences between genders. Moreover, there were no differences between pre-service teachers with respect to the teacher in a family variable. Therefore, the presence of teacher-parents does not affect pre-service physical education teachers in terms of different aspects of attitude. In contrast, physical activity participation is essential for increasing positive attitudes toward teaching through decreasing stress levels. However, it is also important to clarify the possible relationship between physical activity level and attitudes towards teaching, rather than physical activity participation preferences. Finally, pre-service PE teachers are likely to increase their concerns about teaching with the upgrading grade level. This is most probably attributed to stress caused by the central teacher assignment exam. Therefore, it is important to consider stress as a variable in future studies focusing on attitudes towards teaching among pre-service teachers in the Turkish context.

REFERENCES

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2012). Science aspirations, capital and family habitus how families shape children's engagement and identification with science. *American Educational Research Journal*, 49(5), 881-908.

Austin, V., Shah, S., & Muncer, S. (2005). Teacher stress and coping strategies used to reduce stress. *Occupational Therapy International*, *12*(2), 63-80.

Bedel, E. F. (2008). Interactions among attitudes toward teaching and personality constructs in early childhood preservice teachers. *Journal of Theory and Practice in Education*, 4(1), 31-48.

Demirhan, G. (2006*). Spor eğitiminin temelleri*. Ankara: Bağırgan Yayınevi.

Demirtaş, H., Cömert, M., & Özer, N. (2011). Öğretmen adaylarının öz yeterlik inançları ve öğretmenlik mesleğine ilişkin tutumları. *Eğitim ve Bilim,* 36(159), 96-111.

Doğan, T., & Çoban, A. E. (2009). Eğitim fakültesi öğrencilerinin mesleğine yönelik tutumları ile kaygı düzeyleri arasındaki ilişkinin incelenmesi. *Eğitim ve Bilim*, 34(153), 157-168.

Gerber, M., Jonsdottir, I. H., Lindwall, M., & Ahlborg, G. (2014). Physical activity in employees with differing occupational stress and mental health profiles: A latent profile analysis. *Psychology of Sport and Exercise*, *15*(6), 649-658.

Güneyli, A., & Aslan, C. (2009). Evaluation of Turkish prospective teachers' attitudes towards teaching profession (Near East University case). *Procedia-Social and Behavioral Sciences*, 1(1), 313-319.

Inman, D., & Marlow, L. (2004). Teacher retention: Why do beginning teachers remain in the profession? *Journal of Education*, 124(4), 605-614.

Kagan, D. M. (1992). Implication of research on teacher belief. *Educational Psychologist,* 27(1), 65–90.

Kırel, Ç. (2011). *Sosyal psikoloji*. (S. Ünlü, Ed.), Tutum ve tutum değişimi. Eskişehir: Anadolu Üniversitesi Açıköğretim Fakültesi Yayını.

Kullinna, H. P., Brusseau, T., Ferry, M., & Cothran, D. (2010). Preservice teachers' belief systems toward curricular outcomes for physical education. *Research Quarterly for Exercise and Sport*, 81(2), 189-198.

Matanin, M., & Collier, C. (2003). Longitudinal analysis of preservice teachers' beliefs about teaching physical education. *Journal of Teaching in Physical Education*, *22*(2), 153-168.

Nunnally, J. C. (1978). *Psychometric theory*. New York: McGraw-Hill.

Özder, H., Konedralı, G., & Zeki, C.P. (2010). Öğretmen adaylarının öğretmenlik mesleğine yönelik tutumlarının çeşitli değişkenler açısından incelenmesi. *Educational Administration: Theory and Pratice,* 26(2), 253-275.

Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research*, 62(3), 307–332.

Pehlivan, B. (2008). Sınıf öğretmeni adaylarının sosyo-kültürel özellikleri ve öğretmenlik mesleğine yönelik tutumları üzerine bir çalışma. *Mersin University Journal of the Faculty of Education,* 4(2), 151-168.

Pehlivan, Z. (2010). Beden eğitimi öğretmen adaylarının fiziksel benlik algıları ve öğretmenlik mesleğine yönelik tutumlarının analizi. *Eğitim ve Bilim,* 35(156), 126-141.

Rovegno, I. (2003). Teachers' knowledge construction. (In S. Silverman, C. Ennis, Ed.) Student learning in physical education: Applying research to enhance instruction, pp. 295–310. Champaign, IL: Human Kinetics.

Sağlam, A. Ç. (2008). Müzik öğretmenliği bölümü öğrencilerinin öğretmenlik mesleğine yönelik tutumları. *Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergi*si, 5(1), 59-69.

Sandıkçı, M., & Öncü, E. (2013). Beden eğitimi ile diğer alanlardaki öğretmen adaylarının öğretmenlik mesleğine ilişkin yeterlik algıları ve tutumlarının belirlenmesi ve karşılaştırılması. *Pamukkale Journal of Sport Sciences*, 1(4), 135-151.

Sönmez, V. (2014). *Eğitimin tarihsel temelleri.* In Eğitim Bilimlerine Giriş (11th ed.). Ankara: Anı Yayıncılık.

Şişman, M. (1999). *Öğretmenlik mesleğine giriş*. Ankara: Pegem A Yayıncılık.

Tabachnick B. G., & Fidell L. S. (2013). *Using multivariate statistics* (6th Edition). Boston: Allyn and Bacon.

Terzi, A. R., & Tezci, E. (2007). Necatibey Eğitim Fakültesi öğrencilerinin öğretmenlik mesleğine ilişkin tutumları. *Kuram ve Uygulamada Eğitim Yönetimi*, 52, 593-614.

UDC 796.015.3-057.875

Tsangaridou, N. (2006). Trainee primary teachers' beliefs and practices about physical education during student teaching. *Physical Education and Sport Pedagogy*, 13(2), 131–152.

Ünlü, H. (2013). Do prospective physical education teachers really want to be physical education teachers? *Croatian Journal of Education*, 15(4), 211-230.

Ünlü, H. (2011). Beden eğitimi öğretmenliği mesleğine yönelik tutum ölçeği (BEÖYTÖ) geliştirilmesi. *Kuram ve Uygulamada Eğitim* Bilimleri, 11(4), 2005-2020.

Woods, M., Goc Karp, G., & Escamilla, E. (2000). Preservice teachers learning about students and the teaching-learning process. *Journal of Teaching in Physical Education*, 20, 15–39.

Wu, X., Tao, S., Zhang, Y., Zhang, S., & Tao, F. (2015). Low physical activity and high screen time can increase the risks of mental health problems and poor sleep quality among Chinese college students. *PloS one*, *10*(3), e0119607.

ORIGINAL SCIENTIFIC PAPER

A Comprehensive Mapping of High-Level Men's Volleyball Gameplay through Social Network Analysis: Analysing Serve, Side-Out, Side-Out Transition and Transition

Manuel Loureiro[1], Marta Hurst[1], Beatriz Valongo[1], Pantelis Nikolaidis[2], Lorenzo Laporta[1] and José Afonso[1]

Affiliations: [1]University of Porto, Faculty of Sports, Centre of Research, Education, Innovation and Intervention in Sport, Porto, Portugal, [2]Hellenic Army Academy, Department of Physical and Cultural Education, Athens, Greece

Correspondence: Manuel Loureiro, University of Porto, Faculty of Sports, Centre of Research, Education, Innovation and Intervention in Sport, Rua Dr. Placido Costa, Paranhos, 4200-450 Porto, Portugal. E-mail: manel.loureiro@gmail.com

ABSTRACT A deeper understanding of the factors behind performance and their interactions is essential to promote better training practices. Notwithstanding, the focus often relies on the outcomes of players' actions (e.g., efficacy rates), whereas the nature and variations of particular classes of actions remain largely unexplored. Our purpose was to conduct a systemic analysis of categorical game variables and their interactions using Social Network Analysis. Game actions were counted as nodes and their interactions as edges. Eigenvector centrality values were calculated for each node. Eight matches of the Men's World Cup 2015 were analysed, composing a total of 27 sets (1,209 rallies). Four game complexes were considered: Complex 0 (Serve), Complex I (Side-out), Complex II (Side-out transition) and Complex III (Transition). Results showed that teams frequently play in-system when in Complex I (i.e. under ideal conditions), but present reduced variation with regard to attack zones and tempos, whereas in Complex II teams most often play out-of-system. Based on these findings, it was concluded that practicing with non-ideal conditions is paramount for good performance in Complex II. Furthermore, most literature combines Complex II and Complex III as a single unit (counter-attack); however, our results reinforce the notion that these two game complexes differ and should be analysed separately.

KEY WORDS Performance Analysis, Systemic Analysis, Social Networks, Game Logic.

@MJSSMontenegro
A COMPREHENSIVE MAPPING OF HIGH-LEVEL MEN'S VOLLEYBALL GAME
http://mjssm.me/?sekcija=article&artid=140

Introduction

The study of dynamic systems has revealed the existence of common logical principles between social and biological behaviours (Mendes, 2010). Indeed, it is widely recognized that the collective performance of a sport team is more (or less) than the sum of each players' performance (McGarry, 2009). In team sports, different players cooperate to achieve success, such as scoring a goal or blocking the ball, for example (Clemente & Mendes, 2015). Thus, the team acts like a dynamic system, in which different components/parts work together and often produce novel, emergent behaviour, while the overall systemic behaviour retroacts upon the parts (Palomares, 2008). Dynamic systems usually present subsystems that are highly complex and can exhibit partial independence (for example, cell organelles function partially independently, albeit concurring to the overall, systemic pattern of the human body) (Lebed, 2007). The coordinated activity of those subsystems and their interaction support their behaviour and their function (Walter, Lames, & McGarry, 2007). The partial independence of the subsystems contributes to create some instability in the system, leading to the emergence of new patterns or, alternatively, a return to previous patterns (McGarry, Anderson, Wallace, Hughes, & Franks, 2002). It has been reasoned that these principles may reflect the reality of team sports (Walter et al., 2007), in which each player's performance denotes a delicate interplay between their individual actions and the team's behaviours as a whole.

Accepted after revision: October 08 2016 | First published online: September 01 2017

Conflict of interest: None declared.

In this vein, Social Network Analysis (SNA) emerges as a powerful tool to study systemic behaviour (e.g., analysis of its topological conformations), devoting particular attention to the relationships established within the system (Quatman & Chelladurai, 2008). As has been stated (Pow, Gayen, Elliott, & Raeside, 2012), SNA maps assist us in understanding the interactions within a group, namely the links between different players and the flow of information in the system. This method has been used in various fields of research including sport (e.g., Cotta, Mora, Merelo, & Merelo-Molina, 2013; Fransen et al., 2015), usually to expose the relationships between different elements (i.e., persons) of a given system.

Regardless, SNA emerges from graph theory, indicating that it is possible to analyse the interactions between any given set of variables (Lusher, 2010). Therefore, this instrument might be used to provide further insights regarding the logic behind performance in different sports (Bourbousson, 2010). Specifically, it is possible to use SNA to gather topologic information of sets of performance variables (e.g., game actions, behavioral patterns, events, and contextual cues, among others) in order to produce a systemic mapping of the game and its sub-sets (Lusher, Robins, & Kremer, 2010). This, in itself, will provide useful qualitative information, which is complemented by quantitative data pertaining the established relationships (e.g., node centrality measures and density, the strength of edges, and the detection of cliques, among others).

Nonetheless, most match analyses still tend to be compartmentalized and use a marked analytical approach, avoiding a systemic approach, perhaps due to its complexity. In the case of volleyball, some game variables are commonly studied: type and efficacy of the serve (Quiroga et al., 2010); quality of serve-reception (Afonso, Moraes, Mesquita, Marcelino, & Duarte, 2009); setting zone and quality (Afonso, Mesquita, Marcelino, & Silva, 2010); efficacy of the attack (based on zone attack tempo) (Araújo et al., 2011). Volleyball is usually considered to encompass five different game complexes (Ks), which are the equivalents to the concept of the sub-system. According to Hileno and Buscà (2012), volleyball can be divided into six functional and partially independent game complexes: K0 (serve), KI (side-out, including serve-reception, set, and attack); KII (side-out transition, block, dig, set and attack immediately after de side-out); KIII (transition of transitions, including the same items as KII but after another transition); KIV (attack-coverage, analyzing) and KV (freeball transition, transition without attack of the opposite team). Most authors include the K0 in the KII, due to their close functional relationships and tactical unity (e.g., Costa, Afonso, Brant, & Mesquita, 2012), but here we kept them separated as we intended to analyse the sequential paths of the game actions. How these distinct game complexes interact is scarcely known and, to our knowledge, has not been investigated. Certainly, their relationships have not been explored using SNA.

Therefore, the aim of the present study was to analyse the systemic and sub-systemic relationships (both qualitative and quantitative) in a competitive sport context using Social Network Analysis, focusing on relationships between game actions instead of on relationships between players. The specific case of high-level men's volleyball game was considered. The Ethics Committee at the Centre of Research, Education, Innovation and Intervention in Sport of the University of Porto provided institutional approval for this study.

Methods

Eight matches from the Fédération Internationale de Volleyball (FIVB) World Cup 2015 were analysed. This highly prestigious competition is held once every four years; from this tournament, the two best-classified teams gained direct qualification to the 2016 Olympic Games in Rio. Five teams from the top six placed in the FIVB World Rankings were analysed (Poland, 2nd; Russia, 3rd; USA, 4th; Italy, 5th; and Argentina, 6th). Brazil (the number 1 in the ranking) did not participate in this tournament since it was already qualified for the Olympic Games, as the team of the host country. A total of 1,209 rallies were observed, corresponding to 27 sets.

The videos were acquired in the public domain from Youtube.com, and all had a back view of the court. Data collection was accomplished using Microsoft® Excel® 2015 and later analysed using IBM® SPSS® Statistics for Windows (Version 21, E.U.A.). The SNA were performed using Gephi© 0.8.2-beta (Version 10.10.3, France). The observers had been previously trained in order to attain proficiency and consistency in coding the data. For training purposes, each observer analysed a minimum of eight matches from different high-level competitions (men and women). Inter-observer reliability was established with Cohen's Kappa above 0.80 for all the considered variables.

The game complexes included KO (Serve), KI (Side-out), KII (Side-out transition), and KIII (Transition) (Costa et al., 2012). Although K0 is usually included in KII, we analysed it independently to better provide a perceptible sequential analysis of the game actions. Two variables were considered in K0: Serve Zone, following the official FIVB rules which divide the court into six different zones (1, 6 and 5 in the back row, as servers are behind one of these three zones), and Serve Type (jump, jump-float or standing) (Quiroga et al., 2010).

In KI, the following variables were analysed: (a) Reception Zone (the six official volleyball zones); (b) Setting Zone, which was evaluated based on the options available to the setter ("A" if the setter had all options available, "B" if the setter could still use quick plays and use the middle-attacker, but some attack combinations were not possible, and "C" when the setter could not use quick attacks); (c) Attack Tempo (based on Afonso & Mesquita (2007) and Costa et al. (2012)): 1 - the attacker was in the air or performed one step after the set; 2 -

UDC 796.325:796.57

the attacker performed two steps after the set; 3 - the attacker performed three or more steps after the set); and (d) Attack Zone, according to the FIVB's rules. Complexes II and III also made use of Setting Zone, Attack Tempo, and Attack Zone, but further presented specific variables: Block Opposition, which was analysed according to the number of blockers facing the attack (from 0 blockers to 3 blockers), and Defense Zone, which was evaluated as the zone where the dig occurred (official volleyball zones adding "others", outside the field). When any variable did not occur it was registered as Not Occurring (NO).

SNA was used; specifically, eigenvector centralities were calculated for each node. An inherent concept of Eigenvector centrality is the idea that each node is more central if it is connected with central nodes. The centrality of each depends not only on the number of connections but also of their characteristics. (Bonacich, 2007)

For the purposes of inter-observer reliability testing, 366 (30%) of rallies were analysed by an independent observer (who was an experienced coach and researcher), which is well above the 10% suggested by Tabachnick and Fidell (2000). Values of Cohen's Kappa ranged between 0.76 and 1, above the reference value of 0.75 suggested by the specialized literature (Fleiss 2003).

Results

A topological mapping of the interactions through calculation of Eigenvector centralities is presented in Figure 1.

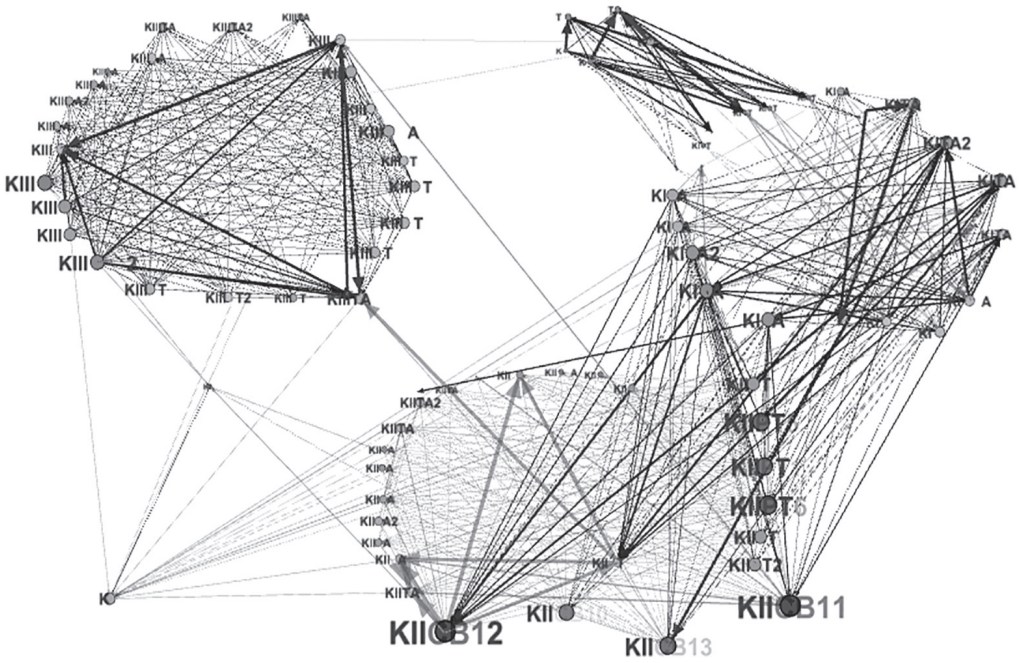


FIGURE 1 A topological mapping of the interactions through calculation of eigenvector centralities

As seen in Table 1, there were no Standing Serves, and the least used Serve Zone was 5 (0.04). There were no apparent differences between jump-float and jump serve, and the same was observed for Serve Zones 1 and 6 (0.05).

TABLE 1 Eigenvector values for Complex 0

	Serve (K0)			
Serve type (K0ST)	Jump (K0STJ)	Jump-float (K0STJF)	Standing (K0STF)	**Range**
	0.06	0.06	-	0.06-0.06
Serve Zone (K0SZ)	ServZ1 (K0SZ1)	ServZ5 (K0SZ5)	ServZ6 (K0SZ6)	**Range**
	0.05	0.04	0.05	0.04-0.05

With respect to KI or side-out (Table 2), all reception zones presented similar eigenvector values (0.08-0.09), with Zone 4 being the exception. Setting Zones A and B obtained the superior eigenvector values (0.39 and 0.38, respectively) when compared to Zone C (0.29). The attack zone with the highest value in side-out was 4 (0.73), followed by Zones 3 and 2 (0.69). Attack Tempos 2 and 3 predominated (0.75).

In KII (side-out transition), the double block had the highest value (1.00), followed by the single block (0.98), with triple blocks (0.81) and no opposition (0.78) being less central in the network. The vast majority of attacks were intercepted in the backcourt defensive zones, with frontcourt defensive zones being less central.

TABLE 2 Eigenvector values for Complex I

Side-Out (KI)								
Reception Zone (KIRZ)	RZ 1 (KIRZ1)	RZ 2 (KIRZ2)	RZ 3 (KIRZ3)	RZ 4 (KIRZ4)	RZ 5 (KIRZ5)	RZ 6 (KIRZ6)	RZ Not Occurring (KIRZNO)	**Range**
	0.09	0.08	0.09	0.06	0.09	0.09	0.02	0.02-0.09
Setting Zone (KISZ)	SZ A (KISZA)	SZ B (KISZB)	SZ C (KISZC)	SZ Not Occurring (KISZNO)	**Range**			
	0.39	0.38	0.29	0.04	0.04-0.39			
Attack Zone (KIAZ)	AZ 1 (KIAZ1)	AZ 2 (KIAZ2)	AZ 3 (KIAZ3)	AZ 4 (KIAZ4)	AZ 5 (KIAZ5)	A Z 6 (KIAZ6)	AZ Not Occurring (KIAZNO)	**Range**
	0.64	0.69	0.69	0.73	0.38	0.55	0.06	0.06-0.73
Attack Tempo (KIAT)	AT1 (KIAT01)	AT 2 (KIAT2)	AT 3 (KIAT3)	AT Not Occurring (KIATNO)	**Range**			
	0.63	0.75	0.75	0.60	0.60-0.75			

Differently from what had succeeded in KI, the attack in KII was mostly built from setting Zone C (0.45). Attack Zone 2 was predominant (0.54), closely followed by Zone 4 (0.51) and Zone 1 (0.50), but plays where an attack could not be built were also central (0.50). Similarly to KI, Attack Tempos 3 and 2 predominated (0.56).

In KIII, the triple block surpasses (0.39) double block (0.38) and single block (0.36). Results for defensive zones were similar to those obtained in KII. Contrary to KII, however, setting Zone A (0.35) again surpassed the centrality values of Zones B and C, as had occurred in KI. Attack Zones 4 (0.30), 1 and 2 (0.28) remained central nodes in the network. Again, Attack Tempos 2 and 3 (0.27 and 0.25) presented superior eigenvector values with respect to Tempo 1.

TABLE 3 Eigenvector values for Complex II

Side-out transition (KII)									
Number of blockers (KIINB)	Triple (KIINB3)	Double (KIINB2)	Single (KIINB1)	No block (KIINB0)	**Range**				
	0.81	1.00	0.98	0.78	0.78 – 1.00				
Defense Zone (KIIDZ)	DZ 1 (KIIDZ1)	DZ 2 (KIIDZ2)	DZ 3 (KIIDZ3)	DZ 4 (KIIDZ4)	DZ 5 (KIIDZ5)	DZ 6 (KIIDZ6)	Other (KIIDFO)	DZ Not Occurring (KIIDZNO)	**Range**
	0.86	0.67	0.67	0.66	0.89	0.91	0.04	0.49	0.04 – 0.89
Setting Zone (KIISZ)	SZ A (KIISZA)	SZ B (KIISZB)	SZ C (KIISZC)	SZ Not Occurring (KIISZNO)	**Range**				
	0.41	0.38	0.45	0.43	0.38 – 0.45				
Attack Zone (KIIAZ)	AZ 1 (KIIAZ1)	AZ 2 (KIIAZ2)	AZ 3 (KIIAZ3)	AZ 4 (KIIAZ4)	AZ 6 (KIIAZ6)	AZ Not Occurring (KIIAZNO)	**Range**		
	0.50	0.54	0.42	0.51	0.42	0.50	0.42 – 0.54		
Attack Tempo (KIIAT)	AT 1 (KIIAT01)	AT2 (KIIAT2)	AT 3 (KIIAT3)	AT Not Occurring (KIIATNO)	**Range**				
	0.36	0.56	0.56	0.53	0.36 – 0.53				

While the K0 always links to KI, by definition the three remaining game complexes (I, II, and III) may originate distinct events. In this case, KI never originated KIV, i.e., there were no plays starting with attack coverage after KI. However, some missed receptions and settings did originate KV.

Discussion

Performance analysis is a powerful method for understanding the complexities, behaviours, and patterns in the game (Travassos, Davids, Araújo, & Esteves, 2013). This kind of information helps coaches in designing training processes that more closely follow the demands of competition (Ericsson, 2003). As team sports, in particular, seem to behave as dynamic systems, systemic analyses are paramount to better frame performance (Walter et al., 2007). In this vein, we applied SNA to high-level men's volleyball. Specifically, eigenvector centrality was calculated for each node, in order to understand the importance of each game action in overall performance as well as the interaction between them. Four game complexes were analysed: K0 (Serve); KI (Side-out); KII (Side-out transition) and KIII (Transition).

UDC 796.325:796.57

Results showed that the standing serve was rarely used, possibly because it tends to be less effective than other serve techniques. Nevertheless, standing serve could be an option to lower the jump frequency in the matches and create a disturbance in game patterns, especially if used as a surprise factor in certain key moments. The jump serve presented a high eigenvector centrality value, in accordance with the role it has in men's volleyball (Costa et al., 2012; Manzanares & Ortega, 2009; Palao, 2009), but this value was not superior to that presented by the jump-float, such serves in men's volleyball being associated with low risk but very low chance to score a point (Palao, 2009). The findings also showed that most of the players chose to serve in their zone of responsibility of defence (i.e., setters and opposites in Z1, outside-hitters in Z6, and middle-blockers in Z5). This seems logical, as the paths from serve to defensive positions are shortest, but may reduce variability and thus make the serve more predictable. Players could benefit from changing their serve zone in specific moments, introducing some randomness in order to imbalance the opponent. Furthermore, the serve rarely targeted Zone 4, even though this could disrupt the outside hitter's attack pattern (Afonso et al., 2010; Lithio & Webb, 2006).

TABLE 4 Eigenvector values for Complex III

				Transition (KIII)					
Number of blockers (KIIINB)	Triple (KIIINB3)	Double (KIIINB2)	Single (KIIINB1)	No block (KIIINB0)			**Range**		
	0.39	0.38	0.36	0.33			0.33 – 0.39		
Defence Zone (KIIIDZ)	DZ 1 (KIIIDZ1)	DZ 2 (KIIIDZ2)	DZ3 (KIIIDZ3)	DZ 4 (KIIIDZ4)	DZ 5 (KIIIDZ5)	DZ 6 (KIIIDZ6)	Other Zone (KIIIDFO)	DZ Not Occurring (KIIIDZNO)	**Range**
	0.34	0.29	0.33	0.24	0.33	0.33	0.28	0.15	0.15 – 0.34
Setting Zone (KIIISZ)	SZ A (KIIISZA)	SZ B (KIIISZB)	SZ C (KIIISZC)	SZ Not Occurring (KIIISZNO)			**Range**		
	0.35	0.29	0.33	0.32			0.29 – 0.35		
Attack Zone (KIIIAZ)	AZ 1 (KIIIAZ1)	AZ 2 (KIIIAZ2)	AZ 3 (KIIIAZ3)	AZ 4 (KIIIAZ4)	AZ 5 (KIIIAZ5)	AZ6 (KIIIAZ6)	Not Occurring (KIIIAZNO)	**Range**	
	0.28	0.28	0.25	0.30	0.05	0.20	0.28	0.05 – 0.28	
Attack Tempo (KIIIAT)	AT 1 (KIIIAT01)	AT 2 (KIIIAT2)	AT 3 (KIIIAT3)	AT Not Occurring (KIIIATNO)			**Range**		
	0.21	0.27	0.25	0.36			0.21 – 0.36		

As for KI (side-out), teams played most often in-system, as the quality of the first contact was such that SZA presented the highest centrality values, as had also been observed by Bergeles and Nikolaidou (2011), having been closely followed by SZB. Despite optimal or near-optimal conditions for attack being the norm in this game complex, the attack options still largely promoted Zone 4 and Tempo 1 was the less central node. According to Costa et al. (2011) and Afonso et al. (2010), this reduces the chance of scoring a point. This has

TABLE 5 Weight values for Complexes IV and KV

	Categories	**KIV (Range)**	**KV (Range)**
Side-out (KI)	KIRZ		1 – 20
	KISZ		1 – 66
	KIAZ		1 – 3
	KIAT		0
Side-out Transition (KII)	KIINB	17-74	
	KIIDZ		1 – 8
	KIISZ		2 – 17
	KIIAZ		1
	KIIAT		1
Transition (KIII)	KIIINB	16-38	
	KIIIDZ		1 – 5
	KIIISZ		1 – 12
	KIIIAZ		1
	KIIIAT		1

practical implications for volleyball practices, as teams use slower attack tempos and reduced variation in attack zone despite having ideal conditions for doing so. Low-risk strategies seem to have been privileged, and it would be interesting to explore further why this is happening, as well as to attempt to understand what would change in the game dynamics if higher-risk strategies were to be applied.

Accordingly, teams playing in KII were able to mount double blocks more often than single blocks, thus building a strong defensive wall, in agreement with previous research (Afonso & Mesquita, 2011; Afonso, Mesquita, & Palao, 2005). Nevertheless, teams spent most of the time playing off-system, as SZC was clearly predominant, in line with the conclusions of Mesquita and Graça (2002). Therefore, even if KI attacks privileged safety over speed and variation, they managed to deliver an effective offense, and double blocks were not capable of maintaining the superior centrality of SZA and SZB over SZC. Expectedly, slower attacks by the extremities of the net emerged as central nodes. Overall, teams should prepare themselves to play KII in off-system conditions, instead of practicing in more structured, in-system contexts.

Contrariwise, the KIII emerged as distinct from the KII. For starters, triple block emerged as central, denoting a better opposition to the attack. Consequently, SZA was again predominant. Nonetheless, slower attack tempos and the extremities of the net were once more central. Unlike KI, though, mounting a quicker offense in KIII may be more difficult due to two major factors: i) most attackers are probably just recovering from the block and may not have the time to participate in quicker attack tempos; ii) in KIII fatigue is already playing a role, thus also contributing to a small centrality of quick attack tempos. The pronounced differences between KII and KIII imply that the two types of counter-attack are qualitatively different and should be analysed separately. Unfortunately, the vast majority of research merges both into a single unit reporting the counter-attack (e.g., Costa et al., 2012; Laporta, Nikolaidis, Thomas, & Afonso, 2015), although there is at least one exception (see Sánchez-Moreno, Marcelino, Mesquita, & Ureña, 2015) consider such functional differences. Finally, our data highlighted the fact that KI never originated KIV, i.e., there were no plays of attack coverage deriving from the side-out.

Overall, this study showed that gameplay under in- or off-system conditions varies depending on the game complex that is being analyzed. Specifically, KI offers volleyball teams greater possibilities of playing in-system, but a still below-expected variability in attack organization was observed. In KII, off-system conditions predominate, and such logic should be replicated in training sessions to better prepare athletes for playing under far-from-ideal conditions. Also of note, significant differences have been established between the KII and KIII, meaning that the distinction of side-out transition and transition is not pedantic, but denotes two distinct game complexes, each with its own functional dynamics. Such accentuated differences should direct researchers against grouping the two types of transition or counter-attack in the same category.

REFERENCES

Afonso, J., & Mesquita, I. (2011). Determinants of block cohesiveness and attack efficacy in high-level women's volleyball. *European Journal of Sport Science,* 11(1), 69-75.

Afonso, J., Mesquita, I., Marcelino, R., & Silva, J. A. (2010). Analysis of the setter's tactical action in high-performance women's volleyball. *Kinesiology,* 42(1), 82-89.

Afonso, J., Mesquita, I., & Palao, J. M. (2005). Relationship between the use of commit-block and the number of blockers and block effectiveness. *International Journal of Performance Analysis in Sport,* 5(2), 36-45.

Afonso, J., Moraes, J., Mesquita, I., Marcelino, R., & Duarte, T. (2009). Variables associated with the effect of serve-reception, in high-level men's volleyball. *Journal of Sports Sciences,* 27(4), S127-128.

Araújo, R., Martins, A., Afonso, J., Botelho, S., Coutinho, P., & Mesquita, I. (2011). Tactical determinants of the attack player in high-level male volleyball. *Revista Portuguesa de Ciências do* Desporto, 11(Suppl.4), 36.

Bergeles, N., & Nikolaidou, M. (2011). Setter's performance and attack tempo as determinants of attack efficacy in Olympic-level male volleyball teams. *International Journal of Performance Analysis in Sport,* 11(3), 535-544.

Bourbousson, J., Poizat, G., Saury, J., & Seve, C. (2010). Team coordination in basketball: Description of the cognitive connections among teammates. *Journal of Applied Sport Psychology*, 22(2), 150-166.

Bonacich, P. (2007). Some unique properties of eigenvector centrality. *Social networks*, 29(4), 555-564.

Clemente, F. M. M. F.& Mendes,R. (2015). There are differences between centrality levels of volleyball players in different competitive levels? *Journal of Physical Education and Sport,* 15(2), 272 - 276.

Costa, G., Afonso, J., Brant, E., & Mesquita, I. (2012). Differences in game patterns between male and female youth volleyball. *Kinesiology,* 44(1), 60-66.

Costa, G. C., Caetano, R., Ferreira, N. N., Junqueira, G., Afonso, J., Costa, R. D., & Mesquita, I. (2011). Determinants of attack tactics in Youth male elite volleyball. *International Journal of Performance Analysis in Sport,* 11(1), 96-104.

Cotta, C., Mora, A. M., Merelo, J. J., & Merelo-Molina, C. (2013). A network analysis of the 2010 FIFA world cup champion team play. *Journal of Systems Science and Complexity,* 26(1), 21-42.

Fransen, K., Van Puyenbroeck, S., Loughead, T. M., Vanbeselaere, N., De Cuyper, B., Vande Broek, G., & Boen, F. (2015). Who takes the lead? Social network analysis as a pioneering tool to investigate shared leadership within sports teams. *Social Networks,* 43, 28-38.

UDC 796.325:796.57

Hileno, R., & Buscà, B. (2012). Herramienta observacional para analizar la cobertura del ataque en voleibol. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte,* 12(47), 557-570.

Laporta, L., Nikolaidis, P., Thomas, L., & Afonso, J. (2015). The importance of loosely systematized game phases in sports: The case of attack coverage systems in high-level women's volleyball. *Montenegrin Journal of Sports Science and Medicine,* 4(1), 19-24.

Lebed, F. (2007). A dolphin only looks like a fish: players' behaviour analysis is not enough for game understanding in the light of the systems approach - a response to the reply by McGarry and Franks. *European Journal of Sport Science,* 7(1), 55-62.

Lithio, D., & Webb, E. (2006). Optimizing a volleyball serve. *Rose-Hulman Institute of Technology Undergraduate Math Journal,* 7(2), 1-20.

Lusher, D., Robins, G., & Kremer, P. (2010). The application of social network analysis to team sports. *Measurement in Physical Education and Exercise Science,* 14(4), 211-224.

Manzanares, P., & Ortega, E. (2009). Techniques used and efficacy of volleyball skills in relation to gender. *International Journal of Performance Analysis in Sport,* 9(2), 281-293.

McGarry, T. (2009). Applied and theoretical perspectives of performance analysis in sport: scientific issues and challenges. *International Journal of Performance Analysis in Sport,* 9(1), 128-140.

McGarry, T., Anderson, D., Wallace, S., Hughes, M., & Franks, I. (2002). Sport competition as a dynamical self-organizing system. *Journal of Sports Sciences,* 20(10), 771-781.

Mendes, P. P. K. D. D. A. N. P. J. M. J. (2010). Networks as a novel tool for studying team ball sports as complex social systems. *Journal of Science and Medicine in Sport* 14, 170–176.

Mesquita, I., & Graça, A. (2002). Probing the strategic knowledge of an elite volleyball setter: a case study. *International Journal of Volleyball Research,* 5(1), 13-17.

Palomares, N. (2008). Toward a theory of goal detection in social interaction: effects of contextual ambiguity and tactical functionality on goal inferences and inference certainty. *Communication Research,* 35, 109-149.

Pow, J., Gayen, K., Elliott, L., & Raeside, R. (2012). Understanding complex interactions using social network analysis. *Journal of Clinical Nursing,* 21(19pt20), 2772-2779.

Quatman, C., & Chelladurai, P. (2008). Social Network theory and analysis: A complementary lens for inquiry. *Journal of Sport Management,* 22, 338-360.

Quiroga, M. E., García-Manso, J. M., Rodríguez-Ruiz, D., Sarmiento, S., De Saa, Y., & Moreno, M. P. (2010). Relation between in-game role and service characteristics in elite women's volleyball. *The Journal of Strength & Conditioning Research,* 24(9), 2316-2321.

Sánchez-Moreno, J., Marcelino, R., Mesquita, I., & Ureña, A. (2015). Analysis of the rally length as a critical incident of the game in elite male volleyball. *International Journal of Performance Analysis in Sport,* 15(2), 620-631.

Travassos, B., Davids, K., Araújo, D., & Esteves, P. (2013). Performance analysis in team sports: Advances from an Ecological Dynamics approach. *International Journal of Performance Analysis in Sport,* 13(1), 83-95.

Walter, F., Lames, M., & McGarry, T. (2007). Analysis of sports performance as a dynamical system by means of the relative phase. *International Journal of Computer Science in Sport, 6*(2), 35-41.

ORIGINAL SCIENTIFIC PAPER

Common Injuries of Collegiate Tennis Players

Christian Wisdom Magtajas Valleser[1] and Ken Ewing L. Narvasa[1]

Affiliations: [1]University of the Philippines Diliman, Department of Sports Science, College of Human Kinetics, Quezon City, Philippines

Correspondence: Christian Wisdom Magtajas Valleser, University of the Philippines Diliman, Department of Sports Science, College of Human Kinetics, Don Mariano Marcos Avenue, Diliman, Quezon City, Philippines, 1101. E-mail: cmvalleser@up.edu.ph

ABSTRACT The purpose of this study is to determine the common injuries of Filipino collegiate tennis players; 110 varsity tennis players with a mean of 20 years old (SD ± 1.7) with an average playing experience of 12 years participated in the study. There was a 100% occurrence of at least one injury with an average rate of 5.98 injuries per person. The authors observed that the most commonly injured anatomical region is the lower extremity; ankles were recorded as the most commonly injured part. Other commonly injured areas included the shoulders and lower back. Furthermore, the most common injury type is tendinitis, sprains, and strains. The recorded injuries were mostly associated with overuse injuries, and the findings were similar to those of most other studies on tennis injuries. A larger sample size may provide more conclusive findings on tennis injuries, particularly in different levels of competition, such as recreational or professional athletes.

KEY WORDS Injuries, Collegiate, Tennis, Student-athletes.

@MJSSMontenegro
COMMON INJURIES OF COLLEGIATE TENNIS
http://mjssm.me/?sekcija=article&artid=141

Introduction

It is widely accepted that while engaging in sports and physical activities reduces the risk of certain diseases, it also entails a noticeable risk of injury among all levels of participation (Bahr & Krosshaug, 2005). Although there is no universally accepted definition, this study defines *sports injury* as a physical condition incurred as a result of sport participation, which requires medical attention and restriction of participation or performance (Hootman, Dick & Agel, 2007). The general objective of this study is to identify the common injuries incurred by collegiate tennis players using student athletes from participant schools of the University Athletic Association of the Philippines (UAAP). Specifically, this research aims to identify the common type of injuries and most commonly injured anatomical regions.

Tennis is a sport widely participated in by the more than 200 countries affiliated with the International Tennis Federation. Along with its popularity are the various national and international tournaments organized throughout the year, many of which feature large prizes (Pluim, Staal, Windler & Jayanthi, 2006). There is increasing research on the epidemiology of tennis and other sport injuries, which further promotes the awareness of injury tendencies and the development of prevention strategies (Rechel, Yard & Comstock, 2008; Hootman et al., 2007).

On the international level, tennis is featured in the Olympics and most notably in major tournaments, such as the Australian Open, Wimbledon Championships, French Open, and US Open. In the Philippines, there are various professional and amateur tennis tournaments; most notably, on the amateur level, the UAAP typically features the best collegiate tennis players in the country. Collegiate players in the UAAP normally take up the sport at a young age, typically no later than ten years old. The risk of early introduction and regular participation in sports is that players starting young could acquire chronic injuries, especially when trained with techniques that are not compatible with what their bodies can tolerate (Reid & Schneiker, 2007). Furthermore, long-term sport participation can cause chronic and acute injuries in the developing bodies of child- and adolescent-aged athletes (DiFiori et al., 2014).

Safran, Zachazewski, Benedetti, Bartolozzi III and Mendelbaum (1999) reported that many athletes have

Accepted after revision: March 29 2017 | First published online: September 01 2017

Conflict of interest: None declared.

claimed that they played or competed through these discomforts. They further noted that low back pain was common in elite junior players. Hellstrom, Jacobsson, Sward and Peterson (1990) also made this observation in elite adult players. Lower-back pain from tennis comes from a wide variety of sources but is mainly due to high demands placed on the lower back and trunk combined with low flexibility resulting in frequent overuse-type injuries. Kibler and Safran (2005) observed that ankle sprains were the most common microtrauma injury in tennis due to the frequent running, pivoting, sudden stopping, acceleration, jumping, and lunging movements in tennis play. Furthermore, lateral epicondylitis (tennis elbow) and medial epicondylitis chronic repetitive motion through firm gripping of the handle of the racket and impact of the ball were common. Generally, hand and wrist complaints are observed, specifically tendinitis. It is often common to have a two-handed backhand stroke in which the non-dominant wrist receives stress through overuse during the backswing phase of the stroke. Strains in the adductor muscles and hamstring are also common, primarily due to sudden changes in direction or slipping on clay courts resulting in splits.

It was also reported by Ireland and Hutchinson (1995) that stress fractures of the ulna of the non-dominant forearm, as well as distal radius and ulna fractures of the dominant wrist, were reported in players with forearm and wrist pain. Renstrom (1995) indicated that 19% of all tennis-related injuries are knee injuries, 70% being acute and 30% overuse.

Most sports injuries, tennis included, occur in the lower extremities particularly the knee and ankles (Pluim et al. 2006; Hootman et al. 2007; Rechel et al., 2008; Abrams, Safran & Renstrom, 2012) while injuries in the trunk were the least common (Rechel et al., 2008; Chard & Lachman, 1987). In the study by Hjelm, Werner, and Renstrom (2010) on the injury profile of junior tennis players, the lumbar spine was the most commonly injured body part. In contrast, Pluim et al. (2006) stated that the most commonly injured anatomical region is the upper extremities followed by the lower extremities and the least injured part was the trunk. In the summary by Kibler and Safran (2005), the most injured region is the lower extremities accounting for 39-59% of reported injuries followed by the upper extremities with 20-45%, and lastly the central core with 11-30% of the total injuries reported. Specifically, the ankles and the thighs showed the highest frequency in the lower extremities, the shoulders and elbows in the upper extremities, and the lower back in the central core.

Concerning practice and tournament injury rates, Hootman et al. (2007) observed that in-season tournaments produced the highest injury rates followed by pre-season practices and in-season practice among student-athletes. Meanwhile, post-season practice accounted for the lowest injury rates. Rechel et al. (2008) also observed that as the level of competition increases so do injury rates and that most injuries occur in competition as opposed to in practice. A variety of reasons that may explain why injury rates are higher during preseason practice than during in-season or post-season practice have been suggested such as coming to pre-season practice poorly conditioned, the duration of pre-season practices being longer than other sport seasons, less-skilled athletes trying to improve technique and becoming injured, and pre-season competitiveness in which players battle for starting positions.

Methods

This study is descriptive research design to identify the common injuries of collegiate tennis players, specifically, the most common types of injury and the anatomical regions at risk.

Subjects

The criteria for the selection of research participants were as follows: (1) a current varsity player of a UAAP school for at least one year and (2) must have played in at least one UAAP season; 110 (60 male, 50 female) collegiate student-athletes (M_{age} 20 ± 1.7 yrs.) representing 100% of all UAAP tennis players in a specific season participated in the study. The subjects had an average playing experience of 12 (SD ± 2.4) years.

Procedure

Data were collected through a survey questionnaire and guided interview using a sports injury questionnaire adapted from Duco (2005) and Reyes (2005). The injury inventory is divided into 20 anatomical regions and identifies nine (9) types of injuries. Certain additions were also gathered to meet the specific objectives of this study, including (1) the message in the project information box, (2) details in the demographic information (3) addition of other types of injuries, (4) the definition of specific types of injury, (5) a more detailed enumeration of musculoskeletal regions and (6) a specified area for other injuries that may not have been covered in the questionnaire such as other anatomical areas or multiple injuries in the same anatomical region. The survey questionnaire has been reviewed by a medical professional in a sports physical therapy unit and verified to meet the specific objectives of the study.

Responses were gathered at the respondents' playing venue. Letters of request were first sent to the coaches, after which, upon being given permission to have access to their players, informed consents were handed out to the players. A brief overview of the objectives and procedure was given to all participants prior to the data collection.

Statistical Analysis

Subjects' responses were interpreted via descriptive statistics and presented in frequency and percentage

UDC 796.342(599)

distribution tables. Graphs are also used to display the findings and provide an overview of common injury trends in collegiate tennis players.

Results

A total of 658 injuries were reported. There was a 100% incidence of at least one injury among the athletes with an average of close to 6 injuries per person. The data showed that the following are the most frequently reported injury types: tendinitis (39%), sprains (32%) and strains (22%). All other injuries were reported at an occurrence of 4% or lesser. Table 1 below summarizes the frequency and percentage distribution of reported injuries.

TABLE 1 Frequency and percentage distribution of type of injury.

Type of injury	Frequency	%
Tendinitis	254	39
Sprain	211	32
Strain	148	22
Inflammation	24	4
Abrasion	12	2
Stress Fracture	6	<1
Dislocation	2	<1
Fracture	1	<1
TOTAL	658	100%

Of all reported injuries, the most common are tendinitis; of these, most were in the shoulders, elbows, knees and wrist (30%, 27%, 20%, and 9% of all reported injuries, respectively). Below, Table 2 presents the percentage distribution of the occurrence of tendinitis.

TABLE 2 Percentage distribution of the occurrence of tendinitis.

Anatomical region	%
Shoulders	30
Elbows	27
Knees	20
Wrists	14
Others	9
TOTAL	100%

The second most common injury were sprains, accounting for 32% of all reported injuries. Sprains were mostly reported in the ankles (94%) and some on the wrists (5%). The percentage distribution of the occurrence of sprains can be seen below in Table 3.

TABLE 3 Percentage distribution of the occurrence of sprains.

Anatomical region	%
Ankles	94
Wrists	5
Others	1
TOTAL	100%

The third most common injury, representing 22% of all reported injuries, were strains. Strains were most likely to be in the lower back (45%) followed by the shoulders (19%) and thighs (17%). Table 4 below illustrates the reported occurrence of strains.

TABLE 4 Percentage distribution of the occurrence of strains.

Anatomical region	%
Lower back	45
Shoulders	19
Thighs	17
Others	19
TOTAL	100%

Anatomical Region

Regarding the anatomical regions at risk, injuries commonly occurred in the ankles (30%), shoulders (16%), lower back (12%), knees (11%) and elbows (10%). All other injury sites were reported to be injured at a rate of seven percent or less. Table 5 below summarizes the frequency and percentage distribution of injuries by anatomical region.

TABLE 5 Frequency and percentage distribution of injuries by anatomical region.

Anatomical region	Frequency	%
Ankles	198	30
Shoulders	106	16
Lower back	82	12
Knees	71	11
Elbows	68	10
Wrists	45	7
Thighs	26	4
Lower leg	17	3
Forearms	12	2
Arms	7	1
Upper back	6	1
Feet	6	<1%
Groin	6	<1%
Head	4	<1%
Hands	2	<1%
Abdomen	2	<1%
TOTAL	658	100%

As the most injured anatomical region, all reported injuries in the ankles were sprains, suggesting the vulnerability of the ankles to sprains. As such, all 198 incidences were ankle sprains. In contrast, injuries in the shoulders were mostly in the form of tendinitis, observed to be accountable for 70% of all injuries in the shoulders, followed by strains (26%). Below, Table 6 summarizes the reported shoulder injuries.

TABLE 6 Percentage distribution of shoulder injuries.

Injury	%
Tendinitis	70
Strain	26
Dislocation	2
Others	2
TOTAL	100

The lower back was reported to be the third most frequently injured anatomical region. Of all injuries in the lower back, the clear majority were strains (86%), suggesting the susceptibility of the lower back to strains among tennis players, while the rest were inflammation (14%) or swelling characterized by tenderness and pain which may or may not be related to strains.

Meanwhile, the fourth most injured region were the knees, mostly in the form of tendinitis (69%) with a few strains (18%) and abrasions (11%). Table 7 below shows the summary of reported knee injuries.

TABLE 7 Percentage distribution of knee injuries.

Injury	%
Tendinitis	69
Strain	18
Abrasion	11
Sprain	2
TOTAL	100

The elbows were the location for 10% of all injuries, the fifth most injured anatomical region. All injuries in the elbow were reported to be tendinitis, most probably lateral epicondylitis or "tennis elbow". All other

UDC 796.342(599)

anatomical regions were reported to be injured less frequently and represent a smaller proportion of all injured anatomical regions.

Discussion

Tendinitis, sprains, and strains were clearly the most common types of injury, as observed in the data. This observation is similar to that of Kibler and Safran (2005), and they postulate that these are mostly microtrauma-related overuse injuries. It may be inferred that most injuries recorded in this study were due to overuse rather than acutely incurred injuries. The findings are also consistent with the conclusions of Lanese, Strauss, Leizman, and Rotondi (1990) and Rechel et al. (2008).

Tennis injuries may occur in many musculoskeletal areas but will most likely be in the ankles, shoulders and lower back. Ankle sprains are perhaps the most common injury in tennis as well as in many sports. In contrast, tendinitis was mostly found in the elbow or shoulders, presumably due to repeated stress, which gives credence to the previous speculation that most injuries will be caused by chronic overuse. These findings were also previously observed by numerous studies (Kibler & Safran, 2005); Pluim et al., 2006; Hootman et al., 2007; Rechel et al., 2008).

Tennis injury studies mostly concur with each other, which suggests the proclivity of tennis to certain injuries. According to the findings of this study, overuse injuries in the form of tendinitis, sprains, and strains were found to be most common especially in the upper extremities. Overall, however, the upper and lower extremities seem to be most susceptible to injuries, primarily due to overuse and may be chronic if not properly addressed.

To further minimize the risk of injury, strength and conditioning programs are recommended to focus on strengthening the upper and lower extremities, specifically the ankles and shoulders. As injuries in tennis may be unavoidable, coaches and team physicians are advised to be prepared for recurring injuries in the upper and lower extremities. Despite the relatively high number of injuries reported, the fact that all these players still have active collegiate careers suggests that returning to play is still very possible. As such, tennis can be safe with an inherent risk of injury, just like many other sports.

REFERENCES

Abrams, G., Safran, M.R. & Renstorm, P. (2012). Epidemiology of musculoskeletal injury in the tennis player. *British Journal of Sports Medicine, 52*, 129-135.

Bahr, R. & Krosshaug, T. (2005). Understanding injury mechanisms: a key component of preventing injuries in sport. *British Journal of Sports Medicine, 39*, 324-329.

Chard, M. D. & Lachman, S. M. (1987). Racquet sports-patterns of injury presenting to a sports clinic. *British Journal of Sports Medicine, 21*(4), 150-153.

DiFiori, J., Benjamin, H., Brenner, J., Gregory, A., Jayanthi, N., Landry, G., & Luke, A. (2014). Overuse injuries and burnout in youth sports: a position statement from the American Medical Society for Sports Medicine. *Clinical Journal of Sport Medicine, 24*(1), 3-20.

Duco, L. (2005). *Injuries among elite and non-elite Filipino gymnasts.* Unpublished undergraduate thesis), Quezon City, Philippines: University of the Philippines Diliman.

Hellstrom, M., Jacobsson, B., Sward, L. & Peterson, L. (1990). Radiologic abnormalities of the thoracolumbar spine in athletes. *Acta Radiologica, 31,* 127-132.

Hjelm, N., Werner, S. & Renstrom, P. (2010). Injury profile in junior tennis players: a prospective two-year study. *Knee Surgery, Sports Traumatology, Arthroscopy, 18*, 845-850.

Hootman, J., Dick, R. & Agel, J. (2007). Epidemiology of collegiate injuries for 15 sports: summary and recommendation for injury prevention initiatives. *Journal of Athletic Training, 42*(2), 311-319.

Ireland, M.L. & Hutchinson, M.R. (1995). Upper extremity injuries in young athletes. *Clinical Journal of Sport Medicine, 14*, 533-571.

Kibler, W.B. & Safran, M.R. (2005). Tennis injuries. *Medicine and Sports Science, 48*, 120-137.

Lanese, R., Strauss, R., Leizman, D. & Rotondi, A.M. (1990). Injury and disability in matched men's and women's intercollegiate sports. *American Journal of Public Health, 80*, 1459-1462.

Pluim, B., Staal, J. B., Windler, G. E. & Jayanthi, N. (2006). Tennis injuries: occurrence, aetiology and prevention. *British Journal of Sports Medicine, 40,* 415-423.

Rechel, J., Yard, E. & Comstock, D. (2008). An Epidemiologic Comparison of High School Sports Injuries Sustained in Practice and Competition. *Journal of Athletic Training, 43*(2), 197-204.

Reid, M. & Schneiker, K. (2007). Strength and conditioning in tennis: current research and practice. *Journal of Science and Medicine in Sport, 11*(3), 248-256.

Renstrom, P. (1995). Knee pain in tennis players. *Clinical Journal of Sport Medicine, 14*, 163-175.

Reyes, M. (2005). *Injuries common to recreational badminton players*. Unpublished undergraduate thesis, Quezon City, Philippines: University of the Philippines Diliman.

Safran, M.R., Zachazewski, J.E., Benedetti, R.S., Bartolozzi III, A.R. & Mendelbaum, R. (1999). Lateral ankle sprains: a comprehensive review part 2 – treatment and rehabilitation with an emphasis on the athlete. *Medicine and Sports Science, 31*(7), S438-S447.

ORIGINAL SCIENTIFIC PAPER

Collaborative Learning with Application of Screen-based Technology in Physical Education

Gabriela Luptáková[1] and Branislav Antala[1]

Affiliations: [1]Comenius University, Faculty of Physical Education and Sports, Bratislava, Slovakia

Correspondence: Gabriela Luptáková, Faculty of Physical Education and Sports, Comenius University, Nábr. Arm. Gen. L. Svobodu 9, 81469 Bratislava, Slovakia. E-mail: gabriela.luptakova@uniba.sk

ABSTRACT Collaborative learning has been shown to be a useful tool for improving several social skills in students; however, it is very difficult to set up the initial conditions that guarantee its effectiveness. Since group projects are made for students and, most importantly, by students, we should not forget to take their opinions based on previous experience into consideration, which might increase the efficiency of their own learning. Therefore, the aim of the study was to investigate what secondary school students learn from and think about group projects in Physical Education. A total of 94 secondary school students (46 girls and 48 boys) participated in the study carried out in the 2015/2016 school year. The participants were given the assignment to create a video exercise, which they were working on in small groups in PE. A questionnaire was designed to investigate students' learning outcomes, participation, evaluation, and attitudes towards the project. Differences for selected categorical variables were determined using the Chi-square test. The majority of the students reported improvement in selected social skills and better relationships with their teammates. In addition, several significant differences in students' opinions with respect to age and gender were found.

KEY WORDS Physical Education, Collaborative learning, Social skills, Attitudes, Technology.

@MJSSMontenegro
COLLABORATIVE LEARNING IN PHYSICAL EDUCATION
http://mjssm.me/?sekcija=article&artid=142

Introduction

Nowadays, employers suggest that schools at all levels need to do more to better prepare students to work in team-based environments. Life skills/social skills have become equally important to the "technical skills" that are still very often prioritized at schools in many countries. Riebe, Girardi, and Whitsed (2016) underline that being able to work effectively and productively with others in teams is essential in the 21st-century employment market. The importance of teamwork capability is repeatedly highlighted in reports from western and other economies. The authors emphasise that teamwork capability can be developed, supported, and improved through effective teamwork pedagogy in which collaborative, cooperative, or experiential learning strategies are necessary.

Collaborative learning creates an environment where students at various performance levels work together in small groups towards a common goal, which encourages their active participation. The students are responsible for one another's learning as well as their own. Thus, the success of one student helps other students to be successful (Gokhale, 1995). Shared learning gives students an opportunity to engage in discussion, take responsibility for their own learning, and thus become critical thinkers (Totten, Sills, Digby & Russ, 1991). Group work can be used to encourage deeper learning and promote students' autonomy by transferring some of the responsibility for teaching and learning to them (Hughes & Large, 1993; Somervell, 1993).

To make the collaborative learning successful, it is necessary to monitor and regulate the interactions. Therefore, the teacher retains an important role in the success of collaborative learning as a facilitator. His role is not to provide the right answer to the students or to say which group members are right, but to facilitate

Accepted after revision: May 11 2017 | First published online: September 01 2017

Conflict of interest: None declared.

and redirect the group work in a productive direction with minimal pedagogical intervention (Dillenbourg, 1999). In a collaborative classroom, the teacher encourages students' use of their own knowledge, ensures that students share their knowledge, expertise and their learning strategies, treat each other respectfully, and focus on high levels of understanding (Bonwell & Eison, 1991).

Another certain way to increase the probability that some types of interaction occur is to carefully design the situation. The most frequent questions that teachers ask themselves are: What is the optimal group size? Should I select group members with respect to some criteria or let them form groups by themselves? Boys and girls together or rather separately? Which tasks are suitable for collaborative processes? These and other questions have inspired empirical research on collaborative learning. However, beyond a few main results, it appears that these conditions interact with each other in a complex way (Dillenbourg, 1995).

Because of these multiple interactions, it is very difficult to set up initial conditions that guarantee the effectiveness of collaborative learning. Since group projects are made for students and, most importantly, by students, we should not forget to take their opinions based on previous experience into consideration, which might increase the efficiency of their own learning.

Moreover, this paper is also supported by Fullan's (2013) arguments about technology having the potential to accelerate learning. The seemingly unstoppable growth in youth's engagement with digital technologies in their personal lives means that digital technologies are socially relevant (Casey, Goodyear & Armour, 2017). This is also a growing opportunity to act as a medium through which to engage young people in immediate, attractive and increasingly personalized ways (Greenhow & Lewin, 2016; Selwyn & Stirling, 2016). Applying new technologies in teaching PE and at school settings is considered to be a possible means of teaching-learning process efficiency and of forming the children' relationship with physical activities, and therefore their performance both in and out of PE (Arnett & Lutz 2003; Štemberger, Knjaz & Tománek, 2011; McKenzie et al., 2013; Cardon et al. 2012; Lee, Burgeson, Fulton & Spain, 2006; Bendíková & Pavlovič, 2013).

Therefore, the aim of the present study was to investigate what secondary school students learn from and think about the group project with the application of new technologies in Physical Education.

Methods

This study reports on a pedagogical experiment that was carried out in the 2015/2016 school year on a sample of 94 Middle Years Programme students (46 girls and 48 boys) of United School Novohradska located in Bratislava, Slovakia. Basic characteristics of the sample are presented in Table 1 below.

The participants were given a group assignment, which they were working on for nine weeks in Physical Education, once a week. The students were split into the coeducational groups of four to five members by their PE teachers. The aim of the assignment was to create a video-exercise, called the "Brain Break", respecting several criteria such as a time limitation (3-5 minutes), a space limitation (classroom settings), a theme limitation (sports, dance, fitness, adapted, cultural), etc. Every team member played a specific role in the project. One was responsible for choreography, others for music, camera, video editing, and the performance. Before the project started, the students had watched some Brain Breaks made by HOPSports© online to get a better idea of and inspiration for the assignment.

A questionnaire was designed to investigate students' learning outcomes, participation, evaluation, and attitudes towards the project. The questionnaire was anonymous for the students, and it consisted of 22 closed questions plus an open question to which the students could comment on the project. Possible answers were arranged across four-item scale: (1) strongly agree, (2) agree, (3) disagree and (4) strongly disagree. Given responses were binarized when answers "strongly agree" and "agree" represented the positive opinion "Yes" and "disagree" and "strongly disagree" represented the negative opinion "No".

All the analyses were processed using SPSS Statistics, v. 17. First, we determined the number of answered questions using percentages (%). Differences for selected categorical variables (age and gender) were determined using Chi-square test (χ^2). Statistical significance was set up at $p<0.05$. Students' answers to the open question were analysed qualitatively.

This study was approved in advance by the Faculty of Physical Education and Sports at Comenius University, as well as by the United School Novohradska/Gymnasium of Juraj Hronec, where the experiment was conducted. Each participant voluntarily provided written informed consent before participating.

TABLE 1 Characteristics of the study sample

Grade	Age (years)	N	Girls (N)	Boys (N)
MYP0	11-12	24	12	12
MYP1	12-13	23	10	13
MYP2	13-14	25	15	10
MYP3	14-15	22	9	13

UDC 796.011-057.874

Results

Among all the students, the prevalence of the students reporting knowledge acquired about composition was 56%. In round figures, 40% of them reported knowledge gained about the music as well as about video editing. Only 33% of all the students reported knowledge gained about physical activity. Significantly, there was no statistical difference between the self-reported acquired knowledge of boys and girls as well as between the students of different age (Table 2 and 3).

TABLE 2 Students' self-reported acquired knowledge and improved skills with respect to age

	Total		**MYP0**		**MYP1**		**MYP2**		**MYP3**		**p value** (χ^2 test)
	N (%)		N (%)		N (%)		N (%)		N (%)		
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	
Through making a video exercise I learnt about:											
Physical activity	33.0	67.0	22.7	77.3	35.0	65.0	31.8	68.2	11.1	88.9	.327
Composition	56.3	43.7	63.6	36.4	47.4	52.6	40.9	59.1	61.1	38.9	.39
Music	43.0	57.0	33.3	66.7	55.0	45.0	18.2	81.8	33.3	66.7	.097
Video editing	37.9	62.1	18.2	81.8	55.0	45.0	27.3	72.7	38.9	61.1	.072
Making video exercise helps to improve my:											
Team work skills	77.7	22.3	86.4	13.6	85.0	15.0	54.5	45.5	72.2	27.8	.059
Communication skills	71.3	28.7	90.9	9.1	75.0	25.0	36.4	63.6	66.7	33.3	.001**
Managerial skills	62.1	37.9	63.6	36.4	60.0	40.0	54.5	45.5	61.1	38.9	.94
Rhythmic skills	63.5	36.5	77.3	22.7	70.0	30.0	27.3	72.7	55.6	44.4	.005**
Creativity skills	74.4	25.6	71.4	28.6	85.0	15.0	72.7	27.3	61.1	38.9	.429
Relationships with others	66.3	33.7	68.2	31.8	75.0	25.0	36.4	63.6	77.8	22.2	.019*

Legend: *p<0.05, **p<0.01

Similarly, no statistical differences in self-reported teamwork, managerial and creativity skills were found among differently aged students when the majority of all students reported improvement in aforementioned skills. However, a lower number of MYP 2 students reported improvement in communication and rhythmic skills compared to the rest of the students ($p<0.01$). Additionally, only 36.4% of MYP 2 students reported improvement of relationships with their teammates, which is a significantly lower number in comparison with all the other students ($p<0.05$), (Table 2). In contrast, no significant differences in self-reported improved skills were found between the boys and the girls (Table 3).

TABLE 3 Students' self-reported acquired knowledge and improved skills with respect to gender

	GIRLS		**BOYS**		**p value** (χ^2 test)
	N (%)		N (%)		
	Yes	No	Yes	No	
Through making a video exercise I learnt about:					
Physical activity	39.1	60.9	26.7	73.3	.206
Composition	46.3	53.7	65.2	34.8	.076
Music	50.0	50.0	35.6	64.4	.16
Video editing	37.8	62.2	38.1	61.9	.976
Making video exercise helps to improve my:					
Team work skills	69.6	30.4	85.4	14.6	.065
Communication skills	62.2	37.8	79.6	20.4	.063
Managerial skills	67.4	32.6	56.8	43.2	.307
Rhythmic skills	65.3	34.7	61.7	38.3	.714
Creativity skills	71.4	28.6	77.3	22.7	.535
Relationships within the group	60.0	40.0	72.7	27.3	.204

In Tables 4 and 5 below, students' attitudes towards the assignment are presented with respect to age and gender. When analysing students' attitudes towards the assignment, the only question for which no statistical difference between the students of different age or gender was found, is "I can find a certain value in doing this kind of project"; 62% of the students agreed with this statement.

A significantly lower number of MYP 2 students as well as of the girls think that this kind of group activity is interesting ($p<0.05$) and that it is a meaningful part of education in PE ($p<0.01$), in comparison to other age groups and the boys.

Although 67.9% of all the students reported that the assignment was clear and instructions were easy to understand, 59.1% of MYP 2 students maintained the contrary ($p<0.01$).

TABLE 4 Students' attitudes towards the assignment with respect to age

	Total		MYP0		MYP1		MYP2		MYP3		p value (χ^2 test)
	N (%)		N (%)		N (%)		N (%)		N (%)		
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	
I find working on the assignment:											
Interesting	47.3	52.7	59.1	40.9	35.0	65.0	18.2	81.8	55.6	44.4	.023*
Meaningful part of PE	43.2	56.8	50.0	50.0	60.0	40.0	9.1	90.9	38.9	61.1	.004**
Valuable	62.0	38.0	57.1	42.9	70.0	30.0	45.5	54.5	55.6	44.4	.46
Enjoyable	47.8	52.2	61.9	38.1	30.0	70.0	40.9	59.1	33.3	66.7	.16
The assignment was clear.	67.9	32.1	90.9	9.1	65.0	35.0	40.9	59.1	72.2	27.8	.005**
In PE, we should only exercise.	50.7	49.3	59.1	40.9	40.0	60.0	45.5	54.5	72.2	27.8	.183
I looked forward to presenting video exercise.	15.7	84.3	0.0	100	15.8	84.2	9.1	90.9	27.8	72.2	.064

Legend: *p<0.05, **p<0.01

A strong majority (84.3%) of the students reported that they were not looking forward to presenting the video exercise to their classmates and the teacher. However, with respect to gender, more girls showed negative attitudes than the boys did ($p<0.01$).

In contrast, major variances in the attitudes among the students (50:50) were found in two questions: (1) "In PE we should only exercise and not do projects like this although they include physical activity", and (2) "I enjoyed working on the project". In both cases, more boys agreed with the statements than the girls did ($p<0.05$).

TABLE 5 Students' attitudes towards the assignment with respect to gender

	GIRLS		BOYS		p value (χ^2 test)
	N (%)		N (%)		
	Yes	No	Yes	No	
I find working on the assignment:					
Interesting	31.0	69.0	61.2	38.8	.004**
Meaningful part of PE	25.0	75.0	58.3	41.7	.002**
Valuable	61.7	38.3	62.2	37.8	.959
Enjoyable	36.6	63.4	57.1	42.9	.052*
The assignment was clear.	65.9	34.1	70.0	30.0	.688
In PE, we should only exercise.	38.5	61.5	63.2	36.8	.03*
I looked forward to presenting video exercise.	5.1	94.9	25.0	75.0	.013**

Legend: *p<0.05, **p<0.01

Students' opinions about the evaluation of and participation in the assignment are presented in Tables 6 and 7. Regarding an evaluation of the project, about 60% of all the students reported that knowledge and understanding as well as reflecting on and improving performance can be assessed through the project. Over 82% of the students reported that planning for performance and applying and performing can be assessed. However, a very low number of MYP 2 students think that knowledge and understanding can be evaluated through the project in comparison to the students of other ages ($p<0.01$). Most importantly, 51.7% of the students regardless the age and gender reported that a group should be assessed as a whole; in other words, every group member should get the same grade. More boys and younger students agreed with the statement than the girls ($p<0.05$) and the older students did ($p<0.01$).

UDC 796.011-057.874

TABLE 6 Students' opinions about the evaluation of and participation in the assignment with respect to age

	Total N (%)		MYP0 N (%)		MYP1 N (%)		MYP2 N (%)		MYP3 N (%)		p value (χ^2 test)
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	
Through the project can be assessed:											
Knowledge and understanding	60.2	39.8	66.7	33.3	75.0	25.0	27.3	72.7	61.1	38.9	.009**
Planning for performance	82.3	17.7	68.2	31.8	100	0.0	76.2	23.8	83.3	16.7	.056
Applying and performing	89.9	10.1	100	0.0	85.7	14.3	77.3	22.7	94.4	5.6	.091
Reflecting and improving performance	61.3	38.7	61.9	38.1	50.0	50.0	50.0	50.0	61.1	38.9	.779
Group should be assessed as a whole.	51.7	48.3	71.4	28.6	60.0	40.0	22.7	77.3	23.5	76.5	.002**
Student's participation depends on:											
Attitudes towards the project	83.3	16.7	81.0	19.0	85.0	15.0	81.8	18.2	88.2	11.8	.929
Role in the project	71.1	28.9	76.2	23.8	80.0	20.0	72.7	27.3	50.0	50.0	.181
In my group, everyone equally participated in project.	45.1	54.9	59.1	40.9	45.0	55.0	27.3	72.7	50.0	50.0	.192

Legend: **p<0.01

With regard to participation in the project, the majority of the students think that one's participation depends on his/her attitude towards the project (83.3%) as well as his/her role in it (71.1%). In addition, almost one half of the students reported that every group member equally participated in doing the project, but fewer girls than the boys did (p<0.01).

TABLE 7 Students' opinions about the evaluation of and participation in the assignment with respect to gender

	GIRLS N (%)		BOYS N (%)		p value (χ^2 test)
	Yes	No	Yes	No	
Through the project can be assessed:					
Knowledge and understanding	55.8	44.2	64.4	35.6	.408
Planning for performance	86.0	14.0	78.6	21.4	.366
Applying and performing	86.4	13.6	93.3	6.7	.276
Reflecting an improving performance	54.3	45.7	68.1	31.9	.174
Group should be assessed as a whole.	40.5	59.5	61.2	38.8	.048*
Student's participation depends on:					
Attitudes towards the project	86.8	13.2	80.0	20.0	.418
Role in the project	75.6	24.4	66.7	33.3	.369
In my group, everyone equally participated in project.	27.0	73.0	60.0	40.0	.003**

Legend: *p<0.05, **p<0.01

Discussion

The aim of the present study was to investigate what secondary school students learn from and think about the group project with the application of screen-based technology in Physical Education. Riebe et al. (2016) found that interest in teaching teamwork in higher education courses was more prolific in the most recent decade (n = 45; 2005 through 2015) than in the previous one (n = 12; 1995 through 2004), which might be caused by current market demand. Authors' findings regarding the research methods employed across journal articles show that quantitative methods remain a popular approach when investigating the efficacy of teamwork pedagogies. Furthermore, some articles (26%) were categorized as conceptual, describing pedagogical interventions or tools for teaching teamwork skills, but not empirically examining such strategies. Samples reported in the journal articles are considered to be small, with 26% reporting sample sizes smaller than 100 individuals, which is also, regrettably, the case of this study. We agree with the authors that future research using longitudinal designs with larger samples would contribute to evidence-based knowledge about the implications of teamwork pedagogy in education.

Researchers contend that training higher education students in teamwork can lead to higher academic achievement (Rapp & Mathieu, 2007). Similarly, results of the present study show that secondary school students acquired some knowledge about composition, music, physical activity, and video editing. In addition, they improved their teamwork, managerial and creativity skills.

About half of the students think that they should only exercise in PE and not do group projects although they include physical activity. In contrast, a similar number of students think that projects are a meaningful part of education in PE; moreover, over 50% of them can find a certain value in this kind of group activity in Physical Education, regardless of their age and gender. The following students' statements support mentioned findings: "The BrainBreak was a great project even though I personally think that PE projects are a bit ridiculous" (boy, 12 years old). "... students in different schools usually don't do projects..." (girl, 15 years old). "Such projects do not belong in PE" (boy, 14 years old). "I found this project interesting however I'm not sure if I want to do it again" (boy, 15 years old).

Half of the students enjoyed working on the project, but almost nobody looked forward to presenting the video-exercise to their classmates, which is supported by these comments: "...this type of project has its pluses and minuses. I enjoyed doing this project but I didn't like the part where we had to show it to the other people" (girl, 14 years old) or "... a project is OK but a video is embarrassing" (girl, 13 years old).

Most of the students' negative expressions concerned evaluation that is strongly connected to the group selection and students' participation in the assignment. In particular, 13- to 14-year old girls had grievances about group evaluation. Two very strong comments are presented below.

... we didn't get to choose the groups which made it very difficult. No matter how much you think we should improve our cooperation it just made it worse. When 90% of the group wants to work and we can't get the rest to work, we end up doing everything last minute because of them, and we got a bad grade which could ruin my whole grade, but we still have to be graded as a group. Now think – how is this fair?" (girl, 14 years old).

"Our group was awful and full of lazy people that just want to take the credit for the work of others. How is giving us the same grade fair?! The group was awful, because we couldn't choose it ourselves. The boys never want to work and pull down the entire group. Why should we suffer because of their incapability of doing a project? ..." (girl, 14 years old).

Working in a group is a skill that needs to be learnt and might be improved consequently. The reviewed journal articles by Riebe et al. (2016) indicate that educators often place students in teams with little or no instruction on how to work in teams prior to assigning complex team projects (e.g., Hansen, 2006; Rafferty, 2012; Sashittal, Jassawalla & Markulis, 2011). We suggest that students must be repeatedly exposed to collaborative/cooperative learning environments to improve their social skills, such as teamwork skills, cooperation, communication, conflict resolution, etc. In this study, a 13-year old boy made a comment that "The instructions were understandable but we didn't know what you expected from us. It was the first time – now we learned" (boy, 13 years old). Similarly, another boy (13 years old) wrote: "It was the first time, so the grades didn't turn out well because we weren't 100 % sure what the teachers wanted to see. Next time they'll be better...".

Many motivational theories highlight the influence social environments have on pupils' motivation. In addition, teachers can support pupils' need for relatedness that is concerned with being connected to others through feelings of belonging and being valued by interactive group activities like the case of PE teacher Dylan Blain who applied such activities with application of the new technologies in teaching basketball to a class of boys aged 13-14 (Casey et al., 2017).

According to Riebe et al. (2016), some educators are challenged by the transition from teacher-centred to collaborative/cooperative teaching methods, which constitutes a significant psychological constraint when it comes to adopting collaborative instructional strategies. Many articles (e.g. Gilson, Maynard & Bergiel, 2013; Kirby, 2011; Snyder, 2010) reported that for some educators it is not always clear how they should teach teamwork skills; therefore, educators may be inadequately prepared to take on the task (Tombaugh & Mayfield, 2014). This has an impact on both educators and students. Many educators are discipline-based scholars and, because of this, they may not have had any formal training in teaching methods or be familiar with resources or collaborative approaches to develop students' teamwork skills (e.g. Hansen, 2006; Kliegl & Weaver, 2013; Sashittal et al., 2011). Similarly, the literature suggests that while some teachers are enthusiastic technology adopters, others are more resistant, perhaps feeling they lack organizational and administrative support or expertise to integrate it (Fullan, 2013).

To conclude, it is crucial to train future teachers in physical education teacher education programs how to teach teamwork skills as much as they do motor skills as well as how to integrate new technologies into Physical Education classes.

Acknowledgements

This study was supported by the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences (VEGA), number 1/0429/16 and title "New

technologies in Physical and Sport Education and their effects on an affective and a cognitive development of a secondary school pupil".

REFERENCES

Arnett, M. G., & Lutz, R. B. (2003). Measurement of moderate to vigorous physical activity of middle school girls, using trigram activity monitors during small-sided, game-based lessons. *Measurement in Physical Education and Exercise Science*, 7(3), 149-59.

Bendíková, E., & Pavlović, R. (2013). Impact of the exercise programme based on Flowin concept and implemented in physical and sports education classes on functions of the postural muscle system. *Sport scientific and practical aspects: international scientific journal of kinesiology*, 10(2), 25-33.

Bonwell, C. C., & Eison, J. A. (1991). *Active Learning: Creating Excitement in the Classroom. ASHE-ERIC Higher Education Report No. 1.* Washington, DC: The George Washington University, School of Education and Human Development.

Casey, A., Goodyear, V. A., & Armour, K. M. (2017). *Digital Technologies and learning in Physical Education: Pedagogical cases.* Oxon: Routledge.

Cardon, G. M., Van Acker, R., Seghers, J., De Martelaer, K., Haerens, L. L., & De Bourdeaudhuij, I.M.M. (2012). Physical activity promotion in schools: which strategies do schools (not) implement and which socioecological factors are associated with implementation? *Health education research*, 27(3), 470-483.

Dillenbourg, P. (1999). What do you mean by collaborative learning? In P. Dillenbourg (Ed.), *Collaborative-learning: Cognitive and Computational Approaches* (pp. 1-19). Oxford: Elsevier.

Ding, H., & Ding, X. (2008). Project management, critical praxis, and process-oriented approach to teamwork. *Business Communication Quarterly*, 71, 456-471. doi:10.1177/1080569908325861

Fullan, M. (2013). *Stratosphere: Integrating technology, pedagogy and changed knowledge.* Toronto, ONT: Pearson.

Gilson, L., Maynard, M. T., & Bergiel, E. B. (2013). Virtual team effectiveness: An experiential activity. *Small Group Research*, 44, 412-427. doi:10.1177/1046496413488216

Gokhale, A. A. (1995). Collaborative Learning Enhances Critical Thinking. *Journal of Technology Education,* 7(1), 22-30.

Goldfinch, J., Laybourn, P., MacLeod, L., & Stewart, S. (1999). Improving groupworking skills in undergraduates through employer involvement. *Assessment & Evaluation in Higher Education*, 24, 41-51. doi:10.1080/0260293990240104

Greenhow, C., & Lewin, C. (2016). Social media and education: Reconceptualizing the boundaries of formal and informal learning. *Learning, media and technology,* 41(4), 6-30.

Hansen, R. (2006). Benefits and problems with student teams: Suggestions for improving team projects. *Journal of Education for Business*, 82, 11-19. doi:10.3200/JOEB.82.1.11-19

Hughes, I. E., & Large, B. J. (1993). Staff and Peer-Group Assessment of Oral Communication Skills. *Studies in Higher Education*, 18(3), 379-385.

Johnson, R. T., & Johnson, D. W. (1986). Action research: Cooperative learning in the science classroom. *Science and Children*, 24, 31-32.

Kirby, D. (2011). No one can whistle a symphony. It takes an orchestra to play it. *Asian Social Science*, 7(4), 36-43. doi:10.5539/ass.v7n4p36

Kliegl, J., & Weaver, K. (2013). Teaching teamwork through coteaching in the business classroom. *Business and Professional Communication Quarterly*, 77, 204-216. doi:10.1177/1080569913507596

Knowd, I., & Daruwalla, P. (2003). Peer Assessment in Hospitality Education. *Journal of Teaching in Travel and Tourism*, 3(1), 65-85.

Lee, S. M., Burgeson. C. R., Fulton, J. E., & Spain, C. G. (2006). Physical education and physical activity: results from the School Health Policies and Programs Study. *Journal of School Health*, 77, 435-63.

McKenzie, T. L., Sallis, J. F., Elder, J. P., Berry, C. C., Hoy, P. L., Nader, P. R., et al. (2013). Physical Activity Levels and Prompts in Young Children at Recess: A Two-Year Study of a Bi-Ethnic Sample. *Research Quarterly for Exercise and Sport*, 68(3), 195-202.

Rafferty, P. (2012). Group work in the MBA classroom: Improving pedagogical practice and maximizing positive outcomes with part-time MBA students. *Journal of Management Education*, 37, 623-650. doi:10.1177/1052562912458644

Rapp, T., & Mathieu, J. (2007). Evaluating an individually self-administered generic teamwork skills training program across time and levels. *Small Group Research*, 38, 532-555. doi:10.1177/1046496407300479

Riebe, L., Girardi A., & Whitsed C. (2016). A Systematic Literature Review of Teamwork Pedagogy in Higher Education. *Small Group Research*, 47(6), 619-664.

Sashittal, H., Jassawalla, A., & Markulis, P. (2011). Teaching students to work in classroom teams: A preliminary investigation of instructors' motivations, attitudes and actions. *Academy of Educational Leadership Journal*, 15(4), 93-106.

Selwyn, N., & Stirling E. (2016). Social media and education ... now the dust has settled. *Learning, media and technology*, 41(1), 1-5.

Sivan, A, Yan, L., & Kember, D. (1995). Peer Assessment in Hospitality and Tourism. *Hospitality and Tourism Educator*, 7(4), 4-20.

Snyder, L. G. (2010). The use of pre-group instruction to improve student collaboration. *Journal of Applied Research for Business Instruction*, 8, 65-69.

Somervell, H. (1993). Issues in Assessment, Enterprise and Higher Education: The Case For Self-, Peer and Collaborative Assessment. *Assessment and Evaluation in Higher Education*, 18(3), 221-233.

Štemberger, V., Knjaz, D., & Tománek, Ľ. (2011). Comparison between elementary school teacher and physical education teacher from Slovenia, Croatia and Slovakia in some of the health dimensions. *Integrative power of kinesiology*, 314-317.

Tombaugh, J., & Mayfield, C. (2014). Teams on teams: Using advice from peers to create a more effective student team experience. *Academy of Educational Leadership Journal*, 18(4), 69-83.

Totten, S., Sills, T., Digby, A., & Russ, P. (1991). *Cooperative learning: A guide to research*. New York: Garland.

UDC 796.011-057.874

Analysis of Dietary Intake and Body Composition of Female Athletes over a Competitive Season

Svetlana Nepocatych[1], Gytis Balilionis[1] and Eric K. O'Neal[2]

Affiliations: [1]Elon University, Department of Exercise Science, Elon, USA, [2]The University of North Alabama, Department of Health, Physical Education and Recreation, Florence, USA

Correspondence: Svetlana Nepocatych, Department of Exercise Science, Elon University, 100 Campus Dr., 2525 CB, Elon, NC 27244. E-mail: snepocatych@elon.edu

ABSTRACT The purpose of the study was to examine dietary intake, body composition and bone mineral density changes at the beginning and end of a competitive season in female athletes of sports that have been less represented in the literature. NCAA Division I basketball (n=10) and softball (n=10) players mean age (20±1 years) completed 3-day food records at the beginning and end of season. Body composition and bone mineral density were measured using dual-energy X-ray absorptiometry (DXA). Mean energy intake was significantly lower at the beginning compared to the end of the season (1925±466 vs. 2326±782 kcals/day; p=0.02). Lean, fat, and total body mass, and total and regional BMD were unaltered from the beginning to the end of season (p>0.05). Macronutrient consumption by percentage did not change across the season (p>0.05) with aggregate data equalling 3.5±1.3, 1.2±0.6, and 1.2±0.5 g/kg/day for carbohydrate, fat, and protein respectively. Carbohydrate and protein intakes were below the recommended levels. Low intake of fibre (17±6.3 g/day) and high sodium (3700±1120 mg/day) also raise concerns. Despite no major alterations in body composition or BMD many female athletes' diets in the sports investigated while living on campus failed to meet recommended intake levels suggesting maximal athletic performance and health parameters may be stunted due to poor nutrient choices.

KEY WORDS Nutrients, Vitamins, Minerals, Performance, Dietary Behaviour, Bone Mineral Density.

@MJSSMontenegro
DIET AND BODY COMPOSITION OF FEMALE ATHLETES
http://mjssm.me/?sekcija=article&artid=143

Introduction

Optimal health and athletic performance over a long and intense season is significantly influenced by training and dietary intake. Restrictive diet, increased demands for energy and certain nutrients may contribute to the increased risk of suboptimal dietary intake in athletes (Sammarone Turocy et al., 2011). Athletes participating in team and individual sports especially in basketball and softball have special nutritional considerations due to the extreme cardiovascular, metabolic and energy demands required for both practice and competition. Estimated energy expenditure (EER) for female athletes based on physical activity levels should range between 37-41 kcal·kg^{-1} per day (Trumbo, Schlicker, Yates, & Poos, 2002). While athletes have energy reserves within the body, it is not sufficient to provide a continuous energy supply for longer periods of time and thus, need to be replenished. Adequate nutrition not only enhances an athlete's training, performance, and recovery, but also helps maintain appropriate body composition, immune, endocrine and musculoskeletal function (Burke, Loucks, & Broad, 2006; Volpe, 2007). Changes in body composition and body weight due to inadequate energy intake or overconsumption may have a negative effect on an athlete's ability to perform and sustain activity during a competitive season (Rodriguez, DiMarco, & Langley, 2009). In addition, maintaining a state of energy balance through adequate energy intake is required for an athlete to achieve appropriate intake of crucial macro- and micro- nutrients (Rodriguez et al., 2009).

Accepted after revision: May 26 2017 | First published online: September 01 2017

Conflict of interest: None declared.

Athletes participating in moderate to high-level intensity training and competition should focus on consuming 6-10 g/kg/day of carbohydrate (CHO) in order to maintain adequate blood glucose levels and replenish muscle glycogen stores (Campbell et al., 2007), 1.2-1.7 g/ kg/day of protein (PRO) to support nitrogen balance, spare amino acids for protein synthesis and to maintain optimum performance (Campbell et al., 2007). Previous research suggests that female athletes often fall short of meeting energy, carbohydrate and protein requirements based on activity levels (Clark, Reed, Crouse, & Armstrong, 2003; Papadopoulou, Papadopoulou, & Gallos, 2002). Furthermore, micronutrients play an essential role in energy metabolism, assist in tissues repair and recovery, transport of oxygen to the working muscles, maintenance of bone mineral density, and protection against oxidative stress. Thus, good nutrition practices are vital for maintaining good health, proper functioning of immune system, athletic performance, delaying fatigue, muscle growth and repair (Burke et al., 2006; Campbell et al., 2007).

College athletes have a unique training and living environment. Student athletes generally have very busy class, training and travel schedules that may impact their dietary practices habits, specifically the quantity and quality of the food consumed. Influences on athletes' dietary practices include the limited food choices on campus, access to grocery stores, late night studying, as well as the time or ability to prepare a home-cooked meal. Furthermore, food consumed on campus tends to be less healthy; higher in fat and added sugars compared to food cooked at home (Pelletier & Laska, 2013). Previously, only one third of college students reported meeting *Dietary Guidelines for Americans, 2000* for the five major food categories (Kolodinsky, Harvey-Berino, Berlin, Johnson, & Reynolds, 2007). In addition, greater intake of fruits, dairy and protein was associated with greater food knowledge (Kolodinsky et al., 2007). Over the past few decades dietary intake and body composition changes occurred not only in the general but also in athletic populations, thus, there is a need to reassess nutrient intakes and dietary practices of college athletes (Hinton, Sanford, Davidson, Yakushko, & Beck, 2004). Moreover, in recent decades, female sports have become more competitive, therefore, more athletes partake in dietary manipulation to elicit their desired body composition changes to improve peak performance.

Previous research has focused on the dietary practices and body composition of female athletes competing in soccer, volleyball, swimming, gymnastics, and distance running (Clark et al., 2003; Hassapidou & Manstrantoni, 2001; Ousley-Pahnke, Black, & Gretebeck, 2001; Papadopoulou et al., 2002). There is a paucity of data evaluating the dietary practices and, body composition of basketball and softball female athletes. We recognize that the training regimens and energy demands of these two sports do differ, however, the purpose of the present study was to examine the dietary intake of essential macro- and micro-nutrients from food sources over a 3-day period, and changes in body composition as well as the use of dietary supplements in NCAA Division I female athletes at the beginning compared to after the end of the competitive season.

Methods

Participants

Twenty-four NCAA Division I female athletes, between 18 and 22 years of age from basketball (n=13) and softball (n=11) teams were recruited for the study. A within subject repeated measures design (begining-to end of-season) was incorporated and comparisons were made between athletes of different sport when appropriate. Prior to the study all participants provided written informed consent form prepared in accordance and approved by the local Institutional Review Board for the protection of Human Participants. Data for dietary intake and body composition were collected twice during the competitive season at the beginning (before official games started) and at the end (immediately after the last tournament game was played). During this time, the athletes participated in regular in-season training including aerobic conditioning, skills, drills and weight training and competed on most weekends.

Dietary Intake and Physical Activity Assessment

Participants were asked to complete 3-day food records including two weekdays (Monday-Friday) and one weekend day (Saturday-Sunday). On the food records, participants recorded type, time, place, amount and method of preparation of food eaten. Participants were given written and verbal instructions by the investigator on how to record food intake including liquids, bites and sips, and were asked to be very specific regarding serving sizes and portions. In addition, participants were provided with a handout of portion sizes (e.g., 3 ounces of meat is the size of deck of playing cards) and sample dietary record forms to use throughout the day to help provide the most accurate food recall. The form included a sample breakfast, lunch, and dinner meals. If food was consumed at a restaurant, participants were asked to provide the name of the restaurant and specific food items ordered to allow for the most accurate nutrient analysis. All records were collected on the following day and were entered by the same two investigators to ensure consistency and accuracy.

Food records were entered and analysed for the total energy, macro- and micro- nutrient intake, food groups and energy expenditure using Nutritionist Pro™ dietary analysis software (StandAlone Version, Axxya Systems, Stafford, TX). Macronutrient intake was compared to the recommendations found in the joint position stand "Nutrition and Athletic Performance" (Rodriguez et al., 2009). Micronutrient intake was compared to the Dietary Reference Intake (DRIs) (Institute of Medicine (IOM) Food and Nutrition Board, 2006). Also, participants were asked about their current multivitamin, single vitamin and mineral use over the past 30 days, reasons for dietary supplement use, sources of information regarding supplements, and who recommended dietary supplement use.

UDC 796.2:613.2

Anthropometric and Body Composition

Participants were asked to provide demographic information including academic classification, ethnicity and sport team affiliation. Descriptive data including age, weight, and height were collected. Participants' body composition and bone mineral density were measured via dual energy X-ray absorptiometry (DXA; Lunar Prodigy Pro, GE HealthCare Lunar, Madison, WI). Total body mass (TBM), total lean body mass (LBM), fat mass (FM), percent body fat (BF %), total bone mineral density (BMD), lumbar spine (L1-L4) and femur BMD were recorded. Participants bone mineral density scores were compared to a T-score. Osteopenia was characterized as having a T-score of -1.0 to -2.5 standard deviations below the mean of young adult reference values. The DXA instrument was calibrated every morning of the scheduled visits and assessment was completed by the same technician according to the manufacturer protocol.

Statistical Analyses

All data are presented as mean±SD. Maulchy's Test of Sphericity was used to test the assumption of sphericity. A time x group repeated measures analyses of variance ANOVA were used to compare differences between sports and time for macro- and micro-nutrient intake, body composition and BMD variables. Intakes of major vitamins and minerals were compared to DRIs and presented as >25% or 10-25% below the recommended amount. Servings of the five major food groups were compared to the recommended serving sizes (U.S. Department of Health and Human Services (USDHHS) and U.S Department of Agriculture (USDA), 2015). An alpha value was set at 0.05. Data analyses were carried out on Statistical Package for the Social Sciences version 21 (SPSS, Inc, IBM, Chicago, IL). All significance was accepted at $p \leq 0.05$.

Results

Demographics

Basketball (n=10) and softball (n=10) players completed the study. The majority of the participants were Caucasian (70%), followed by African American (25%), Hispanic and other (5%). On average participants were 20±1 years of age with an average height of 172±10 cm. There was no significant difference observed in TBM, LBM, BF%, total BMD, L1-L4 BMD, or femur BMD ($p>0.05$) at the beginning compared to the end of the season (Table 1). However, LBM and total BMD was significantly ($p<0.05$) higher in basketball compared to softball players (Table 1). The total body, L1-L4, and femur BMD T-scores fell within the normal ranges for all the athletes.

TABLE 1 Body composition and bone mineral density over a competitive season for basketball and softball players (Mean±SD).

	Basketball (n=10)		Softball (n=10)		Combined (n=20)				
	Begining	End	Begining	End	Begining	End	p-value Time	p-value Group	p-value Time x Group
Total Body Mass (kg)	78.7±16.8	80.1±18.6	75.1±9.1	73.2±8.6	76.9±13.3	76.6±14.5	0.81	0.4	0.1
Body Fat (%)	28.2±7.6	30.1±7.1‡	34.1±7.3	32.3±6.8‡	31.2±7.9	31.2±6.9	0.95	0.21	0.04
Lean Body Mass (kg)	48.3±5.1*	48.1±6.2*	42.9±2.6	43.1±3.0	45.6±4.8	45.6±5.4	0.96	0.02	0.65
Total BMD (g/cm^3)	1.35±0.06*	1.35±0.06*	1.29±0.03	1.29±0.04	1.32±0.06	1.32±0.06	0.67	0.02	0.82
Femur BMD (g/cm^3)	1.27±0.09	1.31±0.12	1.21±0.12	1.23±0.12	1.24±0.11	1.27±0.13	0.17	0.12	0.61
L1-L4 Trend BMD (g/cm^3)	1.47±0.14	1.47±0.16	1.45±0.1	1.42±0.11	1.46±0.12	1.45±0.05	0.35	0.53	0.12

*Significant difference between the beginning and end of competitive season, $p \leq 0.05$.
‡Significant difference between two groups over time, $p \leq 0.05$.

Total Energy and Macronutrient Intake

The average of 3-day total energy and macronutrient intake are presented in Table 2. There was a significantly lower energy intake observed at the beginning compared to the end of the season in both teams (1925±466 vs. 2326±782 kcals, $p<0.05$). In addition, a lower energy intake was reported by softball compared to basketball players ($p<0.05$). Lower CHO (3.1±0.9 vs. 3.9±1.4 g/kg/day, $p<0.05$) and fat (1.0±0.4 vs. 1.4±0.7 g/kg/day, $p<0.05$) intake was observed at the beginning compared to the end of the season, respectively. In addition, fat intake but not carbohydrate intake was higher ($p<0.05$) in basketball compared to softball players. Fat intake was at the higher end with 55% of female athletes exceeding general recommendations of 20-35% (Hedrick Fink & Mikesky, 2015; Trumbo et al., 2002). No significant difference ($p>0.05$) was observed for protein and fibre intake at the beginning compared to the end of the season or between the sports (Table 2). However, 45% of the athletes consumed below the recommended 1.2-1.7 g//kg/day of protein for athletes of similar sports both at the beginning and at the end of the season. On average, athletes consumed 68% and 72% of 25 g of fibre that is recommended per day at the beginning and end of the season, respectively (Trumbo et al., 2002). In addition, fibre intake significantly increased in basketball and significantly decreased in softball players ($p<0.05$) at the beginning compared to the end of the season and yet it did not reach the recommended level. Cholesterol intake was not significantly different at the beginning compared to the end of the season,

TABLE 2 Total calorie and macronutrient intake over a competitive season for basketball and softball players (Mean±SD). Recommendations for total calories, carbohydrate, protein and fat intake per day based on average weight of study participants.

		Basketball (n=10)		Softball (n=10)		Combined (n=20)				
	Recommended	Begining	End	Begining	End	Begining	End	p-value Time	p-value Group	p-value Time x Group
Energy Intake										
Per day (kcal)	2719-3019	2208±373	2567±834*†	1641±375	2085±682*†	1925±466	2326±782	0.02	0.03	0.8
Per body weight (kcal/kg)	37-41	29±8	34±15*	23±6	29±12*	32±13	26±8	0.02	0.21	0.77
Carbohydrate										
Per day (gm)	441-735	254±51	304±74*	207±44	259±79*	230±52	281±78	0.001	0.1	0.94
Per body weight (g/kg)	6-10	3.4±1.0	4.1±1.5*	2.9±0.7	3.7±1.3*	3.1±0.9	3.9±1.4	0.001	0.28	0.61
Energy Ratio (%)	45-65	46±6	50±14	51±8	50±6	49±7	50±10	0.63	0.28	0.46
Protein										
Per day (gm)	88-132	92±29	97±38	73 ±11	86±30	89±23	92±34	0.31	0.13	0.64
Per body weight (g/kg)	1.2 -1.8	1.3±0.6	1.4±0.7	1±0.2	1.2±0.5	1.1±0.4	1.3±0.6	0.3	0.27	0.56
Energy Ratio (%)	10-35	17±5	15±2	18±3	17±3	18±4	16±3	0.13	0.21	0.9
Fat										
Per day (gm)	60-117	87±19	111±42*†	56±17	89±39*†	71±24	96±39	0.01	0.006	0.94
Per body weight (g/kg)	0.8-0.9	1.2±0.3	1.6±0.9*†	0.8±0.3	1.3±0.6*†	1.0±0.4	1.4±0.7	0.02	0.05	0.98
Energy Ratio (%)	20-35	35±5	39±7*†	31±7	38±12*†	33±6	37±6	0.05	0.03	0.99
Fiber (gm)	25	15±4	20±8‡	19±6	16±7‡	17±5	18±7	0.35	0.88	0.01
Cholesterol (mg)	>300	459±286	399±178†	183±54	243±108†	321±246	321±164	0.99	0.003	0.24

Note. Kcal: kilocalories; kcal/kg: kilocalories per kilogram of body weight; gm: grams; g/kg: grams per kilogram of body weight; mg: milligrams.
*Significant difference between the beginning and end of competitive season, p≤0.05.
†Significant difference between bsketball and softball players, p≤0.05.
‡Significant difference between two groups over time, p≤0.05.

however, was significantly (p<0.05) higher in basketball compared to softball players (Table 2). Furthermore, most athletes on average consumed less than recommended amounts of vegetables, fruits, dairy and protein foods (Figure 1).

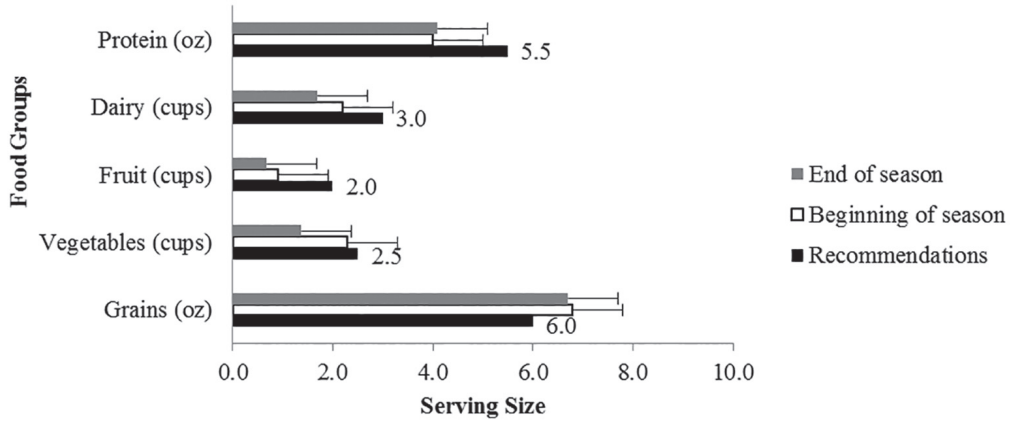


FIGURE 1 Average consumption of five major food groups at the beginning and end of the season compared to the recommended servings sizes by USDA (n=20)

Note. oz: ounces

Micronutrients

There was no significant difference (p>0.05) in vitamin and mineral intake from food sources at the beginning compared to the end of the season (Table 3). Lower intakes compared to DRIs were observed for average potassium, iron, magnesium, calcium, vitamin E at the beginning and end of the season. Vitamin A, vitamin E, magnesium and zinc were >25% below and calcium, potassium, and iron were at least 10-25% below DRIs for females of similar age. A significantly higher (p<0.05) sodium and niacin intake above DRIs was observed. 55% of participants reported using multivitamins over a competitive season; however, inconsistent use of dietary supplements was reported. Six participants reported taking multivitamin on a regular basis. Occasional use was reported for iron, magnesium, folic acid, Vitamin C, Vitamin B6, Vitamin B12 and Vitamin D. Most common reasons for dietary supplement use were to improve and maintain health (25%), prevent health problems (25%), get more energy (20%) and boost immune system (15%). Major sources of information regarding dietary supplements were dietician (30%), physician (25%) or coaches (20%). Most of the time participants initiated dietary supplement use themselves (20%) or following an advice from coaches (20%).

UDC 796.2:613.2

TABLE 3 Comparison of vitamin and mineral intake to DRI over a competitive season for basketball and softball (Mean±SD).

		Basketball (n=10)		Softball (n=10)		Combined (n=20)				
	DRI (19-30y)	Beginning	End	Beginning	End	Beginning	End	p-value Time	p-value Group	p-value Time x Group
Vitamin A (µg) RAE	700	369±357[b]	694±955	382±219[b]	496±403[b]	376±288[a]	595±721[b]	0.19	0.64	0.52
Vitamin C (mg)	75	110±88	158±205	100±93	136±119	105±70	147±164	0.27	0.72	0.87
Vitamin E (mg)	15	4.1±5.8[b]	4.9±4.3[b]	4±3.6[b]	3.2±2.2[b]	4.1±4.6[b]	4.1±3.5[b]	0.98	0.5	0.54
Thiamin(mg)	1.1	1.1±0.6	1.3±0.6	1.3±0.4	1.2±0.4	1.2±0.5	1.2±0.5	0.58	0.79	0.30
Riboflavin (mg)	1.1	1.2±0.6	1.5±0.9	1.7±1.3	1.6±0.7	1.5±1.0	1.6±0.8	0.72	0.43	0.36
Niacin (mg)	14	15.5±9	21.7±13.9	18.3±4.8	22.9±11.2	16.9±7.2	22.3±12.3	0.07	0.6	0.79
Vitamin B6 (mg)	1.3	1.3±0.8	1.6±1.2	1.7±0.8	1.8±0.7	1.5±0.8	1.7±1.0	0.38	0.46	0.67
Folate (µg)	400	349±351[a]	423±265	542±340	399±197	445±351	411±228	0.65	0.45	0.17
Vitamin B12 (µg)	2.4	3±2.5	5.1±5.3	3.3±2.4	3.7±1.7	3.2±2.4	4.4±3.9	0.25	0.57	0.43
Calcium (mg)	1000	817±330[a]	720±282[b]	617±204[b]	683±285[b]	717±286[b]	702±277[b]	0.85	0.23	0.32
Selenium (mcg)	55	65±40	87±45	79±22	72±38	72±32	80±41	0.54	0.98	0.23
Magnesium	310	174±92[b]	200±100[b]	216±71[b]	210±107[b]	195±83[b]	205±101[b]	0.66	0.46	0.50
Iron (mg)	18	15±6[a]	14±7[a]	13±5[b]	16±9[a]	14±6[a]	15±8[a]	0.70	0.91	0.18
Zinc (mg)	8	6±4[b]	8±6	8±3	8±5	7±3	8±5	0.30	0.48	0.62
Potassium (mg)	4700	1544±563[b]	2298±1519[b]	1873±566[b]	1983±735[b]	1709±575[b]	2141±1172[b]	0.07	0.99	0.17
Sodium (mg)	1500	4413±984	4259±963[†]	2872±632	3292±1131[†]	3643±1128	3776±1136	0.65	0.001	0.34

Note. DRI: Dietary Reference Intake; RAE: Retinol Activity Equivalent; mg: milligrams; µg: micrograms.
†Significant difference between bsketball and softball players, p≤0.05.
[a] = >10-25% below DRI, b = >25% below DRI.

Discussion

Several key findings emerged from this study, the 3-day food records indicated inadequate intake of many crucial macro- and micro-nutrients through diet which are critical for energy metabolism, glycogen replenishment, neutralization of free radicals and bone health in young female athletes. In addition, participants did not meet general recommendations for total energy intake, major macronutrients including carbohydrate, fibre and protein and over consumed fat.

Energy

In the present study, mean energy intake was reported below what would be recommended for females of similar age and activity levels. Based on Estimated Energy Requirements (EER) very active female athletes may need to consume anywhere between 2,637-3,211 kcals/day (Trumbo et al., 2002). Energy intake for these participants at the beginning of the season averaged 1925 kcals/day falling within the range of low active individuals and at the end of the season 2326 kcals/day failing to meet the energy needs for active women of the same age (Trumbo et al., 2002). In addition, energy intake did not improve over the competitive season and was lower compared to what would be expected for their energy expenditure. Nonetheless, the observations of the present investigation are in agreement with the results of previous studies that have used dietary recalls to analyse energy intake. Previous studies have consistently demonstrated that female athletes consume insufficient amount of calories and are in a negative energy balance. (Clark et al., 2003; Hassapidou & Manstrantoni, 2001; Hinton et al., 2004; Mullinix, Jonnalagadda, Rosenbloom, Thompson, & Kicklighter, 2003; Papadopoulou et al., 2002; Petersen et al., 2006). Female athletes participating in varsity sports consistently report an average energy intake that meets the minimum requirements for women of similar age who participate in light-to moderate physical activity (Clark et al., 2003; Hinton et al., 2004; Petersen et al., 2006). In addition, similarly lower energy intakes compared to energy expenditures were observed among other sports including volleyball, distance runners, ballet dancers and swimmers while in training and competitive seasons. (Hassapidou & Manstrantoni, 2001; Papadopoulou et al., 2002). Consequently, chronic low energy intake may be detrimental to athlete's performance and overall health. It can lead to inadequate energy levels during exercise and body composition changes that can negatively affect athletic performance and recovery.

Body composition

In the present study, no significant body composition changes were observed due to reported lower energy intake. As presented in Table 1, a non-significant change in total body mass and BF% was observed in athletes over time with no change in LBM. Previously, a decrease in BF% and increase in LBM while in negative energy balance was observed among swimmers and divers at preseason compared to the late season (Petersen et al.,

2006), whereas, Clark et al. (2003) observed no significant changes in total body weight pre- and post-season in female soccer players. Therefore, the results of the present study support the findings of Clark et al. (2003). In addition, a large individual variability was observed between athletes with energy intake ranging between 1,247 to 2,961 kcals/day at the beginning and 1,150 to 4,131 kcals/day at the end of the season. Thus, some athletes may have been in a positive energy balance. Nonetheless, the lack of body composition changes due to lower energy intake could be explained by using estimated energy expenditure based on previous literature and not actually measured. Athletes may have underestimated food intake or increased consumption of food before or after the completion of the three day food records compensating for energy imbalance. (Petersen et al., 2006). Also, athletes may have been more conscious and aware of foods eaten altering the type and amount of food consumed affecting their reported food and energy intake.

A higher total body weight, LBM, BMD and lower BF% was observed in basketball players compared to softball athletes. The difference in weight and body fat % among softball and basketball players could be related to the difference in the type and exercise intensity performed during training and competition. Average BF% fell at the higher end of healthy BF% ranges, however, varied greatly between the athletes (Gallagher et al., 2000). Previously, lower BF% were consistently reported for female athletes of similar sports including soccer (~16%), softball (21%), basketball (16%), and volleyball players (19-23%) (Clark et al., 2003; Hassapidou & Manstrantoni, 2001; Malousaris et al., 2008; Petersen et al., 2006; Tsunawake et al., 2003). However, most of investigations observed elite female athletes whose level, type and amount of training may have been different compared to Division I college athletes. In addition, significant changes in size, body composition and dietary behaviours have been observed in the past few decades among general and athletic populations (Wilborn et al., 2005). Athletes may have higher total body weight and body fat making it difficult to compare past and present studies (Wilborn et al., 2005). Moreover, different methods for measuring body composition were previously used by the studies including skinfolds (Hassapidou & Manstrantoni, 2001; Malousaris et al., 2008; Tsunawake et al., 2003) and hydrostatic weighing (Clark et al., 2003; Tsunawake et al., 2003). As a result, a three component model of body composition employed by DXA may have been more accurate in assessing BMD, LBM and FM compared to two-component model employed by skinfolds and hydrostatic weighing causing discrepancies (Kohrt, 1998).

Desire to lose weight and reduce BF% could lead to severe dietary restrictions and lower energy intakes (Sammarone Turocy et al., 2011). Athletes may feel pressure to achieve or maintain lower body weight therefore may self-select to restrict calorie and carbohydrate intake by following low carbohydrate and high-protein diets or skipping meals (Mullinix et al., 2003). Therefore, this may indicate that athletes may lack proper education and knowledge of how such dietary restrictions during a competitive season may negatively affect their performance. Thus, could benefit from nutrition education by a registered dietician.

Additionally, in order to maintain optimal agility, speed, power, and strength especially in sports where multidirectional movements are performed achieving greater lean muscle mass to fat ratio would be advantageous (Kovacs, 2007; Rodriguez et al., 2009). Although, reported lower energy intakes would lead to body composition changes and optimal physique for some of the athletes it should not be implemented during a competitive season. Extreme weight gains and losses during a competitive season may lead to negative consequences including loss in skeletal muscle mass, hormone imbalances and impaired athletic performance, thus, should be achieved during pre- or off-season training by carefully manipulating diet and training to minimize the impact (Burke et al., 2006; Wilborn et al., 2005).

Macronutrient Intake

In the present study, most of the participants were at the lower end of general recommendations of consuming 45 - 65% of total daily calories as carbohydrates (Hedrick Fink & Mikesky, 2015; Rodriguez et al., 2009; Trumbo et al., 2002). In addition, athletes should be consuming on average 6 – 10 g/kg/day of carbohydrates depending on daily energy expenditure. In the present study, only 10% of athletes consumed the recommended amount of CHO, whereas, most of the participants consumed less than 50% of the lower end of recommended intake. Previously, similar results were observed among basketball, soccer, cross-country runners, and track and field athletes (Mullinix et al., 2003; Shriver, Betts, & Wollenberg, 2013). Clark et al. (2003) observed carbohydrate intake of 5.2 ± 1.1 g/kg/day and 4.3 ± 1.2 g/kg/day with CHO composition of 55% and 57% of total calories during pre- and post-season, respectively. Similarly, Hassapidou and Mastrantoni (2001) observed low CHO intake in adolescent volleyball players of 3.1 ± 1.4 g/kg/day with CHO composition of 46%. It has been observed that athletes consuming higher energy intakes (i.e. 4000-5000 kcals/day) often will meet or exceed their CHO requirements based on % of total energy compared to athletes with lower energy intakes (Burke, Cox, Cummings, & Desbrow, 2001). Diets with low total energy intake where 60-65% of energy is supplied by carbohydrates may still be insufficient to replenish muscle and liver glycogen stores depleted during training or competition (Martin, Lambeth, & Scott, 2006). Hence, it has been suggested that athletes should be provided with gender and sport specific CHO recommendations in grams relative to body weight to allow for flexibility consuming CHO based on their daily energy needs and nutritional goals (Burke et al., 2001).

While evaluating dietary intake based of the self-report we should not only consider the extent of under-reporting and under-estimating food intake but also other dietary habits (Black et al., 1991; Burke et al.,

2001). Lower CHO intake could be attributed to increased consumption of dietary fat and high-protein foods substituting intake of CHO and other important nutrients. Previously, similar findings were observed by multiple investigations among female athletes (Hassapidou & Manstrantoni, 2001; Mullinix et al., 2003; Papadopoulou et al., 2002). In addition, fat intake was at the higher end of recommended percent of total calories with 55% of the participants exceeding the higher end of recommended intake. Although, higher fat intake may be beneficial resulting in glycogen sparing and increased fat oxidation due substrate availability in a short term, over a longer period muscle and liver glycogen stores will be reduced negatively affecting ability to perform and train at the intended level (Jeukendrup, 2003). There was no significant difference in energy derived from protein over a competitive season. On average participants consumed enough protein based on general recommendation of 0.8 g/kg/day and stayed within the range for energy ratio derived from protein (Hedrick Fink & Mikesky, 2015). However, some experts suggest that physically active individuals engaging in endurance exercise should consume 1.2-1.4 g/kg/day and those who engage in weight training up to 1.8 g/kg/day (Hedrick Fink & Mikesky, 2015; Rodriguez et al., 2009). In the present study, only 55% of athletes consumed at least 1.2 g/kg/day of protein and fell below the recommended levels for active individuals. Similar results were observed in female soccer players (Clark et al., 2003), volleyball players (Hassapidou & Manstrantoni, 2001; Papadopoulou et al., 2002) and other college varsity sports (Hinton et al., 2004). Due to observed poor nutritional habits athletes may greatly benefit from altering proportional intake of macro-nutrients. Increased CHO consumption would be advised especially complex CHO which would help increase not only fibre intake but also other important micro-nutrients of concern while substituting foods with higher fat content and empty calories.

Micronutrients and Food Groups

College students and athletes consume most of their meals away from home and often on college campus. Usually these meals are characterized as being higher in energy, total fat, cholesterol, sodium, added sugars and lack in nutrient content (Guthrie, Lin, & Frazao, 2002; Kolodinsky et al., 2007; Pelletier & Laska, 2013). Higher fat, cholesterol, sodium and lower fibre intakes were observed in the present study. In addition, athletes failed to meet the recommendations for five major food group categories, which is typical of modern diet. Athletes consumed less grains, vegetables, fruits and dairy. In addition, insufficient energy intakes as well as low fruit, veggie and dairy intakes corresponds well with lower nutrient content and lack of crucial vitamins, minerals and fibre. Athletes did not meet the DRIs of many crucial nutrients. Similar results were previously found by Hassapidou and Mastrantoni (2001) and Clark et al. (2003). Although, some athletes reported taking supplements, the use was inconsistent. The lack of these nutrients over time could lead to nutrient deficiencies that are detrimental to athletic performance and overall health; therefore, nutritional counselling specific to these micronutrients should be advised (Rodriguez et al., 2009). Nutrition knowledge tends to be related to the individual's food choices and positively relates to healthier eating patterns (Kolodinsky et al., 2007). This may suggest that female athletes may not be knowledgeable enough to make healthy food-related decisions and understand the implications of nutrition on health and sports performance. Nutrition intervention by a registered dietician has been shown to improve nutrition knowledge, body composition, total energy, CHO, PRO and micronutrient intake among athletes (Anderson, 2010; Valliant, Pittman Emplaincourt, Kieckhaefer Wenzel, & Garner, 2012; Wenzel Kieckhaefer, Valliant Wells, Chang, Bomba K., & Lambert G., 2012). In addition, nutrition labels at the dining halls can be used as a tool for educating athletes how to improve their food choices to meet daily energy needs and nutrient requirements (Driskell, Schake, & Detter, 2008).

Limitations

Some challenges when interpreting self-reported dietary intake data should be considered. Previously, failure to report all foods consumed and higher underestimation of habitual food intake was observed among women compared to men (Black et al., 1991; Burke et al., 2001). Although, participants were educated on how to record the food and fluid intake to minimize the impact they were not used to doing it on a regular basis. In addition, the types of foods they consumed may have been influenced by individual athlete's class schedules and food availability at the dining halls. Although, athletes were asked to indicate unusual intake it is difficult to determine wherever this 3-day period represented their habitual dietary intake.

In conclusion, dietary recalls indicated inadequate intake of many crucial macro- and micro-nutrients through diet of student athletes living on campus which are critical for energy metabolism, glycogen replenishment, neutralization of free radicals and bone health in young female athletes. The lack of these nutrients could potentially be affecting athletic performance and overall health; therefore, nutritional counselling specific to energy requirements for the sport, lacking nutrients and efficacy of dietary supplements for female athletes is warranted. Athletes should be encouraged to consume appropriate proportions of macronutrients, be taught how to make the right dietary choices on and off campus and select food that is nutrient dense.

Acknowledgements

We would like to thank our undergraduate student researchers for providing help with data collection and entry. In addition, we would like to thank Dr Takudzwa Madzima for providing writing assistance and proof reading the article.

REFERENCES

Anderson, D. E. (2010). The Impact of Feedback on Dietary Intake and Body Composition of College Women Volleyball Players Over a Competitive Season. *Journal of Strength and Conditioning Research*, 24(8), 2220–2226. https://doi.org/10.1519/JSC.0b013e3181def6b9

Black, A. E., Goldberg, G. R., Jebb, S. A., Livingstone, M. B., Cole, T. J., & Prentice, A. M. (1991). Critical evaluation of energy intake data using fundamental principles of energy physiology: 2. Evaluating the results of published surveys. *European Journal of Clinical Nutrition*, 45(12), 583–99.

Burke, L. M., Cox, G. R., Cummings, N. K., & Desbrow, B. (2001). Guidelines for Daily Carbohydrate Intake. *Sports Medicine*, 31(4), 267–299. https://doi.org/10.2165/00007256-200131040-00003

Burke, L. M., Loucks, A. B., & Broad, N. (2006). Energy and carbohydrate for training and recovery. *Journal of Sports Sciences*, 24(7), 675–685. https://doi.org/10.1080/02640410500482602

Campbell, B., Kreider, R. B., Ziegenfuss, T., La Bounty, P., Roberts, M., Burke, D., … Antonio, J. (2007). International Society of Sports Nutrition position stand: protein and exercise. *Journal of the International Society of Sports Nutrition*, 4(1), 8. https://doi.org/10.1186/1550-2783-4-8

Clark, M., Reed, D. B., Crouse, S. F., & Armstrong, R. B. (2003). Pre-and Post-season Dietary Intake, Body Composition, and Performance Indices of NCAA Division I Female Soccer Players. *International Journal of Sport Nutrition & Exercise Metabolism*, 13, 303–319.

Driskell, J. A., Schake, M. C., & Detter, H. A. (2008). Using Nutrition Labeling as a Potential Tool for Changing Eating Habits of University Dining Hall Patrons. *Journal of the American Dietetic Association*, 108(12), 2071–2076. https://doi.org/10.1016/j.jada.2008.09.009

Gallagher, D., Heymsfield, S. B., Heo, M., Jebb, S. A., Murgatroyd, P. R., & Sakamoto, Y. (2000). Healthy percentage body fat ranges: an approach for developing guidelines based on body mass index. *American Journal of Clinical Nutrition*, 72(3), 694–701.

Guthrie, J. F., Lin, B.-H., & Frazao, E. (2002). Role of Food Prepared Away from Home in the American Diet, 1977-78 versus 1994-96: Changes and Consequences. *Journal of Nutrition Education and Behavior*, 34(3), 140–150. https://doi.org/10.1016/S1499-4046(06)60083-3

Hassapidou, M. N., & Manstrantoni, A. (2001). Dietary intakes of elite female athletes in Greece. *Journal of Human Nutrition and Dietetics*, 14, 391–396.

Hedrick Fink, H., & Mikesky, A. E. (2015). *Practical Applications in Sports Nutrition* (4th ed.). Burlington, MA: Jones & Barlet Learnings.

Hinton, P. S., Sanford, T. C., Davidson, M. M., Yakushko, O. F., & Beck, N. C. (2004). Nutrient intakes and dietary behaviors of male and female collegiate athletes. *International Journal of Sport Nutrition and Exercise Metabolism*, 14(4), 389–405.

Institute of Medicine (IOM) Food and Nutrition Board. (2006). *Dietary Reference Intakes: The Essential Guide to Nutrient Requirements*. Washington, DC: National Academies Press.

Jeukendrup, A. E. (2003). Modulation of carbohydrate and fat utilization by diet, exercise and environment. *Biochemical Society Transactions*, 31(6).

Kohrt, W. M. (1998). Preliminary evidence that DEXA provides an accurate assessment of body composition. *Journal of Applied Physiology*, 84(1), 372–377.

Kolodinsky, J., Harvey-Berino, J. R., Berlin, L., Johnson, R. K., & Reynolds, T. W. (2007). Knowledge of Current Dietary Guidelines and Food Choice by College Students: Better Eaters Have Higher Knowledge of Dietary Guidance. *Journal of the American Dietetic Association*, 107(8), 1409–1413. https://doi.org/10.1016/j.jada.2007.05.016

Kovacs, M. S. (2007). Tennis Physiology. *Sports Medicine*, 37(3), 189–198. https://doi.org/10.2165/00007256-200737030-00001

Malousaris, G. G., Bergeles, N. K., Barzouka, K. G., Bayios, I. A., Nassis, G. P., & Koskolou, M. D. (2008). Somatotype, size and body composition of competitive female volleyball players. *Journal of Science and Medicine in Sport*, 11, 337–344. https://doi.org/10.1016/j.jsams.2006.11.008

Martin, L., Lambeth, A., & Scott, D. (2006). Nutritional Practices of National Female Soccer Players: Anlysis and Recommendations. *Journal of Sports Science and Medicine*, 5, 130–137.

Mullinix, M. C., Jonnalagadda, S. S., Rosenbloom, C. A., Thompson, W. R., & Kicklighter, J. R. (2003). Dietary intake of female U.S. soccer players. *Nutrition Research*, 23, 585–593. https://doi.org/10.1016/S0271-5317(03)00003-4

Ousley-Pahnke, L., Black, D. R., & Gretebeck, R. J. (2001). Dietary intake and energy expenditure of female collegiate swimmers during decreased training prior to competition. *Journal of the American Dietetic Association*, 101(3), 351–354.

Papadopoulou, S. K., Papadopoulou, S. D., & Gallos, G. K. (2002). Nutrient Intake of Adolescent Volleyball Players / 71 Macro-and Micro-Nutrient Intake of Adolescent Greek Female Volleyball Players. *International Journal of Sport Nutrition and Exercise Metabolism*, 12, 71–78.

Pelletier, J. E., & Laska, M. N. (2013). Campus Food and Beverage Purchases Are Associated With Indicators of Diet Quality in College Students Living Off Campus. *American Journal of Health Promotion*, 28(2), 80–87. https://doi.org/10.4278/ajhp.120705-QUAN-326

Petersen, H. L., Peterson, C. T., Reddy, M. B., Hanson, K. B., Swain, J. H., Sharp, R. L., & Alekel, D. L. (2006). Body Composition, Dietary Intake, and Iron Status of Female Collegiate Swimmers and Divers. *International Journal of Sport Nutrition & Exercise Metabolism*, 16(3), 281–295.

Rodriguez, N. R., DiMarco, N. M., & Langley, S. (2009). Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance. *Journal of the American Dietetic Association*, 109(3), 509–527. https://doi.org/10.1016/j.jada.2009.01.005

Sammarone Turocy, P., DePalma, B. F., Horswill, C. A., Laquale, K. M., Martin, T. J., Perry, A. C., … Utter, A. C. (2011). National Athletic Trainers' Association Position Statement: Safe Weight Loss and Maintenance Practices in Sport and Exercise. *Journal of Athletic Training*, 46(3), 322–336.

Shriver, L. H., Betts, N. M., & Wollenberg, G. (2013). Dietary Intakes and Eating Habits of College Athletes: Are Female College Athletes Following the Current Sports Nutrition Standards? *Journal of American College Health*, 61(1), 10–16.

Trumbo, P., Schlicker, S., Yates, A. A., & Poos, M. (2002). Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein and Amino Acids. *Journal of the American Dietetic Association*, 102(11), 1621–1630. https://doi.org/http://dx.doi.org/10.1016/S0002-8223(02)90346-9

Tsunawake, N., Tahara, Y., Moji, K., Muraki, S., Minowa, K., & Yukawa, K. (2003). Body Composition and Physical Fitness of Female Volleyball and Basketball Players of the Japan Inter-high School Championship Teams. *Journal of Physiological Anthropology and Applied Human Science*, 22(4), 195–201. https://doi.org/10.2114/jpa.22.195

US Department of Health and Human Services. (2015). 2015–2020 dietary guidelines for Americans. *Washington (DC): USDA*.

Valliant, M. W., Pittman Emplaincourt, H., Kieckhaefer Wenzel, R., & Garner, B. H. (2012). Nutrition Education by a Registered Dietitian Improves Dietary Intake and Nutrition Knowledge of a NCAA Female Volleyball Team. *Nutrients*, 4(12), 506–516. https://doi.org/10.3390/nu4060506

Volpe, S. L. (2007). Micronutrient Requirements for Athletes. *Clinics in Sports Medicine*, 26, 119–130. https://doi.org/10.1016/j.csm.2006.11.009

Wenzel Kieckhaefer, R., Valliant Wells, M., Chang, Y., Bomba K., A., & Lambert G., L. (2012). Dietary assessment and education improves body composition and diet in NCAA female volleyball players. *Topics in Clinical Nutrition*, 27(1), 67–73. https://doi.org/10.1097/TIN.0b013e318246223b

Wilborn, C., Beckham, J., Campbell, B., Harvey, T., Galbreath, M., La Bounty, P., … Kreider, R. (2005). Obesity: Prevalence, Theories, Medical Consequences, Management, and Research Directions. *Journal of the International Society of Sports Nutrition*, 2(22), 4–31.

Common Running Overuse Injuries and Prevention

Žiga Kozinc[1] and Nejc Šarabon[1]

Affiliations: [1]University of Primorska, Faculty of Health Sciences, Izola, Slovenia

Correspondence: Nejc Šarabon, University of Primorska, Faculty of Health Sciences, Polje 42, 6310 Izola, Slovenia. E-mail: nejc.sarabon@fvz.upr.si

ABSTRACT Runners are particularly prone to developing overuse injuries. The most common running-related injuries include medial tibial stress syndrome, Achilles tendinopathy, plantar fasciitis, patellar tendinopathy, iliotibial band syndrome, tibial stress fractures, and patellofemoral pain syndrome. Two of the most significant risk factors appear to be injury history and weekly distance. Several trials have successfully identified biomechanical risk factors for specific injuries, with increased ground reaction forces, excessive foot pronation, hip internal rotation and hip adduction during stance phase being mentioned most often. However, evidence on interventions for lowering injury risk is limited, especially regarding exercise-based interventions. Biofeedback training for lowering ground reaction forces is one of the few methods proven to be effective. It seems that the best way to approach running injury prevention is through individualized treatment. Each athlete should be assessed separately and scanned for risk factors, which should be then addressed with specific exercises. This review provides an overview of most common running-related injuries, with a particular focus on risk factors, and emphasizes the problems encountered in preventing running-related injuries.

KEY WORDS Runners, Exercise, Pain, Risk factors, Injury mechanism, Preventive methods.

@MJSSMontenegro
RUNNING INJURY PREVENTION
http://mjssm.me/?sekcija=article&artid=144

Introduction

Running is among most popular physical activities, which may be attributed to its accessibility, inexpensiveness and numerous positive effects. It has been shown, for example, to lower diabetes, hypertension and hypercholesterolemia risk (Williams & Thompson, 2013).

Although being a non-contact, submaximal, and continuous activity, running nonetheless elicits a considerable amount of injuries. Runners are particularly prone to sustaining overuse injuries, which occur due to frequent submaximal strain and/or inadequate recovery of the tissues involved (DiFiori et al., 2014). Several risk factors for developing running-related injuries have been investigated, and can be roughly divided into intrinsic (e.g. individual's abilities, anthropometric characteristics, and cognitive properties) and extrinsic (e.g. ground surface, footwear and training load) (Johnston, Taunton, Lloyd-Smith, & McKenzie, 2003).

Various strategies for running injury prevention are applied by coaches and runners themselves (e.g. stretching, warm-up, technique training). In this review, we will discuss the most common running injuries, underlying mechanisms, risk factors, and preventative strategies.

Biomechanics of Running

In this chapter, we will briefly review some biomechanical properties of running, focusing on aspects and parameters relevant to injury development and prevention.

Running cycle and joint kinematics

The running cycle consists of two fundamental phases: the stance phase and the swing phase. In kinematic

Accepted after revision: May 13 2017 | First published online: September 01 2017

Conflict of interest: None declared.

analysis, the first contact with the ground (foot-strike) marks the beginning of the cycle for the leg (Anderson, 1996). From this point on, the muscles contract eccentrically to absorb landing forces. The moment of transition into concentric contraction and force generation is called "mid-stance" (also mid-support). Concluding the stance phase is the point of take-off, the last instant of foot touching the surface. Joint positions, velocity, and other kinematic variables are usually measured at these three crucial moments (Novacheck, 1998).

Most of the joint motion during the running cycle occurs in the sagittal plane. The pelvic range of motion is minimal (approximately 10°), which provides stability and efficiency (Novacheck, 1998). Hip range of motion rarely exceeds 40° (Pink, Perry, Houglum, & Devine, 1994). Peak extension (around 10°) occurs at the take-off. Typical peak hip flexion is around 30° (Nicola & Jewison, 2012). The knee is flexed to 20-25° at the foot strike, reaches 45° flexion in mid-stance and then extends to approximately 25° of flexion at take-off (Novacheck, 1998). In the case of striking heel-first (which most long-distance runners do), there is up to 10° ankle dorsiflexion at foot strike, and some plantar flexion must happen initially. Afterwards, the ankle moves into 20° of dorsiflexion during amortization and then into 20° plantar flexion during propulsion (Dugan & Bhat, 2005).

Abnormal kinematic parameters in the frontal plane (especially excessive ranges of motion) are most often linked to injury development. In the amortization phase, the pelvis drops to the side of the swing leg (generally not over 10°) and then returns to a neutral position throughout the propulsion phase (Nicola & Jewison, 2012). To compensate for this, the trunk is flexed laterally, to the side of the stance leg. Hip abduction and adduction both reach up to 10°. Peak adduction is achieved at the mid-stance, while peak abduction is the highest at the middle of the swing phase (Novacheck, 1998). The ankle is inversed (6 to 8°) at foot-strike, then it moves to 8° of eversion through the amortization phase (Nicola & El Shami, 2012). The eversion range of motion during stance phase is the main determinant of the foot pronation. Anything over 9° of eversion is considered moderate pronation, while 13° or more is labelled high pronation (Morley et al., 2010).

Horizontal movements are, like those in the frontal plane, smaller than sagittal movements (Novacheck, 1998). Internal hip rotation and consequential knee valgus are most often discussed in terms of injury development (Powers, 2003). Horizontal knee and ankle motion are minimal in normal running kinematics (Nicola & Jewison, 2012).

Muscle Work

The muscle activation pattern changes with running velocity and ground slope, yet the main force generators remain the same. Hip extensors are active in the second part of the swing phase and throughout the stance phase. Knee extensors, ankle plantar flexors, and hip abductors are active throughout the stance phase. Hip flexors propagate the leg forwards after the take-off. The glutes and the hamstrings pull the body forwards, while quadriceps and ankle plantar flexors generate more of an upward force. As noted before, there is an eccentric contraction occurring in the amortization phase. Muscles and tendons lengthen, absorbing the forces of the landing. Due to elastic properties, tendons return up to 95% of the energy stored in the amortization phase (Novacheck, 1998). Quadriceps seem to be the largest power contributor in amortization, while the most work in propulsion phase is generated by plantar flexors (Hamner, Seth, & Delp, 2010).

Foot-strike problems

Ground reaction forces are a major concern in running. Several trials have been conducted to investigate different interventions for minimizing these forces. Striking heel-first is particularly problematic, as the first part of the impact cannot be absorbed by the dorsiflexors and is, therefore, transmitted to passive tissues and muscles higher in the kinetic chain (Verdini, Marcucci, Benedetti, & Leo, 2006). Looking at force curve (Figure 1), there are two peaks in the case of heel strike. The height of the first peak should be as low as

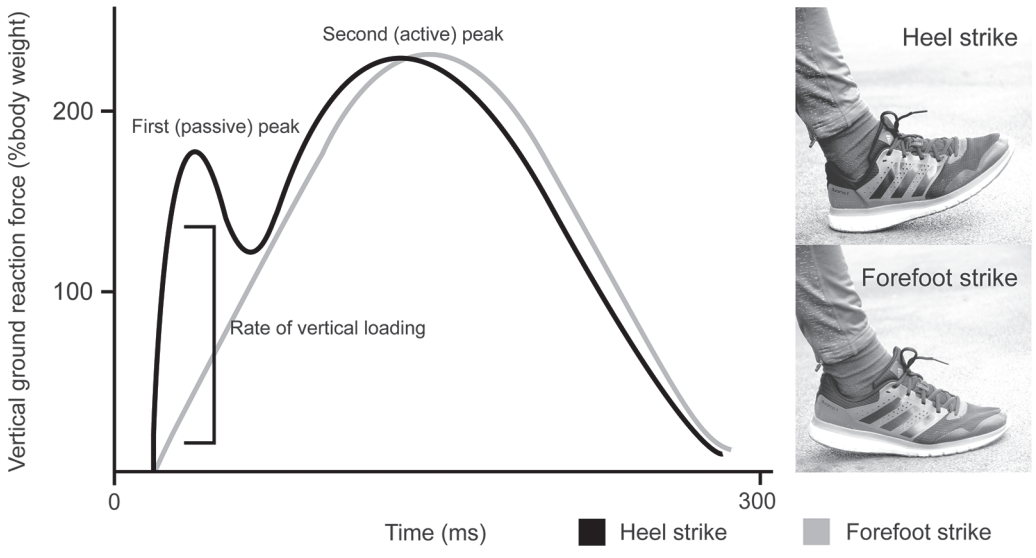


FIGURE 1 Comparison of ground reaction forces between heel strike and forefoot strike technique

UDC 796.412.5:613.64

possible or even absent (which it is, in good running technique). Additionally, the average and the maximum slope of the curve (rate of vertical loading) before the first peak should also be noted. The reduction of all these three parameters is the primary goal when discussing lowering ground reaction forces (Zadpoor & Nikooyan, 2011). Striking heel-first not only increases the mechanical stress; it also causes the loss of energy. In the case of the proper technique, plantar flexors start to contract eccentrically immediately after the first touching the ground, and the energy absorbed is returned later in full amount. The heel strike impedes this, since some degree of plantar flexion must happen first so that the front of the foot also reaches the ground, and some energy is lost (Novacheck, 1998).

Most common running injuries

Sport-related injuries are classified as acute (also traumatic) or chronic (also overuse). Acute injuries occur due to sudden trauma (e.g. leg bone fracture caused by opponents' foul in soccer or sudden hamstring tear during sprinting). Chronic injuries develop gradually as a result of accumulating microtrauma, which is caused by repeated submaximal strain (Roos & Marshall, 2014). Depending on the appearance of pain, chronic injuries are further classified into four stages (McCarty, Walsh, Hald, Peter, & Mellion, 2010):

- Stage 1: Pain, present only after activity;
- Stage 2: Pain, present during activity, not impairing performance;
- Stage 3: Pain, present during activity, impairing performance;
- Stage 4: Ceaseless pain, not receding even with rest

A recent meta-analysis showed an incidence of 2.5 injuries per 1000 hours of exposure in long-distance track and field athletes. However, novice runners are at much higher risk, with an incidence of 33 injuries per 1000 hours of exposure (Videbaek, Bueno, Nielsen, & Rasmussen, 2015). Another review investigated the incidence of individual injuries. The highest incidence was reported for medial tibial stress syndrome (MTSS; 13.6-20.0%), Achilles tendinopathy (9.1-10.9%), patellar tendinopathy (5.5-22.7%), plantar fasciitis (4.5-10.0%), ankle sprain (10.9-15.0%), iliotibial band syndrome (1.8-9.1%), hamstring injury (10.9%) and tibial stress fracture (9.1%) (Lopes, Junior, Yeung, & Costa, 2012). In ultra-distance runners, Achilles tendinopathy and patellofemoral syndrome (PFS) are most common. The relatively low reported incidence of the latter (5.5%) was based on only one study in this review.

Medial tibial stress syndrome

Also commonly referred to as shin splints, MTSS is especially prevalent in military personnel (Sharma, Weston, Batterham, & Spears, 2014), yet also frequent in runners. It is loosely defined as a pain on the inner side of the tibia. The pain is diffuse and not localized, as in tibial stress fractures. The onset of MTSS usually happens in the early stages of the season, or anytime the volume and intensity of training increases suddenly (Putukian, McCarty, & Sebastianelli, 2010). The pain is worsened by exercise.

The exact mechanism for developing MTSS is still to be determined. Most textbooks state that the pain originates from the periosteum along the medial tibia. Several trials have been conducted in order to link a specific muscle to MTSS. The conflicting evidence gathered has led to mixed opinions among experts (Franklyn & Oakes, 2015). However, we know more about risk factors. Increased hip external rotation during the stance phase (in males only), higher body mass index, prior use of orthotics, navicular drop (indicator of resting foot pronation) and fewer years of training experience were all linked to higher risk for sustaining MTSS (Newman, Witchalls, Waddington, & Adams, 2013). Interestingly, females are at higher risk than males are. Newman and colleagues (2013) pointed out that this may indicate a bone-related mechanism behind MTSS development, since women have been shown to have lower bone mineral density.

Treatment of MTSS is dependent on the severity of the injury. Rest alone can cure most cases. Athletes are recommended to participate in cross-training activities that do not overload the area (e.g. swimming) in order to maintain their fitness until the injury ceases. They should then return to running and running-involving activities gradually. Some may benefit from stretching, if there are deficits in the range of motion. Implementation of proprioceptive training and ankle strengthening exercises is also encouraged (Galbraith & Lavallee, 2009).

Tendon injuries

Terminology on tendon injuries is inconsistent and often confusing. Tendinopathy is an umbrella term, describing painful conditions in tendons and surrounding areas due to overuse (Rees, Maffulli, & Cook, 2009). Other terms should be used after histopathological confirmation. Tendinitis is an injury with accompanying inflammation of the tendon (Andres & Murrell, 2008). Tendinosis is defined as a degenerative injury of the tendon with no or few inflammation cells present. Along with changes in the collagen matrix, there is an increased vessel and nerve ingrowth (Ackermann & Renstrom, 2012). Other conditions affecting the tendon include tenosynovitis (inflammation of tendon's synovia (a tendon's sheath)) and peritendinitis (inflammation of muscle-tendon junction and paratendon (the tissue filling the interstices of the fascial compartment in which a tendon is situated)) (Kurppa, Waris, & Rokkanen, 1979). Age and gender, among others, seem to be important risk factors for sustaining a tendinopathy, with males and the elderly being at higher risk (Rees et al., 2009).

Achilles tendinopathy is most prevalent among runners. It is further classified into two major categories based on location: insertional and non-insertional. Patellar tendinopathy is sometimes called jumper's knee, since it is common in sports involving frequent jumping (e.g. volleyball, basketball). However, it is also common in runners.

Several biomechanical risk factors have been linked to development of both aforementioned conditions. These include unequal leg length, poor plantar flexor flexibility, strength imbalances, sudden changes in training load, inappropriate footwear, poor running technique and excessive foot pronation during stance phase, with the latter perhaps being the most significant in Achilles tendinopathy. In patellar tendinopathy, the volume of training (particularly the volume of jumping tasks) seems to play a much bigger role (Rutland et al., 2010).

Plantar fasciitis

Plantar fasciitis is one of the most common causes of pain in the foot. In the general population, it is most frequent at ages 40-60, whereas runners are at the greatest risk at younger ages. Pain is usually limited to the posterior part of the foot, under the heel. It is exacerbated while taking the first few steps after longer inactivity (Waclawski, Beach, Milne, Yacyshyn, & Dryden, 2015). The origin of the pain is the plantar fascia, a connective tissue spanning from the inferior surface of the calcaneus towards the bones in the front of the foot. It was thought that plantar fasciitis is caused by the inflammation of the fascia. Today, the majority of experts believe that degenerative changes are responsible for the onset of injury. A study by Lemont, Ammirati, and Usen (2003) showed an absence of inflammation in samples collected during plantar fasciitis surgery. As with tendinopathies, the dilemma of inflammation versus degenerative changes is not entirely closed, but does lean to the degeneration theory side.

Knowledge of the predictors for sustaining plantar fasciitis is limited. A recent meta-analysis found only an increased body mass index to postulate a higher risk. Other frequently listed risk factors include excessive foot pronation during the stance phase, high foot arch and tight Achilles tendon (Goff & Crawford, 2011).

Many interventions for treating plantar fasciitis have been advocated, but few have been proven effective. Stretching of the Achilles tendon and plantar fascia is generally a good idea, along with strengthening calf muscles. Other non-surgical treatment options are corticosteroid injections, plantar iontophoresis, and extracorporeal shock wave therapy (Molloy, 2012).

Iliotibial band syndrome

Iliotibial band (ITB) syndrome is an injury often associated with running, though it is also common in cycling, weight lifting, skiing, and soccer (Lucas, 1992). ITB is a connective tissue on the lateral aspect of the leg, extending from the pelvis to the knee, entering the lateral tibial condyle. It encompasses the m. tensor fascia latae and is connected to the muscles of the gluteal region and to the lumbar fascia. The pain in ITB syndrome is present around the lateral side of the distal femur, between the lateral femoral condyle and ITB.

ITB syndrome was strongly believed to be caused by repeated rubbing of the band over the lateral femoral epicondyle during flexion-extension cycle, which would cause inflammation of the local bursa or the band itself. In the past decade, several authors have expressed disagreement with this theory. Fairclough et al. (2007), for example, pointed out that ITB movement across the epicondyle is probably an illusion and that only a tension shift from anterior to posterior part of the distal ITB occurs. However, they stated that some medial-lateral movement is present. When the tract moves medially, it compresses the intermediary tissues, which are highly innervated; therefore, they are a good candidate for a pain source.

Kinematic risk factors, associated with ITB syndrome include excessive hip adduction, excessive peak knee internal rotation, and excessive peak trunk ipsilateral flexion during stance phase (Aderem & Louw, 2015). Fredericson et al. (2000) found that long distance runners with ITB syndrome had lower hip abduction strength of the affected leg compared to the unaffected leg and compared to unaffected runners. In contrast, Grau, Krauss, Maiwald, Best, and Horstmann (2008) found no difference in either abduction or adduction strength comparing runners with ITB syndrome with controls. A trial by Willy and Davis (2011) may support this. Their hip-strengthening intervention significantly increased hip abduction and external rotation strength but did not correct the excessive hip adduction during the stance (all the participants in the study were exhibiting increased hip adduction prior to intervention).

Other more or less proven risk factors are tightness of the ITB, increased knee flexion range of motion during stance phase and the dominance of the quadriceps over the hamstrings (Lavine, 2010).

Patellofemoral syndrome

As with many other conditions, there is a lack of universal definition for PFS. It can be described as a painful condition that involves patella and patellar retinaculum, with no apparent specific cause (Holmes & Clancy, 1998). It is often mistaken for patellar chondromalacia, a condition with similar symptoms, but differentiated from PFS by patellar cartilage damage and softening (Salehi, Khazaeli, Hatami, & Malekpour, 2010). The term "runner's knee" is often used when referring to PFS, but we do not recommend using it, since it has been attributed to other conditions. PFS is characterized by pain around patella and sometimes by crepitation in the knee. The pain is exacerbated with squatting, running, cycling and sitting with flexed knees for prolonged period (Heintjes et al., 2004).

UDC 796.412.5:613.64

The primary culprit for PFS development is probably patellar maltracking. In the majority of cases, the patella is translated laterally during knee flexion. The causes of maltracking are a matter of debate. Pal et al. (2011) found that delayed activation of vastus medialis is one of the possibilities. Maltracking can also be a result of structural abnormalities, such as the increased Q-angle (the angle between femur and tibia). However, of all known risk factors, dynamic knee valgus should perhaps be the primary concern, as it could be eliminated or minimized with proper interventions (Ford et al., 2015). Increased foot pronation during the stance phase and weakness of the hip abductors can both elicit a knee valgus, and both were found to be a predictor for PFS. Moreover, women exhibit knee valgus more often and have a significantly higher risk for PFS (Petersen et al., 2014). This is another reason to consider dynamic valgus when attempting to treat or prevent PFS.

PFS is mostly treated conservatively. Sometimes, it recedes with sufficient rest and progressive return to activity. Recommendations for exercise selection are mixed. In their systematic review, Bolgla and Boling (2011) concluded that quadriceps strengthening is the only proven method for eliminating PFS. Hip strengthening protocols also appear promising.

Stress fractures

Repeated submaximal loading on the bones can result in stress fractures. Microscopic injuries develop and accumulate over time, leading to macro-structural breakdown. Stress fractures are most frequent in lower limbs and spine. The pain associated with a stress fracture is usually localized and subsides with rest. Progress through successive workouts is common. Runners and military recruits are at highest risk (Welck, Hayes, Pastides, Khan, & Rudge, 2015). Additionally, females are affected much more often than males are (with estimated incidences of 9.8% and 6.5%, respectively) (Wentz, Liu, Haymes, & Ilich, 2011). This may be attributed to gender-related risk factors, such as the female athlete triad (a syndrome of three interrelated conditions: amenorrhea, eating disorders, and low bone mineral density) (Nattiv et al., 2007).

Tibial stress fractures are most prevalent in runners (Lopes et al., 2012). As said before, if the pain is spread over a larger surface of the tibia, it is more likely to be caused by MTSS. Heel-strike technique and increased ground reaction forces are most often linked to increased incidence for sustaining tibial stress fractures. Milner, Ferber, Pollard, Hamill, and Davis (2006) found female runners with tibial stress fracture history to exhibit increased ground reaction force-related parameters (instantaneous and average vertical loading rates, and tibial shock, i.e. a measure of peak positive acceleration of the tibia). The same conclusions were reached in a research design for runners in general (Davis, Milner, & Hamill, 2004).

Prevention of Running Injuries

We have seen that many injuries share common risk factors, with ground reaction forces, excessive foot pronation, and excessive hip adduction during stance phase being mentioned the most often. Some problematic kinematic abnormalities are shown in Figure 2. One might suspect that designing prevention program should be fairly straightforward, or that there are many interventions proven to lower running injury risks.

FIGURE 2 Kinematic parameters, associated with increased injury risk

Legend:
1 – Pelvic drop
2 – Hip adduction
3 – Knee valgus
4 – Foot pronation

Possibly the most comprehensive review of the literature, regarding running injury prevention, is the one done by Yeung, Yeung, and Gillespie (2011). They focused only on soft-tissue injuries but included a wide range of interventions in their systematic search and further analysis. Twenty-five trials were identified, with the participants being military recruits (19 trials), runners (3 trials), prisoners (2 trials) and soccer referees (1 trial). Strong evidence for a preventative effect was found only for wearing a knee brace. There was also some moderate evidence for the effectiveness of heel pads. No evidence was found to support the preventative effects of stretching, strengthening or balance exercises. The authors concluded that the evidence for the effectiveness of interventions for preventing running injuries is weak and limited. Enke and Gallas (2012) reviewed the literature on treating and preventing four of the more common running injuries: MTSS, PFS, ITB syndrome, and Achilles tendinitis. Concerning prevention, they concluded that individualized programs should be formed, based on the risk factors an athlete is exhibiting. Craig (2008) focused on prevention of MTSS in his systematic review. The interventions found were shock-absorbing insoles, foam heel pads, Achilles tendon stretching, footwear selection, and graduated running programs. None of these prevention methods was effective. Shock-absorbing insoles were the most promising.

Additionally, Saragiotto et al. (2014) reviewed the studies that investigated risk factors for sustaining running-related injuries in general. The main risk factor identified was a previous injury. Weekly distance, weekly training frequency, and increased Q-angle were the only other risk factors identified in at least two trials. Reducing training volume is probably an effective, but impractical method for most runners, especially professionals. Rudzki (1997) showed that reducing the running distance (and adding more weighted marching instead) results in lower injury rates among military recruits. These findings are clearly not relevant for runners, but if they are able to afford some cross-training, they could lower the injury risk.

Certainly, there are interventions that could benefit almost all runners. For instance, lowering ground reaction forces is a good idea in general. Clansey, Hanlon, Wallace, Nevill, and Lake (2014) successfully reduced ground reaction forces-related parameters with gait retraining method. They used what is referred to as biofeedback or real-time feedback method. Participants ran on a treadmill, receiving information about peak tibial acceleration. They were instructed to correct the technique in a way to minimize this parameter. After only six 20-minute sessions spread over three weeks, peak tibial acceleration and both average and instantaneous vertical force loading rates were significantly decreased. Crowell and Davis (2011) managed to lower the same three parameters in their trial. What is more, the reductions were preserved until one-month follow-up measurements. It seems that feedback methods could provide an effective way to lower ground reaction forces and thus reducing injury risk.

Sharma et al. (2014) combined biofeedback methods with an exercise program. This combination substantially reduced the incidence for sustaining MTSS among military recruits over 26 weeks of a military training program. The exercises used were (unlike in most other, unsuccessful, trials) judiciously chosen. Some good examples include bird dog, single-leg squats, drop jumps, single-leg hops, star-excursion stability exercise (touching several marked points on the ground with the free leg in single-leg stance), hip flexors stretch, hip extensors stretch and ankle plantar flexors stretch.

Snyder, Earl, O'Connor, and Ebersole (2009) conducted an interesting trial. Participants underwent a six-week resistance training intervention (3 training sessions per week) that included three exercises in one-legged support: pelvic rotation in the frontal plane, and two hip rotation exercises, with different directions of the load applied by cables. Participants exhibited lower foot pronation but greater hip adduction range of motion during running after the intervention. This is another indication that prior assessment of the athlete should be carried out in order to identify which (if any) risk factors he/she is exhibiting. This intervention may benefit runners with excessive pronation but may do even more harm to those exhibiting excessive hip adduction. Another important aspect of individualized treatment is footwear selection. Motion control shoes, for instance, do reduce injury rates, but only in runners with excessive foot pronation (Malisoux et al., 2016).

Since the greatest risk factors for sustaining running-related injury are mostly unmodifiable (e.g. previous injury, training volume), it seems that individualized treatment is the best approach to prevention. Every individual needs to be assessed in order to find risk factors he/she is exhibiting. Then, these factors should be addressed with appropriate interventions. Such an approach would likely be more effective than generalized prevention programs.

Conclusion

Runners are particularly prone to developing overuse injuries. Evidence regarding prevention methods is weak and limited, with only a few interventions showing benefits. Two of the greatest risk factors are previous injury and training volume. We obviously cannot control the first, while training volume may be modifiable in recreational runners. It seems that designing individualized prevention programs is the best bet for now. Methods for gait retraining are showing some promising results for reducing ground impact forces. More trials to evaluate the effects of interventions on risk factors are desired, along with incidence studies, to determine the direct impact of interventions on injury risk.

UDC 796.412.5:613.64

REFERENCES

Ackermann, P. W., & Renstrom, P. (2012). Tendinopathy in sport. *Sports Health*, 4(3), 193-201.

Aderem, J., & Louw, Q. A. (2015). Biomechanical risk factors associated with iliotibial band syndrome in runners: a systematic review. *BMC Musculoskeletal Disorders*, 16(1), 356.

Anderson, T. (1996). Biomechanics and running economy. *Sports Medicine*, 22(2), 76-89.

Andres, B. M., & Murrell, G. A. (2008). Treatment of tendinopathy: what works, what does not, and what is on the horizon. *Clinical Orthopaedics and Related Research*, 466(7), 1539-1554.

Bolgla, L. A., & Boling, M. C. (2011). An update for the conservative management of patellofemoral pain syndrome: a systematic review of the literature from 2000 to 2010. *International Journal of Sports Physical Therapy*, 6(2), 112-125.

Clansey, A. C., Hanlon, M., Wallace, E. S., Nevill, A., & Lake, M. J. (2014). Influence of tibial shock feedback training on impact loading and running economy. *Medicine & Science in Sports & Exercise*, 46(5), 973-981.

Craig, D. I. (2008). Medial tibial stress syndrome: evidence-based prevention. *Journal of Athletic Training*, 43(3), 316-318.

Crowell, H. P., & Davis, I. S. (2011). Gait retraining to reduce lower extremity loading in runners. *Clinical Biomechanics*, 26(1), 78-83.

Davis, I., Milner, C.E., & Hamill, J. (2004). Does increased loading during running lead to tibial stress fractures? A prospective study *Medicine & Science in Sports & Exercise*, 36(5), S58.

DiFiori, J. P., Benjamin, H. J., Brenner, J. S., Gregory, A., Jayanthi, N., Landry, G. L., & Luke, A. (2014). Overuse injuries and burnout in youth sports: a position statement from the American Medical Society for Sports Medicine. *British Journal of Sports Medicine*, 48(4), 287-288.

Dugan, S. A., & Bhat, K. P. (2005). Biomechanics and analysis of running gait. *Physical Medicine and Rehabilitation Clinics of North America*, 16(3), 603-621.

Enke, R. C., & Gallas, J. E. (2012). Diagnosis, Treatment, and Prevention of Common Running Injuries. *The Journal of Clinical Outcomes Management*, 19(2), 86-94.

Fairclough, J., Hayashi, K., Toumi, H., Lyons, K., Bydder, G., Phillips, N., Best, T.M. & Benjamin, M. (2007). Is iliotibial band syndrome really a friction syndrome? *Journal of Science and Medicine in Sport*, 10(2), 74-76.

Ford, K. R., Nguyen, A. D., Dischiavi, S. L., Hegedus, E. J., Zuk, E. F., & Taylor, J. B. (2015). An evidence-based review of hip-focused neuromuscular exercise interventions to address dynamic lower extremity valgus. *Open Access Journal of Sports Medicine*, 6, 291-303.

Franklyn, M., & Oakes, B. (2015). Aetiology and mechanisms of injury in medial tibial stress syndrome: Current and future developments. *World Journal of Orthopedics*, 6(8), 577-589.

Fredericson, M., Cookingham, C. L., Chaudhari, A. M., Dowdell, B. C., Oestreicher, N., & Sahrmann, S. A. (2000). Hip abductor weakness in distance runners with iliotibial band syndrome. *Clinical Journal of Sport Medicine*, 10(3), 169-175.

Galbraith, R. M., & Lavallee, M. E. (2009). Medial tibial stress syndrome: conservative treatment options. *Current Reviews in Musculoskeletal Medicine*, 2(3), 127-133.

Goff, J. D., & Crawford, R. (2011). Diagnosis and treatment of plantar fasciitis. *American Family Physician*, 84(6), 676-682.

Grau, S., Krauss, I., Maiwald, C., Best, R., & Horstmann, T. (2008). Hip abductor weakness is not the cause for iliotibial band syndrome. *International Journal of Sports Medicine*, 29(7), 579-583.

Hamner, S. R., Seth, A., & Delp, S. L. (2010). Muscle contributions to propulsion and support during running. *Journal of Biomechanics*, 43(14), 2709-2716.

Heintjes, E., Berger, M. Y., Bierma-Zeinstra, S. M., Bernsen, R. M., Verhaar, J. A., & Koes, B. W. (2004). Pharmacotherapy for patellofemoral pain syndrome. *The Cochrane Database of Systematic Reviews* (3), CD003470.

Holmes, S. W., Jr., & Clancy, W. G., Jr. (1998). Clinical classification of patellofemoral pain and dysfunction. *Journal of Orthopaedic and Sports Physical Therapy*, 28(5), 299-306.

Johnston, C. A., Taunton, J. E., Lloyd-Smith, D. R., & McKenzie, D. C. (2003). Preventing running injuries. Practical approach for family doctors. *Canadian Family Physician*, 49, 1101-1109.

Kurppa, K., Waris, P., & Rokkanen, P. (1979). Peritendinitis and tenosynovitis. A review. *Scandinavian Journal of Work, Environment & Health*, 5(3), 19-24.

Lavine, R. (2010). Iliotibial band friction syndrome. *Current Reviews in Musculoskeletal Medicine*, 3(1-4), 18-22.

Lemont, H., Ammirati, K. M., & Usen, N. (2003). Plantar fasciitis: a degenerative process (fasciosis) without inflammation. *Journal of the American Podiatric Medical Association*, 93(3), 234-237.

Lopes, A. D., Junior, L. C. H., Yeung, S. S., & Costa, L. O. P. (2012). What are the Main Running-Related Musculoskeletal Injuries? *Sports Medicine*, 42(10), 891-905.

Lucas, C. A. (1992). Iliotibial band friction syndrome as exhibited in athletes. *Journal of Athletic Training*, 27(3), 250-252.

Malisoux, L., Chambon, N., Delattre, N., Gueguen, N., Urhausen, A., & Theisen, D. (2016). Injury risk in runners using standard or motion control shoes: a randomised controlled trial with participant and assessor blinding. *British Journal of Sports Medicine*, 50(8), 481-487.

McCarty, E. C., Walsh, W. M., Hald, R. D., Peter, L. E., & Mellion, M. B. (2010). *Musculoskeletal Injuries in Sports*. In M. C. Madden, M. Putukian, C. C. Young & E. C. McCarty (Eds.), Netter's Sports Medicine (299-303). Philadelphia, US: Saunders/Elsevier.

Milner, C. E., Ferber, R., Pollard, C. D., Hamill, J., & Davis, I. S. (2006). Biomechanical factors associated with tibial stress fracture in female runners. *Medicine & Science in Sports & Exercise*, 38(2), 323-328.

Molloy, L. A. (2012). Managing chronic plantar fasciitis: when conservative strategies fail. *Journal of the American Academy of Physician Assistants*, 25(11), 48, 50, 52-43.

Morley, J. B., Decker, L. M., Dierks, T., Blanke, D., French, J. A., & Stergiou, N. (2010). Effects of varying amounts of pronation on the mediolateral ground reaction forces during barefoot versus shod running. *Journal of Applied Biomechanics*, 26(2), 205-214.

Nattiv, A., Loucks, A. B., Manore, M. M., Sanborn, C. F., Sundgot-Borgen, J., Warren, M. P., & American College of Sports, Medicine. (2007). American College of Sports Medicine position stand. The female athlete triad. *Medicine & Science in Sports & Exercise*, 39(10), 1867-1882

Newman, P., Witchalls, J., Waddington, G., & Adams, R. (2013). Risk factors associated with medial tibial stress syndrome in runners: a systematic review and meta-analysis. *Open Access Journal of Sports Medicine,* 4, 229-241.

Nicola, T. L., & El Shami, A. (2012). Rehabilitation of running injuries. *Clinical Journal of Sport Medicine*, 31(2), 351-372.

Nicola, T. L., & Jewison, D. J. (2012). The anatomy and biomechanics of running. *Clinical Journal of Sport Medicine*, 31(2), 187-201.

Novacheck, T. F. (1998). The biomechanics of running. *Gait & Posture*, 7(1), 77-95.

Pal, S., Draper, C. E., Fredericson, M., Gold, G. E., Delp, S. L., Beaupre, G. S., & Besier, T. F. (2011). Patellar maltracking correlates with vastus medialis activation delay in patellofemoral pain patients. *The American Journal of Sports Medicine*, 39(3), 590-598.

Petersen, W., Ellermann, A., Gosele-Koppenburg, A., Best, R., Rembitzki, I. V., Bruggemann, G. P., & Liebau, C. (2014). Patellofemoral pain syndrome. *Knee Surgery, Sports Traumatology, Arthroscopy*, 22(10), 2264-2274.

Pink, M., Perry, J., Houglum, P. A., & Devine, D. J. (1994). Lower extremity range of motion in the recreational sport runner. *The American Journal of Sports Medicine*, 22(4), 541-549.

Powers, C. M. (2003). The influence of altered lower-extremity kinematics on patellofemoral joint dysfunction: a theoretical perspective. *Journal of Orthopaedic and Sports Physical Therapy*, 33(11), 639-646.

Putukian, M., McCarty, E. C., & Sebastianelli, W. (2010). *Football.* In M. C. Madden, M. Putukian, C. C. Young & E. C. McCarty (Eds.), Netter's Sports Medicine. Philadelphia, US: Saunders/Elsevier.

Rees, J. D., Maffulli, N., & Cook, J. (2009). Management of tendinopathy. *The American Journal of Sports Medicine*, 37(9), 1855-1867.

Roos, K. G., & Marshall, S. W. (2014). Definition and usage of the term "overuse injury" in the US high school and collegiate sport epidemiology literature: a systematic review. *Sports Medicine*, 44(3), 405-421.

Rudzki, S. J. (1997). Injuries in Australian Army recruits. Part I: Decreased incidence and severity of injury seen with reduced running distance. *Military Medicine*, 162(7), 472-476.

Rutland, M., O'Connell, D., Brismee, J. M., Sizer, P., Apte, G., & O'Connell, J. (2010). Evidence-supported rehabilitation of patellar tendinopathy. *North American Journal of Sports Physical Therapy*, 5(3), 166-178.

Salehi, I., Khazaeli, S., Hatami, P., & Malekpour, M. (2010). Bone density in patients with chondromalacia patella. *Rheumatology International*, 30(8), 1137-1138.

Saragiotto, B. T., Yamato, T. P., Hespanhol Junior, L. C., Rainbow, M. J., Davis, I. S., & Lopes, A. D. (2014). What are the main risk factors for running-related injuries? *Sports Medicine*, 44(8), 1153-1163.

Sharma, J., Weston, M., Batterham, A. M., & Spears, I. R. (2014). Gait retraining and incidence of medial tibial stress syndrome in army recruits. *Medicine & Science in Sports & Exercise*, 46(9), 1684-1692.

Snyder, K. R., Earl, J. E., O'Connor, K. M., & Ebersole, K. T. (2009). Resistance training is accompanied by increases in hip strength and changes in lower extremity biomechanics during running. *Clinical Biomechanics*, 24(1), 26-34.

Verdini, F., Marcucci, M., Benedetti, M. G., & Leo, T. (2006). Identification and characterisation of heel strike transient. *Gait & Posture*, 24(1), 77-84.

Videbaek, S., Bueno, A. M., Nielsen, R. O., & Rasmussen, S. (2015). Incidence of Running-Related Injuries Per 1000 h of running in Different Types of Runners: A Systematic Review and Meta-Analysis. *Sports Medicine*, 45(7), 1017-1026.

Waclawski, E. R., Beach, J., Milne, A., Yacyshyn, E., & Dryden, D. M. (2015). Systematic review: plantar fasciitis and prolonged weight bearing. *Occupational Medicine*, 65(2), 97-106.

Welck, M. J., Hayes, T., Pastides, P., Khan, W., & Rudge, B. (2015). Stress fractures of the foot and ankle. *Injury*, 15, 343-345.

Wentz, L., Liu, P. Y., Haymes, E., & Ilich, J. Z. (2011). Females have a greater incidence of stress fractures than males in both military and athletic populations: a systemic review. *Military Medicine*, 176(4), 420-430.

Williams, P. T., & Thompson, P. D. (2013). Walking versus running for hypertension, cholesterol, and diabetes mellitus risk reduction. *Arteriosclerosis, Thrombosis, and Vascular Biology*, 33(5), 1085-1091.

Willy, R. W., & Davis, I. S. (2011). The effect of a hip-strengthening program on mechanics during running and during a single-leg squat. *Journal of Orthopaedic and Sports Physical Therapy*, 41(9), 625-632.

Yeung, S. S., Yeung, E. W., & Gillespie, L. D. (2011). Interventions for preventing lower limb soft-tissue running injuries. *The Cochrane Database of Systematic Reviews* (7), CD001256.

Zadpoor, A. A., & Nikooyan, A. A. (2011). The relationship between lower-extremity stress fractures and the ground reaction force: a systematic review. *Clinical Biomechanics,* 26(1), 23-28.

UDC 796.412.5:613.64

Functional-Strengthening: A Pilot Study on Balance Control Improvement in Community-Dwelling Older Adults

Micah D. Josephson[1] and John G. Williams[2]

Affiliations: [1]University of Delaware, Department of Kinesiology and Applied Physiology, Newark, DE, USA, [2]West Chester University of Pennsylvania, Department of Kinesiology, West Chester, PA, USA

Correspondence: Micah Josephson, University of Delaware, Department of Kinesiology and Applied Physiology, 541 S. College Ave, 156 Human Performance Lab, Newark, DE, USA 19716. E-mail: micahj@udel.edu

ABSTRACT Adults over the age of 65 have a 1 in 3 chance of falling; in 2012, more than $30 billion was spent on medical costs due to these falls. The division of resistance training and neuromotor training balance improvement interventions has shown to yield low to moderate results. Athletes combine both resistance training and skill development (function) training to improve skilled performance. Older adults may not be performing high-level sports activities, but still require strength, power, and functional fitness levels to perform relatively high-level skills. The purpose of this study was to determine the effects of combining resistance and functional training into functional-strength training on dynamic balance control in moderately active older adults. Eighteen healthy older adults were divided into three groups; functional resistance, standard resistance, and control. All groups met for their intervention twice a week for six weeks. Dynamic balance was assessed using the Fullerton Advanced Balance Scale (0-40). Results of individual paired T-tests showed a significant improvement in balance control in the functional resistance group ($t(5) = -3.492$, $p = .017$) and a very large effect size ($d = 1.33$) whereas neither the standard resistance nor control group had a significant reduction in the risk of falls. Manipulating multidimensional, neuromotor function during resistance training exercises is an effective method of applying the overload principle in order to reduce falls risk in moderately active seniors.

KEY WORDS Neuromotor, ADL, Falls risk, Overload progression, Functional training.

@MJSSMontenegro
FUNCTIONAL-STRENGTHENING
http://mjssm.me/?sekcija=article&artid=145

Introduction

Older Adults have a one in three chance of falling during daily activities (Stevens et al., 2012). Balance control is a critical factor in fall risk, and various authoritative bodies have addressed the issue. Research using exercise to enhance balance has taken many forms, applying various low to moderate intensity interventions. These interventions resulted in low to modest outcomes (Buchner et al., 1997; Means, Rodell, O'Sullivan, & Cranford, 1996; Topp, Mikesky, Wigglesworth, Holt, & Edwards, 1993). In contrast, balance-specific interventions particularly those including strength training have produced positive results (Islam et al., 2004).

Contrary to the latest balance recommendations from the Panel on Prevention (PoP) (Kenny et al., 2011), research shows that standard resistance training has a functional ceiling (Hazell, Kenno, & Jakobi, 2007; Sayers, 2007). If the reported research concludes that the balance:function relationship is not improved through standard resistance training, then it seems that critical dimensions of what is clearly an important motor skill have not been considered.

Combining the multidimensional nature of the balance:skill with standard resistance training can address both the PoP's recommendations and the need for motor skill development. Using progressive overload methods, the exercises can be intensified through normal methodology or a change in stability or complexity. Such techniques have been shown to be an effective means of improving performance in a variety of sports. (Henry, 2011; Myer, Ford, Palumbo, & Hewett, 2005).

Accepted after revision: September 22 2016 | First published online: September 01 2017

Conflict of interest: This research was supported in part by the Student-Faculty Research Grant from West Chester University.

This study was a comparative analysis of a conventional strength training regimen with a "functional" strength training program designed to emphasize balance as a dynamic skill. We predicted that a "functional" training group would show a greater improvement in balance than both the conventional strength training and the control groups.

Methods

Participants

Participants were recruited from a local health club. For participation, responders had to be over 65 years old and not have had any lower body injuries in the previous 12 months or a hip or knee replacement. Eighteen (n=15 women/n=3 men) community-dwelling subjects met the criteria, provided informed consent, and participated in this study. All participants attended senior fitness classes at least three days per week and performed other strengthening and cardiovascular exercise to maintain a moderate level of physical activity as defined by the American College of Sports Medicine (ACSM). The project was approved by the West Chester University of Pennsylvania Institutional Research Board. The mean age was 75.9 (+5.1) years.

Design

This study was a three-group pre- to post- training design. Participants were randomly assigned to intervention groups. Each group attended two exercise classes per week for six weeks for thirty to forty-five minutes at approximately the same time of the day. All three groups met simultaneously and performed their intervention in separate areas of the facility to keep them blind to the other exercises. The exercise programs were delivered by appropriately qualified exercise science certified instructors. The focus was the lower limb function. Groups had a single program progression after three weeks. Participants were assessed pre- and post-training with the Long-Form Fullerton Advanced Balance (FABS) scale. This is a ten-item assessment system developed and validated previously to assess multiple components of balance. It is scored 0-40 with a higher score indicating greater balance control. (Rose, Lucchese, & Wiersma, 2006).

Functional Group (FG)

The FG program was an exercise circuit consisting of seven exercises. Subjects completed the circuit twice and completed eight repetitions of each exercise prior to moving to the next station. The circuit consisted of: (1) Sit-to-stands with feet on a VersaBalance™ pad with a 3.64 kg (8 lb) weight; (2) Step-ups with 5-2 inch risers and a 2.73 kg (6 lb) weight in each hand; (3) Split squats holding onto a support bar; (4) Forty steps of foot heel-to-toe farmer's walks with a 5.54 kg (12 lb) weight in one hand; (5) Standing hip abduction; (6) Standing heel-raises.

In week four, the exercises were progressed to (1) Squats while standing on a VersaBalance™ pad with a 4.55 kg (10 lb) weight; (2) Crossover step-ups with 3.64 kg (8 lb) weights in each hand; (3) Single-leg heel-raises; (4) Split-squats front leg on an Airex mat; (5) Standing long jumps; (6) Forty-foot heel-to-toe farmer's walks with a 6.82 kg (15 lb) weight in one hand; a 187.42 cm (73 in) VersaBalance™ beam was laid out at the twenty-foot mark; (7) One leg-to-one leg lateral jumps. Exercises were modified to allow for individual differences among participants.

Strength group (SG)

The SG exercised in a sets and repetitions program working around a "pin-selectorized", weight-rack apparatus. Two sets of eight repetitions of each exercise were performed at a subject-selected weight, with a 90-second rest interval between each set. The exercises consisted of (1) Seated leg press; (2) Standing hip extension; (3) Seated leg-curl; (4) Seated hip-abduction; (5) Seated hip-adduction; (6) Straight leg heel-raises on seated leg press; (7) Seated knee extension. The leg press, knee extension, leg curl, and heel raise all became unilateral movements. Resistance was increased when the participant could complete both sets comfortably.

Control group (CG)

The CG carried out a seven flexibility/range-of-motion exercise course. For six weeks, the participants performed the same exercises: (1) Figure-four hip-stretch; (2) Seated hamstring stretch; (3) Chair lunge-stretch; (4) Standing chair calf stretch; (5) Standing quadriceps stretch; (6) V-sit inner thigh stretch; (7) Angry cat dynamic stretch. Exercises 1 to 5 were performed either seated in a chair or holding onto a chair for support. Exercises 6 and 7 were performed on the floor.

Statistical analysis

The scores for the FAB were totaled, and data were analysed in SPSS 21. Descriptive statistics were calculated for the pre- and post-training values. As the sample size was that of a pilot study, paired t-tests were performed on each group individually to determine the significance of each intervention group.

Results

Pre-training there were no statistically significant differences in FABS score between the three groups ($F=3.008$, $p>.05$). The overall adherence level was 76 % (± 21%) of exercise sessions, and no statistically significant differences were found between the groups.

UDC 796.015-053.9

TABLE 1 Risk of fall in moderately active older adults pre- and post-exercise intervention

Exercise Condition	Pre- to Post-score change	Adherence	Effect-size
Functional	3.33 (±2.3)*	81% (±20%)	1.33 (very large)**
Conventional	1.0 (±3.4)	73% (±21%)	0.07 (negligible)
Control	.83(±1.7)	75% (±27%)	

Legend: Descriptive statistics (FABS values) under the exercise intervention conditions pre- to post–training. **Cohen's d, (5)= -1.185, p=.289, *significant: t(5) =-3.492, p=.017**.

Of the 18 participants, 10 changed in a positive direction, 4 showed no change, 3 changed in a negative direction, and 1 did not complete the protocol. All groups improved FABS performance at program completion. The FG had a statistically significant 3.33-point improvement in balance control (t(5)-3.492, p=.017); the SG had a 1.0 improvement in balance, and the control group had a 0.83 improvement in balance. Cohen's D was used to compare the effect size of each intervention. Effect size was found to be very large in the functional training group and negligible in the conventional strength group when compared to the control (d=1.33, .07 respectively). These can be observed in Table 1. Figure 1 shows pre- and post-FABS score for each group.

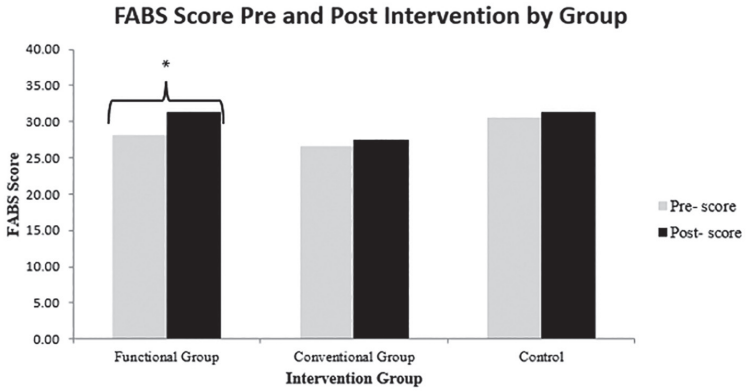


FIGURE 1 Neither the conventional strengthening group (FABS scores: 26.6 to 27.4) or the control group (FABS scores: 30.5 to 31.3) had significant improvements in dynamic balance control pre- to post-intervention. The functional strengthening group showed significant improvements in dynamic balance control pre- to post-intervention (FABS scores: 28 to 31.1; *t(5) =-3.492, p=.017)

Discussion

Functional strength training (FT) was an effective balance intervention, as observed through the "large" effect size. Conventional strength training (CT), as described earlier, alone does not produce significant improvement in balance. Here, neither the CT group nor controls showed statistically significant or clinical changes (effect size) whereas the FT group had a mean change in score of 3.33 (+1.33). In line with the findings of Buchner et al. (1996), functional strength training combining both interventions types yielded a large clinical effect. Therefore, it can be stated that functional strength training is an effective method of applying the overload principle to increase balance control.

This study was limited by its small sample size and current activity level of the participants. These subjects may not necessarily represent the average older adult population. Future studies targeting a sedentary population may show greater improvement with FT.

This type of functional training, unexplored in academic research, has been common practice in the fitness industry for decades. In research, functional training is typically discussed with the interest of sports performance enhancement. In this study, the "sport" is activities of daily living with particular focus on the skill of balance control.

Acknowledgements

Ellis Athletic Center of Newtown Square, PA for the use of the facility.

REFERENCES

Buchner, D. M., Cress, M. E., de Lateur, B. J., Esselman, P. C., Margherita, J., Price, R., & Wagner, E. H. (1997). The effect of strength and endurance training on gait, balance, fall risk, and health services use in community-living older adults. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, *52*(4), M218–M224.

Hazell, T., Kenno, K., & Jakobi, J. (2007). Functional benefit of power training for older adults. *Journal of Aging and Physical Activity*, *15*(3), 349–359.

Henry, T. (2011). Resistance Training for Judo: Functional Strength Training Concepts and Principles. *Strength and Conditioning Journal*, *33*(6), 40–49. http://doi.org/10.1519/ SSC.0b013e31823a6675

Islam, M. M., Nasu, E., Rogers, M. E., Koizumi, D., Rogers, N. L., & Takeshima, N. (2004). Effects of combined sensory and muscular training on balance in Japanese older adults. *Preventive Medicine*, *39*(6), 1148–1155. http://doi.org/10. 1016/j.ypmed.2004.04.048

Kenny, R. A., Rubenstein, L. Z., Tinetti, M. E., Brewer, K., Cameron, K. A., Capezuti, L., … Peterson, E. W. (2011). Summary of the Updated American Geriatrics Society/British Geriatrics Society clinical practice guideline for prevention of falls in older persons. *Journal of the American Geriatrics Society*, *59*(1), 148–157. http://doi.org/10. 1111/j.1532-5415.2010.03234.x

Means, K. M., Rodell, D. E., O'Sullivan, P. S., & Cranford, L. a. (1996). Rehabilitation of elderly fallers: pilot study of a low to moderate intensity exercise program. *Archives of Physical Medicine and Rehabilitation*, *77*(10), 1030–1036.

Myer, G., Ford, K., Palumbo, J., & Hewett, T. (2005). Neuromuscular training improves performance and lower-extremity biomechanics in female athletes. *Journal of Strength and Conditioning Research / National Strength & Conditioning Association*, *19*(1), 51–60.

Rose, D. J., Lucchese, N., & Wiersma, L. D. (2006). Development of a multidimensional balance scale for use with functionally independent older adults. *Archives of Physical Medicine and Rehabilitation*, *87*(11), 1478–1485. http://doi. org/10.1016/j.apmr.2006.07.263

Sayers, S. P. (2007). High-speed power training: A novel approach to resistance training older men and women. *Journal of Strength and Conditioning Research / National Strength & Conditioning Association*, *21*(2), 518–526.

Stevens, J. A., Ballesteros, M. F., Mack, K. A., Rudd, R. A., DeCaro, E., & Adler, G. (2012). Gender differences in seeking care for falls in the aged Medicare population. *American Journal of Preventive Medicine*, *43*(1), 59–62. http:// doi.org/10.1016/j.amepre.2012.03.008

Topp, R., Mikesky, A., Wigglesworth, J., Holt, W., & Edwards, J. E. (1993). The Effect of a 12-week Dynamic Resistance Strength Training Program on Gait Velocity and Balance of Older Adults. *The Gerontologist*, *33*(4), 501–506. http://doi. org/10.1093/geront/33.4.501

UDC 796.015-053.9

Guidelines for Authors

Revised July 2017

*** Please use the bookmark function to navigate within the guidelines. ***

When preparing the final version of the manuscripts, either NEW or REVISED authors should strictly follow the guidelines. Manuscripts departing substantially from the guidelines will be returned to the authors for revision or, rejected.

1. UNIFORM REQUIREMENTS

1.1. Overview

The *Montenegrin Journal of Sports Science and Medicine* (MJSSM) applies the Creative Commons Attribution (CC BY) license to articles and other works it publishes.

There is no charge for submissions and no page charge for accepted manuscripts. However, if the manuscript contains graphics in color, note that printing in color is charged.

MJSSM adopts a double-blind approach for peer reviewing in which the reviewer's name is always concealed from the submitting authors as well as the author(s)'s name from the selected reviewers.

MJSSM honors a six-weeks for an initial decision of manuscript submission.

Authors should submit the manuscripts as one Microsoft Word (.doc) file.

Manuscripts must be provided either in standard UK or US English. English standard should be consistent throughout the manuscripts.

Format the manuscript in A4 paper size; margins are 1 inch or 2.5 cm all around.

Type the whole manuscript double-spaced, justified alignment.

Use Times New Roman font, size eleven (11) point.

Number (Arabic numerals) the pages consecutively (centering at the bottom of each page), beginning with the title page as page 1 and ending with the Figure legend page.

Include line numbers (continuous) for the convenience of the reviewers.

Apart from chapter headings and sub-headings avoid any kind of formatting in the main text of the manuscripts.

1.2. Type & Length

MJSSM publishes following types of papers:

Original scientific papers are the results of empirically- or theoretically-based scientific research, which employ scientific methods, and which report experimental or observational aspects of sports science and medicine, such as all clinical aspects of exercise, health, and sport; exercise physiology and biophysical investigation of sports performance; sport biomechanics; sports nutrition; rehabilitation, physiotherapy; sports psychology; sport pedagogy, sport history, sport philosophy, sport sociology, sport management; and all aspects of scientific support of the sports coaches from the natural, social and humanistic side. Descriptive analyses or data inferences should include rigorous methodological structure as well as sound theory. Your manuscript should include the following sections: Introduction, Methods, Results, and Discussion.

☑Open Submissions ☑Indexed ☑Peer Reviewed

Original scientific papers should be:

- Up to 3000 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 30;
- Maximum combined total of 6 Tables/Figures.

Review papers should provide concise in-depth reviews of both established and new areas, based on a critical examination of the literature, analyzing the various approaches to a specific topic in all aspects of sports science and medicine, such as all clinical aspects of exercise, health, and sport; exercise physiology and biophysical investigation of sports performance; sport biomechanics; sports nutrition; rehabilitation, physiotherapy; sports psychology; sport pedagogy, sport history, sport philosophy, sport sociology, sport management; and all aspects of scientific support of the sports coaches from the natural, social and humanistic side.

☑Open Submissions ☑Indexed ☑Peer Reviewed

Review papers should be:

- Up to 6000 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 100.

Editorials are written or commissioned by the editors, but suggestions for possible topics and authors are welcome. It could be peer reviewed by two reviewers who may be external or by the Editorial Board.

☐Open Submissions ☑Indexed ☑Peer Reviewed

Editorials should be:

- Up to 1000 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 10.

Short reports of experimental work, new methods, or a preliminary report can be accepted as two page papers. Your manuscript should include the following sections: Introduction, Methods, Results, and Discussion.

☑Open Submissions ☑Indexed ☑Peer Reviewed

Short reports should be:

- Up to 1500 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 15.

Peer review - fair review provides authors who feel their paper has been unfairly rejected (at any journal) the opportunity to share reviewer comments, explain their concerns, and have their paper reviewed for possible publication in MJSSM.

☑Open Submissions ☑Indexed ☐Peer Reviewed

Peer review - fair review should be:

- Up to 1500 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 15.

Invited papers and award papers include invited papers from authors with outstanding scientific credentials. Nomination of invited authors is at the discretion of the MJSSM editorial board. MJSSM also publishes award papers selected by the scientific committee of the International Scientific Conference on Transformation Processes in Sport.

☐Open Submissions ☑Indexed ☐Peer Reviewed

Invited papers and award papers should be:

- Up to 3000 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 30;
- Maximum combined total of 6 Tables/Figures.

1.3. Submission

MJSSM only accepts electronic submission to the e-mail of the Journal Office: **office@mjssm.me**.

Submitted material includes:

- A manuscript prepared according to the Guidelines for the Authors;
- A signed form that states the study was not previously published, nor has been submitted simultaneously for consideration of publication elsewhere, that states that all of the authors are in agreement with submission of the manuscript to MJSSM, and that, for studies that use animal or human individuals, authors must include information regarding their institution's ethics committee, and which identifies the official approval number;
- A signed form that there is no conflict of interest.

Name the files according to the family name of the first author. Authors submitting revised versions of the manuscript can use the identification number of their manuscript as provided by the Journal Office. *See* example:

- ✓ FAMILY NAME-manuscript.doc – (main manuscript file)
- ✓ FAMILY NAME-statement.PDF – (authorship statement)
- ✓ FAMILY NAME-declaration.PDF – (declaration of potential conflict of interest)
- ✓ FAMILY NAME-fig1.tiff – (Figure 1)

1.4. Peer Review Process

An original manuscript submitted for publication will be submitted to the review process as long as it fits the following criteria:

- The study was not previously published, nor has been submitted simultaneously for consideration of publication elsewhere;
- All persons listed as authors approved its submission to MJSSM;
- Any person cited as a source of personal communication has approved the quote;
- The opinions expressed by the authors are their exclusive responsibility;
- The author signs a formal statement that the submitted manuscript complies with the directions and guidelines of MJSSM.

The editors-in-chief, executive editor and associate editors will make a preliminary analysis regarding the appropriateness, quality, originality and written style/grammar of the submitted manuscript. The editors reserve the right to request additional information, corrections, and guideline compliance before they submit the manuscript to the ad-hoc review process.

MJSSM uses ad-hoc reviewers, who volunteer to analyze the merit of the study. Typically, one or two expert reviewers are consulted in a double-blind process. Authors are notified by e-mail when their submission has been accepted (or rejected). Minor changes in the text may be made at the discretion of the editors-in-chief, executive editor and/or associate editors. Changes can include spelling and grammar in the chosen language, written style, journal citations, and reference guidelines. The author is notified of changes via email. The final version is available to the author for his or her approval before it is published.

1.5. Open Access License and Publisher Copyright Policies

MJSSM applies the Creative Commons Attribution (CC BY) license to articles and other works it publishes. If author(s) submit its paper for publication by MJSSM, they agree to have the CC BY license applied to their work. Under this Open Access license, the author(s) agree that anyone can reuse their article in whole or part for any purpose, for free, even for commercial purposes. Anyone may copy, distribute, or reuse the content as long as the author(s) and original source are properly cited. This facilitates freedom in re-use and also ensures that MJSSM content can be mined without barriers for the needs of research. On the other hand, the author(s) may use content owned by someone else in their article if they have written permission to do so. If the manuscript contains content such as photos, images, figures, tables, audio files, videos, et cetera, that the author(s) do not own, MJSSM will require them to provide it with proof that the owner of that content has given them written permission to use it, and has approved of the CC BY license being applied to their content. Otherwise, MJSSM will ask the author(s) to remove that content and/or replace it with other content that you own or have such permission to use. MJSSM provides a form the author(s) can use to ask for and obtain permission from the owner.

In addition, the author(s) may freely use the content they previously published in a paper through another publisher and they own the rights to that content; however, that's not necessarily the case and it depends on the license that covers the other paper. Some publishers allow free and unrestricted reuse of article content they own, such as under the CC BY license. Other publishers use licenses that allow reuse only if the same license is applied by the person or publisher reusing the content. If the article was published under a CC BY license or another license that allows free and unrestricted use, the author(s) may use the content in the submitted manuscript provided that the author(s) give proper attribution, as explained above. If the content was published under a more restrictive license, the author(s) must ascertain what rights they have under that license. MJSSM advices the author(s) not to include any content in the submitted manuscript which they do not have rights to use, and always give proper attribution.

The editors of MJSSM consider plagiarism to be a serious breach of academic ethics. Any author who practices plagiarism (in part or totality) will be suspended for six years from submitting new submissions to MJSSM. If such a manuscript is approved and published, public exposure of the article with a printed mark ("plagiarized" or "retracted") on each page of the published file, as well as suspension for future publication for at least six years, or a period determined by the editorial board. Third party plagiarized authors or institutions will be notified, informing them about the faulty authors. Plagiarism will result in immediate rejection of the manuscript.

MJSSM only publishes studies that have been approved by an institutional ethics committee (when a study involves humans or animals). Fail to provide such information prevent its publication. To ensure these requirements, it is essential that submission documentation is complete. If you have not completed this step yet, go to MJSSM website and fill out the two required documents: Declaration of Potential Conflict of Interest and Authorship Statement. Whether or not your study uses humans or animals, these documents must be completed and signed by all authors and attached as supplementary files in the originally submitted manuscript.

1.6. After Acceptance

After the manuscript has been accepted, authors will receive a PDF version of the manuscripts for authorization, as it should look in printed version of MJSSM. Authors should carefully check for omissions. Reporting errors after this point will not be possible and the Editorial Board will not be eligible for them.

Should there be any errors, authors should report them to the Office e-mail address **office@mjssm.me**. If there are not any errors authors should also write a short e-mail stating that they agree with the received version.

1.7. Code of Conduct Ethics Committee of Publications

MJSSM is hosting the Code of Conduct Ethics Committee of Publications of the **COPE** (the Committee on Publication Ethics), which provides a forum for publishers and Editors of scientific journals to discuss issues relating to the integrity of the work submitted to or published in their journals.

2. MANUSCRIPT STRUCTURE

2.1. Title Page

The first page of the manuscripts should be the title page, containing: title, type of publication, running head, authors, affiliations, corresponding author, and manuscript information. *See* example:

Transfer of Learning on a Spatial Memory Task between the Blind and Sighted People Spatial Memory among Blind and Sighted

Original Scientific Paper

Transfer of learning on a spatial memory task

Selcuk Akpinar[1], Stevo Popović[1,2], Sadettin Kirazci[1]

[1]Middle East Technical University, Physical Education and Sports Department, Ankara, Turkey
[2]University of Montenegro, Faculty for Sport and Physical Education, Niksic, Montenegro

Corresponding author:
S. Popovic
University of Montenegro
Faculty for Sport and Physical Education
Narodne omladine bb, 84000 Niksic, Montenegro
E-mail:

Word count: 2,980

Abstract word count: 236

Number of Tables: 3

Number of Figures: 3

2.1.1. Title

Title should be short and informative and the recommended length is no more than 20 words. The title should be in Title Case, written in uppercase and lowercase letters (initial uppercase for all words except articles, conjunctions, short prepositions no longer than four letters etc.) so that first letters of the words in the title are capitalized. Exceptions are words like: "and", "or", "between" etc. The word following a colon (:) or a hyphen (-) in the title is always capitalized.

2.1.2. Type of publication

Authors should suggest the type of their submission.

2.1.3. Running head

Short running title should not exceed 50 characters including spaces.

2.1.4. Authors

The form of an author's name is first name, middle initial(s), and last name. In one line list all authors with full names separated by a comma (and space). Avoid any abbreviations of academic or professional titles. If authors belong to different institutions, following a family name of the author there should be a number in superscript designating affiliation.

2.1.5. Affiliations

Affiliation consists of the name of an institution, department, city, country/territory(in this order) to which the author(s) belong and to which the presented / submitted work should be attributed. List all affiliations (each in a separate line) in the order corresponding

to the list of authors. Affiliations must be written in English, so carefully check the official English translation of the names of institutions and departments.

Only if there is more than one affiliation, should a number be given to each affiliation in order of appearance. This number should be written in superscript at the beginning of the line, separated from corresponding affiliation with a space. This number should also be put after corresponding name of the author, in superscript with no space in between.

If an author belongs to more than one institution, all corresponding superscript digits, separated with a comma with no space in between, should be present behind the family name of this author.

In case all authors belong to the same institution affiliation numbering is not needed.

Whenever possible expand your authors' affiliations with departments, or some other, specific and lower levels of organization.

2.1.6. Corresponding author

Corresponding author's name with full postal address in English and e-mail address should appear, after the affiliations. It is preferred that submitted address is institutional and not private. Corresponding author's name should include only initials of the first and middle names separated by a full stop (and a space) and the last name. Postal address should be written in the following line in sentence case. Parts of the address should be separated by a comma instead of a line break. E-mail (if possible) should be placed in the line following the postal address. Author should clearly state whether or not the e-mail should be published.

2.1.7. Manuscript information

All authors are required to provide word count (excluding title page, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References), the Abstract word count, the number of Tables, and the number of Figures.

2.2. Abstract

The second page of the manuscripts should be the abstract and key words. It should be placed on second page of the manuscripts after the standard title written in upper and lower case letters, bold.

Since abstract is independent part of your paper, all abbreviations used in the abstract should also be explained in it. If an abbreviation is used, the term should always be first written in full with the abbreviation in parentheses immediately after it. Abstract should not have any special headings (e.g., Aim, Results…).

Authors should provide up to six key words that capture the main topics of the article. Terms from the Medical Subject Headings (MeSH) list of Index Medicus are recommended to be used.

Key words should be placed on the second page of the manuscript right below the abstract, written in italic. Separate each key word by a comma (and a space). Do not put a full stop after the last key word. *See* example:

Abstract

Results of the analysis of…

Key words: spatial memory, blind, transfer of learning, feedback

2.3. Main Chapters

Starting from the third page of the manuscripts, it should be the main chapters. Depending on the type of publication main manuscript chapters may vary. The general outline is: Introduction, Methods, Results, Discussion, Acknowledgements (optional), Conflict of Interest (optional), and Title and Abstract in Montenegrin (only for the authors from former Yugoslavia, excluding Macedonians and Slovenes). However, this scheme may not be suitable for reviews or publications from some areas and authors should then adjust their chapters accordingly but use the general outline as much as possible.

2.3.1. Headings

Main chapter headings: written in bold and in Title Case. *See* example:

- ✓ **Methods**

Sub-headings: written in italic and in normal sentence case. Do not put a full stop or any other sign at the end of the title. Do not create more than one level of sub-heading. *See* example:

- ✓ *Table position of the research football team*

2.3.2 Ethics

When reporting experiments on human subjects, there must be a declaration of Ethics compliance. Inclusion of a statement such as follow in Methods section will be understood by the Editor as authors' affirmation of compliance: "This study was approved in advance by [name of committee and/or its institutional sponsor]. Each participant voluntarily provided written informed consent before participating." Authors that fail to submit an Ethics statement will be asked to resubmit the manuscripts, which may delay publication.

2.3.3 Statistics reporting

MJSSM encourages authors to report precise p-values. When possible, quantify findings and present them with appropriate indicators of measurement error or uncertainty (such as confidence intervals). Use normal text (i.e., non-capitalized, non-italic) for statistical term "p".

2.3.4. 'Acknowledgements' and 'Conflict of Interest' (optional)

All contributors who do not meet the criteria for authorship should be listed in the 'Acknowledgements' section. If applicable, in 'Conflict of Interest' section, authors must clearly disclose any grants, financial or material supports, or any sort of technical assistances from an institution, organization, group or an individual that might be perceived as leading to a conflict of interest.

2.4. References

References should be placed on a new page after the standard title written in upper and lower case letters, bold.

All information needed for each type of must be present as specified in guidelines. Authors are solely responsible for accuracy of each reference. Use authoritative source for information such as Web of Science, Medline, or PubMed to check the validity of citations.

2.4.1. References style

MJSSM adheres to the American Psychological Association 6th Edition reference style. Check "American Psychological Association. (2009). Concise rules of APA style. American Psychological Association." to ensure the manuscripts conform to this reference style. Authors using EndNote® to organize the references must convert the citations and bibliography to plain text before submission.

2.4.2. Examples for Reference citations

One work by one author

- ✓ In one study (Reilly, 1997), soccer players…
- ✓ In the study by Reilly (1997), soccer players…
- ✓ In 1997, Reilly's study of soccer players…

Works by two authors

- ✓ Duffield and Marino (2007) studied…
- ✓ In one study (Duffield & Marino, 2007), soccer players…
- ✓ In 2007, Duffield and Marino's study of soccer players…

Works by three to five authors: cite all the author names the first time the reference occurs and then subsequently include only the first author followed by et al.

- ✓ First citation: Bangsbo, Iaia, and Krustrup (2008) stated that…
- ✓ Subséquent citation: Bangsbo et al. (2008) stated that…

Works by six or more authors: cite only the name of the first author followed by et al. and the year

- ✓ Krustrup et al. (2003) studied…
- ✓ In one study (Krustrup et al., 2003), soccer players…

Two or more works in the same parenthetical citation: Citation of two or more works in the same parentheses should be listed in the order they appear in the reference list (i.e., alphabetically, then chronologically)

- ✓ Several studies (Bangsbo et al., 2008; Duffield & Marino, 2007; Reilly, 1997) suggest that…

2.4.3. Examples for Reference list

Journal article (print):

Bangsbo, J., Iaia, F. M., & Krustrup, P. (2008). The Yo-Yo intermittent recovery test: a useful tool for evaluation of physical performance in intermittent sports. *Sports Medicine, 38*(1), 37-51.

Duffield, R., & Marino, F. E. (2007). Effects of pre-cooling procedures on intermittent-sprint exercise performance in warm conditions. *European Journal of Applied Physiology, 100*(6), 727-735.

Krustrup, P., Mohr, M., Amstrup, T., Rysgaard, T., Johansen, J., Steensberg, A., . . . Bangsbo, J. (2003). The yo-yo intermittent recovery test: physiological response, reliability, and validity. *Medicine and Science in Sports and Exercise, 35*(4), 697-705.

Journal article (online; electronic version of print source):

Shaw, A. (1999). The planning and development of New Bombay [Electronic version]. *Modern Asian Studies, 33*(4), 951-988.

Journal article (online; electronic only):

Chantavanich, S. (2003, October). Recent research on human trafficking. *Kyoto Review of Southeast Asia, 4*. Retrieved November 15, 2005, from http://kyotoreview.cseas.kyoto-u.ac.jp/issue/issue3/index.html

Conference paper:

Pasadilla, G. O., & Milo, M. (2005, June 27). *Effect of liberalization on banking competition*. Paper presented at the conference on Policies to Strengthen Productivity in the Philippines, Manila, Philippines. Retrieved August 23, 2006, from http://siteresources.worldbank.org/INTPHILIPPINES/Resources/Pasadilla.pdf

Encyclopedia entry (print, with author):

Pittau, J. (1983). Meiji constitution. In *Kodansha encyclopedia of Japan* (Vol. 2, pp. 1-3). Tokyo: Kodansha.

Encyclopedia entry (online, no author):

Ethnology. (2005, July). In *The Columbia encyclopedia* (6th ed.). New York: Columbia University Press. Retrieved November 21, 2005, from http://www.bartleby.com/65/et/ethnolog.html

Thesis and dissertation:

Pyun, D. Y. (2006). *The proposed model of attitude toward advertising through sport.* Unpublished Doctoral Dissertation. Tallahassee, FL: The Florida State University.

Book:

Borg, G. (1998). *Borg's perceived exertion and pain scales*: Human kinetics.

Chapter of a book:

Kellmann, M. (2012). Chapter 31-Overtraining and recovery: Chapter taken from Routledge Handbook of Applied Sport Psychology ISBN: 978-0-203-85104-3 *Routledge Online Studies on the Olympic and Paralympic Games* (Vol. 1, pp. 292-302).

Reference to an internet source:

Agency. (2007). Water for Health: Hydration Best Practice Toolkit for Hospitals and Healthcare. Retrieved 10/29, 2013, from www.rcn.org.uk/newsevents/hydration

2.5. Tables

All tables should be included in the main manuscript file, each on a separate page right after the Reference section.

Tables should be presented as standard MS Word tables.

Number (Arabic) tables consecutively in the order of their first citation in the text.

Tables and table headings should be completely intelligible without reference to the text. Give each column a short or abbreviated heading. Authors should place explanatory matter in footnotes, not in the heading. All abbreviations appearing in a table and not considered standard must be explained in a footnote of that table. Avoid any shading or coloring in your tables and be sure that each table is cited in the text.

If you use data from another published or unpublished source, it is the authors' responsibility to obtain permission and acknowledge them fully.

2.5.1. Table heading

Table heading should be written above the table, in Title Case, and without a full stop at the end of the heading. Do not use suffix letters (e.g., Table 1a, 1b, 1c); instead, combine the related tables. *See* example:

- ✓ **Table 1.** Repeated Sprint Time Following Ingestion of Carbohydrate-Electrolyte Beverage

2.5.2. Table sub-heading

All text appearing in tables should be written beginning only with first letter of the first word in all capitals, i.e., all words for variable names, column headings etc. in tables should start with the first letter in all capitals. Avoid any formatting (e.g., bold, italic, underline) in tables.

2.5.3. Table footnotes

Table footnotes should be written below the table.

General notes explain, qualify or provide information about the table as a whole. Put explanations of abbreviations, symbols, etc. here. General notes are designated by the word *Note* (italicized) followed by a period.

- ✓ *Note.* CI: confidence interval; Con: control group; CE: carbohydrate-electrolyte group.

Specific notes explain, qualify or provide information about a particular column, row, or individual entry. To indicate specific notes, use superscript lowercase letters (e.g. $^{a, b, c}$), and order the superscripts from left to right, top to bottom. Each table's first footnote must be the superscript ^{a}.

- ✓ ^{a}One participant was diagnosed with heat illness and n = 19.^{b}n =20.

Probability notes provide the reader with the results of the texts for statistical significance. Probability notes must be indicated with consecutive use of the following symbols: * † ‡ § ¶ || etc.

- ✓ *P<0.05,†p<0.01.

2.5.4. Table citation

In the text, tables should be cited as full words. *See* example:

- ✓ Table 1 (first letter in all capitals and no full stop)
- ✓ ...as shown in Tables 1 and 3. (citing more tables at once)
- ✓ ...result has shown (Tables 1-3) that... (citing more tables at once)
- ✓ ....in our results (Tables 1, 2 and 5)... (citing more tables at once)

2.6. Figures

On the last separate page of the main manuscript file, authors should place the legends of all the figures submitted separately.

All graphic materials should be of sufficient quality for print with a minimum resolution of 600 dpi. MJSSM prefers TIFF, EPS and PNG formats.

If a figure has been published previously, acknowledge the original source and submit a written permission from the copyright holder to reproduce the material. Permission is required irrespective of authorship or publisher except for documents in the public domain. If photographs of people are used, either the subjects must not be identifiable or their pictures must be accompanied by written permission to use the photograph whenever possible permission for publication should be obtained.

Figures and figure legends should be completely intelligible without reference to the text.

The price of printing in color is 50 EUR per page as printed in an issue of MJSSM.

2.6.1. Figure legends

Figures should not contain footnotes. All information, including explanations of abbreviations must be present in figure legends. Figure legends should be written bellow the figure, in sentence case. *See* example:

- ✓ **Figure 1.** Changes in accuracy of instep football kick measured before and after fatigued. SR – resting state, SF – state of fatigue, *p>0.01, †p>0.05.

2.6.2. Figure citation

All graphic materials should be referred to as Figures in the text. Figures are cited in the text as full words. *See* example:

- ✓ Figure 1
- × figure 1
- × Figure 1.
- ✓ ….exhibit greater variance than the year before (Figure 2). Therefore…
- ✓ ….as shown in Figures 1 and 3. (citing more figures at once)
- ✓ ….result has shown (Figures 1-3) that... (citing more figures at once)
- ✓ ….in our results (Figures 1, 2 and 5)... (citing more figures at once)

2.6.3. Sub-figures

If there is a figure divided in several sub-figures, each sub-figure should be marked with a small letter, starting with a, b, c etc. The letter should be marked for each subfigure in a logical and consistent way. *See* example:

- ✓ Figure 1a
- ✓ …in Figures 1a and b we can…
- ✓ …data represent (Figures 1a-d)…

2.7. Scientific Terminology

All units of measures should conform to the International System of Units (SI).

Measurements of length, height, weight, and volume should be reported in metric units (meter, kilogram, or liter) or their decimal multiples.

Decimal places in English language are separated with a full stop and not with a comma. Thousands are separated with a comma.

Percentage	Degrees	All other units of measure	Ratios	Decimal numbers
✓ 10%	✓ 10°	✓ 10 kg	✓ 12:2	✓ 0.056
× 10 %	× 10 °	× 10kg	× 12 : 2	× .056

Signs should be placed immediately preceding the relevant number.		
✓ 45±3.4	✓ p<0.01	✓ males >30 years of age
× 45 ± 3.4	× p < 0.01	× males > 30 years of age

2.8. Latin Names

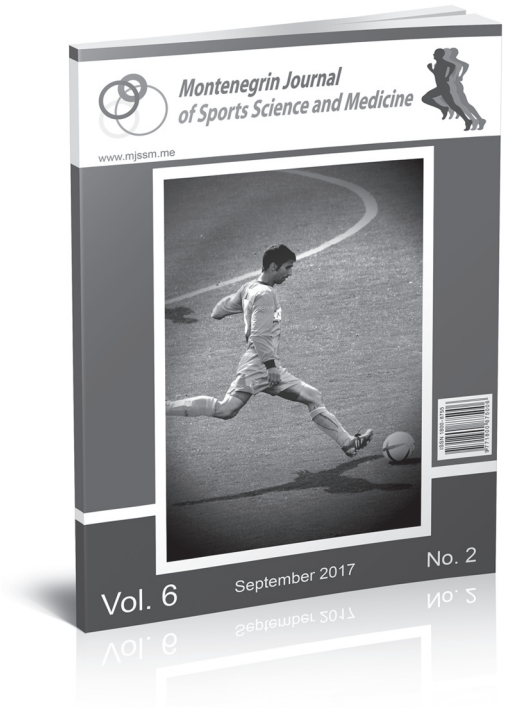
Latin names of species, families etc. should be written in italics (even in titles). If you mention Latin names in your abstract they should be written in non-italic since the rest of the text in abstract is in italic. The first time the name of a species appears in the text both genus and species must be present; later on in the text it is possible to use genus abbreviations. *See* example:

- ✓ First time appearing: *musculus biceps brachii*

Abbreviated: *m. biceps brachii*

Montenegrin Journal of Sports Science and Medicine

MONTENEGRIN JOURNAL OF SPORTS SCIENCE AND MEDICINE



ISSN 1800-8755

CALL FOR CONTRIBUTIONS

Montenegrin Journal of Sports Science and Medicine (MJSSM) is a print (ISSN 1800-8755) and electronic scientific journal (eISSN 1800-8763) aims to present easy access to the scientific knowledge for sport-conscious individuals using contemporary methods. The purpose is to minimize the problems like the delays in publishing process of the articles or to acquire previous issues by drawing advantage from electronic medium. Hence, it provides:

- Open-access and freely accessible online;
- Fast publication time;
- Peer review by expert, practicing researchers;
- Post-publication tools to indicate quality and impact;
- Community-based dialogue on articles;
- Worldwide media coverage.

MJSSM is published biannually, in September and March of each year. MJSSM publishes original scientific papers, review papers, editorials, short reports, peer review - fair review, as well as invited papers and award papers in the fields of Sports Science and Medicine, as well as it can function as an open discussion forum on significant issues of current interest.

MJSSM covers all aspects of sports science and medicine; all clinical aspects of exercise, health, and sport; exercise physiology and biophysical investigation of sports performance; sport biomechanics; sports nutrition; rehabilitation, physiotherapy; sports psychology; sport pedagogy, sport history, sport philosophy, sport sociology, sport management; and all aspects of scientific support of the sports coaches from the natural, social and humanistic side.

Prospective authors should submit manuscripts for consideration in Microsoft Word-compatible format. For more complete descriptions and submission instructions, please access the Guidelines for Authors pages at the MJSSM website: http://www.mjssm.me/?sekcija=page&p=51. Contributors are urged to read MJSSM's guidelines for the authors carefully before submitting manuscripts. Manuscripts submissions should be sent in electronic format to office@mjssm.me or contact following Editors:

Dusko BJELICA, Editor-in Chief – dbjelica@ac.me
Stevo POPOVIC, Editor-in Chief – stevop@ac.me
Selçuk AKPINAR, Executive Editor – sakpinar@nevsehir.edu.tr

Publication date: Spring issue – March 2018
Autumn issue – September 2018

USEFUL CONTACTS

Editorial enquiries and journal proposals:
Dusko Bjelica
Stevo Popovic
Editors-in-Chief
Email: **office@mjssm.me**

Selcuk Akpinar
Executive Editor
Email: **office@mjssm.me**

Marketing enquiries:
Jovan Gardasevic
Marketing Manager
Email: **administration@mjssm.me**

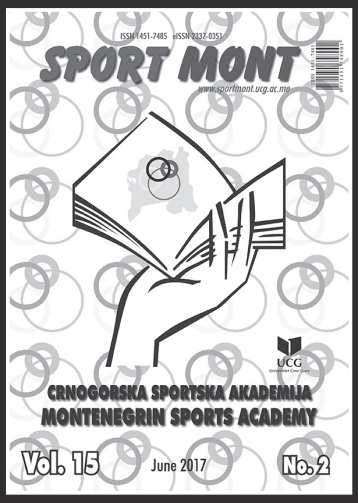
Sports Science and Medicine Journals

from Montenegrin Sports Academy

We have expanded the quality of our journals considerably over the past years and can now claim to be the market leader in terms of breadth of coverage.

As we continue to increase the quality of our publications across the field, we hope that you will continue to regard MSA journals as authoritative and stimulating sources for your research. We would be delighted to receive your comments and suggestions, mostly due to the reason your proposals are always welcome.

Look Inside!



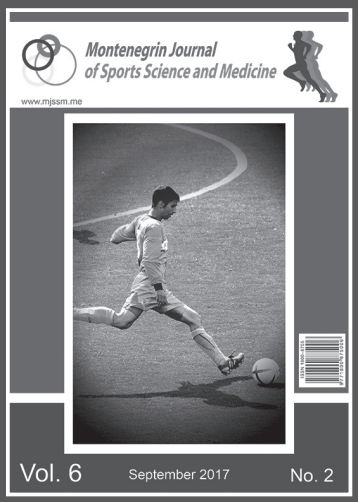
Sport Mont Journal

Editor-in-Chief: **Dusko Bjelica**, Montenegro
Director: **Batric Markovic**, Montenegro
Managing Editor: **Jovan Gardasevic**, Montenegro

Volume 15, 2017, 3 issues per year; Print ISSN: 1451-7485, Online ISSN: 2337-0351

Sport Mont is a scientific journal that provides: Open-access and freely accessible online; Fast publication times; Peer review by expert, practicing researchers; Post-publication tools to indicate quality and impact; Community-based dialogue on articles; and Worldwide media coverage. Sport Mont is published once a year and publishes original scientific papers, notes, preliminary communications, reviews and conference papers in the fields of Sports Science and Medicine, as well as editorials, a "letter to the editor" section, abstracts from international and national congresses, panel meetings, conferences and symposia, and can function as an open discussion forum on significant issues of current interest.

www.sportmont.ucg.ac.me



Montenegrin Journal of Sports Science and Medicine

Editors-in-Chief: **Dusko Bjelica**, Montenegro; **Stevo Popovic**, Montenegro
Executive Editor: **Selçuk Akpınar**, Turkey
Associate Editors: **Mehmet Uygur**, USA; **Catalina Casaru**, USA; and **Predrag Bozic**, Serbia

Volume 6, 2017, 2 issues per year; Print ISSN: 1800-8755, Online ISSN: 1800-8763

Montenegrin Journal of Sports Science and Medicine (MJSSM) is published biannually, in September and March of each year. MJSSM publishes original scientific papers, review papers, editorials, short reports, peer review - fair review, as well as invited papers and award papers in the fields of Sports Science and Medicine, as well as it can function as an open discussion forum on significant issues of current interest. MJSSM covers all aspects of sports science and medicine; all clinical aspects of exercise, health, and sport; exercise physiology and biophysical investigation of sports performance; sport biomechanics; sports nutrition; rehabilitation, physiotherapy; sports psychology; sport pedagogy, sport history, sport philosophy, sport sociology, sport management; and all aspects of scientific support of the sports coaches from the natural, social and humanistic side.

www.mjssm.me

UNIVERZITET CRNE GORE
FAKULTET ZA POMORSTVO – KOTOR

UNIVERSITY OF MONTENEGRO
MARITIME FACULTY - KOTOR

In addition to maritime education in navigation and marine engineering, University of Montenegro - Maritime Faculty in Kotor also provides additional training for professional seafarers in:

- Different IMO model courses
- DP - Dynamic positioning courses
- Offshore courses

From 2015 runs the newly established joint training center with partners from NTNU - Aallesund in Norway, being one of the most experienced and most successful in providing offshore and DP training courses worldwide. The up-to-date bridge simulator, accompanied by AB simulations and instructor station, enables the organization of all the courses held as in the Norwegian training centers, with the same team of instructors and certificates. So far, a series of courses have been organized related to the operation of complex offshore equipment and team work in these demanding operations, both for students and international crews. In addition, the Kotor/Aalesund training center has recently been awarded with the Nautical Institute accreditation for holding DP (Induction and Simulator) trainings and so far has successfully launched several groups of DP operators.

OSC offshore simulator at Maritime Faculty Kotor, Montenegro

Dobrota 36, 85330 Kotor
Tel/Fax ++382(0)32 - 303 - 184
Centrala ++382(0)32 - 303 - 188
fzp@ac.me, www.ucg.ac.me/pfkotor

Ž.R. 510-227-38
PIB 02016702
PDV 30/31-03951-6

University of Montenegro

Cetinjska br.2
81 000 Podgorica
Montenegro

E-mail:
rektor@ac.me
rektorat@ac.me

Phone: + 382 20 414 255
Fax: + 382 20 414 230

Web:
www.ucg.ac.me

The University of Montenegro is the leading higher education and research institution in Montenegro. It is a public institution, established by the state, operating as a unique legal entity represented by the Rector. It is an integrated university organized on the model of the most European universities. Organizational units are competent for provision of study programmes, scientific-research and artistic work, use of allocated funds and membership in professional associations.

Since its foundation, the University of Montenegro has continuously been conducting reforms in the area of education and research, while since 2003 in line with the trends in EHEA. After adoption of the Bologna Declaration, University of Montenegro organized systematic preparation of documents aligned with it. Already in 2003, the experimental teaching programme started and today, all studies are organised in line with the Bologna principles. During the last two years systematic reforms of the University`s study programes have been conducted in order to harmonize domestic higher education system with European standards and market needs to highest extent.

The University of Montenegro has unique academic, business and development objectives. It comprises 19 faculties and two research institutes. The seat of the UoM is in Podgorica, the capital city, while university units are located in eight Montenegrin towns. The University support services and centers (advisory services, accounting department, international cooperation, career orientation) are located in the Rectorate.

Academic community of University of Montenegro is aware of the importance of its functioning for further development of the state and wider region. It has been so far, and will be in the future, the leader in processes of social and cultural changes, along with the economic development.

In the aspect of attaining its mission, University of Montenegro is oriented towards the priority social needs of the time in which it accomplishes its mission; open for all the students and staff exclusively based on their knowledge and abilities; dedicated to preservation of multicultural and multi-ethnic society in Montenegro; entrepreneurial in stimulating social and economic application of supreme achievements within the scope of its activities.

In 2015/16 there were a total of 1.192 employees at UoM, 845 of which were engaged in teaching. In the same year there were 20.236 students registered at all three cycles of studies.

Internationalization is high on the agenda of UoM priorities, thus it has participated in a number of international projects – over 50 projects funded under the Tempus programme, over 15 Erasmus Mundus Action 2 projects for student mobility, a number of projects under FP7 funding scheme or IPA supported projects, Erasmus + capacity building and International credit mobility projects and other.

For more information about University of Montenegro, please visit our website www.ucg.ac.me or send e-mail to pr.centar@ac.me.

BE PART OF OUR TEAM

CRNOGORSKI OLIMPIJSKI KOMITET
MONTENEGRIN OLYMPIC COMMITTEE

UNIVERSITY OF MONTENEGRO
FACULTY OF MECHANICAL ENGINEERING
Podgorica

www. ucg.ac.me/mf

Mechanical engineering studies in Montenegro started during the school year 1970/71. On April 15th, within the Technical Faculty, the Department of Mechanical Engineering was formed. The Department of Mechanical Engineering of the Technical Faculty was transformed in 1978 into the Faculty of Mechanical Engineering, within the University "Veljko Vlahović". Since 1992 the Faculty of Mechanical Engineering is an autonomous University unit of the University of Montenegro. It is situated in Podgorica.

The University of Montenegro is the only state university in the country, and the Faculty of Mechanical Engineering is the only faculty in Montenegro from the field of mechanical engineering.

Activities of the Faculty of Mechanical Engineering can be divided into three fields: teaching, scientific-research work and profes- sional work.

Two study programmes were accredited within the Faculty of Mechanical Engineering:

- Academic study programme MECHANICAL ENGINEERING
- Academic study programme ROAD TRAFFIC

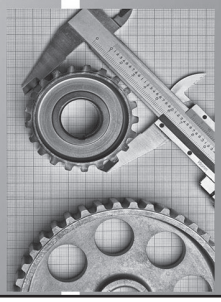
The study programmes are realised according to the Bologna system of studies in accordance to the formula 3+2+3.

On the study program Mechanical Engineering it is possible to study next modules:

- Mechanical Engineering – Production
- Applied Mechanics and Construction
- Energetics
- Energy Efficiency
- Mechatronics
- Quality

At the Faculty of Mechanical Engineering, as organisational units, there are centres and laboratories through which scientific-re- search and professional work is done:

- Centre for Energetics
- Centre for Vehicles
- Centre for Quality
- Centre for Construction Mechanics
- Centre for Traffic and Mechanical Engi- neering Expertise
- Centre for transport machines and metal constructions
- 3D Centre
- Didactic Centre – Centre for Automation and Mechanomics training
- European Information and Innovation Centre
- Cooperation Training Centre
- Laboratory for Metal Testing
- Laboratory for Turbulent Flow Studies
- Laboratory for Vehicle Testing
- Laboratory for Attesting of Devices on the Technical Examination Line



FK MLADOST PODGORICA

www.fkmladost.me

Pro-VLADEX

Ul. Kralja Nikole 8, 81000 Podgorica; Tel: +382 (20) 24-29-00, 24-17-08, 24-55-03; E-mail: vladex@t-com.me

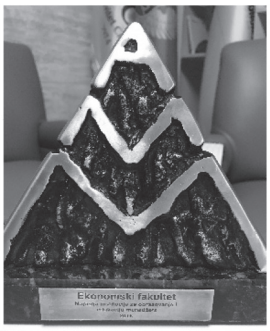
University of Montenegro
FACULTY of ECONOMICS PODGORICA

UCG
University of Montenegro

Faculty of Economics
University of Montenegro

The Faculty of Economics celebrated its 57th anniversary this year, and it is the oldest higher education institution in the country. Since its establishment, 8,630 students graduated at our Faculty.

Today, Faculty of Economics is a largely interdisciplinary institution, characterized by expressed dynamism in its work. Employees at the Faculty are dedicated to constant improvements and enhancements, all in accordance with the needs brought by the changes.



We provide our students with the best theoretical and practical knowledge, enabling them to develop critical spirit in approaching economic phenomena and solving concrete problems in daily work. From September 2017, at the Faculty, the new generation will start a 3 + 2 + 3 study, which will improve the quality of studying.

Development of Faculty of Economics in the coming period will follow the vision of development of the University of Montenegro, pursuing full achievement of its mission

Comprehensive literature, contemporary authors and works have always been imperative in creation of new academic directions at Faculty of Economics, which will form the basis of our future.

Faculty and its employees are dedicated to developing interest in strengthening the entrepreneurial initiative, creative and interdisciplinary approach among young people, using modern teaching and research methods. In this regard, the Faculty has modern textbooks and adequate IT technology, which supports the objectives set.

Jovana Tomaševića 37
81000 Podgorica, Montenegro

www.ekonomija.ac.me
ekonomija@ac.me

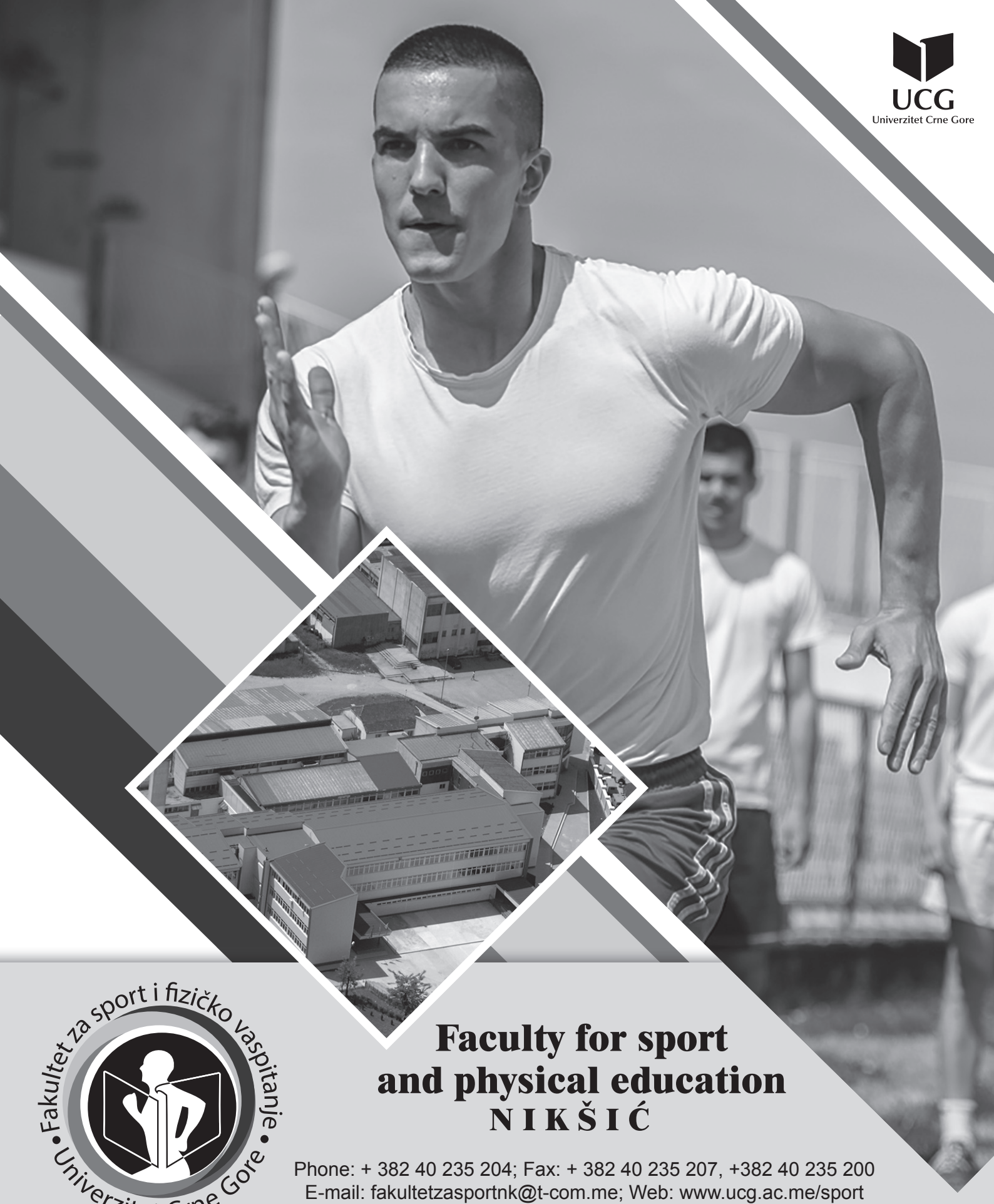
Phone: + 382 20 241 138
Fax: + 382 20 244 588

CIP – Каталогизација у публикацији
Централна народна библиотека Црне Горе, Цетиње

796:61 (497.16)

MONTENEGRIN journal of sport science and medicine / urednik Duško Bjelica. – Vol. 1, no. 1 (2012) - . – Podgorica (Džordža Vašingtona 445) : Crnogorska sportska akademija, 2013 (Nikšić : Art grafika). – 30 cm

Polugodišnje.
ISSN 1800-8755 = Montenegrin journal of sports science and medicine (Podgorica)
COBISS.CG-ID 17824272



UCG
Univerzitet Crne Gore

Fakultet za sport i fizičko vaspitanje
Univerzitet Crne Gore

Faculty for sport and physical education
N I K Š I Ć

Phone: + 382 40 235 204; Fax: + 382 40 235 207, +382 40 235 200
E-mail: fakultetzasportnk@t-com.me; Web: www.ucg.ac.me/sport

Znanje i zdravlje!

MSA Conference 2018

15th International Scientific Conference on Transformation Processes in Sport

UCG
Univerzitet Crne Gore

http://www.csakademija.me/conference/

CRNOGORSKA SPORTSKA AKADEMIJA
MONTENEGRIN SPORTS ACADEMY

SPORT PERFORMANCE

12th - 15th April 2018,
Budva - Montenegro