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TABLE OF CONTENTS

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Dear Readers,

The Montenegrin Journal of Sports Science and Medicine (MJSSM) continues facing the tremendous challenges in last months too. Even though our Journal in 2015 and 2016 achieved the greatest success, and entered two strongest index databases (Web of Science and Scopus), the rest of databases continue recognizing the development of our journal that is proved by reaching highest impact ever, such as Index Copernicus (ICV 2016: 98.15) and Scopus (CiteScoreTracker 2017: 0.50, updated 08 February, 2018). On the other hand, the acceptance rate was decreased on 15% for original research submitted in period 2016-2017 and expected to decrease it further more for the upcoming period, while the time from submission to first decision is also decreased on 38 days, and the time from submission to publication on 55 days (online & print).

We would also highlight that our journal will continue working on growing academic publication in the fields 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, in various formats: original papers, review papers, editorials, short reports, peer review - fair review, as well as invited papers and award papers, as well as promote all other academic activities of Montenegrin Sports Academy and Faculty for sport and Physical Education at University of Montenegro, such as publishing of academic books, conference proceedings, brochures etc.

Finally, we would like to thank our authors one more time, 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 do 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

Middle School Students' Free-living Physical Activity on Physical Education Days, Non-physical Education Days, and Weekends

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ABSTRACT This study measured students' free-living Physical Activity (PA) in order to examine activity patterns of youth. Students (*N*=221) in 12-classes wore accelerometers to measure their PA over six weeks in and out-of-school while participating in a fitness unit. PA was significantly higher during Non-PE-Days and PE-Days than on Sundays. PA was significantly higher during baseline than weeks five and six. There were no significant differences between boys and girls in the number steps taken. Eighth-grade students had the lowest PA levels. On average, the students were attaining 60 minutes of MVPA. Students, however, did not often reach national recommendations. Girls reached their national recommendations five out of six weeks on days that they participated in PE. The results suggest that specific subgroups, such as adolescent girls, are getting the recommended PA but only when the PA is structured. A spike in PA during the first week suggested a possible motivational effect of the accelerometer.

KEY WORDS physical education, adolescent, accelerometer

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PA LEVELS OF MIDDLE SCHOOL YOUTH
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Physical activity levels have often been targeted in curriculum interventions that attempt to reverse the trend of obesity and overweight students (Dudley, Okely, Pearson, & Cotton, 2011). There is no doubt that the obesity epidemic is a hot topic in the media and in much of the health and physical education literature around the world (Eaton et al., 2012, U.S. Department of Health and Human Services (DHHS), 2008). Students and teachers alike are being bombarded with facts about rising obesity and overweight numbers and the ill health effects that come as a result of an inactive lifestyle.

Health issues have been the mainstay of discussion for many years in the field of physical education research. In the U.S.A., national initiatives like the Healthy People 2020 goals (DHHS, 2008) and the NASPE standards (NASPE, 2012), to name two, attempt to disseminate information about the harmful effects of a sedentary lifestyle and the benefits of becoming and staying physically active. These initiatives often compete with a well-documented trend that is increasingly more common in schools calling for a reduction in physical education classes and recess to spend more time in the classroom learning academic subjects in the face of high stakes testing (IOM, 2013). This plan is short-sighted as research suggests that increasing physical education and physical activity time in school does not negatively affect academic scores in other subjects (IOM, 2013). Some research even indicates increases in student academic performance with time spent in physical education (Sallis et al., 1999).

Despite the results research conducted in the field of physical education and the known benefits of physical activity, the majority of youth do not reach the recommended standard of physical activity (PA) (IOM, 2013). The declining trend in youth PA levels is troubling, as physical activity has been shown to reduce the risk of developing chronic diseases (CDC, 1997). The recommended amount of physical activity for young people aged 6 to 17 is 60 minutes a day (DHHS, 2008). In 2009, according to a national survey, less than 20% of students met these guidelines of adequate physical activity (Eaton et al., 2012).

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Conflict of interest: None declared.

Youth PA levels have been monitored in various ways, ranging from PA interventions with researcher observation such as SOFIT (McKenzie, Sallis & Nader, 1991), self-report instruments, such as 3DPAR (Pate et al., 2003), as well as activity monitors, such as accelerometers (Stewart, Dennison, Kohl & Doyle, 2004) and pedometers (Ho et al., 2013). The free-living PA of middle school students has not often been measured, especially for an extended time. Often the reasoning for short bursts of measurement is the risk of losing expensive equipment that measures PA. Additionally, it often is difficult to measure PA objectively when a researcher is not present, such as when students are not in school.

Integrating technology into educational situations has been recommended as an effective tool to supplement learning (NASPE, 2009). Research suggests that including technology in instruction can lead to a positive influence on both students and teachers (Gibbone, Rukavina & Silverman, 2010). To date, however, few studies have examined the implementation of technology into the PE curriculum as an educational tool to monitor PA levels or motivate students to increase PA. Examining students' PA levels with accelerometers that are also used as an educational tool could shed more light on the PA levels of youth in free-living environments.

Previous research has demonstrated significantly higher MVPA on days that students have physical education class than when they do not (Chen, Kim & Gao, 2014). Many studies, however, only tracked students for a relatively short period (7–14 days). Therefore, the purpose of this study was to measure students' physical activity levels in a free-living environment over the course of six weeks, which is roughly equivalent to a typical unit of instruction in physical education.

Methods

These data were collected as a part of a larger study that measured multiple variables of students and teachers who participated in the research project.

Participants

A total of 221 students participated and produced data for the study and were included in the final data analysis. Initially, 258 students began the study, but 37 were dropped due to insufficient readings for PA, questionable and/or invalid scores, or the inability to sufficiently understand and read English to answer the questions posed to them in the greater study. The mean age of participants was 11.96 (±0.943SD). Students ranged from 6th(*N=74)*, 7th(*N=63)*, to 8th(*N=84)* grade. A total of 115 male and 106 female students participated. There were 136 white and 85 non-white students in the study (31 Latino, 3 black, 42 Asian, 1 Pacific Islander, 8 mixed-race). The study consisted of 12 classes. The University Institutional Review Board approved this study. In addition, consent was obtained from all participants' parents. All students signed assent forms.

This study measured student PA levels over six weeks while teachers implemented a unit of instruction in 12 different physical education classes, in Grades 6, 7, and 8 in a major metropolitan area in the north-eastern U.S.A. Students wore wrist-worn accelerometers in and out of school over the course of the unit. Data were collected during the 2014-2015 academic year.

The schools in this study were public schools and consisted of two K-6 elementary schools, one Grade 6th only school, and three Grade 7-12 schools with a combined middle and high school campus. All schools had the use of a gymnasium, outside space, and sufficient materials to teach lessons that the teacher chose to teach. Schools were in different socioeconomic areas. Teachers were split evenly by sex, with six male teachers and six female teachers. All teachers were certified physical educators with a range of teaching experience from a first-year teacher to one with 35 years teaching experience; this resembles a typical school district spread of experience.

Instrumentation

Physical activity levels were measured using the MOVband accelerometer. In a validity study, the MOVband was compared to a pedometer (NL-2000) that had been recommended for use in research (Crouter et al., 2003). The steps measured by the NL-2000 were significantly and positively correlated with the steps recorded by the MOVband (Menickelli et al., 2013). The Institute of Medicine has suggested that accelerometers are the best method for collecting information about energy expenditure for the low and middle ranges (IOM, 2013).

Instructional unit. All students participated in normal physical education classes that, at the time, were implementing a new PA unit, Fitness Integrated with Technology (F.I.T.) unit. The unit consists of a 12-lesson fitness-based unit broken into three themes. The basis of the unit was to deliver fitness-based knowledge while integrating academic subjects into a unit of instruction and empowering students to make their own plans for fitness. In addition, information and data from the accelerometers were used in the lessons.

Throughout the unit, teachers implemented their own general topics of teaching and supplemented that unit with the F.I.T unit. The F.I.T. unit acted as an umbrella over the teachers regularly selected unit plan, not in place of one. The teachers were not forced to augment their unit plans to teach the F.I.T. Unit. They were provided support to supplement their original lessons with fitness knowledge and the integration of technology. The main aspects of the F.I.T. unit were delivered in the introduction and closure of the lessons, when fitness terms were introduced and class discussions were held. The middle part of each lesson followed the plans set forth by the teacher according to his or her unit planning. More information about the F.I.T. unit can be found in Marttinen and Fredrick (2016).

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Procedure

Students were given accelerometers to wear around the clock (in- and out-of-school). Physical activity data were collected for each week and always included, at a minimum, a physical education day, a non-physical education day, a Saturday, and a Sunday. Student PA levels were recorded continuously for six weeks.

School entry and recruiting. Prior to the main study, the lead author made contacts in middle schools (teachers, principals, administrators). Access to the schools was gained through contacts that were made through the first author's time in teaching, cooperating professors, and through recommendations from the supervising researcher. The lead author visited all schools that showed an interest in the study as well as those that sent all teachers a two-page summary of the study that was passed on to the administration. The teachers were chosen because they appeared to have good rapport with students and were very willing to help the project along.

Orientation for teachers. Prior to the beginning of the study and official entry into the schools, the teachers were given an accelerometer to wear for one week. This was done so the teachers had a chance to become comfortable wearing the unit around the clock and to come to know its functions. Teachers were also given an opportunity to create a profile on the MOVband company's internet server before students received the accelerometers for the pre-test. During this orientation process, teachers were taught how to trouble shoot, how to help students view their profiles, and how to upload student data. After three days of wearing the accelerometers, the author checked with the teachers to see how they were using them, and whether they had questions on the how to use them or view their data. Seven days after issuing the accelerometer to the teachers, the start of the Week 1 phase began for the students. Teachers played a crucial role in the fidelity of the students, which means they needed to constantly remind students to keep accelerometers on their wrists and were suggested to wear the accelerometers themselves during the unit.

Students were asked to move about normally but to wear the accelerometer wherever they went. There was a heavy emphasis on "everywhere" (except when showering and swimming). It was imperative that students wear the accelerometer in their daily activities and not forget the unit at home.

The orientation sessions to wearing the MOVbands were completed in a computer lab or with a laptop computer in the gym when a computer lab was inaccessible. Teachers followed a written script to disseminate directions to the participants. As suggested by Trost et al. (2005), to ensure higher compliance in recording physical activity data, a frequently asked questions sheet was passed out to students in case they ran into problems or had questions on how to use the accelerometer. The researcher's email address was given to students for troubleshooting at any time. Students were asked to upload data as frequently as possible. The researcher manually uploaded data at least three times during the unit if students had their accelerometer on. At the conclusion of the unit, the senior researcher completed a final upload of accelerometer data, and students turned in their accelerometers.

Data Analysis

MOVband accelerometer data were requested from the MOVable company database and were delivered in Excel files broken down by hour and day in numbers of steps. The MOVband accelerometer data were uploaded into SPSS. Complete data for physical activity was considered if there were 10 hours or more of physical activity in the 24-hour period registered on the accelerometer.

Activity levels were calculated using the accelerometer data. A detailed literature search was completed regarding cut points and how many hours of data were needed for complete days, as well as the number of days to include in the analyses. To achieve reliability of 0.80 or better, Trost et al., (2005) suggest that four to five days of monitoring is necessary to calculate physical activity levels, other studies also suggest four days of monitoring (Tudor-Locke et al., 2009). Complete days were considered only if there were 10 or more hours of recorded data per day (Chinapaw et al., 2014). Studies showed a high reliability (r=0.86), and sample size could be achieved when children with < two days lasting <10 hours/day were included in analyses (Rich et al., 2013). Finally, both Saturday and Sunday were used; prior studies show that both need to be recorded to obtain an accurate measure of habitual physical activity (Scheers, Philippaerts & Lefevre, 2012). For the purposes of data analysis, scores were calculated from four days of each seven-day week to gather weekly activity levels. Days consisted of a randomly selected physical education day for each week, a randomly selected non-physical education day for each week and a Saturday and a Sunday for each week. School holidays during weekdays were not considered non-PE days.

Data reduction. PA data were reduced to the class level for activity levels. Since all classes completed six weeks of accelerometer wear-time, it was not necessary to use statistical techniques to replace missing data and allowed the use of full data without harmonic means. Although individual students' scores were being recorded, the unit of analysis for inferential statistics was the class (Silverman & Solmon, 1998).

To analyse physical activity results, a 2 × (Sex) × 4 (Type of Day) × 6 (Time) ANOVA with repeated measures was conducted using class means. Pairwise comparisons with a Bonferroni adjustment were used as post hoc tests. Significant results from ANOVAs are reported using the Greenhouse-Geisser adjustment.

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Results

Weekly Physical Activity by Class

Overall class means for physical activity ranged from a high of 13,700 steps (SD=6,219), which occurred on a Week 1 Non-PE Day to a low of 8,536 (SD= 3,814), which occurred on a Sunday in Week 5. Types of days (PE day, Non-PE Day, Sat, Sun) also showed wide ranges. Table 1 provides measures for PE days, Non-PE Days, Saturdays, and Sundays.

TABLE 1 Total Physical Activity by Type of Day

Type of Day	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
NO PE	14359.12	11629.26	11436.80	10331.26	10777.08	10355.84
	4877.52	2459.35	2201.89	2700.42	2828.07	2764.46
	21	21	21	21	21	20
PE Day	12154.63	11734.66	11566.57	11566.09	12550.33	10675.67
	2053.60	2242.97	1961.20	1614.08	3234.85	3503.70
	21	21	20	21	21	20
SAT	9495.06	10878.71	10543.88	10542.49	8864.80	10127.22
	2474.49	4140.80	2771.25	3670.68	2138.35	4866.90
	20	21	21	21	20	20
SUN	9394.47	9989.07	9222.16	9909.33	8664.57	8984.35
	2193.88	2815.82	2909.95	2993.73	2320.21	2770.90
	20	21	19	20	20	19
TOTAL	11397.31	11057.92	10717.86	10595.46	10249.55	10049.08
	3713.17	3034.39	2608.80	2855.12	3071.19	3577.16
	82	84	81	83	82	79

Note: PEDAY= day when student participated in organized physical education in school; NO PEDAY= regular school day without physical education; SAT= Saturday; SUN= Sunday. Scores are the mean, followed by standard deviation on the second line, and *N* on the third line for each section.

Physical Activity by Class and Sex

The range of overall steps varied highly by type of day but not by sex. For example, boys recorded a high of 14,993 (SD=6,753) on a Non-PE Day (girls recorded 12,997 (SD=5,654) on a Non-PE day), and girls recorded the overall low of 8,289 (SD=3,881) for Sundays, yet boys were not far off by recording 8,544 steps (SD=3,216) on a Sunday. This highlighted a pattern throughout the data of relatively consistent PA scores between sexes by type of day, yet wide ranges of scores in the type of day activity occurred (PE Day, Non-PE Day, Sat, Sun). Full data can be found in Table 2.

Total Physical Activity by Type of Day

Average scores ranged from a high of 11,397 (SD=3,713) at Week 1 to a low of 10,049 (SD=3,577) at Week 6. Scores at Week 1 were notably higher than both Week 6 and Week 5. Scores vary drastically within the 6-week period by type of day as was noted in the drop of total steps on a Non-PE day from 14,359 (SD=4,877) during Week 1 to the Week 6 total of 10,355 (SD=2,764) showing a decline of over 4,000 steps in the means.

Total Physical Activity by Sex and Type of Day

The overall average number of weekly steps ranged from a high of 11,874 (SD=4,154) for male students in Week 1 to a low of 9,817 (SD=3,765) for female students in Week 6. Week 1 data included the overall high in the group of 15,401 (SD=5,351) for female students and male students 13,212 (SD=4,273), whereas Week 5 held the overall lows for male students 8,587 (SD=1,833) and female students 8,610(SD=2,552) highlighting a trend of decreasing PA over time.

Physical activity by Type of Day and Sex. To determine if the participants' steps varied by the type of day, a 2 (Sex) × 4 (Type of Day) × 6 (Time) ANOVA with repeated measures on the last two factors was conducted by analysing PA scores as dependent variables (Week 1 to Week 6) and the type of day (PE, Non-PE, Sat, Sun), sex and time as the independent variables. There was a significant main effect of Time [$F(5,64)=3.18$, $p<.05$ $\eta^2=.05$] as well as a Time by Type of Day interaction [$F(15,177)=3.55$, $p<.001$ $\eta^2=.14$]. The Time by Sex interaction was not significant [$F(5,64)=.62$, $p>.05$ $\eta^2=.01$] nor was the three-way Time by Sex by Type of Day interaction [$F(15,177)=.32$, $p>.05$ $\eta^2=.01$]. Tests of between-subject effects showed that there was a significant main effect of Type of Day [$F(3,68)=5.59$, $p<.01$ $\eta^2=.20$]. Sex was not significant [$F(1,68)=3.66$, $p=0.60$ $\eta^2=.05$]. Follow-up pairwise comparison tests with a Bonferroni adjustment showed that the main effect of Time was significant with Week 1 (11,586 SD=3,744) significantly ($p<.05$) higher than Week 5 (10,425 SD=3,087) with a mean difference of 1,140.49 steps more than Week 5. Week 1 was also significantly ($p<.05$) higher with a mean difference of 1,353.39 steps more than Week 6 (10,168 (SD=3,573)). Follow-up pairwise comparison tests with a Bonferroni adjustment for Type of Day showed students were on average (mean difference=2,150.67 steps SE= 683.95) significantly ($p<.05$) more active on Non-PE Days than Sundays, and students were significantly ($p<.01$) more active (mean difference=2,453.95 steps SE=683.95) on PE Days than Sundays. The Time by Type of Day interaction showed PA peaking during the Week 1 measures (Non-PE Day mean=14,651 (SD=4,811)) yet dropping significantly to 10,355 (SD=2,764) by Week 6.

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TABLE 2 Total Physical Activity by Sex

Type of Day	Sex	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
PEDAY	Male	12341.37	12242.40	12190.17	12083.87	12628.49	11317.71
		2500.64	2069.73	1853.75	1200.53	3323.45	2797.65
		11	11	10	11	11	10
	Female	11949.22	11176.15	10942.97	10996.55	12464.34	10033.64
		1527.82	2399.67	1954.34	1870.82	3311.44	4144.04
		10	10	10	10	10	10
NO PEDAY	Male	15401.40	12246.54	12258.44	10966.06	11591.79	10746.86
		5351.25	2183.05	2261.98	2832.56	2523.98	2189.49
		11	11	11	11	11	10
	Female	13212.62	10950.26	10533.00	9632.99	9880.91	9964.81
		4273.31	2677.26	1832.02	2501.17	2998.58	3316.63
		10	10	10	10	10	10
SAT	Male	10025.75	11552.10	10047.06	11083.16	9118.78	9985.03
		2922.88	4677.55	2430.50	3485.26	1730.82	5467.53
		10	11	11	11	10	10
	Female	8964.36	10137.98	11090.37	9947.75	8610.81	10269.41
		1938.42	3553.62	3141.51	3961.69	2552.26	4479.57
		10	10	10	10	10	10
SUN	Male	9331.81	10757.29	9120.62	10185.98	8587.40	8965.23
		2210.05	2197.58	1734.63	3245.42	1833.08	1896.94
		10	11	10	11	11	9
	Female	9457.13	9144.02	9334.98	9571.20	8758.89	9001.56
		2295.20	3277.04	3954.79	2808.18	2926.96	3486.62
		10	10	9	9	9	10
Total	Male	11874.91	11699.58	10915.92	11079.77	10513.31	10286.74
		4154.92	2949.66	2443.73	2817.98	2915.38	3405.84
		42	44	42	44	43	39
Total	Female	10895.83	10352.10	10504.57	10049.07	9958.73	9817.35
		3159.69	3004.53	2791.90	2833.13	3247.44	3765.39
		40	40	39	39	39	40

Discussion

The purpose of this study was to track student PA levels over the course of six weeks in a free-living environment. We wanted to ascertain if students' activity levels varied based on whether or not they had physical education class and how PA levels fluctuated during weekends. Some of the results confirm prior research, such as physical activity levels declining by age (Pate et al., 2009). Prior research with adolescents shows that in order to attain the recommended 60-minutes of moderate to vigorous physical activity (MVPA) boys and girls need to get to 10,000-11,700 steps per day (Tudor-Locke et al., 2011). The results of this study show that although weekly average steps are within this range during the 6-week period of the study, there were several time points where this range was not reached, specifically during weekends.

Research suggests that youth do not engage in adequate amounts of physical activity (IOM, 2013). Overall, students in this study, were active in ranges (10,000-11,700 steps) which research suggests, when reached, may show that adolescents are indeed attaining 60-minutes of moderate to vigorous physical activity a day (Tudor-Locke et al., 2011). These data are reported weekly averages and are the combination of a PE day, Non PE day, and two weekend days. For Saturday and Sunday alone the 10,000-step threshold was not often met. Students were significantly more active on PE days and Non-PE days than Sundays. It seems that in school even when PE is not held, students receive significantly more activity than when they are at home on weekends. This result is in line with a recent meta-analysis of 37 accelerometer studies looking at youth PA that also suggested students are more active during weekdays than weekends (Brooke, Corder, Atkin, & van Sluijs, 2014). Data from this study brings to light important information on weekend habits of students and increases the importance of physical educators promoting lifetime wellness that carries over to out-of-school time, as a recent review noted that "school physical education probably has the greatest reach" (Sallis, Carlson, & Mignano, 2012: 504) on PA levels of students.

Sundays were the least active days in the study. This is not unusual as past research shows that Sundays had the highest levels of inactivity (Scheers, Philippaerts, & Lefevre, 2012). The lack of activity on Sundays may be due to a lack of organized activities available for adolescents (Comte et al., 2013). We do not yet know if this is due to a lack of interest in organized activities on Sundays and how these activities may clash with the culture of the child's community. The lack of activity on Sundays further strengthens the argument to compensate for the loss of active time with more PA during the week in PE classes and after school PA programs. There were no significant differences between Saturdays and PE days or Non-PE days. Although on the average PE Day and Non-PE day students were getting enough PA to get 60-min of MVPA, 75% of the weekend days measured, did not reach this threshold. Past research shows increases in sitting, TV/electronics, and chores on weekend days (Jago, Anderson, Baranowski, & Watson, 2005), which may explain the reduced weekend activity in this study. These data may add to the research on the importance of physical activity not only in physical education class but the PA students receive in and around the school day.

Reaching fitness guidelines. In the U.S.A., national recommendations suggest the girls (ages 6-17) should aim for 11,000 and boys should aim for 13,000 steps per day (The President's Council on Fitness, Sports & Nutrition, 2015). The students in this study on average did not meet these goals regularly. Boys on average never reached the 13,000-step recommendation on PE days, Saturdays, or Sundays. Conversely, girls reached or were within 60 steps of their suggested (11,000) ranges five out of six weeks when they participated in PE. Girls only met the recommendations once during non-PE-Days (during Week 1). These data highlight the importance of physical education for young adolescent girls. Girls are not meeting national recommendations regularly unless they are getting physical education in school.

The National Association for Sport and Physical Education (NASPE) recommends middle school students get 225 minutes of PE each week (NASPE, 2012). Students in this study may not have been reaching the national recommendations for physical activity (11,000 steps for girls 13,000 steps for boys) regularly as none of the schools in this study attained the NASPE recommendations for minutes of PE. Most of the schools had PE twice or three times a week, with a range of PE minutes from 90 to 150 minutes per week. The reality of PE in the USA is that daily PE has declined from 1999-2011 (Eaton et al., 2012). Research suggests that increasing PE time in schools and physical activity in schools does not negatively affect academic scores (IOM, 2013), yet the trend of cutting PE hours continues. Girls in this study only reached the national recommendations regularly on PE-days. Therefore, the less common daily PE becomes and the inability of schools to reach PE time recommendations increases, the less likely it is that students, specifically adolescent girls, will be sufficiently active to gain health benefits. There is a need to develop more opportunities for young girls to be active outside of school or in well-developed after school activity programmes so girls can attain the same level of PA as they do on PE days. Past research shows a marked sex difference, with girls showing higher inactivity, in late afternoon physical activity and recommends this time for possible interventions (Jago et al., 2005).

Spike at the beginning of study. There is an interesting physical activity spike at the beginning of the study. Across all categories of days, the Week 1 data point contains the highest number of steps in comparison to all other data points. It begins higher and then drops to a consistent level in subsequent weeks, especially on Saturdays and non-PE days. This may be due to the novelty of the new technology piquing the students' interest followed by the eventual, yet relatively quick, return to normal levels. Prior research examines the motivational effect of activity monitors showed a significant decline in PA from the beginning to the end of data collection (Ho et al., 2013), mirroring data in this research. Ho et al. (2013) showed that girls who wore an activity monitor had more steps than those who did not. It is difficult to generalize findings from the current study as it spanned a considerably longer period of data monitoring than past studies using accelerometers.

The accelerometers may indeed have excited the students to take more steps. If this occurred, it happened immediately when students received the units during Week 1, and then the steps returned to their normal levels. Following the spike in PA during Week 1, the PA levels began a decline yet were still above national averages (Tudor-Locke, Johnson & Katzmarzyk, 2010). When students first received their MOVBands, many were observed instantly running around and jumping rope or even doing cartwheels to see how those movements measured up to steps in their accelerometer. The study of Ho et al. (2013) noted the possibility of higher PA associated with the use of an activity monitor but noted that it was short-lived and mainly associated with girls, which could further explain the spike at the first data collection time. A review on whether pedometers increased PA in intervention studies showed a moderate and positive increase in PA levels (Kang, Marshall, Barreira & Lee, 2009), which may partially explain the peak of PA at Week 1 in this study.

The highest scores were found during non-PE Days in Week 1 (often the first full-day the students had the device) for boys and girls. Future research should examine how to capture and build on the initial excitement present in this and other studies to determine how accelerometers can be used as a motivating tool to increase PA. Although students participating in this unit were taking more steps than the average U.S. student takes, (Tudor-Locke, Johnson & Katzmarzyk, 2010) the effect of the accelerometer as a motivating factor, if at all, was short lived. Students did not experience lasting high levels of PA over six weeks, yet it is difficult to ignore the spike in PA levels with the introduction of the accelerometers to students. Future research should examine ways that curricula may affect PA levels when using new and emerging technologies, such as accelerometers. Past research has shown an increase in physical activity when participating in curricula that are technology driven, such as HOPSports (West & Shores, 2014). Perhaps a long-term intervention, similar to past curricular interventions such as SPARK (Sallis et al., 1997) or CATCH (Luepker et al., 1996), can have a more profound effect on PA levels.

All-female physical education. Class level data showed that Class 4 was significantly lower than four other classes based on steps taken and ranged from 3,908 to 5,050 steps lower than the others. Class 4 was also the only all-female PE class in the study. Although, legally students should not be in single sex PE classes in the

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U.S.A. (United States Department of Education, 2002) there were two classes that were split between sexes at one of the schools. The single sex classes were not significantly different from each other in number of steps taken, yet the all- female class had one of the lowest PA levels in the study. The all-female class scored below the co-ed class average physical activity at every measurement point throughout the study. This is in line with past research (McKenzie, Prochaska, Sallis, & LaMaster, 2004) that showed students in all-female PE classes record significantly less MVPA than their co-educational class peers.

The results of this study bring to light many different topics that further extend our knowledge of young students' physical activity habits. The U.S.A battles similar health issues as many other countries around the world do. Although this research followed a population of students in Northeast U.S.A., similarities run parallel to other countries and the issues they face with getting students physically active. As shown in past research, (Dudley et al., 2011) physical education is crucial in increasing young students' physical activity levels. PE is important especially for young girls who only reached the goal set by the Presidential Council for Fitness, Nutrition and Sport on days when they participated in physical education, and only once on Non-PE days or weekends over six weeks of monitoring. This suggests that more attention needs to be paid to specific subgroups such as young girls to increase their attitudes toward PE (Prochaska et al., 2003). Not only are high amounts of physical activity related to healthy living (CDC, 1997), but enjoyable experiences encourage participation in physical education and physical activity (CDC, 1997; Dismore & Bailey, 2011). Additionally, after school programs could help fill the lack of available PA during school by providing young girls opportunities to be physically active in after school programs if indeed the trend of not providing daily PE in schools continues. Future research on physical activity interventions for young girls in out-of-school environments should be pursued.

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Muscle Damage Indicators after Land and Aquatic Plyometric Training Programmes

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ABSTRACT Plyometric training is an important part of athletic conditioning with many significant benefits, including improved motor abilities and performance, but it can also increase the serum indices of muscle damage, collagen breakdown, muscle swelling, and soreness. Due to the physical characteristics of water, plyometric training in water presents less eccentric contraction, facilitates faster transition from the eccentric to concentric phase of a jump and offers greater resistance during concentric contraction with acute lower indices of muscle damage. To advance our understanding of the long-term effects of an eight-week plyometric training programme on land and in water on muscle damage indicators (lactate dehydrogenase (LDH), creatine kinase (CK) and serum urea (SU)), two experimental groups of physically active men (a group on land (EG1) and a group in water (EG2)) were tested before and after the first and the last plyometric training to monitor muscle damage indicators and adaptations. The results showed changes in CK activity after both plyometric trainings for EG1 and only after the first training for EG2. Moreover, after the eight-week programme, significant difference was observed in CK activity in comparison with EG2. There were no observed changes in LDH activity while SU showed greater changes for the group on land. The plyometric training programme in water resulted in smaller levels of muscle damage indicators. Although both experimental groups conducted the same plyometric training with the same jump volume, the eccentric and concentric loads were not the same, so it can be concluded that adaptations in muscle damage processes are faster with smaller eccentric loads.

KEY WORDS Plyometric training programme, water plyometrics, muscle damage, lactate dehydrogenase, creatine kinase, serum urea

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Introduction

Plyometrics is a form of training that represents a fundamental and significant aspect of physical conditioning in numerous team and individual sports, while moderate load eccentric exercise is also used in rehabilitation for different medical issues (Hoppeler, 2016). During plyometric motor patterns, such as jumping, running, hopping, etc., the stretch-shortening cycle (SSC) plays a key role in improving strength, power, speed, joint function and stability, balance and neuromuscular control during landing (Donoghue et al., 2011; Marković & Mikulić, 2010; Martel et al., 2005). Although there are many benefits of plyometric training, studies have shown that plyometric exercises can increase the serum indices of muscle damage, collagen breakdown, and muscle swelling and soreness (Kamadulis et al., 2011; Komi, 2000; Miyama & Nosaka, 2004; Tofas et al., 2008); they can also attenuate muscle function and cause musculoskeletal injuries, especially of the lower extremities (Serrao, 2003). This often happens in programmes in which the overuse of plyometric exercises is involved, as well as in cases with inappropriate levels of plyometric motor patterns. It is well documented that the greatest muscle damage occurs after eccentric exercises, primarily after ones to which the athlete is unaccustomed, whether the cause is the type, the duration or the intensity of the exercise itself (Schoenfeld, 2012). Eccentric contraction during plyometric exercises can generate high tensions per myofibre that lead to alterations in motor unit recruitment and result in muscle fibre damage. For a long time, it was considered that the greater the damage, the greater would be muscle adaptations such as muscle hypertrophy; however, there is now evidence that proofs that every muscle has a threshold after which further damage does not augment muscle remodelling (Schoenfeld, 2012). Regarding that

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fact, plyometric training in water could probably present an optimal load with less muscle damage (Donoghue et al., 2011; Marković & Mikulić, 2010; Martel et al., 2005; Robinson et al., 2004). It is important to be aware that a certain type of plyometric exercise, upon considering the type and the number of contacts with the ground, does not present the equal volume and intensity when performed in water and on land. Studies of plyometric training in water have shown statistically significant improvements in motor abilities and performance (Martel et al. 2005; Miller et al., 2002; Miller et al. 2007; Robinson et al., 2004; Shiran et al., 2008; Stemm & Jacobson, 2007). There are several studies showing that muscle stress and damage indicators are lower after aquatic plyometric training in comparison to the identical training on land (Miller et al. 2007; Pantoja et al., 2009; Stemm & Jacobson, 2007). In addition, there is also certain evidence regarding lower muscle damage indicators in water and on land after plyometric training programmes (Robinson et al, 2004; Shiran et al., 2008).

Monitoring muscle damage indicators plays a vital role in controlling the physiological and training status of athletes, while muscle adaptation to physical load is associated with an improved regulation of enzyme activity and stress indicators (Brancaccio et al., 2006; Brancaccio et al., 2007; Butova & Masalov, 2009). Therefore, the purpose of the present study was to compare muscle stress (serum urea (SU)) and muscle damage indicators (lactate dehydrogenase (LDH) and creatine kinase (CK)) after a single plyometric training session and after an eight-week plyometric training programme performed in water and on land.

Material and Methods

Data collection

With the aim of monitoring the influence of a plyometric training programme on muscle stress and muscle damage indicators, blood analysis was conducted in two experimental groups of twenty male kinesiology students. Blood parameters were measured four times, before and after the first and last training session of the eight-week training programme. Basic anthropometric parameters were also measured to prove the absence of statistical differences between the two experimental groups. All tests were performed at the Sports Diagnostic Centre of the Faculty of Kinesiology, while the programme was conducted in the large sports hall of the Faculty of Kinesiology and at the swimming pools of the "Mladost" Sports Recreation Centre in Zagreb. This training programme included unilateral and bilateral plyometric exercises (Ankle jumps, Countermovement jumps; Drop jumps (30 cm), Single leg ankle hops, Single leg countermovement jumps, Single leg forward jumps, Alternate-leg bounds, Single leg lateral hops, Lateral bounds) with progressive loading from 150 to 200 contacts with the ground, as recommended by Potach and Chu (2000). The experimental group in water (EG2) conducted the programme in water at hip-depth level with arms positioned on hips, while the experimental group on land (EG1) conducted the programme in a gym hall with arms positioned on hips. To monitor the effects of land and water plyometric training programme on performance, six motor performance parameters were measured before and after completion of the plyometric programme. Speed was assessed using the time for a 5-metre sprint running (v5), 10-metre sprint running (v10) and 20-metre sprint running (v20) which were measured using a photocell system (Newtest, Finland). Agility, also referred as change of direction speed was assessed using the time for running 20 yards (20y) with two changes of direction. Explosive power was assessed using height for a standing vertical jump (VJ) and length for a standing horizontal (long) jump (SLJ).

Each participant was informed about the aim of the study and gave written consent for participation in the study. The protocol of the study was approved by the Ethical Committee of the Faculty of Kinesiology, University of Zagreb, in accordance with the Declaration of Helsinki.

Participants

Twenty healthy and physically active male second-year students at the Faculty of Kinesiology, University of Zagreb, were randomly divided into two experimental groups. No history of injury was reported in the previous six months. The first experimental group (EGL: n=10) participated in the eight-week plyometric training programme on land, and the second experimental group (EGW: n=10) participated in the same plyometric training programme but carried out in water. Both experimental groups underwent 16 identical training sessions (two per week). They were all instructed not to include any other activity during the training programme.

Blood sampling and analysis

Blood samples were taken from the cubital vein, and the samples were immediately centrifuged (StatSpin® Express 2). Further analysis of the blood serum was performed with a biochemical analyser (Olympus AU480®) based on the recommendations of the International Federation of Clinical Chemistry (IFCC). Blood was taken one hour before the first and last training sessions in the plyometric programme, as well as 24 hours after the first and last training sessions.

One of the blood parameters that was tested was lactate dehydrogenase (LDH), which is the enzyme responsible for catalysing glycolytic reactions, conversion of pyruvic acid to lactate acid and reversible action. The activity of serum LDH is important and very often used as a biochemical diagnostic method for monitoring muscle tissue and its damage in sports. The normal level of LDH in blood serum is up to 241 U/l; however, the level of serum LDH in athletes can be lower before a physical load when compared to non-athletes (Eiras et al., 2009). It is documented that LDH can increase from 30% to 200% depending on the intensity of the plyometric training or, more precisely, depending on eccentric contractions, and it can remain elevated for 24 to 72 hours (Chatzinikolaou et al., 2010; Eiras et al., 2009; Tofas et al., 2008).

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The second parameter that was tested was creatine kinase (CK). The elevated activity of this muscle damage marker, which typically does not leak out of non-damaged cells, has been used as a marker of the functional status of muscle tissue, and it varies widely in both pathological and physiological conditions (Lee et al., 2002). Although the normal level of CK in blood serum can be up to 177 U/l, reference intervals for athletes can be 82–1083 U/l and 47–513 U/L for male and female athletes, respectively (Mougios, 2007). Blood CK activity can peak from 24 to 72 hours after strenuous eccentric exercises.

The third measured parameter was the serum urea as an indicator of fatigue and oxidative stress. Concentrations between 1.7 and 8.3 mmol/l are referred to as normal; however, there is no evidence that the mentioned levels can be attributed to athletes (Hartmann & Mester, 2000).

Statistical analysis

All statistical analysis was performed using STATISTICA 10.0 (StatSoft, USA). The results were expressed as the mean and standard deviation (X±SD). Due to a relatively small sample size, all data were presented and treated as not normally distributed, so nonparametric analyses were performed. The Mann-Whitney U-Test was used to determine the differences in parameters between the two groups, while the Wilcoxon Matched Paired Test was used to determine the differences before and after the first and second measurement of blood parameters in both groups. The level of significance (p) was set at 0.05 for all analyses.

Results

All participants completed the eight-week plyometric training programme without any reported injuries. During the programme, there were complaints of muscle soreness among the participants, which was an expected reaction to intensive eccentric and concentric muscle action, especially for the experimental group on land. The basic anthropometric status of the participants is outlined in Table 1.

TABLE 1 Descriptive statistics of participants' anthropometric status

GROUP	Number of participants	Age (years)	Body Mass (kg)	Body Height (cm)	Body Fat (%)
EGL	10	22.33 ± 2.06	79.10 ± 9.24	180.27 ± 7.31	12.34 ± 4.75
EGW	10	21.90 ± 1.73	81.68 ± 10.24	178.58 ± 6.27	13.47 ± 6.21

Note: Values are presented as mean ± standard deviation (X ± SD); EGL - experimental group on land; EGW - experimental group in water.

Figure 1 shows the statistical differences in CK levels in both experimental groups as resulting from the non-parametric Wilcoxon Matched Paired Test. The results of the experimental group on land show differences before and after both plyometric trainings (1st - 277.33±101.93 (pre) – 551.74±283.50 (post); 2nd - 250.17±64.89 (pre) – 515.59±327.74 (post)), probably because of high eccentric contraction during the plyometric training. The results of the experimental group in water also show significant differences before and after both plyometric trainings, but with somewhat lower CK levels (1st - 263.89±119.08 (pre) – 486.21±369.92 (post); 2nd - 226.51±101.02 (pre) – 310.73±136.82 (post)).

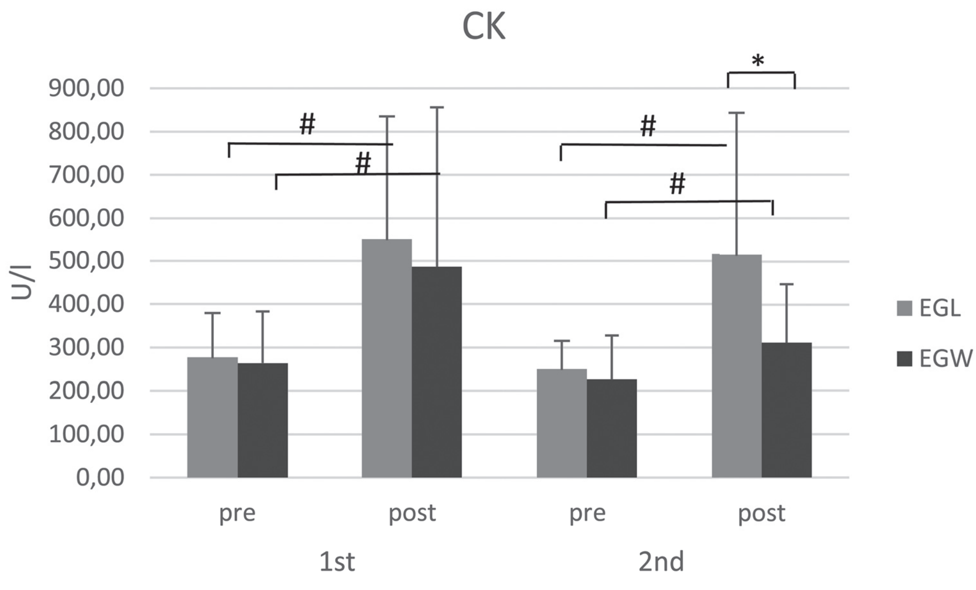

FIGURE 1 Creatine kinase results before (pre) and after (post) the first (1st) and last (2nd) plyometric training sessions

Note: * indicates a significant difference (p<0.05) between the results of the two experimental groups; indicates a significant difference (p<0.05) between the results before (pre) and after (post) the plyometric training session.

The Mann-Whitney U Test showed only one significant difference between the groups and that was in the level of CK activity after the last training session (2nd post measurement) (Z=2.29, p=0.03).

No other differences in CK activity were observed between the experimental groups, nor were there any significant differences in LDH levels in the blood serum observed before and after the first and last plyometric training session, or between the two groups in any measurement (Figure 2).

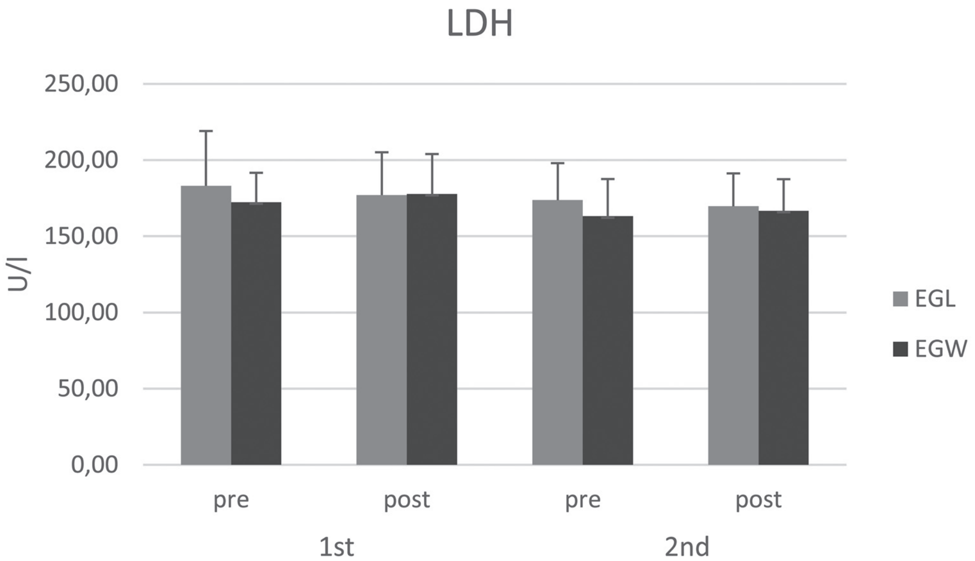

FIGURE 2 Lactate dehydrogenase results before (pre) and after (post) the first (1st) and last (2nd) plyometric training session

The only statistically significant difference in SU was a change after the first plyometric training session in the experimental group on land (Z=2.50, p=0.01) (Figure 3). Regarding the levels of SU, most of the results were within the interval, which is referred to as normal (1.7 – 8.3 mmol/L). No other significant differences in SU were observed between the two experimental groups. The plyometric training programme on land has shown improvement on three motor performance variables (v10, v20, and VJ), while the plyometric training programme in water influenced all motor performance variables except the standing long jump (SLJ). Both treatments resulted in greater motor performance, while EGW showed greater improvement due to water plyometrics.

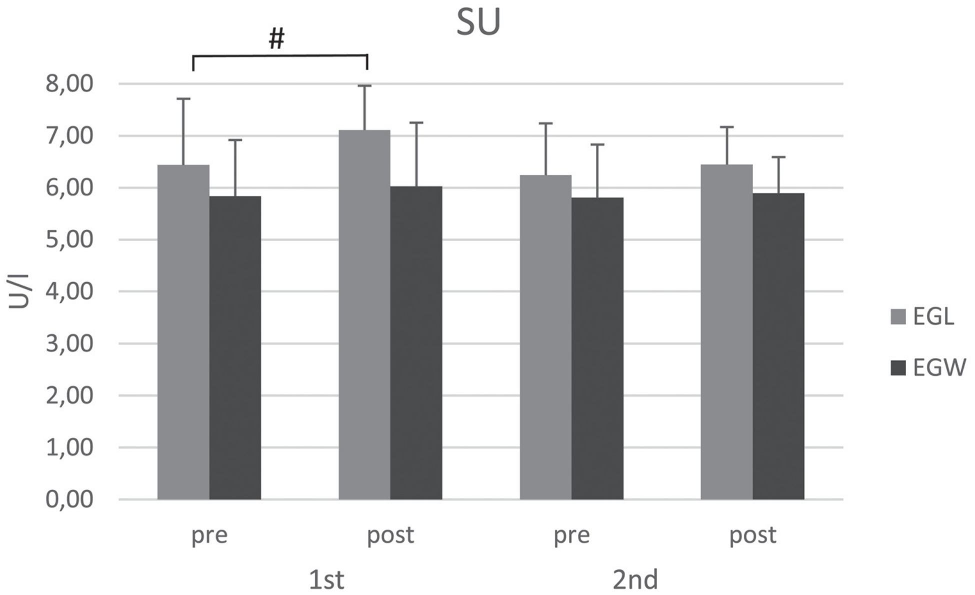

FIGURE 3 Serum urea results before (pre) and after (post) the first (1st) and last (2nd) plyometric training session
Note: # indicates a significant difference (p<0.05) between the results before (pre) and after (post) the plyometric training sessions.

Discussion

The purpose of the present study was to compare the effects of plyometric training on muscle damage markers after two plyometric training sessions, one at the beginning and the second after an eight-week plyometric

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training programme in water and on land. It is known that strenuous plyometric training can damage the muscle cell membrane, which can result in the leakage of CK and LDH and generate a delayed onset of muscle soreness (DOMS) (Clarkson et al., 2005; Lee et al., 2002; Shiran et al., 2008). The aquatic environment has demonstrated less change in muscle damage indicators due to slower and less intensive eccentric contraction and a more rapid neuromuscular recovery (Pantoja et al., 2008; Robinson et al., 2004; Shiran et al., 2008). The main finding of this study is that land plyometrics showed a significant difference in CK activity after both training sessions, both at the beginning of the programme, as well as after the eight-week programme in comparison with water plyometrics. The results showing 198.98% and 206.09% higher levels of CK in EGL indicate the possibility that there were no adaptations to plyometric training after the eight-week programme; however, the fact that this study showed a large standard deviation, a relatively small sample and variability of the measured variables (CK and the others) indicates the need for individual interpretations of the results (Hecksteden et al., 2006). Totals of 184.24 % and 137.18% higher levels of CK in EGW also demonstrate the acute effect of strenuous plyometric training sessions; however, minor changes after the eight-week programme reflect the possibility of a faster adaptation to the lower eccentric intensity.

The authors presume that the participants of the study could adapt sooner to the lower intensity, which was a result of a lower level of muscle damage during the programme conducted in water. This conclusion also raises the question of the comparative value of the two identical plyometric programmes, but with a lower eccentric intensity for the one in the water. In previous studies, the conclusion was made that the aquatic plyometric training programme showed no significant differences in motor performance and motor abilities effects compared to the plyometric training programme on land (Miller et al., 2002; Miller et al. 2007; Shiran et al. 2008; Stemm & Jacobson, 2007). Kobak and his colleagues (2015) demonstrated that the eight weeks of water-based plyometrics resulted in significant improvements in balance, vertical jump height, and isokinetic strength. Therefore, if there is a possibility to improve performance with lower levels of muscle damage (CK activity), there is no reason for aquatic plyometrics not to be incorporated in different periods of physical conditioning for athletes.

While CK activity was high, there were no differences in LDH activity between the two experimental groups, before and after the plyometric training sessions within each separate experimental group. In their study conducted with wrestlers, Shiran et al. (2008) also demonstrated significant results in CK activity in the blood, but with no significant differences in LDH activity. Previous studies have confirmed that LDH can remain elevated for 24 to 72 hours after high-intensity plyometric training sessions and thus provide information on muscle damage and adaptation to the physical load; therefore, it is necessary to measure LDH activity at baseline, 30 minutes, 6 hours, 24 hours, 48 hours, and 72 hours after the test (Brancaccio et al., 2006; Brancaccio et al., 2007; Paschalis et al., 2007). Perhaps in this study the extent of muscle damage was not high enough to result in an increase of LDH activity. In addition, other limitations of this study are unknown factors such as nutrition and physiological fluctuations of the participants (Shiran et al., 2008). Regarding the above-mentioned, LDH activity must be regularly measured in order to monitor the individual response to the plyometric training and to control all the parameters that can influence muscle damage indicators during the experimental protocol.

Previous studies of serum urea reported that elevated SU levels should be measured for two or three days to draw conclusions on changes in metabolic activity or to determine that muscle stress and damage are present (Corsetti et al., 2016; Hartmann & Mester, 2000). After a six-week plyometric training programme, Bal et al. (2012) noted no significant changes in serum urea levels among jumpers. In their study, SU levels had been measured 24 hours after the training session and showed no particular activity, except for the EGL after the first plyometric training session. Souglis et al. (2015) reported significant changes in SU levels after different sport matches, but the results decreased to baseline levels within 13 hours after the matches. It is therefore possible that, due to a higher level of physical conditioning and recovery, the SU was influenced by a better metabolic regulation and resulted in no statistical differences after 24 hours, although somewhat higher concentrations were found in each experimental group. After comparing the experimental groups, it is clear that the EGW had lower results than EGL for SU in both measurements, although there were no statistical differences, perhaps because of lower oxidative stress produced by water-based plyometrics. Considering the lower results for every muscle damage indicator, we can confirm that aquatic plyometric training has fewer effects on muscle stress and muscle damage indicators in comparison to plyometric training on land. In contrast, plyometric training on land resulted in high levels of muscle damage indicated as CK activity, as well as the metabolic stress indicator (SU), thus resulting in no adaption after the eight-week plyometric programme.

In conclusion, this study confirmed that plyometric training programmes on land and in water can affect the creatine kinase activity as an indicator of muscle damage with slightly higher levels for the group that performed the plyometric training on land and which showed significantly higher levels after eight weeks, possibly because of load adaption for the group that performed the plyometric training in water. As for the lactate dehydrogenase activity, there were no changes, while the serum urea showed that plyometric training on land can influence muscle stress and metabolic status. We can conclude that the aquatic plyometric training programme resulted in less muscle damage and can, therefore, provide an excellent practical training option when lower muscle damage effects are specifically needed. After taking into consideration all the aspects of this study, measuring three muscle damage indicators at the same time points to the need for individual measurement of each parameter with more measuring points, as well as to the need for individual interpretation of muscle damage indicators.

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ORIGINAL SCIENTIFIC PAPER

The Perception of the Autonomy Supportive Behaviour as a Predictor of Perceived Effort and Physical Self-esteem among School Students from Four Nations

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ABSTRACT Grounded in self-determination theory (SDT), this study tested a model of motivational sequence in which perceived autonomy support from teachers in a physical education (PE) context predicted the perceived effort and physical self-esteem via self-determined motivation in school students. School students aged 12 to 16 years from Estonia (N = 816), Lithuania (N = 706), Hungary (N = 664), and Spain (N = 922) completed measures of perceived autonomy support from PE teachers, need satisfaction for autonomy, competence, relatedness, self-determined motivation, perceived effort and physical self-esteem. The results of the structural equation model (SEM) of each sample indicated that the students' perceived autonomy support from the teacher was directly related to effort and indirectly via autonomous motivation, whereas physical self-esteem was related indirectly. Confirmatory factor analyses and multi-sample structural equation revealed well-fitting models within each sample with the invariances of the measurement parameters across four nations. The findings support the generalizability of the measures in the motivational sequence model to predict perceived effort and physical self-esteem.

KEY WORDS perceived autonomy support, physical self-esteem, effort, physical education

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Introduction

Self-determination theory (SDT; Deci & Ryan, 1985, 2000) has been extensively explored to predict various cognitive, affective, and behavioural outcomes in physical education (PE) settings (see Ntoumanis & Standage, 2009). SDT emphasizes that three inner needs are central to human growth and psychological development: the needs for autonomy, competence, and social relatedness. According to Vallerand's motivational sequence model (1997), based on SDT, motivation is influenced by social factors (e.g. teacher behaviour, learning environment) via the satisfaction of the above-mentioned needs. The satisfaction of these psychological needs mediates the influence of social factors on motivation, which in turn will lead to cognitive, affective, and behavioural consequences of PE, such as leisure time physical activity (e.g. Hagger et al., 2009), body image and body mass (Markland & Ingledew, 2007).

In addition to encouraging a physically active lifestyle, PE also aims to promote and develop global self-esteem (Standage & Gillison, 2007; Standage, Gillison, Ntoumanis & Treasure, 2012). Self-esteem is enhanced when one's actions are self-determined (Deci & Ryan, 1995), and its promotion is possible via volitional action and experiences during the action as an inner sense of efficacy. Several studies in physical activity (PA) settings have shown that self-determined motivation is related to physical self-esteem (Martín-Albo, Domínguez,

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León & Tomás, 2012; Standage et al., 2012; Standage & Gillson, 2007), but only a few studies have followed all components of the motivational sequence model. Garn, McCaughtry, Martin, Shen, and Fahlman (2012) found that the effect of autonomy supportive behaviour on self-concept was mediated via need satisfactions, but the effect of self-determined motivation on the self-concept was not investigated. In the same study, the model in which the mediation effect of need satisfaction between autonomy support and physical self-esteem was tested; the added direct effect from autonomy support to self-esteem was not significant. Standage et al. (2012) proposed a model in which the physical self-concept was predicted by the perceived autonomy support from the teacher, need satisfactions, and autonomous motivation.

The motivational sequence model has also been widely studied to explain the antecedents of effort. Zhang (2009) and Ntoumanis (2001) found that intrinsic and identified forms of motivation were the strongest predictors of students' enjoyment and perceived effort. Moreover, Reeve, Jang, Hardre, and Omura (2002) stated that autonomy-supportive behaviour with a rational explanation of the importance of a learning activity facilitates students' self-determined motivation, which in turn was associated with greater effort to learn. Standage, Duda, and Ntoumanis (2006) demonstrated that the perceived autonomy support from the teacher positively predicted needs for autonomy, competence and relatedness, which in turn predicted self-determined motivation and consequently teacher ratings of effort and persistence. Taylor, Ntoumanis, Standage, and Spray (2010) showed that students with higher scores on the psychological needs reported higher levels of effort and no change of these relationships over a three-month period. Gillison, Standage, and Skevington (2013) confirmed that the perceived autonomy support from the teacher and intrinsic motivation are predictive of perceived effort. Although the indirect and direct effects of psychological need satisfaction on adaptive outcomes have been explored (e.g., Cox, Smith & Williams, 2008; Standage, Duda & Ntoumanis, 2005), there is relatively little empirical work examining the role of the perceived autonomy support from the teacher in the motivational sequence model to predict physical self-esteem and perceived effort.

To date, the measurement invariances of different psychological constructs have been tested, comparing people from individualistic and collectivistic backgrounds (Hagger et al., 2003; 2009; Marsh, Marco & Asci, 2002; Vlachopoulos et al., 2013). Although the cross-cultural invariances of diverse instruments have been examined, the cross-cultural invariances of the constructs of the motivational sequence model in PA settings need to be clarified. Deci et al. (2001) investigated the equivalence of the motivational sequence model to predict anxiety, task engagement and general self-esteem in the USA and Bulgaria, and found that the model fits the data satisfactorily. However, some differences in the paths from autonomy support to need satisfaction and from latter to anxiety were observed. It is notable that the association between need satisfaction and general self-esteem was equivalent. Furthermore, Quested et al. (2013) using the motivational sequence model to predict dropout from sport, provided evidence of factor loading and structural path invariance across five European countries. More recently, Chen et al. (2015) have found that need satisfaction for autonomy and competence had unique associations with well-being, and individual differences in need valuation did not moderate these associations. Moreover, the effects of need satisfaction and need frustration were found to be equivalent across the samples from Belgium, China, USA, and Peru, and were not moderated by individual differences in the desire for need satisfaction. However, to our knowledge, no cross-cultural comparisons exist in which the equivalence of all components of the motivational sequence model in PE context in which the students' perception of effort and physical self-esteem as outcomes were investigated. Consequently, the present research provides a comprehensive test of predicting physical self-esteem and perceived effort using SDT across four national groups (Estonia, Lithuania, Hungary, and Spain). Although their socio-political structure is currently similar, a generation previously, only Spain was not under the totalitarian Soviet regime, and Hungary had suffered less from the consequences of that regime. This allows assuming that the construction of students' perception may be still influenced by the previous education system. Furthermore, education systems differ from country to country with respect to teacher education and school curriculum. Considering such ethnic differences, it will be reasonable to test whether the students' perception of the psychological constructs of measurement models and structural models are acceptable across the four observed nation groups. It was expected that the measurement models of study variables and structural models will be appropriate within each sample and will exhibit little variation across cultures. This will provide evidence that the constructs measures from the hypothesized motivational sequence model to predict effort and physical self-esteem are applicable within each sample and offer valid measures of the proposed model across cultures. We also hypothesized that perceived autonomy support from the teacher is directly related to students' perceived effort and physical self-esteem and, indirectly, via self-determined motivation.

Methods

Research Participants and Design

School students (N = 3108) were recruited from Estonia (421 males, 395 females; mean age = 14.17, SD = 1.00), Lithuania (288 males, 418 females; mean age = 14.41, SD = 1.04), Spain (481 males, 441 females; mean age = 14.18, SD = 1.30), and Hungary (354 males, 310 females; mean age = 14.35, SD = 0.87, range: 14 to 18). Prior to data collection, consent for participation was obtained from the parents and school principals. Students completed the questionnaires during their PE lessons. All items were designed to reflect general opinions about the dimensions related to PE context.

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Measures

A modified version of Ryan and Connell's (1989) perceived locus of causality scale by Standage, Duda, and Ntoumanis (2005) was used to measure different types of motivation (intrinsic motivation, identified regulation, introjected regulation, and external regulation) in PE. The four motivational constructs were integrated into a single index of autonomous motivation by calculating a relative autonomy index (RAI) (Vallerand & Ratelle, 2002). According to Guay, Mageau, and Vallerand (2003), the weights were assigned to each item from the intrinsic motivation (+2), identified regulation (+1), introjected regulation (-1), and extrinsic regulation (-2) scales. These items were used as indicators of a single latent relative autonomy index (RAI) factor. That is, RAI characterized autonomous motivation in subsequent analyses.

The participants' perception of need satisfaction for autonomy (5 items), competence (5 items), and relatedness (5 items), was measured using scales proposed by Standage et al. (2005). Students' perception of the importance of effort (4 items) in PE was measured with a subscale of the Intrinsic Motivation Inventory (McAuley, Duncan & Tammen, 1989). The six items from PSDQ (Marsh, Richards, Johnson, Roche & Tremayne, 1994) were used to measure physical self-esteem. The perceived autonomy support from the teacher was assessed by the six items presented by Reeve and Halusic (2009). All responses were made on a seven-point Likert scale except PSDQ, for which items were rated on a six-point scale. The items of the scales used in this study are presented in Appendix A.

Translation procedures

The questionnaires for use with the four national samples were developed using standardized back-translation procedures by three independent bi-lingual translators (Brislin, 1986). The back-translation procedure was repeated iteratively until the original and back-translated English versions of the questionnaires were virtually identical.

Data Analyses

AMOS 21 software was employed for confirmatory factor analyses (CFA) and structural equation modelling (SEM). The adequacy of the CFA models was estimated by using recommended incremental goodness-of-fit indexes: CFI (comparative fit index), NNFI (non-normed fit index), and RMSEA (root mean square error of approximation). A cut-off value greater than 0.90 for the CFI, NNFI and less than or equal to 0.08 for the RMSEA were considered adequate for model fit (Hu & Bentler, 1999). The hypothesized relationships among the models' constructs were tested using SEM (Figure 1). Model fit was evaluated using the goodness-of-fit indexes cited previously.

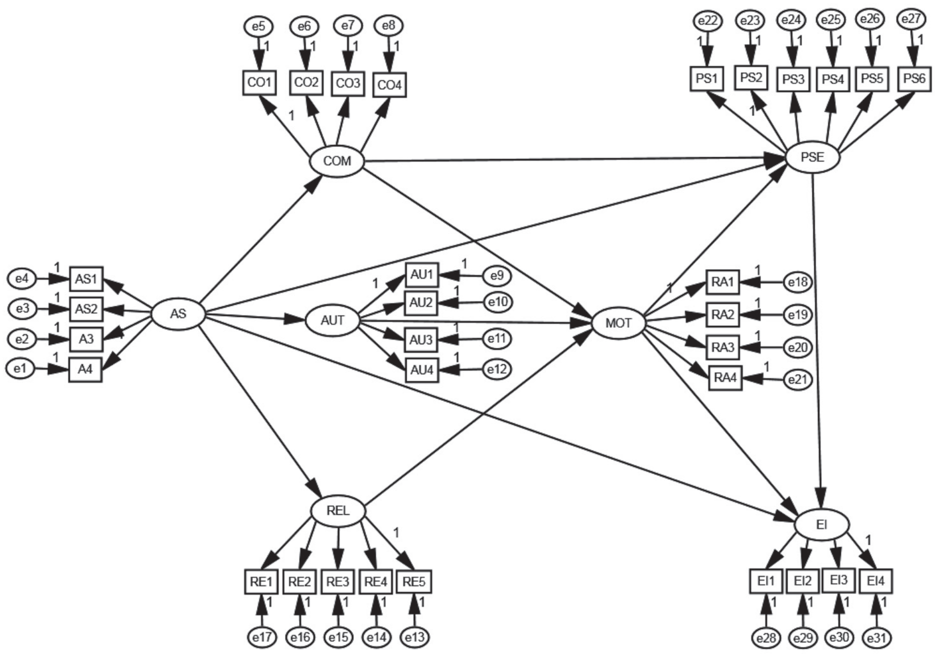

FIGURE 1 Hypothesised structural equation model of the motivational processes to predict physical self-esteem and effort

Note: AS = perceived autonomy support; AUT = need satisfaction for autonomy; COM = need satisfaction for competence; REL = need satisfaction for relatedness; MOT = autonomous motivation; PSE physical self-esteem; EI = perceived effort importance.

To test the invariances of the hypothesized structural model across the four national samples, the multistep approach of Byrne (2010) was followed. Before testing the hypothesized SEM, the measurement model with all study variables across four samples was estimated. This is a prerequisite for establishing a configural model, which will be used to ensure that the hypothesized model which consists of seven factors (perceived autonomy support, need satisfaction for autonomy, competence and relatedness, autonomous motivation index, physical self-esteem and effort/importance) fits well for all observed groups (Byrne, 2010). If this model fits the data well for all samples, the hypothesized model will remain under test for equivalence across the four groups. In contrast, should the hypothesized model exhibit a poor fit to the data even for one of the groups, it will be modified accordingly and become the hypothesized multigroup model under test.

The first step of the analysis included testing the data for each country using four independent CFA to validate the baseline model. The second step involved testing the fit of the configural model. This model incorporates the baseline models for four groups within the same file, allowing for invariance tests across the groups simultaneously. The configural model enables testing whether the same number of common factors would be present in each group and whether each factor would be associated with the same set of items. The fit of the configural model provides a baseline value against which all subsequently specified invariance models (measurement weight, structural weight, structural covariances and structural residuals) are compared. According to Cheung and Rensvold (2002), the evaluation of multigroup CFA nested models was based on the ΔCFI value between the two nested models. Values not exceeding .01 would indicate invariance. Scale reliability was calculated based on the composite reliability index for each used subscale that reflects the proportion of shared variance to error variance in a construct (Li, Harmer & Acock, 1996).

Results

Distributional properties of the responses to all the items were examined. The Mardia's coefficient values ranging from 58.452 to 98.502 within the data of each sample indicated multivariate non-normality. Therefore, the bootstrapping procedure with 2000 bootstrap replications was used.

The initial results of the CFA for measurement model of each sample showed that goodness-of-fit indices were not at an acceptable level. Inspection of the standardized residual matrixes of the observed samples revealed that multiple large residuals (exceeding ± 2.00) were detected for several items: "My teacher conveys confidence in my ability to do well in the course" and "My PE teacher encourages me to ask questions" of the perceived autonomy support scale, "I have some choice in what I want to do" of the need satisfaction for autonomy scale, and "I cannot do PE very well" of the need satisfaction of competence scale. These items were removed from the subsequent analyses. Further, considering the large modification indices showed by the Lagrange Multiplier test, the covariances between several items were added: "I am satisfied with the kind of person I am physically" and "Physically, I am happy with myself" of the physical self-esteem scale, "With the other students in this PE class I feel supported" and "With the other students in this PE class I feel understood" of the perceived need satisfaction relatedness scale, and "I can decide which activities I want to practice" and "I have a say regarding what skills I want to practice" of the perceived need satisfaction for autonomy scale.

TABLE 1 Goodness-of-fit Statistics for Single-sample Confirmatory Factor Analytic and Structural Equation Models for Each National Sample

Sample	Model	χ^2	d.f.	NFI	NNFI	CFI	RMSEA	CI_{95}RMSEA
Estonian	CFA	978.538	410	0.933	0.955	0.960	0.041	0.038 - 0.045
	SEM	1058.872	416	0.928	0.950	0.955	0.044	0.040 - 0.047
Spanish	CFA	1275.801	410	0.929	0.944	0.950	0.048	0.045 - 0.051
	SEM	1328.000	416	0.926	0.942	0.948	0.049	0.046 - 0.052
Lithuanian	CFA	946.794	410	0.920	0.945	0.953	0.043	0.040 - 0.047
	SEM	1009.585	416	0.914	0.941	0.948	0.045	0.041 - 0.049
Hungarian	CFA	1464.415	410	0.907	0.922	0.931	0.062	0.059 - 0.066
	SEM	1526.501	416	0.903	0.919	0.928	0.063	0.060 - 0.067

Note: CFA - confirmatory factor analysis; SEM - structural equation model; χ^2 - chi-square; d.f. - degrees of freedom; CFI - comparative fit index; NNFI - non-normed fit index; and RMSEA - root-mean squared error of approximation.

Goodness-of-fit indices for the modified measurement model of each sample are given in Table 1. In all cases, the measurement models approached the more stringent cut-off value for a well-fitting model, suggesting that the model adequately accounted for the covariance matrices of the data from all four samples. Furthermore, standardized factor loadings for the latent factor on each of its indicators were all positive and statistically significant. Factor correlations and composite reliability coefficient indexes for the CFA models of the measured constructs in each sample are presented in Table 2. All factor correlations were statistically significant, and the difference between unity and the value of the correlations exceeded 1.96 multiplied by the standard error of the correlation and therefore supporting discriminant validity of the scale. Composite reliability coefficients exceeded the recommended value of 0.70, except for the scale of perceived need satisfaction for autonomy in the Lithuanian sample.

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TABLE 2 Factor Correlations for the Latent Factors from the Confirmatory Factor Analysis of the Measurement Model

Factor	ρ_c	1	2	3	4	5	6	7
1.Autonomy support		-						
Estonian	0.801							
Hungarian	0.868							
Lithuanian	0.731							
Spanish	0.794							
2.Need for competence			-					
Estonian	0.849	0.377						
Hungarian	0.877	0.323						
Lithuanian	0.792	0.531						
Spanish	0.864	0.294						
3.Need for autonomy				-				
Estonian	0.739	0.901	0.576					
Hungarian	0.800	0.767	0.510					
Lithuanian	0.666	0.748	0.777					
Spanish	0.707	0.705	0.365					
4.Need for relatedness					-			
Estonian	0.910	0.340	0.392	0.394				
Hungarian	0.950	0.767	0.376	0.715				
Lithuanian	0.881	0.467	0.566	0.533				
Spanish	0.924	0.418	0.308	0.335				
5.Autonomous motivation						-		
Estonian	0.844	0.631	0.482	0.782	0.311			
Hungarian	0.896	0.636	0.468	0.838	0.602			
Lithuanian	0.858	0.526	0.565	0.728	0.351			
Spanish	0.848	0.429	0.425	0.453	0.255			
6.Effort/importantance							-	
Estonian	0.785	0.395	0.357	0.588	0.263	0.400		
Hungarian	0.840	0.554	0.502	0.679	0.562	0.616		
Lithuanian	0.858	0.496	0.624	0.668	0.334	0.545		
Spanish	0.848	0.514	0.465	0.433	0.303	0.461		
7.Physical self-esteem								
Estonian	0.918	0.291	0.605	0.357	0.323	0.385	0.164	-
Hungarian	0.916	0.147	0.574	0.318	0.254	0.344	0.261	
Lithuanian	0.924	0.220	0.584	0.392	0.393	0.227	0.287	
Spanish	0.947	0.215	0.538	0.226	0.268	0.195	0.290	

Note: ρc, composite reliability coefficient. All correlations are statistically significant $p<0.01$.

Given the adequacy of the measurement models a SEM was estimated independently for each sample (Table 1). The purpose of the SEM model (Figure 1) was to examine the influence of the perceived autonomy support from teachers on perceived effort and the physical self-esteem in the PE context directly and indirectly via the constructs of the three need satisfactions and autonomous motivation. Although the initial fit indices for the single-sample models were on an acceptable level, the modification indices shown by the Lagrange Multiplier test suggested adding the path from the perceived need for competence to physical self-esteem. Goodness-of-fit indices for the modified single-sample SEM models are presented in Table 1. Standardized parameter estimates for the structural relations among the latent constructs in the model in each sample are presented in Table 3.

In general, the relationships between the constructs of the models were similar, but some differences were followed in the coefficient values between groups. The values of the relationships between perceived autonomy support and perceived effort/importance were all statistically significant and not different among the groups. For all groups, the relationships between need satisfaction for relatedness and autonomous motivation were not statistically significant. The perceived autonomy support directly and indirectly via constructs of need satisfactions and autonomous motivation predicted perceived effort/importance, whereas physical self-esteem was related only indirectly (Table 4).

Given that the SEM models were replicable in each individual sample, a series of the multi-sample SEM model to identify variation in the measurement and structural parameters among the constructs in the hypothesized

TABLE 3 Standardized Parameter Estimates among Latent Factors and Explained Variance in (%) in Physical Self-esteem and Effort/importance for the Structural Model for Each National Sample

	Sample			
Parameter	**Estonian**	**Hungarian**	**Lithuanian**	**Spanish**
Structural parameters (λ)				
PAS → Autonomy	0.897*b,c,d	0.770*a,d	0.764*a	0.721*a,b,c
PAS → Competence	0.389*c	0.332*c	0.560*a,b,d	0.311*c
PAS → Relatedness	0.348*b,c	0.772*a,c,d	0.469*a,b	0.424*b
PAS → Effort/Importance	0.303*	0.297*	0.305*	0.363*
PAS → Physical Self-esteem	-0.010,d	-0.133*,d	-0.113d	0.084*c
Autonomy → Motivation	0.693*b,d	0.801*a,c,d	0.696*d	0.364*a,b,c
Competence → Motivation	0.096*d	0.068d	0.088d	0.288*a,b,c
Relatedness → Motivation	0.008	0.008	-0.076d	0.044c
Motivation → Effort/Importance	0.217*b,c	0.411*a,d	0.374*b	0.298*b,c
Motivation → Physical Self-esteem	0.120*c,d	0.172*c,d	-0.158*a,b,	-0.076a,b
Competence → Physical Self-esteem	0.561*c	0.539*c	0.757*a,b,d	0.549*c
Physical Self-esteem → Effort/importance	0.003,c,d	0.081*,	0.144*	0.156*a
Variance explained (%)				
Effort/importance	23	45	42	37
Physical Self-esteem	38	35	39	31

Note: * $p<0.05$. Significantly different ($p<0.05$) from the respective value: a - in Estonia, b - in Hungary, c - in Lithuania, d - in Spain.

model across the four samples was conducted following the recommendation of Byrne (2010). In terms of the measurement invariance models, a multi-group comparison between the configural model and the models testing for the invariance of measurement weight, structural weight, structural covariances and structural residuals was based on the ΔCFI value which was expected to be 0.01 or less to indicate no difference between the tested models. Goodness-of-fit indices for each model in invariance routine are presented in Table 5. At first, the configural (unconstrained) model was estimated to test whether the pattern of items and factors was feasible across the samples. This model demonstrated a good fit with the data according to the multiple

TABLE 4 Indirect Effects of Perceived Autonomy Support on Physical Self-esteem and Effort/importance

	Sample			
Parameter	**Estonian**	**Hungarian**	**Lithuanian**	**Spanish**
Indirect effect				
PAS → Physical Self-Esteem	0.294	0.290	0.337	0.142
	(0.182-0.344)	(0.147-0.289)	(0.235-0.529)	(0.083-0.194)
PAS → Effort/Importance	0.144	.278	0.237	0.146
	(0.072-0.292)	(0.175-0.302)	(0.295-0.473)	(0.112-0.211)

Note: Standardized coefficients are presented with bootstrap-generated bias-corrected 95% confident intervals. PAS - perceived autonomy support from teacher.

criteria adopted (Table 5). Subsequently, to test the invariance of the measurement weight, the factor loadings were constrained to be invariant across the four samples. Invariance of the factor loadings is considered the minimum acceptable criterion for measurement invariance (Byrne, 2010). The difference of the incremental fit indices (ΔCFI; 0.944 - 0.939 = 0.005) did not exceed the value of 0.01, indicating the existence of the invariance of measurement weight. In the subsequent nested model in which the invariance of the structural weights was tested beyond the constraints of factor loadings, the structural paths were constrained to be equal. The result of ΔCFI also indicated the invariance of structural weights. Finally, the ΔCFI values of the models testing the invariance of structural covariances and structural residuals (error variance associated with dependent factors) showed the equality of these parameters across the four nations.

TABLE 5 Goodness-of-Fit statistics and Model Comparisons for Multisample Structural Equation Models

Models	χ^2	**d.f.**	**NFI**	**NNFI**	**CFI**	**RMSEA**	CI_{95}**RMSEA**
Unconstrained model	4922.958	1664	0.918	0.938	0.944	0.025	0.025 - 0.027
Measurement weight	5301.435	1736	0.912	0.935	0.939	0.026	0.025 - 0.027
Structural weight	5595.844	1772	0.907	0.931	0.934	0.026	0.026 - 0.027
Structural covariances	5681.868	1775	0.906	0.930	0.933	0.027	0.026 - 0.027
Structural residuals	5981.988	1802	0.901	0.926	0.928	0.027	0.027 - 0.028

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Discussion

The aim of the present study was to test the cross-cultural generalizability of the model based on SDT in which students' perception of autonomy support from teachers, basic psychological needs and self-determined motivation in PE predict physical self-esteem and effort across four national samples with different cultural backgrounds. It was expected that the measurement aspects of the proposed models (measurement weight, structural weight, structural covariances and structural residuals) would be appropriate within each sample and would exhibit little variation across samples.

The initial results of the CFA for measurement model of each sample indicated the inadequate fit and, therefore, the models were re-analysed using the modification indices and considering the high values of standardized residuals of some items. The item "My teacher conveys confidence in my ability to do well in the course" was removed from the perceived autonomy support scale. This item was worded slightly differently in the study of Standage et al. (2006) among British students, and no reason for exclusion from the scale was fixed. Obviously, the formulation this item is sensitive to ethnic differences. The item "My PE teacher encourages me to ask questions" was also removed from the same subscale as PE teachers from the observed countries are perhaps not often asking questions during instruction and, consequently, the students have not experienced such kind of teacher behaviour. The items "I have some choice in what I want to do" of the need satisfaction for autonomy scale, and "I cannot do PE very well" of the need satisfaction of competence scale also did not reflect the students' perception of teachers' behaviour adequately. Ntoumanis (2001) noted that PE teachers are usually following a prescriptive school curriculum that does not allow them to provide opportunities for students' initiatives. This is probably the case in all observed countries and may explain why the students did not perceive this item as exactly reflecting teachers' behaviour as satisfying their need for autonomy. Another reason may be that PE teachers do not feel skilled using supportive instructional behaviours. This statement is also reinforced by previous research in which the preference for using controlling teaching styles (reproductive) in respect of students' autonomy supportive teaching styles (productive) among teachers from these countries was reported by Hein et al. (2012). The item, "I cannot do PE very well" may be interpreted by students very differently: the general skill level, physical fitness or ability, health problems, etc. This negatively worded item of the need satisfaction for competence scale was not used in the cross-cultural study of Chen et al. (2015). Therefore, this item can be considered to be unsuitable for measuring the need satisfaction for competence. In the final CFA models for each sample, based on the modification indexes the error covariance between several items was set to be free, although the error terms for any pairs of items are usually assumed to be uncorrelated. However, Bentler and Chou, (1987) noted that incorporating error terms into a CFA model does not undermine the factorial validity of the data obtained, but enables a more realistic factorial representation of the observed data.

In general, the results of the SEM model (Figure 1) provided support for the proposed relations between the observed variables, which were guided by SDT. Furthermore, the psychometric parameters were on an acceptable level. To some extent, this model is similar to the models presented previously by Standage and Gillson (2007) in which instead of physical self-esteem the global self-esteem was observed and with the recently proposed model (Standage et al., 2012) where the physical self-esteem was measured by the scale used in the present study. However, in the latter model, the effect of self-determined motivation in PE on physical self-esteem was estimated via self-determined motivation in a leisure-time context. Moreover, it is noteworthy that in a study of Garn et al. (2012) the direct effect of autonomy support on physical self-esteem was not significant in a similar model. The direct effect of autonomous motivation on effort in the model of each sample provides support to earlier studies (Ntoumanis, 2001; Martin-Albo et al., 2012), which reported that intrinsic motivation was the strongest predictor of effort. Autonomous motivation was a stronger predictor of effort for Hungarian and Lithuanian students than for Estonian and Spanish students. Students' high self-determined motivation means that they experience PE as exciting and are, therefore, willing to exert high effort to learn new skills.

This model demonstrated that the direct effect from perceived autonomy support on effort was significant in each sample. This finding is consistent to some extent with several previous studies (Ntoumanis, 2001; Reeve, Jang, Hardre & Omura, 2002) that reported a positive relationship between perceived autonomy support and effort. Indeed, a significant direct effect from autonomy support on self-esteem was not followed in each sample. The results of the proposed motivational sequence model confirmed the hypothesis that the effect of the perceived autonomy support on physical self-esteem and effort is influenced via psychological needs satisfaction and autonomous motivation.

The perception of autonomy support from the teacher was significantly related to need satisfaction for autonomy; competence and relatedness in all samples, but little variation in the strength of the effects was followed. Perceived autonomy support was more strongly related to need satisfaction for autonomy in the Estonian sample, to need satisfaction for competence in the Lithuanian sample and to need satisfaction for relatedness in the Hungarian sample than in others. Obviously, the teachers from the observed countries provide autonomy support from different aspects; they may have different orientations in respect of autonomy supportive behaviour. These results also corroborate the findings obtained by Standage and Gillson (2007) and Standage et al. (2012), in which the highest relation between perceived autonomy support from the teacher and need satisfaction for autonomy in comparison with the need satisfaction for competence and relatedness was found.

APPENDIX A Questionnaire items used in the study

Autonomy support	Physical self esteem
I feel that my teacher provides me with choices and options.	I am satisfied with the kind of person I am physically.
I feel understood by my teacher.	Physically, I am happy with myself.
My teacher conveys confidence in my ability to do well in the course.	I feel good about the way I look and what I can do physically.
My teacher encourages me to ask questions.	Physically I feel good about myself.
My teacher listens to how I would like to do things.	I feel good about who I am and what I can do physically.
My teacher tries to understand how I see things before suggesting a new way to do things.	I feel good about who I am physically.
Need satisfaction for autonomy	Motivation
I can decide which activities I want to practice.	I take part in PE classes…
I have a say regarding what skills I want to practice.	Intrinsic motivation
I feel that I do PE because I want to.	because PE is fun.
I feel a certain freedom of action.	because I enjoy learning new skills.
I have some choice in what I want to do.	because PE is exciting.
Need satisfaction for competence	because of the enjoyment that I feel while learning new skills/techniques.
I think I am pretty good in PE.	Identified regulation
I am satisfied with my performance in PE.	because I want to learn sport skills.
When I have participated in PE for a while, I feel pretty competent.	because it is important for me to do well in PE.
I am pretty skilled in PE.	because I want to improve in sport.
I cannot do PE very well.	because I can learn skills which I could use in other areas of my life.
Need satisfaction for relatedness	Introjected regulation
With other students in PE classes I feel…	because I want the teacher to think I'm a good student.
Supported.	because I would feel bad about myself if I didn't.
Understood.	because I want the other students to think I'm skilful.
Listened to	because it bothers me when I don't.
Valued.	External regulation
Safe.	because I'll get into trouble if I don't.
Effort/Importance	because that's what I am supposed to do.
I put a lot of effort into PE.	so that the teacher won't yell at me.
I didn't try very hard to do well in PE. (R)	because that's the rule.
I tried very hard on PE.	
It was important to me to do well in PE.	

The most prominent finding in the present study is the relatively consistent pattern of influence among the model constructs across the four cultural groups. There were only a few structural parameters that varied significantly across the samples. An explanation for a non-significant path from need satisfaction for relatedness to self-determined motivation among the Estonian and Lithuanian samples may be that they have relatively stronger individualism values in comparison to Hungarians and Spaniards. However, such statement is in contrast with several previous reports (Markus & Kitayama, 1991; Oyserman, Coon & Kemmelmeier, 2002), in which these nations are characterized as endorsing more collectivist values.

The results of the presented motivational sequence model suggest that more autonomy supportive behaviour from the teacher facilitates students to feel physically well and to put more effort into exercising. Students who perceive the effort as an integral component of physical activity do not need to force themselves to engage in physical exercise. In this case, they can easily engage in exercise during leisure time.

In conclusion, these results suggest that teachers' autonomy supportive behaviour will help foster effort directly and indirectly via autonomous motivation, whereas the effect on physical self-esteem is mainly indirect. The present research makes a unique contribution to the literature providing a comprehensive test of the prediction the physical self-esteem and importance of perceived effort on the basis of SDT across four national groups with diverse cultural backgrounds. The findings support the generalizability of the measures in the motivational sequence model to predict perceived effort and physical self-esteem.

The information provided could inform teachers' practice by showing how their behaviour is related to perceived physical self-esteem and effort, which in turn may be related to PA outside of school. Also, the information about the differences in the students' cognition may be valuable for those who have the intention to teach PE in different countries.

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A Physical Activity Learning Module Improves Medical Students' Skills and Confidence for Advising Patients about Physical Activity

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ABSTRACT Physicians' knowledge, confidence, and prior training will influence physical activity (PA) counselling in general practice. This study evaluated the effects of a PA learning module on knowledge, skills, and attitudes toward PA counselling in third-year medical students. Students (n=216; age: 21.1±2.2 years; 47% males; participation rate 91%) participated in a PA learning module that included tutorials, lectures, and experiential learning through providing health checks to adults. At baseline and four months after the intervention, students completed a paper questionnaire about their awareness of current PA guidelines, benefits of, and attitudes toward PA advising, perceived competence/importance of PA advising skills, and personal PA habits. Data were analysed using a t-test for dependent samples and Chi-square analysis. After the intervention, students reported a greater awareness of the PA guidelines (pre vs. post: 3.1±1.1 vs. 3.8±0.9), the national PA initiative (4.2±0.9 vs. 4.7±0.7), the importance of PA counselling in general practice (4.1±0.8 vs. 4.3±0.8), and their confidence (3.2±0.9 vs. 3.9±0.8), and perceived competence (3.1±0.8 vs. 3.8±0.8, all $p<0.05$) in providing PA advice compared to baseline. In conclusion, exposure to a PA learning module increased medical students' awareness and knowledge of the current PA guidelines and improved their confidence and perceived competence in providing PA advice. However, even after the training, students on average perceived themselves to be only moderately competent in providing PA advice. Therefore, clinical training for medical students should be designed to improve students' competence and skills in PA counselling.

KEY WORDS Medical students, education, physical activity, physical activity advising, curriculum, intervention

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Introduction

Lack of physical activity (PA) and sedentary lifestyles among all segments of the population represent global public health problems in both developed and developing countries (World Health Organization, 2004). According to the World Health Organization, physical inactivity (lack of PA) has been identified as the fourth leading risk factor for global mortality, causing an estimated 3.2 million deaths annually (World Health Organization, 2015). Global recommendations for PA have been developed for children and adolescents, adults, and older adults (World Health Organization, 2010). According to the current PA guidelines, adults should engage in at least 150 minutes of moderate-intensity PA or at least 75 minutes of vigorous-intensity PA throughout the week, or an equivalent combination of moderate- and vigorous-intensity PA and include muscle strengthening activities on at least two days per week (Haskell et al., 2007). Additional health benefits are achieved by increasing PA above the minimum recommended levels (Haskell et al., 2007; World Health Organization, 2010). However, only one in four adults and one in five adolescents globally meet minimum PA recommendations (World Health Organization, 2015).

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Reducing physical inactivity by 10% worldwide is one of the nine global targets for non-communicable disease prevention (World Health Organization, 2013). Increasing PA is a societal, not just an individual problem, and requires a population-based, multi-sectoral, multi-disciplinary, and culturally relevant approach (World Health Organization, 2004). Consequently, PA is becoming an integral part of health-related initiatives across all segments of the population and in various settings including communities, workplaces, and schools, as well as extending into the fields of urban design, transportation and policy development. Given the key role of physicians in the public health domain, it is important to train medical students to use PA as a medical therapeutic option and to provide individualized PA advice to their patients.

Physicians can be effective in increasing patients' health-promoting behaviours, including PA (Elley, Kerse, Arroll & Robinson, 2003; Harsha, Saywell, Thygerson & Panozzo, 1996; Swinburn, Walter, Arroll, Tilyard & Russell, 1998). However, less than one half of physicians screen patients for physical inactivity (Sherman & Hershman, 1993; Walsh, Swangard, Davis & McPhee, 1999) and less than one third of patients report receiving PA advice in the previous year (Croteau, Schofield & McLean, 2006; Eakin, Brown, Marshall, Mummery & Larsen, 2004; Wee, McCarthy, Davis & Phillips, 1999). The main factors associated with the increased likelihood of physicians providing PA advice include 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; Frank, Tong, Lobelo, Carrera & Duperly, 2008).

Medical students (Connaughton, Weiler & Connaughton, 2001; Vallance, Wylie & MacDonald, 2009) and residents (Rogers et al., 2002) have modest competence and confidence in providing PA advice. PA also has intrinsic benefits for students in terms of their own health and wellbeing (Dyrbye, Satele & Shanafelt, 2016). The authors of this paper recently reported that third year (pre-clinical) medical students in New Zealand were generally physically active and had a good understanding of the links between PA and health, but were lacking skills for PA advising and knowledge of specific PA guidelines for healthy individuals and clinical populations (Mandic, Wilson, Clark-Grill & O'Neill, 2017). In addition, regularly active medical students felt more confident in providing PA advice and perceived a greater impact of PA advising on patients' quality of life (Mandic et al., 2017). Since physicians' confidence in PA-advising skills was significantly influenced by prior training (Rogers et al., 2002), it is essential to provide opportunities for medical students to develop effective skills in PA advising as a part of their undergraduate training. A recent systematic review of PA counselling in medical education curriculums reported positive changes in students' attitude towards PA, their PA counselling knowledge and skills, and their self-efficacy to provide PA advice (Dacey, Kennedy, Polak & Phillips, 2014). The effective medical education programmes incorporated experiential learning, theoretically based frameworks, and students' personal PA habits (Dacey et al., 2014). The heterogeneity of the PA-related curriculum and weak study design of previous studies (Dacey et al., 2014) warrant further examination of the effects of the inclusion of curricula on PA advising in medical education. The current study examined the effects of an introductory learning module on PA on knowledge, skills, and attitudes toward PA advising in third-year medical students in New Zealand.

Methods

Participants

All third-year medical students at the Dunedin School of Medicine, University of Otago, (Dunedin, New Zealand, n=237) were invited to participate in this study, and 216 students (91%) gave signed consent and participated. The study was approved by the University of Otago Human Ethics Committee.

Study design

Participants completed a baseline survey in April 2009, participated in the intervention (April-May 2009) and completed the post-intervention survey in October 2009. Baseline and post-intervention surveys, were 15- to 20-minutes long and were completed on paper during tutorial classroom time.

Intervention

The PA Learning Module (intervention) consisted of three tutorials and one lecture related to PA advising and experiential learning through providing health checks to local residents. As a part of the health checks, medical students assessed the PA habits of the city residents and provided PA advice. Health checks were organized as a part of the Healthy Education Lifestyle Programme ("HELP" Day) in May 2009.

Outcome Measures

Outcome measures and measurement procedures have been described in detail elsewhere (Mandic et al., 2017) and are briefly summarized below.

Demographic characteristics. Basic demographic data collected included age, gender, ethnicity, country of origin, and self-reported height and weight. Body mass index was calculated as weight in kg divided by height in cm squared.

Assessment of knowledge, skills, and attitudes. Several questionnaires and items developed specifically for this study were used to assess knowledge, skills, and attitudes toward PA advising. Items were developed for this

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study to assess the awareness of current PA guidelines, publicly available resources on exercise prescription, the 'Green Prescription' initiative, and the benefits of exercise. These items were assessed using five-point Likert scales (1 [strongly disagree] to 5 [strongly agree]). The Green Prescription health initiative is a primary healthcare referral programme available in New Zealand since 1998 (Ministry of Health, 2016). 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). In July 2009, the Green Prescription Initiative was transferred from Sport and Recreation New Zealand (SPARC) to the Ministry of Health New Zealand.

A validated Exercise and Physical Activity Competence Questionnaire (Connaughton et al., 2001) was used to assess students' perceived competence and importance of skills in PA advising. Specific skills included performing a 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 six-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 and PA advising was modelled on previous work (Abramson, Stein, Schaufele, Frates & Rogan, 2000; Keats, Culos-Reed & Courneya, 2007). Students were asked to put themselves in the role of a primary care physician and identify their potential motivations for advising patients about PA, demonstrate their knowledge of current PA recommendations, and identify other health professionals that could assist in providing PA advice (Mandic et al., 2017).

Statistical analysis

Demographic characteristics were described using descriptive statistics. Differences between baseline and follow-up assessments were examined using the paired t-test for continuous variables and Chi-square for categorical variables. 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

Third-year medical students (n=216; age 21±2 years; 47% male) participated in the intervention and completed both baseline and follow-up questionnaires (9% loss to follow-up) (Table 1).

TABLE 1 Demographic Characteristics

	Total sample (n= 216)
Gender [n(%)]	
Males	101 (47)
Females	115 (53)
Age (years)	21.1 ± 2.2
Height (cm)	172 ± 9.6
Weight (kg)	67 ± 10.6
Body mass index (kg/m^2)	19.4 ± 2.5
Ethnicity* [n(%)]	
New Zealand European	141 (65)
Māori	14 (7)
Chinese	32 (15)
Other	60 (28)
Country of origin†	
New Zealand	111 (51)
Malaysia	23 (11)
China	13 (6)
Other	52 (24)

Note: *Some participants selected 2 or more ethnic groups; †Other countries of origin include England, Korea, Australia, Brunei, Taiwan, South Africa, Saudi Arabia, and others. Data were missing for 17 participants.

Awareness and knowledge of PA guidelines

The exposure to the intervention increased students' awareness of the Green Prescription Initiative in New Zealand and the PA guidelines for New Zealand adults (Table 2). The awareness of the American College of Sports Medicine guidelines for exercise in individuals with chronic medical conditions improved but remained low after the intervention. Although the majority of students were aware of the various benefits of

PA before the exposure to the intervention, at the follow-up assessment significantly more students reported awareness of the benefits of both aerobic and resistance training as well as the health benefits and safety of exercise in individuals with chronic medical conditions.

TABLE 2 The effects of the intervention on students' knowledge of physical activity guidelines, initiatives, and benefits and attitudes towards PA advising

	Baseline	Follow-up	p-value
Physical Activity Guidelines & Initiatives			
I am aware of the current New Zealand guidelines for physical activity in healthy adults.	3.10 ± 1.07	3.84 ± 0.94	<0.001
I am aware of the current American College of Sports Medicine guidelines for physical activity in individuals with chronic diseases.	1.38 ± 0.66	2.25 ± 0.99	<0.001
I am aware of "Green Prescription" Initiative in New Zealand.	4.24 ± 0.93	4.71 ± 0.69	<0.001
Physical Activity Advising			
I am confident in my ability to advise patients about physical activity.	3.19 ± 0.87	3.92 ± 0.76	<0.001
I perceive exercise advising as having a high priority in general practice.	4.07 ± 0.84	4.28 ± 0.77	0.002
Exercise counselling impacts patients' quality of life.	4.13 ± 0.74	4.26 ± 0.74	0.032
Benefits of Physical Activity			
Some physical activity is better than none.	4.84 ± 0.46	4.77 ± 0.70	0.241
For most health outcomes, additional benefits occur as the amount of physical activity increases through higher intensity, greater frequency, and/or longer duration.	3.90 ± 0.87	3.95 ± 0.87	0.496
Both aerobic (endurance) and muscle-strengthening (resistance) physical activity are beneficial.	4.38 ± 0.76	4.61 ± 0.73	< 0.001
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.	4.68 ± 0.58	4.73 ± 0.68	0.369
The benefits of physical activity far outweigh the possibility of adverse outcomes.	4.17 ± 0.80	4.21 ± 0.81	0.487
Adults with chronic conditions obtain important health benefits from regular physical activity.	4.03 ± 0.82	4.41 ± 0.76	<0.001
When adults with chronic conditions do activity according to their abilities, physical activity is safe.	4.26 ± 0.76	4.50 ± 0.78	<0.001
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.	4.62 ± 0.65	4.54 ± 0.76	0.197

PA advising: Attitudes, competence, and future intentions

The exposure to the intervention increased students' appreciation of the importance of PA advising in general practice and the impact of PA advising on quality of life (Table 2). After the intervention, students also reported higher levels of confidence in their ability to provide PA advice (Table 3). At baseline, most medical students perceived PA advising to be important, and this perception was not significantly changed

TABLE 3 The effects of the intervention on students' self-perceived competence in providing PA advice and importance of PA advising

	Baseline	Follow Up	p-value
Competence			
I feel competent to conduct a physical exam on a healthy adult to approve that person to begin a physical activity programme.	2.38 ± 1.13	3.73 ± 1.13	<0.001
I feel competent to determine the maximum heart rate for a healthy adult.	2.90 ± 1.54	3.53 ±1.41	<0.001
I feel competent to determine the daily caloric and nutritional needs of a healthy adult.	2.95 ± 1.20	3.31 ± 1.19	<0.001
I feel competent to determine the body mass index for a healthy adult.	5.83 ± 0.42	5.86 ± 0.50	0.498
I feel competent to calculate the aerobic training heart rate for a healthy adult.	2.47 ± 1.33	3.01 ± 1.31	<0.001
I feel competent to design a physical activity prescription including frequency, duration, and intensity for a healthy adult	2.26 ± 1.22	3.27 ± 1.30	<0.001
Overall perceived competence scale mean (out of 6)	3.10 ± 0.80	3.78 ± 0.80	<0.001
Importance			
It is important to be able to conduct a physical exam on a healthy adult to approve that person to begin a physical activity programme.	5.05 ± 1.21	5.09 ± 1.08	0.685
It is important to be able to determine the maximum heart rate for a healthy adult.	4.24 ± 1.21	4.35 ± 1.21	0.204
It is important to be able to determine the daily caloric and nutritional needs of a healthy adult.	4.87 ± 1.01	4.68 ± 1.16	0.026
It is important to be able to determine the body mass index for a healthy adult.	5.24 ± 0.97	5.23 ± 0.95	0.899
It is important to be able to calculate the aerobic training heart rate for a healthy adult.	4.14 ± 1.15	4.23 ± 1.18	0.318
It is important to be able to design a physical activity prescription including frequency, duration and intensity for a healthy adult.	4.96 ± 1.19	4.75 ± 1.17	0.021
Overall perceived importance scale score (out of 6)	4.75 ± 0.80	4.72 ± 0.80	0.651

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as a result of the intervention (Table 3). Although still only moderately competent, after the intervention students perceived increased competence in performing a physical examination, determining maximal heart rate and daily nutritional needs, calculating training heart rate, and designing an exercise programme, in comparison to the baseline (Table 3).

When students were asked to imagine themselves working as primary care physicians five years in the future, the main reasons for future PA advising in general practice (improved fitness, disease prevention, weight control and psychological benefits) remained unchanged between the baseline and follow-up assessments (Table 4). However, a greater proportion of students reported that they were more likely to provide PA advice for musculoskeletal health, physical appearance and social interaction at the follow-up assessment in comparison to the baseline (Table 4). After the intervention, a greater proportion of students reported that they would refer patients to a Green Prescription support (38% increase) and physiotherapist (7% increase), and a smaller proportion would refer patients to a personal trainer (11% decrease) or exercise physiologist (5% decrease) for more specific PA advice compared to the baseline (Table 4).

TABLE 4 The effects of the intervention on the reasons for providing PA advice in future and utilization of specialists for further advice

	Baseline	Follow-up	p-value
Reasons for providing PA advice [n(%)]			
Cardiovascular fitness	209 (97)	212 (98)	0.712
General health/Disease prevention	208 (97)	209 (97)	0.132
Musculoskeletal health	172 (80)	193 (89)	<0.001
Weight control	206 (95)	199 (92)	0.145
Physical appearance	93 (43)	139 (64)	<0.001
Psychological benefits	195 (90)	199 (92)	0.004
Social interaction	119 (55)	151 (70)	0.001
Utilization of specialists for further PA advice [n(%)]			
Green Prescription support	93 (43)	174 (81)	<0.001
Physiotherapist	97 (45)	112 (52)	<0.001
Personal trainer	106 (49)	83 (38)	<0.001
Exercise physiologist	46 (21)	35 (16)	0.012
Sports medicine doctor	25 (12)	33 (15)	0.002
Nurse / Nurse practitioner	5 (2)	7 (3)	0.032
Other medical doctor	2 (0.9)	2 (0.9)	0.891
Other	4 (2)	4 (2)	0.782

Discussion

In the present study, the exposure to the PA learning module increased medical students' awareness and knowledge of the PA guidelines and improved their confidence and self-perceived competence in providing PA advice in future. However, even after the intervention, students still perceived themselves to be only moderately competent in providing PA advice. The exposure to the PA learning module broadened students' understanding of different reasons for providing PA advice in general practice and the awareness of other health professionals, particularly Green Prescription support personnel in New Zealand, for further PA advice for their patients. Background knowledge and confidence for PA advising provide a foundation for successful PA advising in general practice. These findings suggest the importance of incorporating PA advising-related curriculum in undergraduate medical degrees.

The present study shows that the exposure to the PA learning module significantly increased medical students' awareness of the PA guidelines, national PA-related programmes (i.e. Green Prescription Initiative in New Zealand), understanding of specific benefits of exercise such as the safety of exercise in clinical populations and the awareness of the other health professionals who can assist in providing further PA advice. These findings are consistent with the results of recent studies and findings from a recent systematic review on PA counselling in medical school education (Dacey et al., 2014; Jones, Brooks & Wylie, 2013). The authors of the present study previously reported that New Zealand medical students had a good understanding of the links between exercise and health and positive attitudes towards PA advising in general practice (Mandic et al., 2017) and those outcomes were not changed considerably after the intervention in the present study. Although the intervention increased students' awareness of the PA guidelines for individuals with chronic medical conditions, students' self-perceived awareness of these guidelines remained low even after the intervention in this study. This finding is not surprising given the brief nature of this intervention, as well as the complexity of and background knowledge required for prescribing exercise for individuals with different medical conditions.

Due to the comprehensive background knowledge required for designing exercise prescription and the time constraints for PA advising in primary care practices, it is therefore essential to raise medical students' awareness of the other health professionals who could assist them in providing comprehensive PA advice for their patients, especially for patients with chronic medical conditions. In the present study, after the intervention, over 80% of New Zealand medical students reported that they would refer their patients to the Green Prescription support (38% increase from baseline) and approximately half of the students would refer their patients to the physiotherapist (7% increase from baseline) compared to the baseline assessment whereas there was a reduction in proportion of students who would refer their patients to a personal trainer. These findings indicate that the exposure to the PA Learning Module in the undergraduate curriculum significantly increased medical students' awareness of the other competent health professionals who could assist in proving specific PA advice for their patients. As suggested previously (Mandic et al., 2017), offering medical students an opportunity to interact with different exercise professionals during their medical training may be an effective way of raising students' awareness of the role of those professionals and the support they can provide.

Although the exposure to the PA learning module increased students' self-perceived competence in providing PA advice, on average students perceived themselves to be only moderately competent in providing such advice. Several previous studies reported that medical students (Connaughton et al., 2001; Vallance et al., 2009) and resident physicians (Rogers et al., 2002) lacked competence for prescribing exercise. Since physicians' confidence in PA-advising skills was significantly influenced by prior training (Rogers et al., 2002), it is essential to provide opportunities for medical students to develop effective skills in PA advising as a part of their undergraduate training. A recent systematic review found that the inclusion of PA advising in medical school curriculum increased students' knowledge, skills, and self-efficacy to conduct PA counselling (Dacey et al., 2014). The results of the present study show that exposure to a short PA learning module consisting of one lecture, three tutorials, and one-day experiential learning increased students' self-perceived competence in providing PA advice and this increase was maintained for four months after the exposure to the intervention. However, even after the intervention, on average pre-clinical medical students perceived themselves to be only moderately competent in providing such advice. Therefore, more extensive training in PA advising may be necessary as a part of the undergraduate medical curriculum to develop medical students' skills, knowledge and confidence for providing effective PA advice in future. As suggested previously, improving medical students' knowledge of and confidence regarding PA promotion is a step forward and may increase the rates and effectiveness of physicians' PA counselling in the future (Jones et al., 2013).

The findings of this study have significant implication for future undergraduate medical curriculums. Given the effectiveness of the PA advising in general practice (Elley et al., 2003; Harsha et al., 1996; Swinburn et al., 1998), the multiple benefits of PA in healthy individuals and clinical populations (Warburton, Nicol & Bredin, 2006), and global efforts to reduce physical inactivity by 10% worldwide (World Health Organization, 2013), it is essential to equip future physicians with the skills, and knowledge for PA advising. The present study shows that the inclusion of the PA Learning Module in undergraduate medical curriculum increases medical students' awareness of the PA guidelines, their self-perceived competence for providing PA advice to patients and awareness of the existence of other health professionals. Since increasing PA levels has multiple health benefits, taking an PA history should be a standard feature of routine medical assessment. Therefore, undergraduate medical training should include a comprehensively planned and delivered the curriculum related to PA assessment and advising. Our findings suggest that future tutorials on PA advising for medical students need to be designed to provide specific training for advising and focus on improving students' competence in providing patient-oriented exercise prescription.

Study limitations

Study limitations include the non-experimental pre-test/post-test study design without a control group and the assessment of students in one medical school. In addition, the newly developed PA Learning Module was designed to introduce PA advising to medical students and did not specifically aim to increase students' overall competence in providing comprehensive PA advice. Finally, the long-term effects of the exposure to the PA Learning Module as a part of the medical education curriculum on subsequent rates of PA advising by future physicians remain unknown. Despite these limitations, the current study was conducted on a large sample of pre-clinical medical students with a high participation rate (91% of the total sample). In addition to the lectures and tutorials, PA learning module in this study included an experiential learning through providing health checks and assessing PA habits of the city residents. Future studies need to examine the effects of comprehensive medical curriculum interventions focused on PA and health and PA advising on short-term outcomes (students' attitudes, knowledge, and confidence in providing patient-oriented exercise prescriptions) and long-term outcomes (the influence of undergraduate medical training on the subsequent rates of PA advising by future physicians in specialist and general practice). Future studies should use objective measures of the medical students' knowledge, skills, and competencies for PA advising and objective measures of students' PA.

Conclusion

The exposure to the PA learning module increased medical students' awareness and knowledge of the current PA guidelines and improved their confidence and perceived competence in providing PA advice. However, even after the training on average students perceived themselves to be only moderately competent in providing PA advice. Therefore, future clinical training on PA advising for medical students should be

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designed to provide specific training in PA advising focusing on improving students' competence and skills in providing patient-oriented exercise prescription as well as increasing their awareness of other healthcare professionals specializing in PA advice.

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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.

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The Effect of Kick Type on the Relationship between Kicking Leg Muscle Activation and Ball Velocity

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ABSTRACT This study aimed to identify the effects of different kick types on the relationship between kicking leg muscle activation and ball velocity. The muscle activation of selected knee extensor and flexor muscles of 10 amateur soccer players were measured using electromyography during the performance of six maximal soccer kick types. The highest ball velocity was achieved by the instep kick (96.2 km/hr^{-1}), followed by the lofted kick, the inside curve kick, the outside kick, the outside curve kick, and finally the inside kick (81.3 km/hr^{-1}). There were significant positive correlations between muscle activation and ball velocity for the vastus lateralis and lofted (0.765), inside curve (0.792) and instep kicks (0.788), and for the gastrocnemious with the outside kick (0.796). Non-significant correlations between muscle activation and ball velocity exhibited a trend such that they were positive for the vastus medialis and vastus lateralis but negative for the biceps femoris and gastrocnemious for inside-foot-dominated kicks, while this trend was reversed for outside-foot-dominated kicks. According to results, the noted trends can be explained by the change in muscle activation patterns required to orientate the foot for each type of kick; this has implications for players' training activities.

KEY WORDS soccer, kick type, electromyography, ball velocity

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Introduction

Various kick types are used in soccer to kick a stationary ball and can be classified as: (1) inside, (2) lofted, (3) inside curve, (4) instep, (5) outside, and (6) outside curve kicks (Bauer, 1993). All these kick types can be used for scoring and players who are proficient in the use of each increase their possibility of scoring a goal because it reduces the time the goalkeeper has to react (Sterzing et al., 2009).

To our knowledge, the ball velocities of only three kick types (inside, instep, outside) have been analysed in previous studies (Nunome et al. 2002; Asai et al. 2002; Katis & Kellis, 2010). The velocity of the ball has been used as a key indicator for total kick performance (Kellis & Katis, 2007; Lees & Nolan, 1998). Katis and Kellis (2010) determined ball velocity in youth players and found the inside kick velocity (70.6±5.8 km/h^{-1}) to be higher than that of the outside kick (65.2±5.4 km/h^{-1}). Other studies (Kawamoto et. al., 2007; Levanon & Dapena, 1998; Nunome et al., 2002) also showed that the instep kick generates higher ball speeds than the inside and outside kick types do. However, no study has reported ball velocities from the other types of kick that are defined in the current study.

As the kick type changes from the inside kick to the outside curve kick, movement patterns and limb positions change. For example, when kicking the ball using the inside kick, the player needs to *outwardly* rotate and extend the hip joint, flex the knee and *evert* and plantar flex the ankle. In contrast, kicking the ball using the outside curve type requires the player to *inwardly* rotate and extend the hip joint, to flex the knee, and to *invert* and plantar flex the ankle.

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Movement patterns and the position of the limbs for different kick types occur as a result of muscular contractions surrounding the hip, knee, and ankle joints. Several studies have been conducted to explain the muscle activation patterns that occur during kicking by electromyography (EMG) but only for the inside and instep kicks (Brophy et. al., 2007; Cerrah et al., 2011; Dorge et al. 1999; Scurr et. al., 2011). The soccer kick is considered to be the result of the simultaneous activity of many muscles connecting segments and causing joint movement. Some of these muscles act as antagonists during the kick and are thought to limit performance. This is termed the "soccer paradox" (Clarys et. al., 1984; Bollens et al., 1987; De Proft et al., 1988; McCrudden & Reilly, 1993).

In the kicks performed with the inside and outside parts of the foot, the lower limb extremity joints show higher rotations in the transverse and frontal planes, which are necessary in order to bring the foot to the appropriate position (inverted, dorsi-flexed, and supinated) for ball contact, in comparison with the instep kick (Kellis and Katis, 2010; Nunome et al., 2002). This means that, while the sagittal plane movements of the lower limb show similarity between different types of kick, the frontal and transverse joint rotations through the forward motion of the kicking leg differ between the differing types of kick. Consequently, muscle activation might also change according to kick type. To date, there have been no studies that have investigated the relationship between the level of muscle activation and ball velocity for different kick types.

Our purpose, therefore, is to define the relationship between the muscle activation of selected muscles operating around the kicking leg knee with the ball velocities produced during the maximal performance of different kick types. We hypothesized that a relationship between muscle activation and ball velocity will exist and will be affected by kick type.

Methods

Ten amateur male soccer players (height: 177.4±6.6 cm, mass: 74.7±6.4 kg, age: 24.3±2.7 years) who could successfully perform the kick types investigated volunteered to participate in the current study. All participants were soccer players of the same team competing in the local amateur league, and their training frequency was three times a week with a competition on weekends. Their descriptive statistics are summarized in Table 1. None of the participants reported any previous injury to their lower limbs. All players were informed about the protocol of the training, possible benefits, and risks, and gave their written informed consent. This study was approved by the University Ethics Committee (Protocol Number: PR-08-12-04-08) and carried out in accordance with the Declaration of Helsinki.

TABLE 1 Descriptive statistics for amateur soccer players (n=10)

Age (years)	Athletic History (years)	Position				Kicking Leg	
mean±SD	mean±SD	GK	D	MF	F	right	left
24.3±2.7	12.9±3.0	1	2	2	5	10	0

Note: GK - goal keeper, D - defence, MF - midfielder, F - forward

The soccer kick test was performed following a warm up (10 min jog) and five soccer-specific stretching exercises (10 min) in an indoor sport area. For standardization purposes, players were asked to perform the inside kick (0-10° approach angle), lofted kick (0-10° approach angle), inside curve kick (30-45° approach angle), in-step kick (0-10° approach angle), outside kick (0-10° approach angle) and outside curve kicks (30-45° approach angle) in a random order. The descriptions of kick types are given in Table 2. The inside kick was performed with one step and the remaining kicks were performed with two advancing steps towards a stationary ball aimed at a target (width 3.00 m, height 2.44 m) 15 m away with a full size (number 5) soccer ball approved by the International Football Federation (Masuda et al., 2003). Ball pressures were adjusted to 11 psi with a pressure measurement device (Rucanor, Netherland). Participants were asked to kick the ball with maximal velocity and accuracy so as to strike a target. A total of three kicks were analysed, and the data averaged. Ball velocity was measured with a radar gun (Bushnell Velocity Speed Gun, USA) held behind the goal. All kicks were recorded with a video camera (Canon Hg 21) at 50 Hz and the toe-off to impact time during kick identified with video analyses software for sport (Kinovea 0.8.15). A mechanical switch was attached to the shoe of the players to accurately measure the moment of the contact between the player's foot and ball. The signal obtained from the contact of the foot was superimposed on the EMG recordings.

The EMG measurement sites were prepared according to SENIAM recommendations (Hermens et al., 2000). The centre-to-centre distances between two Circular Ag/AgCl surface electrodes (Blue Sensor Electrodes, Noraxon) was 2cm and were placed longitudinally with respect to the underlying muscle fibre arrangement. The muscles investigated were the *m. rectus femoris* (RF), the *m. vastus lateralis* (VL), the *m. vastus medialis* (VM), the long head of *m. biceps femoris* (BF), and the *m. medial gastrocnemius* (GAS). Furthermore, the reference electrode was placed on the lateral malleolus of the fibula. Only five muscles' EMG recording were analysed because these muscles were mostly analysed in previous studies and were more suitable for dynamic action such as soccer kicks. Moreover, the maximum isometric voluntary contractions (MVIC) of the quadriceps (RF, VL, VM) was assessed by knee extension when sitting with the knee at a 65° angle (0°

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TABLE 2 Description of kick types

Kick Types	Description
Inside Kick	The kicking leg is rotated outward from the hip joint, and the ankle joint is rotated outward to form approximately a 90º angle of the foot to the direction of the kick. The contact area is between the metatarsals and calcaneus on the medial aspect of the foot and close to the centre of mass for the ball
Lofted Kick	The kicking leg is rotated outward from the hip joint, and the ankle joint is rotated outward to form approximately a 45º angle of the foot to the direction of the kick with the toe close to the ground. The contact area for the foot is around the metatarsals, and for the ball, underneath its centre of mass
Inside Curve Kick	The kicking leg is rotated outward from the hip joint and the ankle joint is rotated outward to form approximately a 45º angle of the foot to the direction of the kick. To spin the ball with the right foot, the contact area is around the metatarsals for the foot and underneath, but to the outside of the centre of mass for the ball
Instep Kick	The kicking leg is rotated slightly outward from the hip joint, and the ankle joint is plantar flexed so the toes point to the ground. The contact area for the foot is around the laces of the soccer shoe and for the ball, close to its centre of mass
Outside Kick	The kicking leg is oriented inward from the hip joint, and the ankle joint is rotated outward to form approximately a 30-45º angle of the foot to the direction of the kick with the toe close to the ground. The contact area for the foot is slightly above the metatarsals, and for the ball, underneath but to the outside of its centre of mass
Outside Curve Kick	The kicking leg is oriented inward from the hip joint, and the ankle joint is rotated outward to form approximately a 30-45º angle of the foot to the direction of the kick. To spin the ball with the right foot, the contact area for the foot is slightly above the metatarsals and for the ball, underneath but to the inside its centre of mass.

full extension) against a resistance, while the MVIC of hamstrings (long head of BF) was assessed in a prone position with the knee at a 30° angle against a resistance (Kellis and Baltzopoulus, 1988). For the MVIC of the GAS, participants were asked to perform plantar flexion against a resistance when in the supine position (Cerrah et al., 2011). A Biovision EMG system was used to record EMG signals (Biovision, Germany) with maximum intra-electrode impedance and minimum CMMR of 6 K-Ohm and 95 dB, respectively. Analogue signals were pass band filtered between 20–500 Hz and digitized by a 12-bit A/D converter at 1000 Hz. To display the activation patterns of the muscles, which occur in six different kick types, the filtered EMG signals were smoothed using a 40ms root-mean-square filter. They were also normalized by the maximal EMG activity recorded during MVICs for each participant (Cerrah et al. 2011). The mean of the normalized EMG data from the beginning of toe-off of the kicking leg to ball contact was averaged over the three kicks and repeated for each of the six different kick types to give a value for muscle activation (Table 4) and subsequently correlated with ball velocity.

Descriptive statistics were applied to identify the characteristics of the participants and groups. Mean scores were calculated for each participant's three kicks for each type of kick and then averaged across each group. All data were normally distributed (Shapiro Wilk). Ball velocities are expressed as mean ± SD. Two one-way analyses of variance (ANOVA) were performed to firstly analyse differences between ball velocities and kick types, and secondly to analyse differences between muscle activation and kick types. The level of significance was set at $p<0.05$. When a significant interaction was detected, data were subsequently analysed using a Tukey post-hoc test. Pearson Correlation was used to correlate muscle activation and ball velocity for each muscle and the six kick types. Pearson's Correlation coefficient was interpreted according to Domholdt (2000): 0.00–0.25=little if any correlation, 0.26–0.49=weak correlation, 0.50–0.69=moderate correlation, 0.70–0.89=strong correlation, 0.90–1.00=very strong correlation.

Results

The highest ball velocity was achieved for the instep kick followed by the lofted kick, the inside curve kick, the outside kick, the outside curve kick, and finally the inside kick (Table 3). Significant differences occurred between the inside kick and the lofted, inside curve, and instep kicks. Other significant differences occurred for the outside curve kick with the lofted and instep kicks.

TABLE 3 Ball velocities from different kick types

	Kick Type	mean±SD
Ball Velocities ($km \cdot h^{-1}$)	Inside	81.3±3.9
	Lofted	92.3±8.1 **Ψ**,α***
	Inside Curve	91.2±8.0 **Ψ***
	In-step	96.2±7.3 **Ψ,** α****
	Outside	87.5±5.4
	Outside Curve	83.5±5.9

Note: Ψ - Statistically significant different to the inside kick; α - Statistically significant different to the outside curve kick; * - p<0.05; **:p<0.01

In RF, the highest level of muscle activation occurred for the outside kick and was significantly different from the rest of the kicks (Table 4). In VL, the highest muscle activation occurred for the outside curve kick but was significantly different only from the inside kick. In VM, the highest muscle activation also occurred in the outside curve kick. In BF, the highest muscle activation occurred for the inside kick while in GAS, the highest muscle activation occurred in the lofted kick. The mean muscle activation values for each muscle and the significance of differences with regard to kick types are given in Table 4**.**

TABLE 4 Mean normalized muscle activation from different kick types (% of MVIC)

		Inside	Lofted	Inside Curve	In-step	Outside	Outside Curve
	Muscles	mean±SD	mean±SD	mean±SD	mean±SD	mean±SD	mean±SD
Mean (%)	RF	0.39±0.09[e**]	0.39±0.06[e**]	0.36±0.06[e**]	0.40±0.07[e**]	0.57±0.14	0.36±0.05[e**]
	VL	0.25±0.08[f*]	0.34±0.11	0.34±0.09	0.37±0.09	0.38±0.12	0.39±0.12
	VM	0.23±0.09	0.39±0.10[a**]	0.32±0.11	0.36±0.11	0.38±0.08[a*]	0.42±0.09[a**]
	BF	0.22±0.08	0.16±0.06	0.15±0.05	0.12±0.07[a**]	0.09±0.02[a**]	0.10±0.05[a**]
	GAS	0.23±0.09[b*]	0.36±0.12	0.26±0.09	0.28±0.09	0.22±0.04[b**]	0.23±0.04[b*]

Note: RF - Rectus Femoris, VM - Vastus Medialis, VL - Vastus Lateralis, BF - Biceps Femoris, GA- Gastrocnemious, MVC - Maximum Voluntary Contraction, **a** - Statistically significantly different to the inside kick, **b** - Statistically significantly different to the lofted kick; **c** - Statistically significantly different to the inside curve kick; **d** - Statistically significantly different to the instep kick; **e** - Statistically significantly different to the outside kick; **f** - Statistically significantly different to the outside curve kick; *:p<0,05; **:p<0,01

There were significant positive correlations between muscle activation and ball velocity for VL and lofted, inside curve, and instep kicks, and a significant positive correlation for GAS with the outside kick (Table 5). The inside-dominated kicks (inside, lofted, inside curve, instep) followed a trend of positive correlations (0.560 to 0.792) for VL and VM and negative correlations (-0.057 to -0.601) for BF and GAS. The outside-dominated kicks (outside and outside curve kick), followed an opposite trend of negative correlations for VM (-0.136 to -0.292) but positive correlations (0.079 to 0.796) for BF and GAS.

TABLE 5 Correlation between five muscles and six different kick types

Kick types	Muscles				
	RF	VM	VL	BF	GAS
Inside	-0.038	0.629	0.311	-0.513	-0.601
Lofted	-0.471	0.560	0.765*	-0.057	-0.058
Inside curve	0.280	0.635	0.792*	-0.146	-0.436
In-step	-0.169	0.513	0.788*	0.313	-0.070
Outside	-0.463	-0.136	0.361	0.0791	0.796*
Outside curve	-0.361	-0.292	0.600	0.0845	0.673

Note: RF - Rectus Femoris, VM - Vastus Medialis, VL - Vastus Lateralis, BF - Biceps Femoris, GAS – Gastrocnemious, *:p<0.05

Discussion

The aim of this study was to define the relationship between activation characteristics of five muscles around the kicking leg knee and ball velocity for six different kick types. The main findings are that (1) both muscle activation and ball velocity changed as a function of kick type, (2) there was a significant relationship between muscle activation and ball velocity for certain muscles and certain kick types, and (3) there was a trend for the inside-orientated kicks to have muscle activation patterns opposite to those found in the outside orientated kicks.

Different kick types have been found to produce significantly different maximal velocities. The highest velocity (96 km/h^{-1}, instep) is 18% greater than the lowest velocity of the inside kick (81 km/h^{-1}). These data are similar to those reported by Nunome et al., (2006) (94.7 m/s^{-1}, instep) for experienced players but greater than those reported by Kellis et al. (2006) (88.9 km/h^{-1}, instep, two-step) for amateur players and lower than those reported by Cometti et al., (2001) (106.4 km/h^{-1}, free approach) for professional players. Muscle activation also differed significantly between kick types. There is a lack of published data on this variable so it is not possible to make direct comparisons with the literature. However, the differences found suggest that establishing the relationship with ball velocity would be productive.

The relationship between muscle activation and ball velocity has been speculated upon by others (e.g. Kellis and Katis, 2010; Nunome et al., 2002). The different limb motions and postures required to achieve each type of kick would appear to require different muscle activation patterns. In this study, the kick types that required the greatest foot re-orientation (the inside kick and the outside kick) produced the lowest velocities suggesting that the process of re-orientating the foot for ball impact compromises foot (and hence ball) velocity. To our

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knowledge, no study has reported any correlation between muscle activation and ball velocity for a range of commonly used kick types. The correlation between five muscles of the kicking leg and the ball velocities of six different kick types show positive and negative correlations. The significant positive correlations occurred in VM for the fastest of the kicks (instep, inside curve and lofted kicks). This finding implies that knee extensor muscle activation is a significant contributor to kick performance, particularly in those kicks with which the leg is turned outwards to make contact on the inside or medial aspect of the foot. Because of the curved approach, the medial aspect of the foot naturally contacts the ball so it would appear that in these types of kicks the knee extensors are able to operate effectively (i.e. their muscle line of action is not required to deviate in order to produce a medial or lateral re-orientation of the foot for contact). The greater ball velocity may be interpreted in terms of greater muscle activation combined with better functionality of joint action.

A trend was observed between inside (inside, lofted, inside curve, and instep) and outside (outside and outside curve) foot-dominated kicks. The former kicks are observed to produce positive correlations with ball velocity for VM and VL and mainly negative correlations for BF and GAS, while the latter produce an opposite pattern. Those kicks, which are inside-dominated require high levels of knee extensor muscle activation, but *reduced* activation of the knee flexors as these inhibit knee extension as a characteristic of the "soccer paradox". Outside foot-dominated kicks do not show this feature, which suggests that these types of kicks require fundamentally different movement patterns. They are considered to be the most technically difficult. That they demonstrate lower knee extensor activity combined with greater knee flexor activity is a consequence of the requirement to inwardly rotate the foot for ball contact on the outside of the foot. Reduced knee extensor activity and increased knee flexor activity would negatively impact foot (and hence ball) velocity at impact; therefore, a reduced average ball speed would be expected. This is found for the outside kick, which is an extreme form of this type of kick, but not to the same extent for the outside curve kick. The significant relationship between GAS and ball velocity for the outside kick might be due to the need for greater foot rigidity, leading to better foot-ball interaction. The correlation for the outside curve kick is not significant but follows the same trend suggesting a similar need for enhanced foot rigidity.

Finally, the role of RF is worth noting: it generally has a low negative correlation between muscle activation and ball velocity. This suggests that it is not a prime mover for the technical changes required for the more complex kicks. Because the RF muscle is a two-joint muscle, it could be contributing to the well-executed kick by allowing the upper leg to decelerate. Therefore, elastic energy is transferred from the thigh to the shank. For that reason, the role of RF muscle should be investigated further together with kinematic data in order to identify the contribution this muscle makes during kicking performance.

Activation patterns of muscles for the different kick types used here are similar to those described in other studies, which is that the kick requires a proximal-to-distal segmental movement occurring as a result of motion-dependent moments generated by active involvement of the whole body (Shan and Westerhoff, 2005; Nunome et al., 2002; Lees, 2010).

It has been shown in the current study that even though the general activation patterns are similar, the involvements of the muscles that determine the kicking velocity change according to kick type. This would suggest that some form of training taking into account the findings described above would be beneficial to players.

This study was a preliminary investigation into an under-reported area of soccer performance related to different kick types. Within the limitations of the study, it has been found that VL and VM muscles are significant determinants for the inside, lofted, inside curve and instep kicks while BF and GAS muscles are significant determinants for the outside and outside curve kicks. It seems that the fastest kick types use high activation of knee extensors and low activation for the knee flexors. For the outside kick types, the leg and ankle flexors play a more important role, but to the detriment of the knee extensors.

Conclusion

The results of this study demonstrate that maximal kicking velocity is dependent on kick type and can in part be explained by the level of muscle activity in leg muscles, which supports the hypothesis of this paper. The muscle activation characteristics of the knee flexors and extensors studied are significant determinants of different kick types. Therefore, a type of muscle training that improves the coordination pattern of muscle activation relevant to the different kick types described could be beneficial to players. Therefore, power training should be suitable for all types of kicks; however, in order to train specific kicking types, resistance band (cable) and coordination training that represent kicking motion could be recommended for players and coaches. Moreover, it could be more beneficial if the resistance trainings are organized regarding the positions of trunk, hip, leg and ankle with active involvement of muscles described in the current study. This study provides baseline findings for further investigation into the changes in muscular activation values and patterns due to kick type, including the influences of age and players' skill level.

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ORIGINAL SCIENTIFIC PAPER

Perceived Autonomy Support and Basic Psychological Needs of Participants in a Women's Health-Related Exercise Programme according to Exercise Stage of Change and Exercise Type

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ABSTRACT This study applied the self-determination theory to examine the perceived autonomy support and basic psychological needs of women participating in a health-related exercise programme with respect to exercise stage of change (three stages including Preparation, Action, and Maintenance) and exercise type (Aerobic vs Strength & Flexibility). The sample consisted of 316 women (M age=25.1 years, SD=7.2) who completed the Perceived Autonomy Support Scale for Exercise Settings: Basic Psychological Needs in Exercise Scale and the Physical Activity Stages of Change Questionnaire. Participants' heart rate during the exercise and the exercise content were used to categorize the exercise classes as Aerobic or Strength & Flexibility. Data were analysed using ANOVA and MANOVA ($p<.05$). The findings indicated that participants perceived autonomy support differed according to exercise type (F (1,315)=6.44, $p<.05$, $\eta^2=.02$). Moreover, participants' basic psychological needs differed according to both exercise stage of change (F (3,311)=3.97, $p<.05$, $\eta^2=.04$) and exercise type (F (3,312)=5.63, $p<.05$, $\eta^2=.05$). To address the needs of worksite health-related exercise programme participants, programme providers and instructors should further consider exercise stages of change and participants' preferred type of exercise.

KEY WORDS women, self-determination theory, exercise stages, exercise type, worksite health promotion

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Introduction

Participation in physical activity has decreased among adults, and the prevalence of a number of health problems has increased, especially in industrialized countries. These trends have led researchers to explore the motivational aspects of physical activity to improve participation among adults. As the majority of adults spend most of their daily life at work, organizing worksite health-related exercise programmes might be beneficial for promoting employees' level of physical activity.

Worksites offer different health promotion programmes that aim to enhance the health and wellbeing of employees and their families. The effects of worksite physical activity interventions on increasing physical activity levels among adults have been examined by different researchers (Shephard, 2002; Proper et al., 2002; Abraham & Graham-Rowe, 2009). According to recent reviews and reports from the World Health Organization, worksites are a preferred setting for promoting the health and physical activity levels of adults (Dugdill, Brettle, Hulme, McCluskey & Long, 2008; Abraham & Graham-Rowe, 2009). In addition, different researchers (Anderson et al., 2009; Conn et al., 2009, Crump, Earp, Kozma & Picciotto, 1996) have confirmed the benefits of worksite health promotion (WHP) programmes regarding employees' behaviour.

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The effect of health-related exercise programmes, such as those providing fitness (Rebold, Kobak, Peroutky & Glickman, 2015), aerobic (Korshøj et al., 2015) and yoga classes (Cowen, 2010), has been examined in different worksite populations, including academic staff, cleaners, and firefighters. These studies identified a positive effect of these interventions on both physical and mental health outcomes. In addition to enhancing employees' cardiorespiratory and muscular endurance performance, these WHP programmes may help participants focus on their work and may relieve work stress.

Women are currently employed in a number of different positions in addition to having family-related roles and responsibilities. Therefore, the interactions between their work and family and stressful environments may affect women's general health and work ability (Collins, Hollander, Koffman, Reeve & Seidler, 1997). However, despite the importance of physical activity for women who are employed, previous studies have shown that employed women engage in a lower percentage of regular participation in exercise than the general population (Lee, Djoussé, Sesso, Wang, & Buring, 2010). Pohjonen and Ranta (2001) determined that worksite programmes have the potential to improve physical activity levels, address the lack of time for exercise, and prevent decreases in work ability among female workers.

Although studies have examined the effects of worksite health-related physical activity for over two decades, few researchers have considered the motivational aspects involved in increasing employees' engagement in physical activity. Examining the women's worksite-health related physical activity setting with self-determination theory constructs with respect to exercise stages of change construct of Transtheoretical Model and preferred type of exercise (Aerobic vs Strength & Flexibility) may strengthen understanding of the topic.

The self-determination theory provides a multidimensional approach to identifying reasons for participation in physical activity (Deci & Ryan, 2008). According to the self-determination theory, adults with a more intrinsic form of motivation for exercise have greater intention to regularly participate than people with extrinsic purposes do (Ryan & Deci, 2008). If the environment supports more autonomy, individuals will feel autonomous rather than controlled (Gagne, 2003). Perceptions of autonomy support by different individuals such as coaches, fitness instructors, and peers could increase the internalization of the three psychological needs (autonomy, competence, and relatedness) of exercise participants in health-related physical activity programmes (Ryan & Deci, 2008).

According to the Transtheoretical Model, exercise participants in different stages of change (Preparation (people who have recently started participating in regular exercise), Action (people who have participated in regular exercise for more than 1 month to less than 6 months), Maintenance (people who have participated in exercise for more than 6 months) need different motivational approaches from their instructors (Prochaska & DiClemente, 1984). In addition, previous researchers also claimed that motivation to participate in exercise depends on the exercise type and intensity and the individual's stage of participation (Frederick, Morrison, & Manning, 1996; Duncan, Hall, Wilson & Jenny, 2010).

Considering the abovementioned findings, the aim of this study was to examine the perceived autonomy support and basic psychological needs of participants in women's health-related exercise programmes, considering exercise stage of change (Preparation, Action, and Maintenance) and preferred exercise type (Aerobic vs. Strength & Flexibility), using a university sports centre as the WHP setting. This study addressed four research questions: 1) What is the effect of the exercise stage of change on the perceived autonomy support of participants in a women's health-related exercise programme? 2) What is the effect of the preferred exercise type on perceived autonomy support among participants in a women's health-related exercise programme? 3) What is the effect of the exercise stage of change on the basic psychological needs of participants in a women's health-related exercise programme? and 4) What is the effect of the preferred exercise type on the basic psychological needs of participants in a women's health-related exercise programme?

Method

Participants

This study was conducted at a university, which functioned as the WHP setting. A total of 1697 people participated in health-related exercise programmes during the study period (2013-2014 spring semester), including academic and administrative staff and students. Data were collected from 369 participants in Zumba, Power Step, Pilates, Freestyle Tempo, Freestyle Combat, Yoga, and Total Body classes who volunteered to participate in this study. Data were initially screened for incomplete responses, resulting in the exclusion of 53 respondents. A total of 316 women participated in this study. Their mean age was 25.1 years (SD=7.2), with a range from 18 to 65 years.

Data Collection Instruments

Quantitative data were collected with three instruments: 1) The Perceived Autonomy Support Scale for Exercise Settings (PASSES), 2) the Basic Psychological Needs in Exercise Scale (BPNES), and 3) the Physical Activity Stages of Change Questionnaire (PASCQ).

Perceived Autonomy Support Scale for Exercise Settings (PASSES)

PASSES was used to measure the perception of autonomy support in exercise settings in terms of the instructors and was developed by Hagger et al. (2007). The items are scored on a seven-point Likert scale

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ranging from 1 (strongly disagree) to 7 (strongly agree). It is one-dimensional and consists of 12 items (e.g. my health-related exercise instructor encourages me to engage in active sports and/or vigorous exercise in my free time). The validity of this scale has been assessed through a cross-cultural investigation, and the results indicated that it was valid for use in exercise settings for young people (Hagger et al., 2007). This scale was adapted to Turkish by Müftüler and İnce (2015); according to their findings, the Turkish version has good internal consistency (α=.97) and construct validity.

Basic Psychological Needs in Exercise Scale (BPNES)

The BPNES is a self-report instrument developed by Vlachopoulos and Michailidou (2006). It consists of 12 items that assess the extent to which psychological needs related to autonomy (4 items), competence (4 items), and relatedness (4 items) are satisfied in an exercise context. Example items for each sub-scale include the following: "The exercise programme I follow is highly compatible with my choices and interests" for autonomy; "I feel I have been making substantial progress with respect to the end results I am pursuing" for competence; and "I feel extremely comfortable with the other exercise participants" for relatedness. The items are scored on a five-point Likert scale ranging from 1 (I do not agree at all) to 5 (I completely agree). The reliability and validity of this scale across cultures including Turkish were assessed in a cross-cultural investigation (Vlachopoulos & Michailidou, 2006). The internal consistency of the scale in the Turkish population was α=.62 for autonomy, α=.77 for competence, and α=.69 for relatedness (Vlachopoulos et al., 2013).

Physical Activity Stages of Change Questionnaire (PASCQ)

The PASCQ was used to evaluate participants' physical activity stage. This questionnaire was developed by Marcus, Rossi, Selby, Niaura, and Abrams (1992) and is a binary questionnaire. The results were used to classify participants into five different groups according to the scoring algorithm: Pre-contemplation (unaware of their problematic behaviour and lack of intention to participate in an activity), Contemplation (intention to change the behaviour within six months, but no commitment to participate in an activity), Preparation (intention to participate in an activity in the next month without successful action in the past year), Action (changed behaviour and participation in an activity from one day to six months), and Maintenance (continuation of an activity for more than six months). The test-retest reliability (ICC=.80) and construct validity of the Turkish version of the PASCQ were reported by Cengiz, Asci, and İnce (2010).

Categorization of Preferred Exercise Type

Latin Aerobics, Zumba, Power Step, Tempo, Freestyle Combat, Total Body, Yoga, and Pilates classes were offered by the worksite exercise programme and were visited by the lead researcher. The exercise classes were first observed, and then the instructors of each class were asked about the main purpose of the class. Based on the observation and instructors' report, the exercise programmes were grouped into two main categories: 1) aerobic-oriented classes including Latin Aerobics, Zumba, Power Step, Tempo, and Freestyle Combat, and 2) muscular strength and flexibility-oriented classes including Yoga, Pilates, and Total Body.

One session of each class was then visited. Volunteer participants (Latin Aerobics (n=8); Zumba (n=13); Power Step (n=14); Tempo (n=8); Freestyle Combat (n=11); Total Body (n=8); Yoga (n=14) and Pilates (n=6))

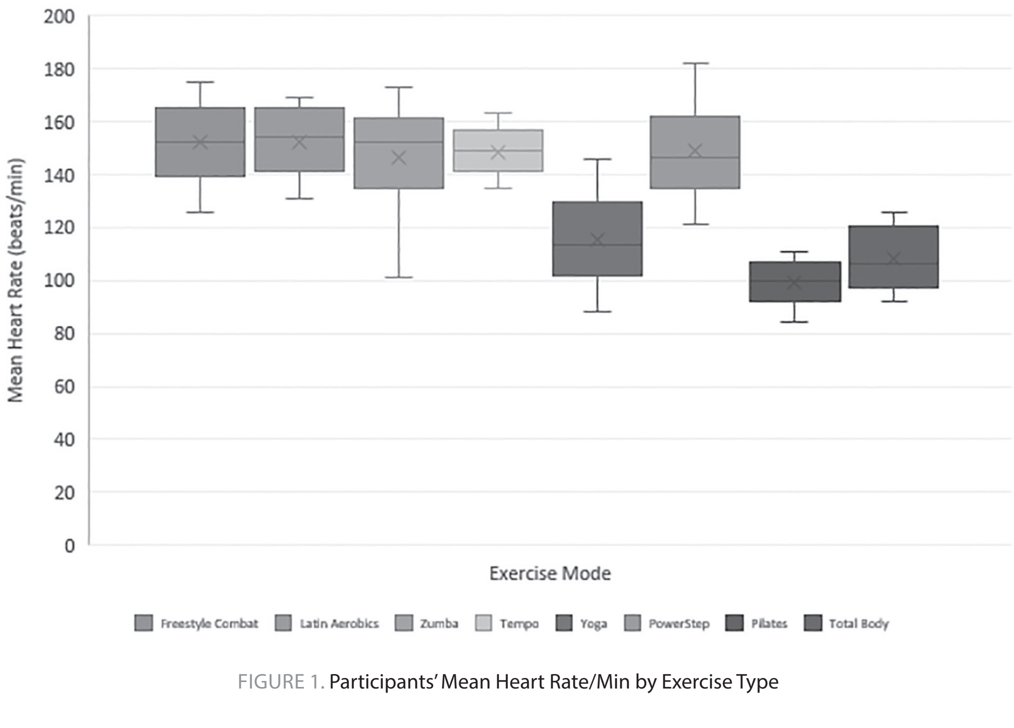

FIGURE 1. Participants' Mean Heart Rate/Min by Exercise Type

wore heart rate monitors with data storage capability (Polar RJ 300X). Data were transferred to a computer and analysed using descriptive statistics to examine the participants' mean, maximum and minimum heart rate/min during the entire session. Based on the findings, participants in aerobic activities had a higher mean heart rate/min during the exercise sessions (Latin Aerobics=152.25 ± 13.76, Zumba=146.31±19.83, Power Step=148.93±17.08, Tempo=148.63±9.62, and Freestyle Combat=152.27±15.55) than the values of participants in the strength and flexibility activities (Yoga=115.07±17.09, Pilates=99.17±9.57, and Total Body=108.00±12.18) (see Figure 1).

Data Collection Procedure

After the study was approved by the Human Subjects Ethics Committee (Approval No: 28620816/168-327), the researcher visited the Zumba, Power Step, Pilates, Tempo, Freestyle Combat, Yoga and Total Body Step classes offered by the Sports Directory of the University under the health-related exercise programme. The researcher explained the aims of the study and asked for voluntary participation. Volunteer participants completed the study questionnaires at the end of their class and returned them to the researcher. Participants completed the questionnaires in approximately 10 minutes.

Data Analysis

First, descriptive statistics were conducted, and the means and standard deviations were generated. After the assumptions of normality and homogeneity of variance were checked for the univariate and multivariate analyses, ANOVA was used to analyse the first and second research questions, and MANOVA, the third and fourth research questions (p<.05).

Results

The first research question aimed to examine perceived autonomy support among participants in the health-related fitness programme according to exercise stage. According to the ANOVA, health-related fitness participants' perceived autonomy support did not significantly differ according to exercise stage (F (2, 315)=2.55, p>.05).

The second research question aimed to examine participants' perceived autonomy support according to their preference for aerobic or strength- and flexibility-type activities. The ANOVA results for the second research question indicated that aerobic exercise participants had significantly higher perceived autonomy support than strength and flexibility exercise participants (F (1, 315)=6.44, p<.05, η^2=.02). Mean value of the aerobic type of exercise participants was higher (M=71.81, SD= 10.70) than the mean value of strength and flexibility type of exercise participants (M=68.59, SD=11.89) (Table 1).

TABLE 1. Descriptive Statistics of PASSES by Stages of Change and Preferred Exercise Type.

Variable	***Stages of Change***	***M***	***SD***
PASES & Stages of Change	Preparation (P)	68.26	11.98
	Action (A)	71.55	12.21
	Maintenance (M)	71.14	10.03
	Total	70.32	11.37
	Exercise Type		
PASES & Preferred Exercise Type *	Aerobic (A)	71.81	10.70
	Strength & Flexibility (S&F)	68.59	11.89
	Total	70.32	11.37

Note: *Significant difference (p <.05)

The third research question aimed to examine the basic psychological needs of participants in the health-related exercise programme according to exercise stage of change. The MANOVA results indicated that the basic psychological needs of these participants differed significantly according to exercise stage of change (*Pillai's Trace*=.07, F (3,311)=3.97, p<.05, η^2=.04). The post hoc test revealed that participants in the maintenance stage had significantly higher mean values of the autonomy (M=16.21, SD=2.69), competence (M=16.55, SD=2.52) and relatedness (M=17.06, SD=2.30) subscales than the mean values of participants in the preparation stage (autonomy: M=14.71, SD=2.63), competence: M=15.68, SD=2.21, and relatedness: M=15.94, SD=2.13) (Table 2).

The fourth research question aimed to examine the basic psychological needs of health-related exercise programme participants according to their preference for aerobic or strength- and flexibility-type activities. According to the MANOVA, there were significant differences between participants who preferred aerobic exercise and those who preferred strength and flexibility activities in perceived autonomy, competence and relatedness (*Pillai's Trace*=.05, F (3,312)=5.63, p<.05, η^2=.05). Participants in aerobic activities had higher perceived autonomy (M=16.06, SD=2.62), competence (M=16.57, SD=2.26), and relatedness (M=16.89,

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TABLE 2. Descriptive Statistics of the BPNES by Stages of Change and Preferred Type of Exercise.

Variables	**Sub-Scale**	***Stages of Change***	***M***	***SD***	***Significant differences p<.05***
BPNES & Stages of Change	Autonomy*	Preparation (P)	14.71	2.63	P<M
		Action (A)	15.52	2.49	
		Maintenance (M)	16.21	2.69	
		Total	15.53	2.69	
	Competence*	Preparation (P)	15.68	2.21	P<M
		Action (A)	16.30	2.77	
		Maintenance (M)	16.55	2.52	
		Total	16.20	2.52	
	Relatedness*	Preparation (P)	15.94	2.13	P<M
		Action (A)	16.30	2.30	
		Maintenance (M)	17.06	2.30	
		Total	16.49	2.29	
		Exercise Type			
BPNES & Preferred Exercise Type	Autonomy*	Aerobic (A)	16.06	2.62	A>S&F
		Strength & Flexibility (S&F)	14.92	2.63	
		Total	15.53	2.68	
	Competence*	Aerobic (A)	16.57	2.26	A>S&F
		Strength & Flexibility (S&F)	15.77	2.73	
		Total	15.20	2.52	
	Relatedness*	Aerobic (A)	16.89	2.21	A>S&F
		Strength & Flexibility (S&F)	16.03	2.30	
		Total	16.48	2.91	

Note: *Significant difference (p <.05)

SD=2.21) scores than the scores of participants in strength and flexibility activities (autonomy: *M*=14.92, *SD*=2.63), competence: *M*=15.77, *SD*=2.73, and relatedness: *M*=16.03, *SD*=2.30) (*p<.05*) (Table 2).

Discussion

The results indicated a non-significant difference in perceived autonomy support of WHP programme participants based on their exercise stage of change, whereas perceived autonomy support differed significantly between participants based on their preferred type of exercise. Specifically, participants in aerobic exercise classes had a higher mean score for perceived autonomy support than participants in strength and flexibility classes did.

Moreover, the findings indicated that the basic psychological needs of the WHP programme participants differed significantly according to their stage of change and preferred type of exercise. Further analyses demonstrated that participants in the maintenance stage had significantly higher mean scores for basic psychological needs than those in the preparation stage. Furthermore, aerobic exercise participants had higher basic psychological needs scores than participants in strength and flexibility classes did.

The results of a systematic literature review conducted by a group of researchers (Teixeira, Carraca, Markland, Silva & Ryan, 2012) indicated the value of the self-determination theory in realizing the exercise behaviour and the importance of autonomous forms of motivation in fostering long-term exercise adherence. Moreover, different studies (Mullan et al., 1997; Daley & Duda, 2006) have shown that an increase in autonomous motivation has a positive effect on advancing the exercise stage of change of exercise participants. For instance, the relationship between self-determined exercise behaviour and exercise stage of change in adults was explored by Mullan et al., (1997) and self-determination was found to increase from the lower to higher stages of change. Very similar outcomes were reported by Daley and Duda (2006). They claimed that participants who were in the early stages had a less self-determined form of motivation than participants in higher stages of change.

Although Mullen et al. (1997) reported a positive relationship between self-determined exercise behaviour and the exercise stage of change, the difference in basic psychological needs between health-related physical activity programme participants in different stages of change has not been described in previous studies. The significant results obtained in this study indicated that the basic psychological needs of participants change with their exercise stage of change.

Most participants begin exercising for instrumental reasons such as improving their health and fitness, increasing their muscular endurance and strength or losing weight, but they may not be sufficiently engaged in these activities to continue performing them. There is a lack of information on the difference in perceived autonomy support of health-related physical activity participants according to their preferred exercise. In the current study, these two variables were significantly related. Moreover, the results showed that participants in the aerobic exercise had higher perceived autonomy support than participants in strength- and flexibility-type exercise. Therefore, providers of women's WHP programmes should consider autonomy support-related issues (e.g. instructors' behaviour) in strength and flexibility exercise classes.

Several limitations should be considered when interpreting the findings of this study. First, participants' perceived autonomy support, basic psychological needs, and exercise stages were determined by surveys. Therefore, the related data depend on the trustworthiness of their responses. Second, the findings of this study represent the Turkish university setting as one context for a WHP programme, and the findings may not be generalizable to other settings.

In conclusion, based on the results of this study, providers and instructors involved in women's WHP programmes should focus on certain factors. First, instructors should attempt to provide a climate that supports participants' perceived autonomy based on the needs of each participant's stage of change and preferred type of exercise. Second, as aerobic activities better met the participants' basic psychological needs compared with the strength and flexibility exercise classes, providers and instructors in these programmes should further consider the basic psychological needs of participants in strength and flexibility exercise classes.

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Physical Activity Cannot be Treated as a Predictor of Anthropological Status among Six-year-old Children

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ABSTRACT The objective of this study was to examine the relationship between physical activity and anthropological status in six-year-old children. The study was conducted on 30 boys (years 6.34 ± 0.51) and 30 girls (years 6.21 ± 0.59). Six tests for motor ability evaluation, two measures for assessing morphological characteristics, and a questionnaire for assessing physical activity and sedentary activities, the Netherlands Physical Activity Questionnaire (NPAQ), were applied to the participants. The correlation analysis results clearly show that sedentary activity cannot be regarded as a predictor of anthropological status in six-year-old children ($p>0.05$). This research provides an insight into the complex issue of the precise identification of the effects of physical activity, and changes in anthropological status that are influenced by natural growth and development.

KEY WORDS fundamental movement skills, BMI, motor skills, growth, development

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Introduction

For preschool children, movement is exceedingly important for harmonious psychophysical growth and development (Hills, 1995). Furthermore, certain motor skills for children of this age are recognized as fundamental and necessary in the development of more complex movement patterns that an individual will use throughout their life (Barnett, Lai, et al., 2016; Barnett, Salmon, & Hesketh, 2016; Bellows et al., 2017; Čuljak, Miletić, Delaš Kalinski, Kezić, & Žuvela, 2014; Gallahue & Donnely, 2003; Tompsett, Sanders, Taylor, & Cobley, 2017; Yu et al., 2016). Fundamental movement skills are also considered to be the basis for specific sports skills (Donath, Faude, Hagmann, Roth, & Zahner, 2015; Kirk & Rhodes, 2011; Kordi, Nourian, Ghayour, Kordi, & Younesian, 2012; Logan, Robinson, Wilson, & Lucas, 2012; Lubans, Morgan, Cliff, Barnett, & Okely, 2010). Insufficiently stimulated and underdeveloped motor skills and knowledge at a young age can be the cause of decreased or "slumbered" motor creativity (Struza Milić, 2014). Physical exercise and health are closely related, so it is important to create the habit of regular physical activity from the earliest age (Cohen, Morgan, Plotnikoff, Callister, & Lubans, 2015; Liong, Ridgers, & Barnett, 2015; Lovrić, Jelaska, & Bilić, 2015; Rush & Simmons, 2014; Slykerman, Ridgers, Stevenson, & Barnett, 2016). However, the result of modern lifestyles is often minimal physical activity and, subsequently, health problems may occur (Al-Kloub & Froelicher, 2009; Goldfield, Harvey, Grattan, & Adamo, 2012). Therefore, it is of great relevance to monitor and control the level of physical activity of children from an early age (Montoye, Kemper, Saris, & Washburn, 1996).

Previous studies indicate a link between basic motor skills and physical activity (e.g., Lubans et al., 2010). However, no significant correlations between morphological features and physical activity of children have been identified in these studies (Hills & Byrne, 2010). For example, the realization of basic motor skills is not related to body mass index (BMI) in children four to eight years of age (Cantenassi et al., 2007). Accordingly, the objective of this study is to examine the correlation between physical activity, morphological features, and motor skills among six-year-old children.

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Conflict of interest: None declared.

Method

Participants

The sample included 30 boys (years 6.34±0.51) and 30 girls (years 6.34±0.51). Children with health problems and motor disorders were not included. Before the research, parents were informed about the details of the study and signed consent forms to allow their children to participate. The research was conducted in accordance with the Declaration of Helsinki, and the institutional ethics committee of the Faculty of Kinesiology, University of Split, approved the proposed research design.

Variables

All participants were measured for height and weight, and BMI scores were calculated. For the evaluation of physical activity and sedentary activity of children, parents were asked to complete the NPAQ (Montoye et al., 1996) of determined psychometric characteristics (Janz, Broffitt, & Levy, 2005). The NPAQ consists of two sections: assessment of physical activity and assessment of sedentary activities. The section that evaluates activity contains seven statements that parents must answer using a Likert scale (1–5) regarding how much they agree with the statement, and the total score is the mean value of all answers (KA). The part that evaluates the child's inactivity contains only two questions related to the average daily time spent doing sedentary activities (watching television and using a computer). The total is calculated by summing the two responses (SA). A six-test set was used to evaluate motor skills: crawl with the ball (PL); bend on the bench (PK); standing broad jump (SUD); side rope jumps (BPK); change of running direction (TPS); and standing on a bench (SK).

Crawl with the ball (PL)

The participant lies on the ground in front of the start line holding a ball of 16 cm in diameter with one hand tight to their body. While they are crawling, the ball should not be dropped or rolled on the floor. If the participant drops the ball during the task, the exercise must be repeated. The time, in seconds, is measured from the oral instruction "Go" to the moment at which the participant moves across the finish line, which is 4 m from the start line.

Bend on the bench (PK)

The participant stands on the bench with their feet together and toes at the edge of the bench where a measuring tape is attached to the bar. The arms should be stretched out and crossed, with the right palm over the left. The participant is required to start lowering into a bend by pulling their hands along the measuring tape. During the exercise, the legs must be straight. The task is completed when the participant reaches the lowest point they can sustain, and this is recorded in centimetres. The zero point is equal with the box. If the participant bends below the zero point, a negative result is recorded.

Standing broad jump (SUD)

Using a two-foot take-off and landing, with the swinging of arms and bending of knees, the participant should attempt to jump as far as possible. The measurement is taken from the take-off line to the nearest point of contact on the landing (back of the heels). No part of the participant's foot may cross over the edge of the scratch board/tape prior to the jump attempt; if this occurs, the jump should be repeated. At the start of the jump, both feet must be parallel to one another; if not, the jump should be repeated. Finally, if the participant lands on a body part other than their feet, the jump should be repeated.

Side rope jumps (BPK)

The participant stands sideways next to the rope that lies on the ground. They are required to start jumping the rope using a two-foot take-off and without double bouncing. The task is performed for 20 seconds. The number of repetitions (one jump over the rope and back again) within 20 seconds is recorded.

Change of running direction (TPS)

Two parallel lines 3 m apart are drawn on the ground. When the tester signals, the participant needs to run four times from line to line, and at each change of direction, at least one foot must completely cross the line marked on the ground. The time, in seconds, is measured from the oral instruction "Go" to the moment at which the participant crosses the marked line the fourth time.

Standing on bench (SK)

With arms next to their body, the participant must step with one foot on a bench (dimensions 10 cm ×6 cm × 6 cm), whilst the other leg is bent at the knee. The participant is asked to maintain this position for as long as possible, and the obtained result is measured in seconds.

All tests were repeated three times and conducted by two testers with many years of experience.

Statistical methods

As a measure of reliability, for all motor variables, Cronbach alpha (Cα), average inter-item correlation (IIR) and coefficient of variation (CV) (Hopkins, 2000) were calculated. Additionally, due to the identification of within-trial bias, repeated ANOVA measures were applied. Gender differences (i.e. homogeneity of subsamples, boys vs girls) were examined using the t-test for independent samples. The normality of distributions was tested using the Kolmogorov–Smirnov test with Lilliefors correction. As a measure of association between

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variables, the Pearson coefficient of correlation was calculated. Type one error was set at α=5%. All data were calculated using the "Statistica 13.0." data analysis software (Dell Inc., OK, USA).

Results

The distribution normality for both subsamples in all applied variables indicated that only the SK variable in the boys' subsample has a distribution that slightly deviates from normal. Furthermore, using the t-test for independent samples, we determined the homogeneity of the observed sample in motor skill tests, morphological features and physical activity. Considering the statistically significant differences identified in PK (t=2.48, p=0.01), KA (t=2.05, p=0.04) and BMI (t=3.03, p<0.01) variables, the boys were observed separately from the girls. Table 1 presents the reliability analysis results of the observed variables.

TABLE 1 Results of the reliability test and the t-test for independent samples in motor tests, morphological features and physical activity (Mean±SD: mean ± standard deviation; Cα: Cronbach alpha, IIR: infinite impulse response; CV: coefficient of variation; F: ANOVA test value, p: level of significance)

	Mean±SD	Cα	IIR	CV	F	*p*
	Boys (N=30)					
PL	11.18±3.96	1.00	0.99	3.01	0.08	0.93
PK	-3.00±7.35	0.99	0.98	53.45	0.29	0.75
SUD	103.97±10.99	0.94	0.85	4.21	2.97	0.06
BPK	17.00±2.39	0.96	0.90	4.94	1.57	0.22
TPS	6.70±0.74	0.98	0.95	2.60	1.74	0.19
SK	6.59±5.93	0.99	0.98	13.56	0.98	0.38
PA	3.62±0.57					
SA	108.17±68.84					
BMI	15.44±1.34					
	Girls (N=30)					
PL	12.43±2.28	0.99	0.98	2.81	0.55	0.59
PK	-6.83±4.19	0.98	0.96	14.50	0.32	0.73
SUD	100.30±9.56	0.96	0.93	3.64	0.14	0.87
BPK	16.80±2.76	0.95	0.87	6.28	4.25	0.02
TPS	7.02±0.70	0.96	0.90	3.35	1.19	0.31
SK	8.41±4.58	0.99	0.97	9.15	3.76	0.03
PA	3.34±0.50					
SA	107.50±43.25					
BMI	14.53±0.97					

Note: PL: crawl with the ball; PK: bend on the bench; SUD: standing broad jump; BPK: side rope jumps; TPS: change of running direction; SK: standing on bench; PA: physical activity; SA: sedentary activities; BMI: body mass index.

The results clearly indicate that almost all the applied variables are satisfyingly reliable. The exception is the variable SK whose reliability is slightly reduced. In accordance with other objectives of this study, we have determined the correlation between physical activity and sedentary activities and BMI divided by gender. The results clearly indicated that kinesiological activity (boys: r=0.28, p=0.67; girls: r=-0.13, p=0.42) and sedentary activities (boys: r=0.01, p=0.89; girls: r=0.26, p=0.77) have no significant impact on BMI.

Furthermore, we have determined the correlation between physical activity and sedentary activities and motor skill tests divided by gender.

TABLE 2 Correlation coefficient with significance motor skill assessment tests for the variables of physical activity and sedentary activities in boys and girls

	PL	PK	SUD	BPK	TPS	SK
			Boys			
PA	-0.06	0.03	-0.05	-0.00	-0.20	-0.21
SA	0.32	0.11	-0.18	0.31	0.19	0.13
			Girls			
PA	-0.25	0.07	0.37*	-0.01	-0.05	-0.14
SA	-0.26	0.16	-0.03	0.25	-0.13	0.15

Note: Motor skill tests (PL: crawl with the ball; PK: bend on the bench; SUD: standing broad jump; BPK: side rope jumps; TPS: change of running direction; SK: standing on bench). Variables of the questionnaire (PA: physical activity; SA: sedentary activities, * p<0.05)

The results clearly indicate that there is no significant correlation between physical and sedentary activities and motor variables. A significant correlation of the variable SUD with physical activity was identified, but only for girls. A previous study in which the authors recorded an average physical activity of boys of 3.30 using NPAQ also indicates that there is no correlation between physical activity and sedentary activities and motor skills tests; however, they suggest that this could be the result of the small number of participants in the research (Janz et al., 2005).

Discussion

Differences between boys and girls in applied motor skill tests were identified only in the flexibility test, which confirms previous research in which girls were found to perform better than boys did (Kraljević, Gađić, & Vučković, 2013). As expected, boys have a significantly higher average BMI and higher physical activity than girls do (Olsson, Fahlen, & Janson, 2008). Boys may have a higher physical activity score because of the selection of the games that they play in their free time (Hamar, Biddle, Soos, Takacs, & Huszar, 2010).

No correlation was found between BMI and physical activity and sedentary activities, which means that boys and girls who spend more or less of their free time actively do not necessarily have a higher or lower BMI. These results are analogous to previous studies (e.g. Green & Cable, 2006), which indicated that the activity level of preschool children does not significantly affect their body weight. The results also indicate that the recorded level of physical activity and sedentary activities does not significantly affect their performance in motor skills tests. These results point to the persistence of the assumption that children, through their innate need for movement, experience harmonious growth and development, which is independent of external influences, such as levels of physical and sedentary activities (Franjko, Žuvela, Kuna, & Kezić, 2013).

The next question is to what extent children are able to meet their needs for movement during further growth and development, and how their level of physical activity will affect the development of motor skills and morphological features, keeping in mind the school's obligations and a social environment that is mostly sedentary (Biddle, Marshall, Gorely, & Cameron, 2009; Veitch et al., 2011). In this study, comparisons between physical activity and sedentary activities and motor skills tests did not show any correlation in boys; in girls, the correlation between physical activity was indicated in only one motor skill test. The most probable reason for the absence of significant correlation between physical activity and motor skills can most likely be sought in the non-measurement of the quality of physical activity. Specifically, in addition to the amount of physical activity, it is also necessary to determine its quality, i.e. the type of organization and methods of implementation.

Therefore, despite this deficiency, this article provides a good understanding of the complex interaction dynamics of the natural process of growth and development with various modes of free time activity for preschool children. Furthermore, the information obtained can be a theoretical basis for the precise structuring and practical implementation of organized leisure activities. The objective would also be to establish and hierarchically structure the predictors of harmonious growth and development. Additionally, based on the obtained predictors, it may significantly influence the optimal anthropological status in preschool children.

Further monitoring and control of the correlation between anthropological characteristics and external factors are necessary. Longitudinal studies of this type with a larger sample size would provide a deeper insight into the structure of children's growth and development mechanisms.

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ORIGINAL SCIENTIFIC PAPER

Force-Velocity Profiles of Elite Athletes Tested on a Cycle Ergometer

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ABSTRACT The present study explored the sensitivity of the force-velocity (F-V) modelling approach obtained from maximal sprints on a leg cycle ergometer to detect selective changes of the mechanical capacities of the lower body muscles associated with high-level training. Specifically, we assumed that the F-V relationship parameters, such as maximum force (F_0), velocity (V_0), power (P_M) and slope, would differ among individuals of different high-level training backgrounds. In total, 111 elite athletes divided into four groups (*Combat sports*, *Athletic sprints*, *Team sports* and *Physically active*) performed maximal sprints on a leg cycle ergometer loaded with 7%, 9%, and 11% of body weight. The findings obtained suggest an exceptionably strong and linear F-V relationship in most of the participants ($r > 0.95$), while higher P_M have been found in all groups of athletes compared to the *Physically active* group ($p < 0.05$). In addition, sport-specific F-V profiles have been observed in athletes that belong to distinctively different sports (i.e. higher F_0 and force-oriented slope for strength-trained *Combat sports* and higher V_0 for speed-trained *Athletic sprints*). To our knowledge, this is one of the rare studies that evaluate the F-V profiles with such a large sample of elite athletes obtained from commonly used task such as maximal sprints on a leg cycle ergometer. The results obtained support a high sensitivity of the F-V modelling approach to distinguish among elite athletes with different training histories.

KEY WORDS sprint cycling test, force-velocity relationship, sensitivity, linear regression, elite athletes

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Introduction

For the successful performance of various functional movement tasks from daily life or sport, muscle mechanical capacities to produce high levels of force, velocity, or power are essential. However, the testing of muscle capacities has been routinely performed under a single pre-defined movement condition that allows obtaining single outcomes, such as the jump height, exerted force, or cycling frequency. As a result, selective assessment of the partly independent muscle capacities for producing maximal force (F_0), velocity (V_0) or power (P_M) could not be possible through a single outcome (Jaric, 2015), since it changes substantially with load and movement velocity due in part to F-V and P-V relations (Westing, Seger, & Thorstensson, 1990). This certainly leads to a fundamental problem in the contemporary literature and practice regarding both the testing procedures and the interpretation of results. To address the discussed problem, researchers occasionally apply test batteries that include different tasks such as sprints, repetition maximum tests, vertical jump tests, etc., or perform a specific task under different loading conditions. The assumption that greater performance in different tests or a specific task performed with heavy and light loads would be indicative of the better F_0 and V_0, respectively, could not be properly supported by the quantitative outcomes provided by independent tests or loading conditions.

A more promising solution of the discussed problem could be based on recent research focused upon the modelling of the F-V relationship of muscular system with performing different functional tasks or sport activities under two or more loading conditions. Specifically, the loaded functional multi-joint movements (e.g.

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jumping, walking, running, cycling, lifting, throwing) typically display a strong and linear F-V relationship of the tested muscles (Jaric, 2015; Vandewalle, Péerès, & Monod, 1987). This enables determining the distinctive muscle capacities to produce F_0, V_0, their ratio (the relationship slope), and P_M (Jaric, 2015). The parameters obtained from the linear F-V relationship have consistently revealed high reliability (Jaric, 2015). In addition, the abilities to generate high movement velocity or resistance to high external load have been shown to be determined by V_0 (Feeney, Stanhope, Kaminski, Machi, & Jaric, 2016) and F_0 (Driss, Vandewalle, Le Chevalier, & Monod, 2002), respectively, while ballistic performance is largely dependent not only on P_M (Samozino, Rejc, Di Prampero, Belli, & Morin, 2012; Vandewalle, Peres, Heller, Panel, & Monod, 1987) but also on an optimum balance between F_0 and V_0 (i.e., F-V slope) (Jiménez-Reyes, Samozino, Brughelli, & Morin, 2017; Samozino et al., 2014).

These findings suggest that chronic exposure to training programs based on high movement velocity, explosive movements, or resistance exercise would result in selective changes in F_0, V_0, P_M, and slope. Although there are many studies in which various maximum performance functional tasks have been used to assess the different training effects or distinguish among various populations (for review, see Cormie, McGuigan, & Newton, 2011a, 2011b), there is a lack of research that has examined sensitivity of the F-V relationship parameters to detect different training adaptations (Jaric, 2016). To the best of our knowledge, the only several studies have examined sensitivity of the F-V relationship parameters to distinguish among individuals with different training backgrounds (Cuk et al., 2016; Giroux, Rabita, Chollet, & Guilhem, 2016; Ravier, Grappe, & Rouillon, 2004; Vandewalle et al., 1987). Evaluating the F-V relationship through maximal sprints on the leg cycle ergometer, Vandewalle et al. (1987) revealed a greater P_M and V_0 for fast and powerful athletes in comparison to endurance athletes. In addition, better P_M and V_0 capacities have been observed in karate athletes at higher competition levels (Ravier et al., 2004). Using vertical jumps for the evaluation of the F-V relationship, Cuk et al. (2016) found higher P_M and F_0 capacities in strength-trained athletes in comparison to physically active and sedentary persons. Evaluating various elite athletes, Giroux et al. (2016) also found that the chronic practice of specific sports leads to differently balanced force-velocity profiles. Although the mentioned findings support the existence of the selective changes in the F-V profile regarding a specific focus of long-term training, for a better understanding of the mentioned problem, further research is required. It seems of interest to elucidate subtle changes in the F-V relationship of various elite practitioners whose training in high-level sport has been focused mainly on improving the power production capacity: the power output can be increased either by improving the capacity to develop a higher level of force in the same period (i.e. improving F_0) or to develop the same amount of force over a shorter duration (i.e. improving V_0) (Newton & Kraemer, 1994). Therefore, the F-V modelling approach could be appropriate to reveal specific training adaptation through any changes in F_0, V_0, P_M and slope. Particularly, it would be important to assess the sensitivity of the F-V modelling approach obtained from commonly used testing modality such as maximal sprints performed on a leg cycle ergometer. When compared with other functional tasks used to evaluate the F-V relationship of leg extensors (e.g. vertical jumps, running, different types of closed kinetic chain leg extension movements, etc.; Jaric, 2015), the maximal sprints performed on a cycle friction ergometer allows a simple and accurate manipulation of external loading and, therefore, it is used as the preferred task for the evaluation of muscle mechanical capacities in numerous studies (Pazin, Bozic, Bobana, Nedeljkovic, & Jaric, 2011; Henry Vandewalle et al., 1987).

To address the problems discussed above, we explored the sensitivity of the F-V relationship obtained from maximal sprints on a leg cycle ergometer to detect selective changes on the mechanical capacities of the lower body muscles associated with high-level training. We hypothesized that (H1) sports in which muscle capacities greatly determine success would reveal higher P_M in comparison to other sports. Regarding the changes in the F-V relationship shift associated with chronic practice in a specific sport, we hypothesized that (H2) the sports mainly focused on developing power production at lower relative loads and higher velocities would reveal velocity-oriented profile, while sports focused on developing power at heavier relative loads would reveal a force-oriented profile.

Methods

Subjects

One hundred and eleven elite athletes were selected to participate in this study. They were allocated into four groups according to their training history: *Combat sports* (Chaabene et al., 2016; including wrestling and judo athletes; mainly focused on developing power production at heavier relative loads; Franchini, Del Vecchio, Matsushigue, & Artioli, 2011; Tabben et al., 2014), *Athletic sprints* (including athletes form track and field sprint disciplines 60–400 m; mainly focused on developing power production at lower relative loads; Morin et al., 2012), *Team sports* (including athletes from team sports, such as volleyball, handball, and basketball; high levels of muscle capacities are desirable, but not always necessary since technical and tactical skills greatly determine performance; Apostolidis, Nassis, Bolatoglou, & Geladas, 2004; Gabbett, Georgieff, & Domrow, 2007; Massuça & Fragoso, 2013) and *Physically active* (including athletes from auto racing and shooting; without significant requirements for production of maximum force, velocity, or power). The subjects' characteristics are depicted in Table 1. The sample of participants consisted of members of national selections, medallists in either international or national championships. None of the participants reported any medical problems or recent injuries that could compromise the tested performance. The participants

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were informed regarding the potential risks associated with the applied testing protocol and asked to sign an informed consent document prior to the testing protocol. The study was approved by the Institutional Review Board of the Serbian Institute of Sport and Sports Medicine, and carried out according to the Declaration of Helsinki.

Testing procedures

Anthropometric measures were taken according to the procedures recommended by the International Society for the Advancement of Kinanthropometry (Norton et al., 2000). Body height and body mass were measured to the nearest 0.5 cm and 0.1 kg, respectively. Testing of the force-velocity relationship was performed through the 6-s maximal cycling sprint test (Logan, Fornasiero, Abernethy, & Lynch, 2000; Mendez-Villanueva, Bishop, & Hamer, 2007) on a Monark 834E leg cycle ergometer (Monark, Varberg, Sweden). Several studies confirmed high test-retest reliability of this (r = 0.98; Wilson, Newton, Murphy, & Humphries, 1993) and similar sprint cycling tests (Dotan & Bar-Or, 1983; r = 0.89–0.96; Evans & Quinney, 1981; Patton, Murphy, & Frederick, 1985), while Mendez-Villanueva et al. (2007) found low within-subject variations when the 6-s maximal cycling sprint test was preceded by a familiarization session (CV < 2%). One potential advantage of the selected cycling test could also be that it was non-specific for each group of participants. Finally, when compared with other standard tests, such as Margaria, vertical jumps, isokinetic testing, the selected 6-s maximal cycling sprint test allows a simple and accurate manipulation of external loading. The maximal 6-s cycling sprints were performed with three different loads: 7, 9, and 11% of body weight (BW). Prior to the test, subjects performed a standardized warm-up procedure comprising 5-min of cycling. A self-selected cadence against 2% of BW frictional load was applied to the flywheel, followed by 3-min of easy stretching of the musculature of the lower extremities. Finally, a specific warm-up protocol consisting of two bouts of 3-s maximal acceleration separated by 3-min rest were applied. Following a 5-min recovery period, the subjects performed three 6-s sprints against different loads in a random sequence. They were instructed to perform an “all out” effort from the very beginning of the test until instructed to stop. The seat height was adjusted to each participant’s satisfaction, and toe clips with straps were used to prevent the feet from slipping off the pedals. The start position on the cycle ergometer was strictly standardized: the subject was seated on the saddle during the sprint and initiated the exercise with his preferred leg, the crank was located at 45° forward. Strong verbal encouragement was provided during each trial. The rest period among consecutive sprints was 4-min. Fatigue was never an issue.

The subjects were asked to follow their normal diet and to refrain from any form of intense physical activity for 48 h, as well as to fast for 2 h prior to each testing session.

Data analyses

The device software was used to acquire power and pedalling frequency presented as a revolution per minute (rpm). The power and frequency data were calculated for every revolution of the flywheel and were continuously presented as a mean value of one second. To assess the corresponding F-V relationship, we previously perform several calculations to obtain V and F data. V was calculated from pedalling frequency (rpm) and the crank length (r = 0.17m):

$$V = \frac{rmp}{60 \times 2r\pi} \qquad \text{Eq. 1.}$$

F was calculated as P divided by V. For further calculations, we used values of V and F at the instant of maximal pedalling frequency during 6 s. To avoid the effect of body size dimensions on test results, indices of force were normalized for body size using the body mass raised to the power of 0.67 (i.e. in N/kg0.67; Jaric, 2002) providing the normalized values of F.

Linear regression methods were used for modelling of the F-V relationship. Therefore, using X = velocity (m/s), Y = force (N), and b0 and b1 = statistically determined regression coefficients, the regression is:

$$Y = b_0 + b_1 X \qquad \text{Eq. 2.}$$

The F-V relationships were extrapolated to determine the maximum force (F_0; force or Y-intercept), maximum velocity (V_0; velocity or X-intercept), maximum power

$$P_M = \frac{F_0 \times V_0}{4} \qquad \text{Eq. 3,}$$

as well as the slope of the relationship

$$a = \frac{F_0}{V_0} \qquad \text{Eq. 4.}$$

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Statistical analyses

Standard descriptive statistics were calculated for all depended variables and groups. The Levene test was used to verify the homogeneity of variance for each variable analysed. One-way analysis of variance (ANOVA) with Hochberg's GT2 post hoc comparisons test was applied to assess between-group differences of the regression parameters (F_0, V_0, P_M and slope). The effect size was used to estimate the magnitude of differences of the main effects, their interactions, and the post-hoc differences ("$p\eta^2$" for ANOVA and "d" for post hoc calculations; Cohen, 1988). The differences were considered as either small ($p\eta^2$= 0.01; d = 0.2), moderate ($p\eta^2$ = 0.06; d = 0.5), or large ($p\eta^2$ = 0.15; d = 0.8). In addition, statistical power of difference (i.e. 1-β) was calculated. Statistical significance was set at $p < 0.05$ and the data were analysed using SPSS (v. 21.0, IBM, Armonk, New York, USA).

Results

Figure 1 shows the typical F-V and P-V relationships obtained from representative individuals of the four different sport groups during maximum pedalling activity performed at different applied loads. As expected, the force data declined with increasing movement velocity. The force-velocity relationship has been found to be an exceptionally strong and approximately linear in most of the participants (r > 0.95) while the corresponding power-velocity relationship could be optimally explained by the second-order polynomial regression.

TABLE 1. Subjects' characteristics (mean ± SD)

Variable	Combat sports (n = 20)	Athletic sprints (n = 9)	Team sports (n = 39)	Physically active (n = 43)
Height (cm)	177.9 ± 7.1	185.1 ± 4.8	193.5 ± 9.1	180.4 ± 7.6
Body mass (kg)	78.8 ± 8.7	77.2 ± 9.1	86.5 ± 11.4	77.8 ± 12.1
Age (years)	22.2 ± 2.9	20.4 ± 3.5	20.9 ± 3.5	22.4 ± 4.3

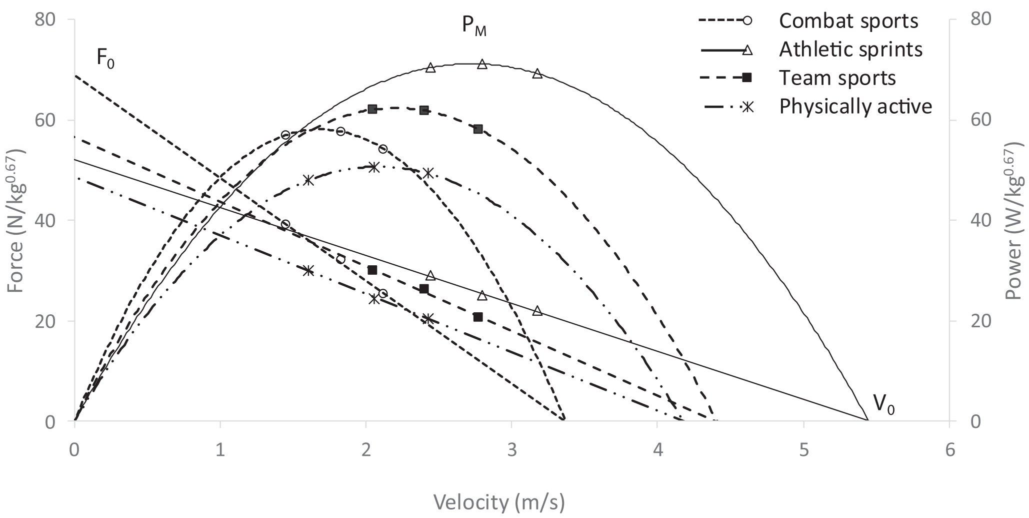

FIGURE 1 Typical example of the linear force-velocity and the polynomial power-velocity relationships, obtained during maximal sprinting on a leg friction-loaded cycle ergometer from 3 loading conditions (7%, 9%, and 11% of body weight) for representative individuals of the four groups.

Figure 2 illustrates the main findings of the present study. The sensitivity analysis was based on the data set obtained from four groups (N = 111) distinguished either by their training history or by the level of physical activity. The residuals of dependent variables observed in the F-V test appeared to be normally distributed ($p > 0.40$). The values for different groups (*Combat sports* vs *Athletic sprints* vs *Team sports* vs *Physically active*) are shown separately for slope (panel a), F_0 (panel b), V_0 (panel c), and P_M (panel d). Significant differences among groups were obtained for the all evaluated variables, slope ($F_{3,110}$ = 3.37; p = 0.02; $p\eta^2$ = 0.09; 1-β = 0.75), F_0 ($F_{3,110}$ = 4.89; p = 0.00; $p\eta^2$ = 0.12; 1-β = 0.90), V_0 ($F_{3,110}$ = 5.10; p = 0.00; $_p\eta^2$ = 0.13; 1-β = 0.91) and P_M ($F_{3,110}$ = 10.78; p = 0.00; $p\eta^2$ = 0.23; 1-β = 1.00). The post-hoc analysis suggested that the *Combat sports* group revealed force-oriented slope and higher values of F_0 than *Physically active* did, while the *Athletic sprints* showed the highest values of V_0 in comparison to all groups. *Physically active* were less powerful in comparison to other groups while moderate differences in P_M were obtained between groups of *Athletic sprints* and *Team sports.*

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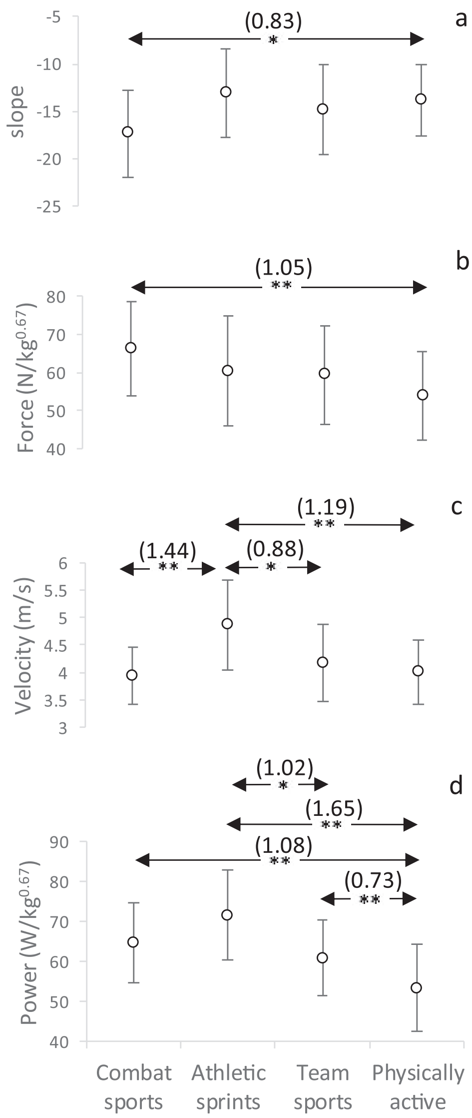

FIGURE 2 Averaged values of the regression parameters, slope (panel a), FMAX (panel b), VMAX (panel c) and PMAX (panel d), for different groups of subjects (mean with SD error bars). The lines with arrows depict differences between groups at p < 0.05 (*) and p < 0.01 (**) with corresponding effect sizes in parentheses.

Discussion

To our knowledge, this is one of the rare studies that evaluate the F-V profiles in such a large and differentiated sample of elite athletes obtained from commonly used tasks, such as maximal sprints on a leg cycle ergometer. Specifically, we tested the hypothesized differences among elite athletes with distinct training histories. Overall, the obtained findings suggest an exceptionally strong and approximately linear force-velocity relationship in most of the participants, while both significant differences and mainly large effect sizes in power production capacities have been observed not only between groups of athletes and physically active participants, but also between groups of athletic sprinters and team sport athletes. These findings approved the first hypothesis of the present study. In addition, sport-specific F-V profiles have been observed for athletes that belong to distinctively different sports (i.e. force-oriented profile for strength-trained combat athletes and velocity-oriented profile for speed-trained athletic sprinters) that proved the second hypothesis. Both the individual findings and their implications will be discussed in the following text.

In support of the first hypothesis, elite athletes participated in sports in which muscle capacities determine success (i.e. *Combat sports, Athletic sprints* and *Team sports*) produced higher P_M than control group of athletes that are not characterized with outstanding muscle capacities (in this study labelled as *Physically active*). The obtained findings are in line with similar studies that show significant differences in P_M between strength, speed or power-trained athletes compared to physically active or sedentary individuals (Cuk et al., 2016; Giroux et al., 2016; Pazin et al., 2011). In addition, the higher power-producing capacities of *Athletic sprints* group in comparison to *Team sports* group could also be expected since team sports allow slightly reduced muscle capacities compensated by outstanding technical and tactical skills (Reilly, Williams, Nevill, & Franks, 2000). Regarding the second hypothesis, the force-oriented slope and consequently higher F_0 was observed in the *Combat sports* group compared to the *Physically active* group. Traditionally, grappling combat sports, such as judo and wrestling, rely more on a high force-generating capacity due to the close contact between athletes during the match and during groundwork action (Chaabene et al., 2016; Franchini et al., 2011; Tabben et al., 2014). Moreover, significant differences were also found between *Athletic sprints* and other groups regarding V_0. Higher velocity and power-generating capacities in the group of *Athletic sprints* may relate to the specific demands of sprint-running performance. Indeed, sprinters are required to produce high amounts of explosive power (i.e. P_M) during push-off phase on the staring block (Harland & Steele, 1997; Rabita et al., 2015), as well as the ability to produce relatively higher force at high velocity movements (i.e. V_0) that prevent premature force decline over the acceleration phase and maintain relatively higher force production at maximal speed (Morin et al., 2012). The hypothesized differences observed in the F-V relationship parameters among the groups of elite athletes reflect both the properties and the adaptation mechanisms of the neuromuscular system associated with specifically focused long-term training (Enoka, 1997) and, possibly, the effect of selection (Jenkins, 2012).

Of importance could be the practical implications and limitations of the obtained findings. Taken together, the present findings support the use of the F-V modelling approach obtained from loaded maximal sprints on a cycle ergometer to detect specific training adaptations and talented athletes. The F-V modelling arguably provides a marked advantage over standard methods typically based on single trials when evaluating the effectiveness of various training programs since it allows the separate monitoring of the specific changes in the muscle mechanical capacities, such as high F, V and P output (Jaric, 2015). Such a set of information could be valuable not only in sport but also in other non-clinical (physical education, ergonomy) as well as clinical areas (physical medicine, physical therapy). In addition, using functional movements in testing protocols provides high ecological validity of the assessment of muscle mechanical capacities. Regardless of the generally encouraging results, several potential limitations and directions for future research need to be addressed. Firstly, despite the fact that we applied standard set of loading conditions for testing elite athletes on a leg cycle ergometer (Henry Vandewalle et al., 1987) that allows reliable measurements (García Ramos, Torrejón, Morales Artacho, Pérez Castilla, & Jaric, 2017), more precise calculation of P_M (Pazin et al., 2011) and decreased bias toward V_0 or F_0 (Pérez-Castilla, Jaric, Feriche, Padial, & García-Ramos, 2017), it is noted that it was relatively narrow. Therefore, further research should evaluate the sensitivity of the F-V relationship conducted over wider loading conditions. Finally, for the sake of providing a more robust set of data, a similar evaluation on different functional tasks that include both, upper and lower extremity muscle groups, as well as on diverse populations should also be conducted.

Although various standard tests have been found to be sensitive enough to detect differences among various populations, the F-V approach allows assessment of selective changes in the mechanical capacities of lower body muscles associated with chronic practice in a specific sport. While a higher P_M production has been expected with high-level training, using other F-V relation parameters, such as F_0, V_0, and slope, allows the evaluation of specific F-V profiles that enable differentiation of elite athletes from distinct sport settings. Therefore, these results support a high sensitivity of the F-V modelling approach obtained from maximal sprints on a leg cycle ergometer to distinguish among elite athletes with different training histories.

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Differences in Physical Activity and Academic Performance between Urban and Rural Schoolchildren in Slovenia

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ABSTRACT In Slovenia, the existing studies of relations between physical activity (PA), academic performance (AP) and urbanization grade have used subjective self-reporting tools for assessing physical activity, which usually led to an underestimation of true PA. We have attempted to overcome this and have investigated the link between PA in rural and urban Slovenian schoolchildren by an objective assessment of PA, using a multi-sensor SenseWear PRO armband. The analysis showed that urban children in Slovenia are more physically active than rural children are and achieve better AP (mathematics grade). Additionally, children who are active between 60 and 120 minutes of MVPA/day have higher AP than their peers who are active less than 60 or more than 120 minutes, whereas the latter groups did not differ in academic performance.

KEY WORDS physical activity, mathematics, accelerometery

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Introduction

An increase of physical activity (PA) can have a positive impact on the academic performance of children (Shephard, 1997), since the performance of complex movements stimulates the frontal cortex of the brain, an area which is responsible for learning and problem solving (Jensen, 2005). A number of studies have already documented a positive relationship between PA and academic performance (AP) (Singh, Uitjtdewilligen, Twisk, Van Mechelen & Chinapaw, 2012), but researchers also acknowledge that the increase in PA can have many other beneficial effects, such as higher self-esteem, body image (Libbey, 2004), improved concentration (Caterino & Polak, 1999) and better behaviour in the classroom (Evans, Evans, Schmid & Pennypacker, 1985; Allison, Faith & Franklin, 1985). The consequent increase of AP of children contributes to better classroom climate, better attitudes of teachers towards students, and improved self-esteem of children (Nelson & Gordon-Larsen, 2006), which are psychological factors often associated with high levels of PA.

It has been well documented that there are differences in PA behaviours associated with living in urban and rural environments (Loucaides, Chedzoy & Bennett, 2004; Joens-Matre, Welk, Calabro, Russel, Nicklay & Hensley, 2008). While evidence often shows lower PA levels in urban children compared to their rural counterparts (Joens-Matre et al., 2008; Dolman, Norton & Tucker, 2002), this pattern has not been confirmed in Slovenia, where the opposite patterns have been observed (Planinšec, 2006; Planinšec, Pišot & Fošnarič, 2006).

Slovenian urbanization is characterized by a large number of small settlements; it has only two cities with more than 50,000 inhabitants (Ljubljana and Maribor), with 90% of all settlements having fewer than 500 inhabitants (Mesta in urbana območja, 2017). Several studies have compared urban and rural schoolchildren's PA in Slovenia. Planinšec (2006) investigated possible links between school achievement and the volume

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of average daily PA in younger schoolchildren (1st–5th grades), and whether differences in PA occurred regardless of gender, or school grade. The study showed that the most physically active children had above average school performance, whereas the least active children had below average school performance (as measured by grade point average (GPA) or mathematics grade). Children who exceeded the average academic achievement were physically active for 91 min/day; the average ones were active for 85 min/day and children whose academic achievement was below average were active for 84 min/day (Planinšec, 2006). Similarly, Planinšec, Pišot and Fošnarič (2006) found that children from suburban areas of Slovenia were slightly more active (87 min/day) than children from urban areas (85 min/day), while the least active children came from the rural areas (82 min/day). This study also showed that the level of PA in Slovenian children is well above the WHO recommendations of 60 minutes of moderate to vigorous PA per day (World Health Organization, 2010). Finally, Zurc more recently (2011) assessed the PA of Slovenian schoolchildren using self-reporting and established that (from the sample of 1,660 schoolchildren), 746 are active more than one hour per day; boys tended to be significantly more active and more involved in organized PA than girls were.

To summarize, the previous findings on PA in Slovenian schoolchildren showed that children from rural areas are less active than urban schoolchildren, while those with higher PA levels demonstrate (slightly) better AP. However, all the above-mentioned data were based on subjective assessments and self-report. Subjective assessment of PA is known to underestimate levels of true PA, leading to inconsistent estimations of energy expenditures and blunt conclusions based on habitual PA. To overcome these issues, this study investigated the link between PA in rural and urban Slovenian schoolchildren by measuring PA objectively using a multi-sensor device (SenseWear Armband PRO, Bodymedia, Inc., Pittsburgh, PA).

Methods

Participants

The sample was defined by an initial round of research conducted by Šturm in 1970 (1972) and was carried out in 10 research sites (Figure 1). The primary sampling unit was "school" and the secondary "class". The analysis focused on pupils from grades 1 to 8 of elementary schools. Due to changes in the educational system, and the introduction of nine-year elementary school in the 1990s, the research rounds from 1993 onwards included pupils from grades 1 to 9 (Jurak, Kovač & Starc, 2013; Starc et al., 2014). Measurements included only those pupils who had not been permanently or temporarily excused from physical education classes due to health reasons. Parents gave their written informed consent for their children to be included in the study.

Physical activity measurements

Physical activity was measured using a SenseWear Armband accelerometer (Bodymedia, Pittsburgh, Pennsylvania), which measures body acceleration in three axes (i.e. triaxial activity monitors), with the epoch length of 60 seconds. The SenseWear Armband was placed on the upper-left arm at the level of the triceps following established guidelines (Van Remoortel et al. 2012). The data sample consisted of those children who wore the device for at least three days during the weekdays and two days during weekends, for more than 90% of the time (i.e. 21 hours and 20 minutes). Levels for the moderate PA detection algorithm were set at 4.0 METs, and activity levels were defined for five levels: inactivity, sedentary, low, moderate and vigorous. Based on the purified value of PA, four groups were constructed (Table 1). PA is expressed as active energy expenditure (AEE) in kilojoules (kJ) and minutes of PA/day (duration) for the remainder of this paper.

Academic performance assessment

We used the mathematics grade as the indicator of AP. Previous studies showed that in Slovenia there is a high correlation between mathematics grade and GPA, but that the mathematics grade has slightly better reliability (Flere, Klanjšek, Musil et al. 2009). In Slovenia, maths grades are given using the following scale: 1 (inadequate), 2 (sufficient), 3 (good), 4 (very good), and 5 (excellent). Based on the assessment in mathematics, children were divided into three groups: low AP (< 3), normal AP (> 3 < 4) and high AP (> 4).

Place of residence

School regions were selected and divided based on their economic and socio-demographic characteristics within the Republic of Slovenia (Figure 1). In this study, the two schools from Ljubljana, the only Slovenian city with more than 300,000 inhabitants, were categorized as urban, and all others as rural schools. Ljubljana was also the only research site with two schools included in the data analysis.

Data collection

Data were collected during the research project Analysis of Development Trends of Children and Youth in Slovenia (ACDSi); methodology are reported elsewhere (Jurak, Kovač & Starc, 2013). Data were collected in three parts during two days at one research site: anthropometry (measurement of physical characteristics in a separated area), fitness (majority of fitness tests were carried out in the school gym, except for running (60 m and 600 m) which was carried out outside), and psychology

FIGURE 1 Map of the ACDSi research sites

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(children answering questionnaires via internet in computer labs and under the supervision of one or two members of the research team). Data were collected in the autumn of 2013.

Data processing

All statistics were conducted using IBM SPSS 22.0. Normal distribution was checked visually, and with the Kolmogorov-Smirnov test. After examination of the data (and eliminating unfitted measurements from samples due to missing results), descriptive statistics were made. For all physical fitness, PA and AP parameters (e.g. motor abilities and physical dimensions of the body) correlation coefficients were analysed using the nonparametric Spearman's rho test. To determine differences between stratifications of PA (low PA, normal PA, high PA, and very high PA) and indicators of physical fitness, a nonparametric Kruskal-Wallis test was performed. To determine the differences between groups of PA and academic performance, a nonparametric Kruskal-Wallis test was performed, which is used when operating with ordinal data. When the significance level was higher than 0.05, we determined that no difference exists, but when the significance level was <0.05, a Mann-Whitney U test was performed to determine the between-PA group differences, and differences in AP. For all post hoc comparisons, a Bonferroni correction was performed, and effect size was calculated.

Results

The sample of schools included the capital city (Ljubljana, the only urban city and the administrative centre of Slovenia); industrial centres (Jesenice, Ravne na Koroškem, Trbovlje) and places with a strong rural hinterland and various industrial plants (Tolmin, Žalec, Izola, Ormož, Trebnje, Metlika). In the present study, n=356 schoolchildren participated, and after cleaning the data, a total of n=166 (nboys=87, ngirls=79) elementary school children, aged 11 (grade 6) from 11 Slovenian elementary schools in 10 different economic and socio-demographic areas of the Republic of Slovenia were included for final analysis. A sample of children from the present study was also measured in September and October 2013. Altogether, four different PA groups were identified (low PA group, normal PA group, high PA group, very high PA group) (Table 1).

TABLE 1 PA groups

Group	Levels of PA	Values for levels of PA (min)	N
1	Low PA	Up to 60 min/day	24
2	Normal PA	From 61 to 120 min/day	46
3	High PA	From 121 to 180 min/day	57
4	Very high PA	From 180/day and more	39

Slovenian grade 6 children are, on average, physically active 141.83 + 7.37 min/day and expend 2386.42 + 166.89 kJ of energy daily. The average AP for all children participating in this study was 4.11 + 0.89. Descriptive statistics for objectively-measured PA is shown in Table 2. Spearman's rho coefficient (r=-0.24)

TABLE 2 PA descriptive statistics

	N	min	max	SD	SW	p	S/K
AEE	166	343	24708	2150.25	0.17	0.00	70.32/0.38
Duration	166	21	915	94.97	0.13	0.00	3.57/25.82

Note: AEE – active energy expenditure (kJ); Duration – duration of PA (min); N – sample size; min – minimum value; max – maximum value; SD - standard deviation; p – significance level; SW – Shapiro-Wilk test; S/K – skewness/kurtosis.

showed statistically significant (p<0.05) correlations between AP and objectively-measured PA in grade 6 schoolchildren. The correlation coefficient showed small, negative correlations between these variables. The independent-sample Kruskal-Wallis test showed statistically significant differences between the distributions

TABLE 3 Mann-Whitney U test for objectively measured PA groups and AP

Low and normal PA groups	Low and high PA groups	Low and very high PA groups	Normal and high PA groups	Normal and very high PA group	High and very high PA group
MR1=11.25	MR1=17.31	MR1=16.69	MR2=23.28	MR2=22.19	MR3=25.73
MR2=13.13	MR3=17.56	MR4=112.87	MR3=20.40	MR4=14.47	MR4=19.26
N=24	N=34	N=27	N=42	N=35	N=45
Z=-0.656	Z=-0.064	Z=-1.18	Z=-0.78	Z=-2.3	Z=-1.69
p= 0.51	p= 0.95	p= 0.24	p= 0.44	p= 0.02	p= 0.09
				ES= 0.39	

Note: MR1 represents Mean Rank for low PA group, MR2 represents Mean Rank for normal PA group, MR3 represents Mean Rank for high PA group, and MR4 represents Mean rank for very high PA group.

of objectively measured PA and AP (0.04, $p<0.05$). The normal PA group (MR2 = 22.19) performed better in AP compared to the high PA group (MR4 = 14.47).

Mann-Whitney U values (Table 3) were found to be statistically significant ($Z=-2.3$, $p<0.05$), and the differences between groups were moderately large (ES=0.39). Statistically significant differences in AP were found between the normal (60 – 120 min/day) and high (180 and more min/day) PA groups. The normal PA group performed significantly better in AP than the high PA group did.

Average daily PA in urban (M=162.07 + 157.7 min/day) and rural areas of Slovenia (137.7 + 75.6 min/day, $p<0.05$) show skewness coefficients that indicate that the results are skewed to the left, thus in the direction of less active children. Normal distributions of urban and rural PA duration significantly deviate from the theoretical distributions. Nonparametric Mann-Whitney test (U=1727) did not show a statistically significant difference between rural and urban children's PA duration (Table 4).

TABLE 4 Urban and rural children's PA descriptive statistics

PA	N	M	SD	SW	p	S/K	MW
Urban Rural	166	162.1 137.7	157.7 75.6	0.52	0.00	4.25/20.8	MRu=88.7 MRr=82.45 U=1787.00 Z=-0.625 P=-0.625

Note: PA – Physical activity (min/day); N – sample size; M – arithmetic mean; SD – standard deviation; SW – Shapiro-Wilk test; N- sample size; p – significance level; S/K - Skewness/Kurtosis; MW – Mann-Whitney test; MRu – median ranks urban; MRr – median ranks rural; U – U value; Z – Z value; P – Mann-Whitney P value; Mann-Whitney test is significant after performing Bonferroni correction at 0.025.

Spearman's rho coefficient showed that there is a negative correlation between PA and AP in boys ($r=0.24$). Urban grade 6 children achieved an average mathematics grade of 4.25+0.85 in comparison to 3.56 + 1.16 in rural grade 6 children. Skewness coefficients for urban areas show that results of AP are skewed to the right, meaning in the direction of children who perform better in mathematics. Skewness coefficients for rural areas show that results of AP are skewed to the left, therefore in the direction of worse mathematics grades. Normal distributions of urban and rural AP deviate from the theoretical distributions. The non-parametric Mann-Whitney test (U=358.5) was statistically significant ($Z=-2.38$, $p<0.05$), and the difference between rural and urban children in AP was considered a medium effect size (ES=0.29). Urban schoolchildren (MRu=42.26) performed better in mathematics in comparison to rural schoolchildren (MRr=30.97).

Discussion

Children exceeding the WHO (2010) recommendations for PA perform better in academics, but only within certain limits of PA durations. In the very low PA group with less than 60 minutes of MVPA per day, and in the PA groups exceeding 120 minutes or MVPA/day, did not show significant differences in AP in favour of the more active children. In this regard, WHO (2010) recommendations seem too modest to improve the cognitive and physical health of children, and it would be advisable to change the recommendations to 60 to 120 MVPA per day, whereby the threshold for moderate physical activity could be moved from 3 to 4 MET. Children from urban areas tend to perform significantly better in mathematics in comparison to children from the rural areas of Slovenia, which is in contrast with some other studies in which children from rural areas perform better in academics, such as reading and mathematics (Alspaugh, 1992; Alspaugh & Harting, 1995). For the current study, only the national capital region of Slovenia was treated as an urban city. Urban Audit defines medium-sized cities as having populations between 50,000 and 250,000 inhabitants, and large cities as having 250,000 or more inhabitants. Ljubljana and Maribor are thus classified as medium cities, but since Ljubljana meets the criteria of ≥ 250,000 inhabitants (Klement, 2006), it is the only urban city in Slovenia. Because of the diverse landscape and greater dispersion of smaller cities in Slovenia, the results obtained in the present study are relevant only for international comparisons, and not for assessing the real urban-rural situation in the country. Therefore, factors for potential differences in AP between rural and urban settlements in Slovenia may be a reflection of specific regional environments, availability of resources, differences in socioeconomic status of families, community influence, and parental expectations towards PA.

In comparison to other regions of Slovenia, Ljubljana is considerably more developed, and experiences the positive migration balance of highly educated people, than other regions of the country. The reason for higher AP in urban children may, therefore, also be due to the influence of the parental educational level. Sember (2017) has reported that a mother's ($r=0.26$, $p<0.05$) and father's education ($r=0.22$, $p<0.05$) are significantly correlated to children's academic performance. Since better-educated parents are likely to move to the capital region (Rebernik, 2003), there may also be a greater percentage of children who perform better in academics for this reason alone.

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In terms of assessing academic performance, the math grade is the best one for the Slovenian education setting, with the highest predictive value of overall AP (r=0.50) (Flere, Klanjšek, Musil et al. 2009), including higher levels of reliability (0,89 – 0,94) (Carlson, Fulton, Lee et al. 2008). AP grades were based on ratings by school teachers; therefore, any potential personal bias cannot be entirely excluded. Nevertheless, although the strongest relationships were found between aerobic fitness and achievement in mathematics (Fedewa & Ahn, 2011), grade point average and mathematics grade are the only two instruments of AP used in larger studies of this nature; thus, the results of this study can only be generalized to those instruments that measure AP using the mathematics grade.

The current results show some differences in PA duration between urban and rural children. Urban children are slightly more active than rural children in Slovenia, which is consistent to the results of Planinšec (1997), Matejek and Planinšec (2008), and Planinšec, Pišot and Fošnarič (2006), who found that children from rural areas were the least active in Slovenia. All studies mentioned above were assessing PA using self-report methods, and the uncertainty of these results (Warnecke, Johnson, Chavez et al. 1997) has now been confirmed using objective measures of PA. All comparative studies of rural and urban children's PA in the Slovenian environment were conducted only in one geographical setting, meaning that the results could not be generalized to the entire Slovenian population. The results of the presented study introduce additional high-quality evidence of relations between urbanization grade, PA, and AP due to objectively assessed PA, and geographic dispersity of research sites, but to confirm the findings and make them more generalizable, future research should include larger numbers of children, and mathematics grades should also be combined with grades of other subjects and GPA.

Ethical Considerations

Approval of the National Medical Ethics Committee for the ACDSi study was obtained in June 2013 (ID 138/05/13).

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ORIGINAL SCIENTIFIC PAPER

Discriminate Scoring Skills and Non-Scoring Skills According to Results in the Brazilian Men's Volleyball SuperLeague

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ABSTRACT This study analysed the Brazilian SuperLeague Men's Volleyball 2011/2012 season and 2012/2013 season, in an attempt to identify the game-related factors allowing the determination of winning and losing teams. All games (n=294) of the Brazilian SuperLeague Men's Volleyball 2011/2012 season and 2012/2013 season were analysed. In the 2011/2012 season, the Total Set Actions (TSETA) and Total Points Made (TPM) were factors that determined the game result as a defeat. The factor that determined the victory was the Total Attack Actions (TAA). In the 2012/2013 season, the factors Total Serve Actions (TSA) and Total Set Actions (TSETA) generated victory, and the factors that led to defeat were the TPM and TAA. The scoring skill (TPM) determined the final game result but surprisingly is associated with the defeat and the TSA with victory. The scoring skill (TAA) determining the result of the game was probably associated with victory in the 2011/2012 season and defeat in the 2012/2013 season. The non-scoring skill TSETA determined the result of the game, and this may be associated with defeat in the 2011/2012 season and the victory in the 2012/2013 season.

KEY WORDS Match Analysis, Statistics Related-Gaming, Scoring Skill, Non-Scoring Skill and Volleyball

Introduction

According to Ortega, Villarejo and Palao (2009), the analysis of game statistics, regarding individual and collective skills, is a tool that can be used to describe and monitor the behaviour of opponents. Although the limitations may arise from the different variables used in these studies (Hughes, Cooper, & Nevill, 2002), this type of data is always useful for a greater knowledge of the game.

As Sampaio, Janeira, Ibanez and Lorenzo (2006) explain, the identification and codification of game action statistics, used as performance scorers, have been presented in the literature in order to contribute to the improvement of different sports.

The study of sport through the observation of players and the behaviour of teams is of vital importance for the organization, design, teaching and training of teams; most of these research studies analyse the different performance indicators within each sporting modality (Shaughnessy, 2006). Performance indicators are defined as the selection and combination of variables that define some aspect of performance and help in achieving athletic success (Hughes & Bartllet, 2002). These indicators are an ideal pro-performance factor that must be present in the sports mode to achieve this performance and can be used to predict the future behaviour of the activity (Ortega et al., 2009).

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A performance indicator is a selection or combination of action variables that affect some or all aspects of a performance. Analysts and technicians use performance indicators to evaluate the performance of an individual, a team, or team elements (Lobietti, Coleman, Pizzichillo & Merni, 2010; Marcelino, Mesquita, Sampaio & Moraes, 2010). They are often used in a comparative way, with opponents, other athletes or groups of athletes or teams, but often they are used in isolation as a measure of the performance of a team or a single person (Hughes & Bartlett, 2002).

A limitation was that some studies used a univariate technique in the data analysis, not enabling inferences about the interaction between the different performance indicators nor about the degree of importance of each of them on the final performance of the team.

In that sense, volleyball is an active game that provides a confrontational property between two teams. Its primary purpose is to shoot the ball in the team's court or to commit a fault or foul. With the change of the rules and the scoring system, the period of the game is reduced, generating ball possession disputes with maximum intensity and speed to overcome the opponent (Castro, Matias, Carvalho, Berriel & Greco, 2013).

Thus, in order to favour the understanding of the structure of the game, as well as its training dynamics, the development of this is typically divided into two major phases: the side-out or complex 1 (K1) (Zetou & Tsigilis, 2007; Castro & Mesquita, 2008) as the attack carried out from the reception of the opponent's service, and the side-out transition or complex 2 (K2) (Zetou, Moustakidis, Tsigilis & Komninakidou, 2006; Castro & Mesquita, 2008), which refers to the attack carried out from the defence of the opposing attack (Lerbach & Vianna, 2007).

Marcelino et al. (2010) report that the technical fundamentals of volleyball are actions that grant the player offensive action (Serve, Attack and Block), the structure of the attack (Reception and Set), and defensive action (Block and Defence). It is understood that the quality in the realization of the fundamentals of the team will affect the game, which can lead to victory or defeat.

Little is known about this subject in Brazilian volleyball. The aim of this paper is to understand the ideal combination of these indicators to help achieve success in the Brazilian Men's Volleyball SuperLeague. In this sense, the objective of the present study is to identify which statistics related to the game allow determining the result (victory and defeat), the actions of game "Scoring Skills" (Attack, Serve and Block) and the actions of game "Non-Scoring Skills" (Pass, Reception and Defence), in the Brazilian Men's Volleyball SuperLeague.

Methods

Sample

All games (n = 294) of the Men's Volleyball Brazilian SuperLeague of the 2011/2012 season (n = 148) and the 2012/2013 season (n = 146) were analysed.

Instruments and Variables

The data were collected from official game scouts through the official website of the Brazilian Volleyball Confederation (CBV), provided by SCConsultoria, a private company dedicated to the performance measurement of the teams of the Brazilian SuperLeague Volleyball. In view of the difficulties inherent in carrying out this type of study, the use of secondary data with a high degree of reliability has been approved by those who use them in a careful way to conduct investigations in the field of sport.

The dependent variable was the Match Result (MR) - Victory or Defeat and the independent variables were Total of Points Made (TPM); Number of Substitutions (NS); Total Attack Points (TAP); Total Attack Actions (TAA); Total Block Points (TBP); Total Block Actions (TBA); Total Serve Points (TSP); Total Serve Actions (TSA); Adversary Errors (AE); Total Excellent Defence (TED); Total Defence Actions (TDA); Total Excellent Set (TES); Total Set Actions (TSETA); Total Excellent Reception (TER); Total Reception Actions (TRA).

Reliability Analysis

The reliability of the observations was tested in 10% of the sample (29 assisted games) by comparing the 14 variables in the results obtained from the Brazilian Volleyball Confederation database, showing inter-observer Cohen (K) inter-observer between 0.92 and 1 The data reliability analysis was performed with the Statistical Package for Social Sciences (SPSS) version 20.0 and with a significance level of 5%.

Statistical analysis

Initially, the Kolmogorov-Smirnov test was used to analyse the normal distribution of the data. The value of the variables was less than 0.05, thus not presenting a normal distribution. As non-parametric data and the samples are not paired, the Mann-Whitney Test was used to evaluate the differences between the general averages of all victories with the general averages of all defeats.

Finally, Discriminate Analysis (DA) was used to evaluate the significance of game statistics on whether the team is likely to be the winner or loser. The statistical significance of the obtained function was analysed, and through the Structural Canonical Coefficients (SCC), the most powerful indicators were identified. With this, it was considered that the SCC with statistical significance would have values equal to or greater than 0.30, in other words SCC ≥ 0.30 (Tabachnick & Fidell, 2007).

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For all statistical treatment, Microsoft Excel Software version 2010 was used to catalogue and organize all the data and the Statistical Package for Social Sciences (SPSS) version 20.0 software to perform the descriptive, variance and discriminate analyses. The level of significance was respected p <0.05, the confidence level was 95%, and for p <0.01 the confidence level was 99%.

Results

Table 1 shows the values of the comparison of the data regarding victories and defeats for the 2011/2012 season.

TABLE 1 Comparison of the factors in the victories and defeats of the Brazilian SuperLeague of Men's Volleyball 2011/2012 using the Mann-Whitney Test

Factors	Victories (n=148) (means ± sd)	Defeats (n=148) (means ± sd)	Mann-Whitney U (U)	Wilcoxon W (Z)	Sig. (*p*)
(TPM)	91.33 ± 15.03	80.89 ± 19.09	7569.50	18595.50	0.00*
(NS)	7.25 ± 2.98	8.75 ± 2.63	7713.50	18739.50	0.00*
(TAP)	49.59 ± 10.32	45.45 ± 11.65	8800.00	19826.00	0.03*
(TAA)	95.12 ± 22.75	98.66 ± 21.07	9839.00	20865.00	0.13
(TBP)	9.93 ± 3.62	7.83 ± 3.66	7365.50	18391.50	0.00*
(TBA)	47.47 ± 11.55	44.67 ± 12.93	9271.00	20297.00	0.02*
(TSP)	4.53 ± 2.27	3.42 ± 2.26	7714.50	18740.50	0.00*
(TSA)	89.88 ± 16.18	81.86 ± 18.57	7924.00	18950.00	0.00*
(AE)	27.76 ± 6.38	24.09 ± 6.75	7563.00	18589.00	0.00*
(TED)	33.99 ± 9.45	30.72 ± 9.92	8930.00	19956.00	0.01*
(TDA)	62.46 ± 15.48	62.71 ± 15.10	10723.00	21749.00	0.76
(TES)	26.88 ± 9.50	25.09 ± 9.77	9621.00	20647.00	0.07
(TSETA)	91.70 ± 21.74	95.62 ± 20.35	9699.50	20725.50	0.09
(TER)	34.39 ± 11.06	36.97 ± 12.23	9543.50	20569.50	0.06
(TRA)	65.52 ± 16.27	74.94 ± 13.11	7325.00	18351.00	0.00*

Note: * Level of Significance (p<0.05); Total of Points Made (TPM); Number of Substitutions (NS); Total Attack Points (TAP); Total Attack Actions (TAA); Total Block Points (TBP); Total Block Actions (TBA); Total Serve Points (TSP); Total Serve Actions (TSA); Adversary Errors (AE); Total Excellent Defence (TED); Total Defence Actions (TDA); Total Excellent Set (TES); Total Set Actions (TSETA); Total Excellent Reception (TER); Total Reception Actions (TRA).

Significant differences were observed in almost all variables, with the exception of Total Attack Actions (TAA) (p = 0.13), Total Defence Actions (TDA) (p = 0.76), Total Excellent Set (TES) (p = 0.07), Total Set Actions (TSETA) (p = 0.09) and Total Excellent Reception (TER) (p = 0.06).

TABLE 2 CCE values of the Discriminating Function of the factors between victories and defeats of all the games of the Brazilian SuperLeague of Men's Volleyball 2011/2012

Factors	Function 1 |SC|
Total Attack Actions (TAA)	-0.81*
Total Set Actions (TSETA)	0.70*
Total Points Made (TPM)	0.42*
Total Attack points (TAP)	-0.24
Total Serve Actions (TSA)	-0.18
Adversary Errors (AE)	-0.10
Total Excellent Reception (TER)	0.09
Total Serve Points (TSP)	0.06
Number of Substitutions (NS)	0.05
Total Excellent Set (TES)	0.05
Total Reception Actions (TRA)	0.05
Total Defence Actions (TDA)	0.05
Total Block Actions (TBA)	0.04
Total Excellent Defence (TED)	0.02
Total Block Points (TBP)	-0.01
Wilks' Lambda	0.12
Qui-Square	614.18
Auto-Value	7.60
Canonical Correlation	0.94
Central Mean – Defeats	2.75
Central Mean – Victories	-2.75

Note: * |SC|≥0.30

In Table 2, the results of the discriminate analysis between victories and defeats for the factors of all games are shown in the general form of the 2011/2012 season.

The values of CCE of the factors TSETA (CCE = 0.70) and TPM (CCE = 0.42) were discriminated so that the Match Result (MR) was negative, in this case, the defeat. The factor that determined that the MR was positive, that is, the victory, was the TAA (CCE = -0.81).

TABLE 3 Comparison of the factors in the victories and defeats of the Brazilian SuperLeague of Men's Volleyball 2012/2013 using the Mann-Whitney Test

	Victories (n=146)	Defeats (n=146)	Mann-Whitney U	Wilcoxon W	Sig.
Factors	**(m ± sd)**	**(m ± sd)**	**(U)**	**(Z)**	**(*p*)**
(TPM)	93.26 ± 14.43	82.95 ± 19.61	7548.50	18279.50	0.00*
(NS)	7.05 ± 3.20	8.96 ± 2.66	6792.00	17523.00	0.00*
(TAP)	51.58 ± 10.03	46.69 ± 12.26	8250.50	18981.50	0.00*
(TAA)	101.01 ± 25.99	104.22 ± 23.88	9920.50	20651.50	0.31
(TBP)	10.81 ± 3.45	8.51 ± 4.37	6700.00	17431.00	0.00*
(TBA)	51.21 ± 13.34	47.73 ± 14.07	9067.00	19798.00	0.03*
(TSP)	4.26 ± 2.05	3.04 ± 1.98	6902.50	17633.50	0.00*
(TSA)	91.77 ± 14.93	83.75 ± 19.01	8012.00	18743.00	0.00*
(AE)	26.64 ± 5.72	24.77 ± 6.43	8676.00	19407.00	0.01*
(TED)	37.29 ± 10.73	33.73 ± 11.61	8850.50	19581.50	0.01*
(TDA)	65.37 ± 16.96	66.47 ± 16.69	10246.00	20977.00	0.57
(TES)	27.86 ± 9.78	24.54 ± 11.47	8342.00	19073.00	0.00*
(TSETA)	98.90 ± 24.50	101.43 ± 22.87	9967.50	20698.50	0.34
(TER)	34.38 ± 12.42	35.88 ± 13.49	9957.50	20688.50	0.33
(TRA)	68.92 ± 17.56	77.04 ± 13.79	7796.00	18527.00	0.00*

Note: * Level of Significance ($p<0.05$)

In the classification of Matrix of Confusion, the Discriminate Function between victories and losses for the factors of all games in the general form of the 2011/2012 season, the success of the adjustment quality of the DA was of 100% in both game results. In defeats, 100% of the games (148 of 148) are classified successfully. The same is also true of victories: 148 games of 148 are classified successfully.

TABLE 4 CCE values of the Discriminating Function of the factors between victories and defeats of all games of the Brazilian SuperLeague of Men's Volleyball 2012/2013

Factors	**Function 1**
	|SC|
Total Points Made (TPM)	1.78*
Total Serve Actions (TSA)	-1.72*
Total Set Actions (TSETA)	-0.81*
Total Attack Actions (TAA)	0.53*
Total Block Points (TBP)	0.23
Total Attack Points (TAP)	0.22
Total Block Actions (TBA)	-0.17
Total Reception Actions (TRA)	-0.15
Number of Substitutions (NS)	0.15
Total Defence Actions (TDA)	0.13
Total Excellent Set (TES)	-0.06
Total Excellent Reception (TER)	0.04
Total Serve Points (TSP)	0.03
Total Excellent Defence (TED)	0.01
Adversary Errors (AE)**	-0.06
Wilks' Lambda	0.14
Qui-Square	560.28
Auto-Value	6.29
Canonical Correlation	0.93
Central Mean – Defeats	2.50
Central Mean – Victories	-2.50

Note: * $|SC|\geq0.30$; ** Unused variable in the analysis, because as failed tolerance test

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Table 3 shows the comparison values of the victories and defeats data for the 2012/2013 season.

Significant differences were observed in almost all variables, with the exception of Total Attack Actions (TAA) ($p = 0.31$), Total Defence Actions (TDA) ($p = 0.57$), Total Set Actions (TSETA) ($P = 0.34$) and Total Excellent Reception (TER) ($p = 0.33$).

Table 4 shows the results of the discriminate analysis between victories and defeats for the factors of all games in the general form of the 2012/2013 season.

The values of CCE of the factors TSA (CCE = -1.72) and TSETA (CCE = -0.81) generated the positive MR, in this case possibly associated with victory. However, the factors that caused the MR to be negative (i.e. possibly associated with defeat) were (TPM) = 1.78 and (TAA) CCE = 0.53.

In the classification of the confusion matrix of the Discriminating Function between victories and defeats for the factors of all games in the general form of the 2012/2013 season, the success of DA adjustment quality was 100% in both game results. In defeats, 100% of the games (146 of 146) are classified successfully. The same is also true of victories: 146 games of 146 are classified successfully.

Discussion

In the 2011/2012 season, as was shown in Table 1, significant differences were observed in which the winning teams obtained higher averages of Total Points Made (TPM), Total Attack Points (TAP), Total Block Points (TBP), Total Block Actions (TBA), Total Serve Points (TSP), Total Serve Actions (TSA), Adversary Errors (AE) and Total Excellent Defence (TED) than the losing teams did, thus achieving victory.

Some researchers believe that teams that are at a disadvantage in the game may take more risks when serving, probably because they have nothing to lose (João, Leite, Mesquita & Sampaio, 2010). However, as Yiannis, Panagiotis, Ioannis and Alkinoi (2004), when they risk more, these teams also end up failing more frequently, thus increasing the number of errors. In contrast, if they take chances, the opposing reception will be more complicated, increasing the prospects for error of the part of the other team.

The literature on the volleyball block points to its importance to the game result (Afonso, Mesquita, Marcelino & Silva, 2010; Palao, Santos & Ureña, 2004). Organization through strategies and trainings of triple block can increase the possibility of successful blocking. Palao (2008) determined that successful blocking offers more chances to win. In addition, blocking is the first terminal action (Scoring Skill) that can lead to an opponent's attack and can result in a direct point.

In relation to the attack points, game analysis studies (Costa, Ferreira, Junqueira, Afonso & Mesquita, 2011; Costa, Mesquita, Greco, Ferreira & Moraes, 2011; Garcia-Hermoso, Dàvila-Romero & Saavedra, 2013; Marcelino, Mesquita & Sampaio, 2011) in this study, we found that the point in volleyball is derived mainly from the attack and is directly related to the success of the game (Garcia-Hermoso et al. 2013; Marcelino et al., 2011).

Instead, losing teams achieved the highest averages of Number of Substitutions (NS) and Total Reception Actions (TRA) that the winning teams did, even though they did not achieve victory. It is not enough to just carry out more reception actions, but to execute them with excellence; not to obtain error in the reception is a factor that distinguishes the performance of the teams (Silva, Lacerda & João, 2014, García-Alcaraz, Palao & Ortega, 2014).

The discriminatory factor shown in Table 2, which caused the MR to be positive, was the TAA (CCE= -0.81). Surprisingly it is unlike the perceived averages, since the losing teams presented a higher average of TAA compared to the winning teams. However, it should be noted that this difference in means was not significant. Thus, it is assumed that the winning teams were able to take advantage of the attack actions and convert them into more attack points, which is evidenced by the significant difference in the averages of TAP.

The discriminatory factors that caused the (MR) to be negative were the (TSETA) CCE = 0.70 and (TPM) CCE = 0.42 because the score was close to a mean of 2.75, which caused the team's defeat. In fact, the average of (TSETA) ($m = 95.62$) of the defeated teams was higher than that of the winning teams ($m = 91.70$), although it was not a significant difference. Even if a team performs more setting actions, it is not a condition that it has a positive MR, because, in order to be a good condition in the setting action, the team must first have a good reception and then increase the probability of obtaining the point of attack and, consequently, victory (Matias & Greco, 2011).

In the 2012/2013 season of the Brazilian Men's Volleyball SuperLeague, significant differences were found in Table 3: the winning teams obtained the highest averages of Total Points Made (TPM), Total Attack Points (TAP), Total Block Points (TBP), Total Block Actions (TBA), Total Serve Points (TSP), Total Serve Actions (TSA), Adversary Errors (AE) and Total Excellent Defence (TED) than the losing teams did; thus, the only difference between the seasons was that in 2011/2012 the average of the Total Excellent Set (TES) of the winning teams was also higher than that of the losing teams, but with a significant difference.

In contrast, losing teams have achieved the highest averages of Number of Substitutions (NS) and Total Reception Actions (TRA) than the winning teams did, even though they did not reach victory, just like in the 2011/2012 season. A team performing more reception actions is likely to lead to more errors in the same actions. Several studies have found an association between reception effectiveness and effects on the result of the match (Silva et al., 2014).

Regarding the discriminatory values, as seen in Table 4, the results of CCE of the factors TAA (CCE = 0.53) and TPM (CCE = 1.79) were discriminate that the (MR) was negative, due to the score being close to a central mean of 2.50 that influence the team in the case, to the defeat. In fact, the average of (TAA) (m = 104.22) of the defeated teams was higher than that of the winning teams (m = 101.01), although it was not a significant difference. Even though a team can perform more attack actions, more attack errors can occur, so the attack error provides the direct point to the opponent, increasing the chances of defeat (Costa, Barbosa, Freire, Matias & Greco, 2014; Garcia-Hermoso et al., 2013). Regarding the attack, Cerrato, Palao, Marzo, Puche & Ureña (2007) verified that the speed of the shot varies between men (61.2Km/h and 112.3km/h) and has been increasing in recent years.

The factors that defined the MR as positive were the (TSA) CCE = -1.72 and (TSETA) CCE = -0.81. because the score was close to a mean of -2.50 that influenced the team: in this case, to victory. These discriminatory values are further substantiated by the highest average (TAS) (m = 91.77) of the winning teams compared to the losing teams (m = 83.75). In volleyball, the serve has become an influential action of attack and, at the same time, of defence: from attack, when the direct point is obtained, and defence, making reception difficult and preventing the opposing team from organizing a perfect attack (Mackenzie, Kortegaard, LeVangie & Barro, 2012).

The average (TSETA) (m = 98.90) of the winning teams, although smaller than that of the losing teams (m = 101.43), however was not a significant difference, was a discriminate factor to the (MR) positive, due to the better use of execution action (TES) (m = 24.54) of the losing teams compared to the (TES) average (m = 27.86) of the winning teams, with a significant difference. The quality of the reception or the defence influences when it is desirable to prepare offensive situations appropriate to the attacker (Claver Rabaz, Jiménez Castuera, Gil Arias, Moreno Domínguez & Moreno Arroyo, 2013). Even in cases in which the first touch feature is of poor quality, the excellent setting action tends to prepare offensive situations favourable to the attacker, as this may prevent the blocking from anticipating their tactical choice (Inkinen, Häyrinen & Linnamo, 2013; Marcelino et al., 2010; Zetou et al., 2006).

Conclusion

According to the results obtained from this study, we can affirm that in the Brazilian Men's Volleyball SuperLeague 2011/2012 season, the factors that possibly caused the defeat were Total Set Actions (TSETA) and Total Points Made (TPM). The Total Attack Action (TAA) factor was probably key to the victory. In the Brazilian Men's Volleyball SuperLeague 2012/2013 season, the Total Serve Actions (TSA) and Total Set Actions (TSETA) factors were likely to have caused the victory. The factors that probably led to the defeat were Total Attack Actions (TAA) and Total Points Made (TPM).

Thus, in response to the objectives that we proposed, the Scoring Skill (TPM) determines the final game result, but it surprisingly is associated with defeat. The Scoring Skill (TSA) discriminates against the final game result, supposedly associated with victory. The Scoring Skill (TAA), however, determines the final game result, probably associated with both victory and defeat. In this case, it is related to the victory in the Brazilian Men's Volleyball SuperLeague 2011/2012 season and to the defeat in the Brazilian Men's Volleyball SuperLeague 2012/2013 season.

The Non-Scoring Skill (TSETA) determines the final game result, possibly being associated with both victory and defeat. In this situation, it is related to defeat in the Brazilian Men's Volleyball SuperLeague 2011/2012 season and to victory in the Brazilian Men's Volleyball SuperLeague 2012/2013 season.

We suggest that these variables should be considered as useful information for progress in the development of successful training procedures.

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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

C O P E COMMITTEE ON PUBLICATION ETHICS

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]

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[2]University of Montenegro, Faculty for Sport and Physical Education, Niksic, Montenegro

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Faculty for Sport and Physical Education
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E-mail: stevop@ac.me

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):

Nepocatych, S., Balilionis, G., & O'Neal, E. K. (2017). Analysis of dietary intake and body composition of female athletes over a competitive season. *Montenegrin Journal of Sports Science and Medicine, 6*(2), 57-65. doi: 10.26773/mjssm.2017.09.008

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. doi: 10.1007/s00421-007-0468-x

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. doi: 10.1249/01.MSS.0000058441.94520.32

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

Williams, R. (2016). Krishna's Neglected Responsibilities: Religious devotion and social critique in eighteenth-century North India [Electronic version]. *Modern Asian Studies, 50*(5), 1403-1440. doi:10.1017/S0026749X14000444

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.

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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%	✓ 10º	✓ 10 kg	✓ 12:2	✓ 0.056
× 10 %	× 10 º	× 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

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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.

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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.

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For more information about University of Montenegro, please visit our website www.ucg.ac.me or send e-mail to pr.centar@ac.me.

CRNOGORSKI OLIMPIJSKI KOMITET
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MARITIME FACULTY - KOTOR

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- Different IMO model courses
- DP - Dynamic positioning courses
- Offshore courses

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OSC offshore simulator at Maritime Faculty Kotor, Montenegro

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University of Montenegro
FACULTY of **ECONOMICS** PODGORICA

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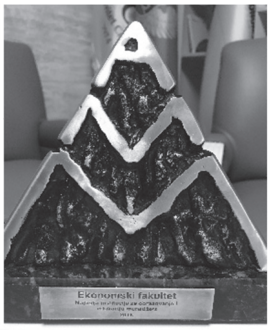

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Development of Faculty of Economics in the coming period will follow the vision of development of the University of Montenegro, pursuing full achievement of its mission

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.

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PRAVNI FAKULTET – PODGORICA

Pravni fakultet u Podgorici osnovan je 27. oktobra 1972. godine kao nastavno-naučna i obrazovna ustanova u kojoj se organizuje i razvija obrazovni i naučno-istraživački rad u o oblasti pravnih i njima srodnih društvenih nauka. U skupštini Socijalističke Republike Crne Gore, prilikom donošenja Zakona o osnivanju Pravnog fakulteta, istaknuto je da se „osnivanje ove visokoškolske Ustanove nameće kao neophodno sa stanovištva ukupnih društvenih potreba Republike". Pravni fakultet je jedan od utemeljivača Univerziteta Crne Gore.

U svom četrdesetpetogodišnjem postojanju, Fakultet je izrastao u modernu, savremenu, obrazovnu naučno-istraživačku jedinicu. Na njemu se školovalo 45 generacija. Upisalo se oko 17.000 studenata. Diplomiralo je 4285. Oko 15% studenata bilo je van Crne Gore. Dio najboljih studenata stručno usavršavanje, kroz poslijediplomske studije i doktorate, nastavljalo je u drugim i svijetu poznatim univerzitetskim centrima. Većina bivših studenata životno je vezana za Crnu Goru. Na Fakultetu je radilo 88 nastavnika i saradnika, od čega je 26 bilo gostujućih. Sada uglavnom nastavu izvode i gro kadra predstavljaju bivši studenti fakulteta.

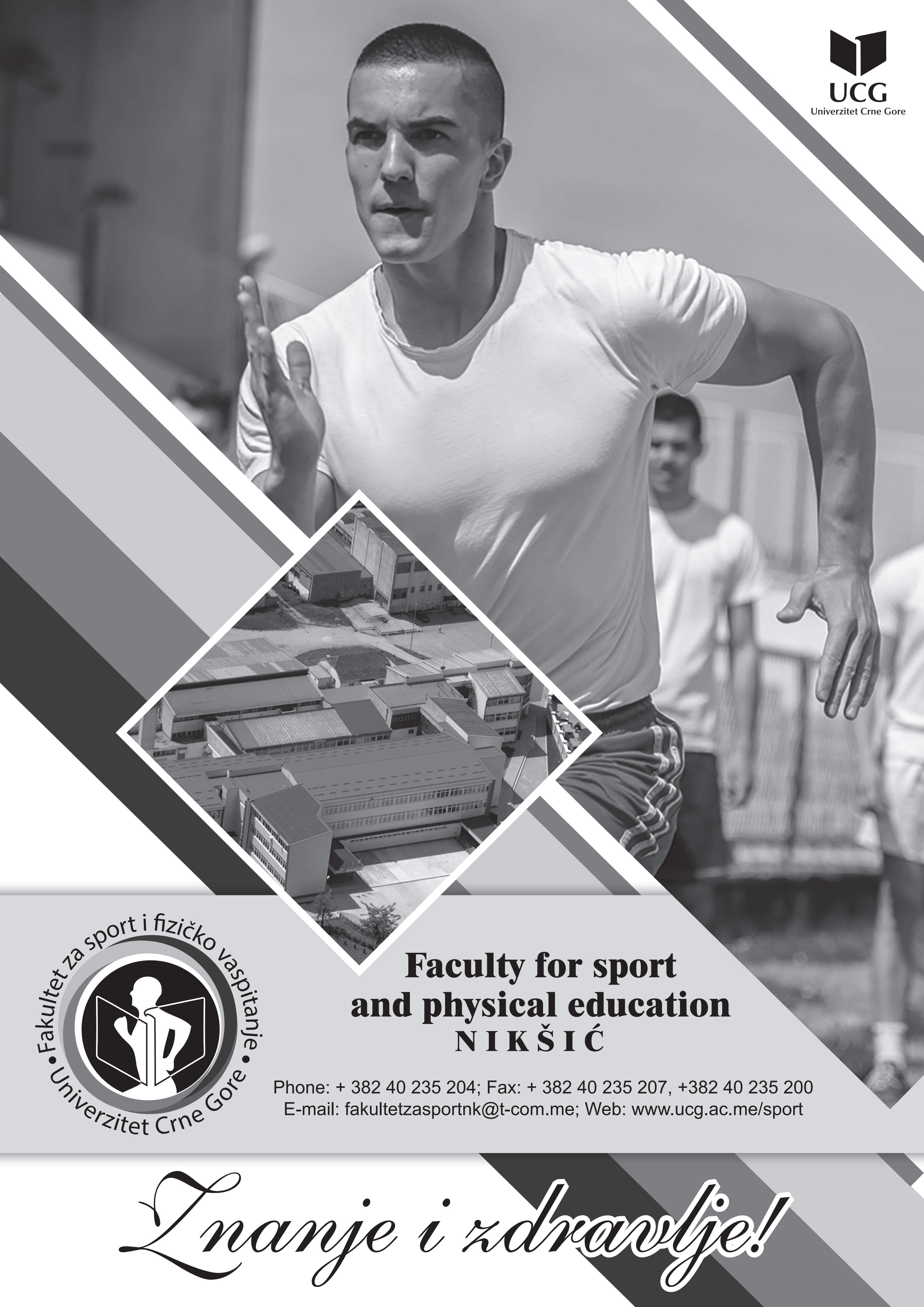
Fakultet organizuje osnovne i poslijediplomske studije. Postoje zakonske i kadrovske mogućnosti za organizovanje specijalističkih i doktorskih studija u svim oblastima prava.

Kao univerziteska jedinica, u okviru Univerziteta Pravni fakultet realizuje znatan dio svojih programskih ciljeva i zadataka i rješava mnoga važna pitanja organizaciono-kadrovske, tehničke i materijalne prirode. Posredstvom Univerziteta, fakultet u velikoj mjeri razvija mrežu svoje međunarodne saradnje.

Fakultet prati svjetske trendove i dostignuća u oblasti visokog školstva s ciljem da sopstvenu djelatnost uskladi sa evropskim i svjetskim zahtjevima. Sa ovom školskom godinom, čine se prvi koraci realizacije Bolonjske deklaracije. Svojim kadrom Fakultet opslužuje kompletan nastavno-obrazovni proces.

Nastao kao izraz potreba dostignutog nivoa u društveno-ekonomskom, političkom, kulturnom i socijalnom razvoju Crne Gore, fakultet je tokom cijelog cvog postojanja dijelio sudbinu crnogorskog društva. Činiće to i u buduće praveći, naravno, iskorake u novu praksu i odnose primjenom modernih trendova razvijene Evrope.

Fakultet je sada postao složena organizacija i upravljačka struktura.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