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CONTENTS

ORIGINAL ARTICLE

Timeless evolution of walking and pace strategy of women's race walking

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection.

Abstract

Purpose: The purpose of this research was to study the timeline evolution of walking, as well as the Pacing Strategy Profiles of high-level women in the 20 km of race walking.

Material: The practical example of applying the theoretical basis was made during the Women's Greek Championship (Megara 2016), in which 12 athletes aged 19 to 40 participated (28.50 ± 7.20). The certified distance of the 20km route was divided into 10 sections of 2 km each. The same happened with the times (intermediate, final) corresponding to the individual sections (2 km) of the route. The athletes were divided into 4 groups: the first 3, those who finished 15% slower than the first, those who finished 15% - 30% slower, and those who finished more than 30% slower than the winner. Finally became comparison of the first 6 and last 6 athletes' groups.

Results: The individual pace strategies that describe the tactics of the athletes in this race have been calculated. It was found that the winners of the race used Even Pacing Strategy, maintaining a steady speed on most of the route. As the level of women athletes became lower, Variable Pacing Strategy was used, while the athletes who finished last did not seem to be able to maintain any particular pacing strategy.

Conclusions: It is suggested that athletes should follow Even Pacing Strategy during the race in order to improve their performance.

Keywords: race walking, even pacing strategy, variable pacing strategy, performance.

Introduction

Various activities that are repeated on a daily basis put the human body on a motor alert, whether it is for social, working or sporting purposes. Beginning of walking from stillness is considered to be one of the most common activities of a person in its daily living. Depending on the purpose and the method, we can divide it as follows:

1) Simple walk or walk is considered as the natural way of moving the human body into space from its infancy [1].

2) The healing walk, which is the acceptance of exercise as a practical form of rehabilitation, promotion and preservation of health, as it was known by Byzantine medicine [2].

3) Recreational walk or walk as a recreation. Mannel & Reid, [3] and Sylvester, [4] define three dimensions based on: (a) Leisure as free time, (b) Leisure as an experience, (c) Leisure as an activity. It is therefore understood, that recreation is a broader concept that involves active activity, whereas entertainment involves passive activity [5].

4) Nordic walking is walking with specially designed walking sticks, to improve fitness [6].

5) Race walking is a part of the classical athletics and one of the Olympic Games, in which athletes move as fast as possible without running in routes of 20 km and 50 km.

The great schools of race walking were created after the war. First the Soviet School, later the Italian, the Spain, the Mexican, the Poland, the German and last the Chinese. The most important athlete of race walking was the Polish Robert Korzeniowski. He has had gain four gold Olympic medals (3 in 50 km and 1 in 20 km), and four medals in World Championships (3 gold and 1 bronze, all in 50 km).

The basic rules of race walking:

Race walking is carried out on flat public roads. Athletes walk 20 km, repeating 10 times routes of 2 km, or 4 times routes of 5 km. There are rules that differentiate walking from running and athletes of race walking have to know them and follow them. According to Regulations, article 230 IAAF Track and Field Regulations 2012-13 "Race walking is a sequence of steps. The race walker contacts the ground in a way that, no visible (in the human eye) loss occurs.

The forward leg should be stretched (not bent at the knee) from the point of first contact with the ground to the vertical upright position". Judges of race walking watch the athletes during the race and exclude them, if their foot is not stretched on the ground or, if they both lose contact with it. When the judge finds an infringement, he makes his first remark. If the offense is repeated, then the athlete's warning exclusion is placed on a sign visible to all participants in the race. If three different judges charge the athlete in violation, then exclusion follows.

Pace strategy in race walking

The observation that athletes' speed during a race varies caused interest as far as the pace strategy they should follow is concerning. This strategy is a key factor in the success of athletes in sports events [7]. Pace strategy is the ability to regulate the speed of an athlete's movement in order to reach the end of the race in a shorter

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time [8, 9]. The tempo or pace strategy relates to racing: (a) up to 40 sec (sprint), (b)from 40 sec up to a few minutes (short distance), (c) medium and long distance and overtime, which last for hours [10]. Aschenbrenner, Erdmann, Giovanis, & Lipinska, [11] had investigated the tactics and technique of race walking at the 2004 Athens Olympics. Ruchlewicz et al., [12] studied the tactic of race walking, based on measurements made in athletes on a floor meter. It is well known that athletes should not run at high speed early in their race. Often the elite athletes run the second part of a distance faster than the first part [13, 14].

Hypothesis

The following research questions will be investigated in the present study:

a. Will analysing the strategy of the race help coaches and athletes?

b. Do athletes or groups of athletes differ in terms of pace strategy?

Purpose

The purpose of this research was to study the timeless evolution of walking, as well as the Pacing Strategy Profiles of high-level women in the 20 km of race walking. The importance of the research was significant as follows: the above information would be able to extend theoretical knowledge, so that the methodology of analysing the data of races, that have been or will be conducted in the future, is applied in practice.

Material and Methods

Participants

The practical example of applying the theoretical basis was made during the Women's Greek Championship (Megara 2016), in which 12 athletes of race walking aged 19 to 40 participated (28.50 ± 7.20). Athletes had experience in endurance training in race walking for at least 5 years [15, 16]. A prerequisite for their participation in the study was their ability to have reached the qualifying thresholds for the Race Walking National Championships. Which means that these athletes had a high level of training experience and endurance [17]. The race course was certified and measured by SEGAS at 20km. Took place on the Megara beach on a public road, and consisted of a 2km circular route, which athletes were required to walk 10 times.

The present study was a targeted review work with a practical example of applying the theoretical basis.

Independent variables: High-level women athletes in the 20 km race track, initially divided into 4 groups. The first 3, those who finished 15% slower than the first, those who finished 15% - 30% slower and, finally, those who finished more than 30% slower than the winner. Then, they are splitted into two groups: those finishing in the top 6 and bottom 6. Also, the predefined distances of the sections of the route.

Dependent variables: The performance of top-level women athletes in the race of 20 km. The individual times of the athletes in the predetermined sections of the track, as well as their pace strategy.

Research Design

Initially, the certified distance of the race track (St-20km) divided into 10 sections of 2km each was recorded. The same happened with the times (intermediate, final) corresponding to the individual sections (2 km) of the route. Based on the data of the individual track distances and the respective times of the athletes, the individual pace strategies were found that describe the athletes' tactics in this race.

The appliances that were used to perform the measurements and to evaluate the data were:

a) One video camera (Sony, Full HD 1080, 50 Hz). The camera's resolution was 0.02s and it was firmly positioned at the start-stop (where the athletes completed the 2km cycle). The video recording of the athletes' passes at 2km and recording the electronic timer,

(b) The protocols in which the distances of the race and the kinematic parameters were written.

Statistical Analysis

The analysis included:

1. Descriptive statistics: mean (M), standard deviation (SD) and coefficient of variation (V).

2. Pace strategy analysis for the top 3 athletes, those who finished 15% slower than the first, those who finished 15% to 30% slower than that and, finally, those who finished more than 30% slower than the winner [18].

3. Relation of the times (intermediate and final) of the 12 athletes, as well as the first 6 and last 6 athletes, in relation to the distances of the sections of the track.

4. After a detailed explanation of all the terms used for the statistical processing of the work, follows a reference to the t-test. The t - test method investigates the difference between the mean values of a variable at two time points. In other words, it examines whether the difference of two averages is due to random factors. A prerequisite for the above hypothesis to be valid is that the index t to be greater than or equal to the criterion (tc) value of the t-test. The criterion value is derived from the special t-student price table by selecting any level of significance and any degrees of freedom. In this work the t - test calculations were performed with 5% statistical significance and two -sided control, with degrees of freedom N - 1, where N is the sample population.

Results

The following results expand the theoretical knowledge of women's pace strategy in 20km of race walking. So that the methodology of analysing the data of races that have been or will be conducted in the future is applied in practice.

Figure 1 shows the time course of the athletes in the predetermined intermediate sections of the 20km route of the race, in relation to their ranking. The Table 1 shows the finish times (t) of the leader in each group of athletes of 20 km of race walking, and their relationship (r) with the distance travelled (s) in individual sections of the route.

For the first athlete (Figure 2) we can see that, there are no significant fluctuations in the intermediate times between her passes. In other words, it is observed that she follows ***Even Pacing Strategy***, which concerns the uniform distribution of the expenditure of her forces during the struggle [19].

Table 1. Finish times (t) of the leader in each group of athletes of 20 km of the race walking and their relation (r) with the distance travelled (s) in individual sections of the route.

Athletes	Time(M)	r = distance (s) - time (t)
Winner	1.29.35	**0,44**
Group< 15%	1.37.14	**0,50**
Group 15 - 30%	1.43.36	**0,49**
Group 30%	1.59.54	**0,47**
Group 100% (12)	1.47.83	0,55

In other words, the first winner tried to keep constant the time in the individual passes, throughout the race, in order to run at the same pace.

The athletes, who finished in times up to 15% slower than the 1st winner (Figure 3), had fluctuations in the intensity of their effort or rhythm during the race. In the team that finished in times up to 15-30% slower than the 1st winner (Figure 4) you can see that the fatigue comes much faster than in the previous group. In other words, their intermediate times, along the route, vary from passage to passage, either increasing or decreasing significantly. These athletes display ***Variable Pacing Strategy*** [19, 7].

As for the athletes who finished in times over 30% slower than the first winner (Figure 5), their common tactics are obvious up to the 14th kilometre. But from then on, with the effect of fatigue, we notice a big difference in times of this group in the last kilometres. The athletes don't seem to have used a specific pace strategy; they just tried to keep a steady pace all the way, which they didn't manage. The difference in capacity between this group and the previous ones is obvious. Since we are talking about athletes who finished in the last positions of the race

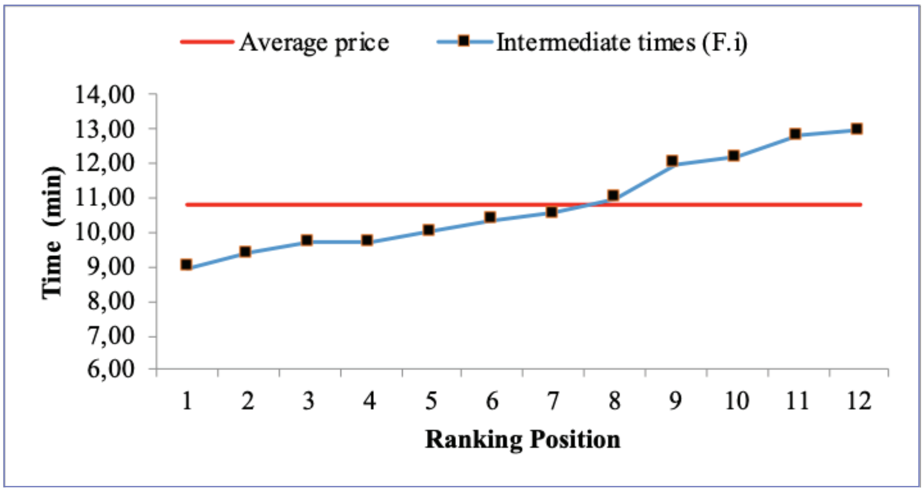

Figure 1. An intermediate time in the respective sections (F.i) of women's 20km of race walking in relation to their classification position.

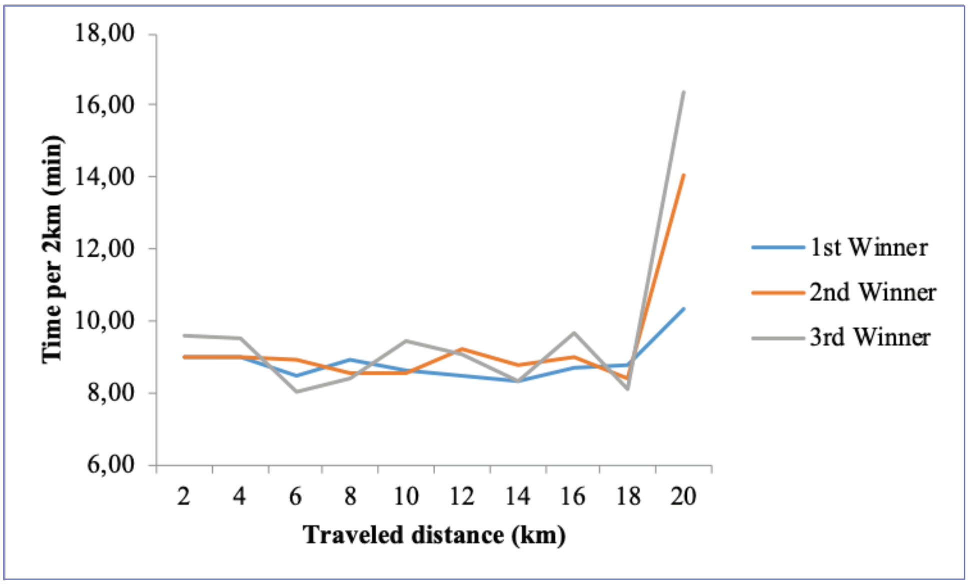

Figure 2. The individual times per 2km of the winners in the 20km women's race walking.

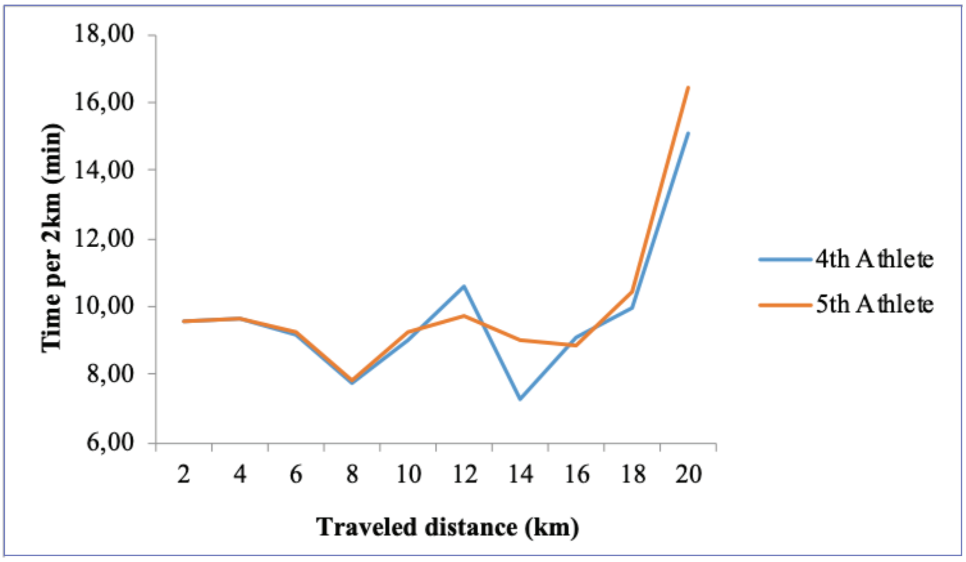

Figure 3. The individual times per 2km of the group<15% of the athletes in the 20km of race walking

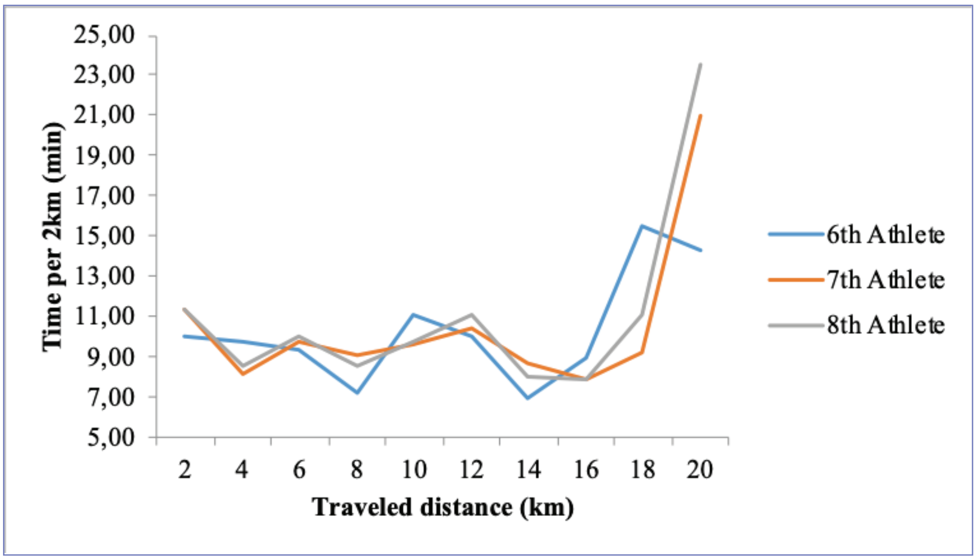

Figure 4. The individual times per 2km of the group 15-30%, of the athletes in the 20km of race walking.

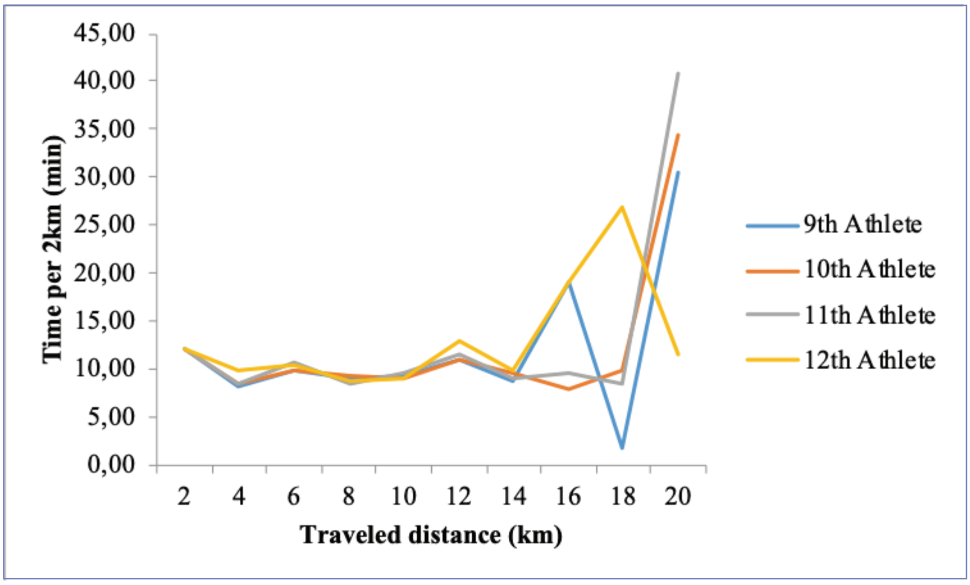

Figure 5. The individual times per 2km of the group> 30% of the athletes in the 20km of race walking.

(Figure 6), and that was the reason that the fatigue came earlier than the previous groups [19].

Correlation coefficients (r) in relation to the performance of the women's teams were significant (Table 2). The t-test between the team of the first 6 athletes M1-6 (9.69 ± 0.48 min) and that of 6 last athletes M7-12 (11.92 ± 0.97 min), with a correlation r = 0.97. Showed the difference in performance between the two groups of athletes (Figure 7) t = 6,255> tc = 2,179 with bilateral control (p <0.05). It was found that none of the

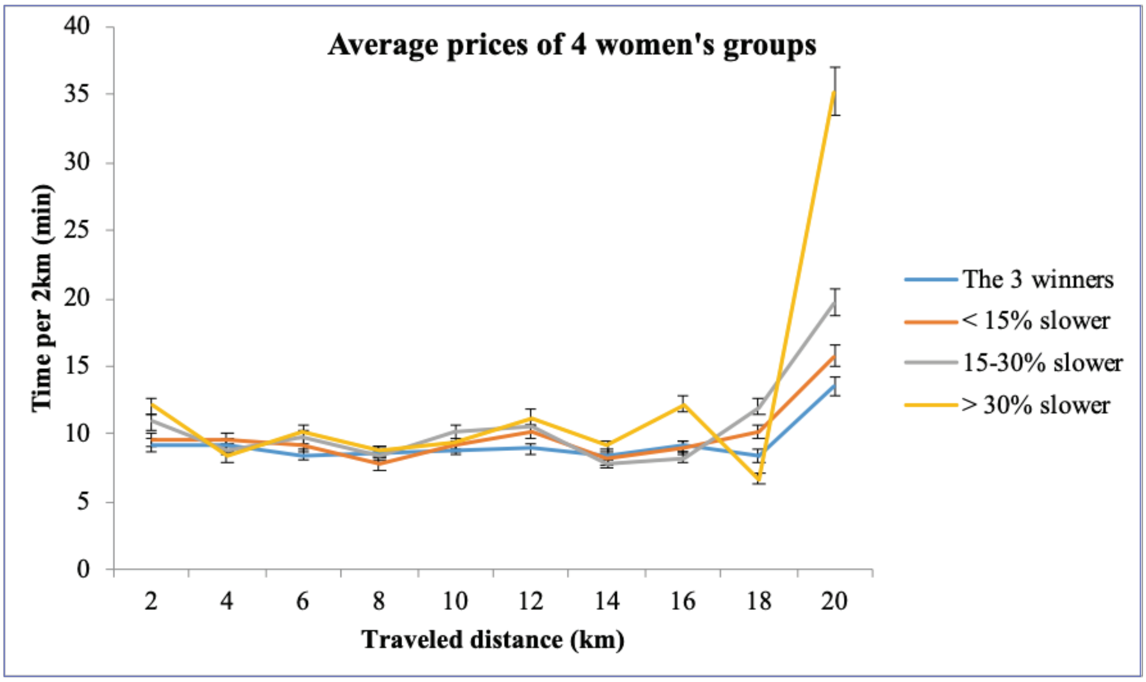

Figure 6. The individual times per 2km of the four groups in the 20km women's race walking.

Table 2. The correlation coefficients (r) in relation to the performance of the groups of walkers.

r	The 3 winners	<15% slower	15-30% slower	>30% slower	12 athletes
The 3 winners	X	0,94	0,90	0,98	0,95
< 15% slower		X	0,97	0,92	0,98
15-30% slower			X	0,89	0,98
> 30% slower				X	0,95
12 athletes					X

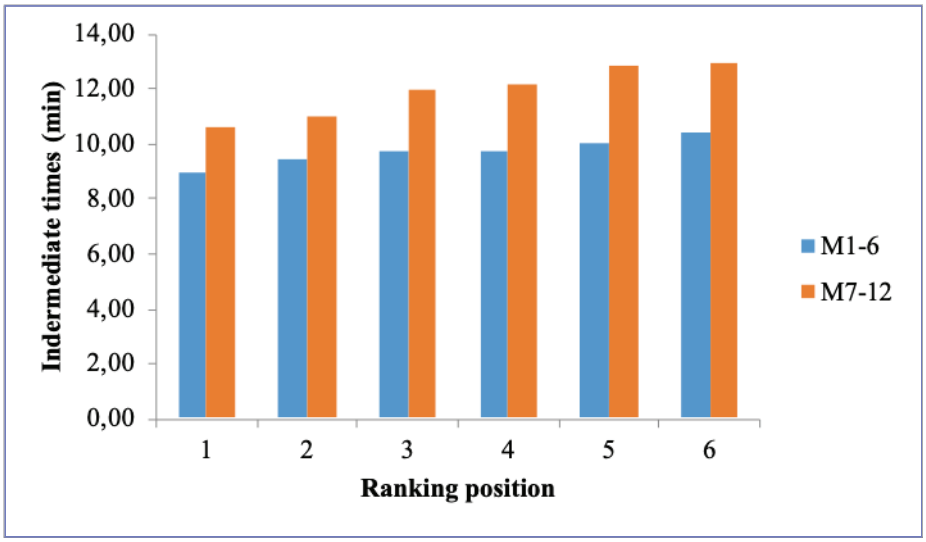

Figure 7. Comparison of the mean values (M) of the performance between the group of the first 6 athletes M1-6 (9.69 ± 0.48) and the last 6 athletes M7-12 (11.92 ± 0.97), with correlation r = 0.97 where the t-test showed the difference in performance between the two groups of athletes t = 6.25>tc = 2,179 with bilateral control (p <0.05).

athletes who belonged to the first group, who were the winners, started the race faster than their personal record. The athletes of the last group started the race faster than their own performance [19].

The fact that a large percentage of athletes that did not finish in the first places, start faster than the ones that followed. Leads us to the conclusion that, these athletes started the race seduced by how relaxed they felt at that moment, not having the perception of impending fatigue.

Discussion

As we can observe by studying the profiles of the pace strategy at 20km of race walking in the practical example of application of the theoretical basis, there are differences from athlete to athlete. The winners (the first three athletes) seem to follow the ***Even Pacing Strategy***, which deals with the uniform distribution of the cost expenditure of their forces during the race. In other words, these athletes tried to maintain a constant passage time, in each circular route of 2km and a small difference of their individual speeds between their passes [19]. The lower this deviation, the better the performance of the athletes. Leads us to the conclusion that, the optimal tactic at this distance is the constant passes of the athletes at a speed equal to the average speed.

After all, the tactics of walking, like all long-distance roads, must be accompanied by specialized technique and speed distribution [19]. These findings are in line with previous studies that have analysed the path of athletes in the marathon. They found that the change in speed was less for the best runners compared to the slower athletes [20, 19]. Athletes, who finished up to 30% slower than the winner, show ***Variable Pacing Strategy***. These athletes had greater fluctuations in the intensity of their effort, or rhythm, during the race. The pace strategy in race walking, as in all long-distance roads, must be accompanied by the specialized technique [19]. It was found that, the optimal deviation of the speed from the average speed improves the final performance of the athletes, which was expected according to previous studies conducted in this subject [8, 9].

Conclusions

With the help of this study, we obtained the following important information: that the winners of the race used ***Even Pace Strategy,*** maintaining a constant speed for most of the route at the 20 km of race walking. We also concluded that, the groups of athletes tested differ from each other in terms of pace strategy. As the level of the athletes decreases, the ***Variable Pace Strategy*** was used, while the athletes, who finished in the last positions, do not seem to have managed to maintain any particular pace strategy.

It is therefore recommended that athletes should design with their coaches the model of the pace strategy they wish to follow. Not be carried away by the momentary latent sense of relaxation, they have at the beginning of the race. The application by the coaches of the relevant training protocols to their athletes, will significantly contribute to the improvement of their final performance.

Conflict of interest

Authors declare no conflict of interest.

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ORIGINAL ARTICLE

The relationships between dynamic balance and sprint, flexibility, strength, jump in junior soccer players

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection.

Abstract

Purpose: The present study aimed to investigate the relationships between sprint, flexibility, upper extremity strength and Star Excursion Balance Test performances in soccer players aged 12–14 years.

Material: Eighteen junior soccer players (mean age, 9.78 ± 1.6 years; height, 139.5 ± 11.0 cm; weight, 34.3 ± 9.9 kg; BMI, 17.3±2.9; leg length; 63.7±5.9 cm) participated in this study voluntarily. They were training 2 or 3 times a week with the addition of one match per month and none of them had reported injuries or diseases related to sports. After measuring the anthropometrics of the subjects, they were familiarized with the test procedures. Measurements included handgrip strength (HD), 30 sc. sit-ups (SU), standing long jump (SLJ), Countermovement jump (CMJ) and 20m-Sprint tests as independent variables, and Star Excursion Balance Test (SEBT) as dependent variables. Then, statistical analysis was applied to the data transferred to SPSS 24.0 Packet program.

Results: The inconsistent correlations between variables of SEBT and selected parameters were found. The strongest significant relationships of the variables of SEBT with selected variables were observed between anterolateral (AL) and SU (r=646, p<0.05), and between posteromedial (PM) and Sprint (r=-650). No significant correlations were observed between variables of dynamic balance and CMJ, SLJ, Relative Handgrip Strength (RHS).

Conclusions: As a result, strength and power performances may not necessarily be related to impaired balance directly in young soccer men. Moreover, low back flexibility may have negative or positive influences on dynamic balance.

Keywords: strength, flexibility, soccer, sprint, anthropometry, balance.

Introduction

It has been well documented that physical fitness components that may affect overall athletic performance have relationships with each other. Particularly, muscular strength as a major fitness component is related to other components such as speed, power, endurance and balance. Previous studies on this topic have revealed that the more an athlete can increase their strength or power, the greater their endurance performance, balance and sprint ability will occur. Likewise, dynamic balance ability, which is an important component for overall athletic performance for many sports, may be affected by several performances such as strength and flexibility [2]. On the other hand, the effect size of these relationships varies according to such as age, gender, sports, specific training and performances [3, 4].

It is clear that relationships between physical fitness components can be critical for athletes and coaches in terms of strength/conditioning and sports medicine. With respect to sports medicine, Caspersen, Powell, & Christenson, which is one of the first studies investigating the relationship between balance and muscle strength/power, revealed that skill-related components of physical fitness are not independent with each other [5]. Furthermore, this association is important for the identification of at-risk individuals because deficits in these neuromuscular components are associated with an increased risk of sustaining injuries and falls [6]. When considered the fact that dynamic balance is also linked to cognitive functions [7] as muscular strength may [8], the studies investigating the relationship between strength and balance should be interpreted comprehensively. Muehlbauer et al. have also deduced that "these relationships are important from two perspectives: (a) testing and identifying at-risk individuals, and (b) developing and implementing individually tailored injury and fall-prevention programs" [9]. Although the importance of this issue is clear in terms of medicine (general health and sports) and athletic performance, there are limited studies that have been reported until today. Moreover, it is hard to compare the findings of previous studies due to they have methodological differences in terms of testing models and populations. With respect to measurements, while some studies have used isokinetic tests for strength measurements, some with performing functional strength tests. Furthermore, their dynamic balance testing models were different. For instance, Star Excursion Balance Test (SEBT) which is most commonly utilized as a postural control testing is a dynamic test that requires strength, flexibility, and proprioception [6]. On the contrary flexibility and strength are not necessary for other balance tests (static balance tests, postural sway or other reactive balance tests). In addition to measurement differences, population differences have an impact on the interrelationships between athletic performances. It is

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previously reported that the factors of age and maturation affect athletic performances and injuries [10].

In addition, sports have different physical and physiological demands, so players' athletic performances (strength, endurance, power, speed, agility, balance, etc.) vary by sports type. Since several team sports like soccer demands both aerobic and anaerobic conditioning variables such as pace, agility, balance, muscular strength and endurance [6] and interpreting the relationships between fitness components in those sports should also be elaborated. Previous studies have shown that small-to-medium correlations (r <.40) between strength, flexibility and balance [6, 9]. A recently conducted systematic review on the relationship between dynamic balance, strength and power detected that there are small-sized correlation coefficients between these parameters in children, adolescents, and young, middle-aged, and old adults across the lifespan but age/maturation may have an impact [9]. Hammami, Chaouachi, Makhlouf, Granacher, & Behm have also stated that knowledge about the relationship between balance and strength, power might provide greater insight into the way maturity modifies the effectiveness of different training regimes (e.g., balance and strength training). Considering the literature, the present study aimed to investigate the relationships between sprint, flexibility, upper extremity strength and Star Excursion Balance Test performances in soccer players aged 12–14 years.

Materials and Methods

Participants

Eighteen junior soccer players who had been playing for a farm team of a first division team in Turkey (mean age, 9.78 ± 1.6 years; height, 139.5 ± 11.0 cm; weight, 34.3 ± 9.9 kg; BMI, 17.3±2.9; leg length; 63.7±5.9 cm) participated in this study voluntarily. They were training 2 or 3 times a week with the addition of one match per month (there were no official tournaments for adolescent players) and none of them had reported injuries or diseases related to sports. The inclusion criteria were (1) have more than a 6-month detraining period (2) at least 1 year of systematic soccer training with a minimum of three training sessions per week (i.e.,90 min per session). (3) have suffered any musculoskeletal, neurological and orthopedic disorder that might have affected their ability to perform strength, power and balance tests.

After measuring the anthropometrics of the subjects, they were familiarized with the test procedures.

Research Design.

Measurements included handgrip strength (HD), 30 sc. sit-ups (SU), standing long jump (SLJ), Countermovement jump (CMJ) and 20m-Sprint tests as independent variables, and Star Excursion Balance Test (SEBT) as dependent variables. As body weight is a determinant factor in strength parameters [12] relative values were computed separately for handgrip strength but not for sit-up test (BW has no or even negative impact on Sit-up performance).

Dynamic Balance.

SEBT was to evaluate the dynamic balance abilities of the subject. The subject performed to reach 8 different directions; anterolateral (AL), anterior (ANT), anteromedial (AM), medial (MD), posteromedial (PM), posterior (PO), posterolateral (PL), and lateral (LAT). It is previously demonstrated that reach distances of SEBT test should be normalized to leg length to obtain more accurate dynamic postural control scores [13]; therefore, normalized values for each subject were computed. All subjects wore athletic shoes during the performance of the test.

Jump

Jump performances were tested using by the Optojump (Optojump, Microgate, Bolzano, Italy) and assessed by vertical countermovement jump (CMJ) with arm swing during the execution of the jump (i.e., hands were free to move) distances. The subject had performed three times, with 45 seconds of passive recovery and the highest scores (in centimetres) were recorded [14]. Standing long jump (SLJ) is an effective and practical test for predictive muscular strength and power [11] and so this test was also measured.

Sprint

This distance was chosen because it is valid and highly reliable in physically active individuals (correlation coefficient of 0.91 between test and retest) [15]. Tests were conducted using photoelectric cells (Witty, Microgate, Bolzano, Italy) and performed on a synthetic grass pitch. Participants were permitted three trials, and the best performance was recorded.

Strength

The muscular strength of the upper extremity was determined by using a handgrip dynamometer (Takei, Tokyo) and applying a 30-sec sit-up test (SU). To obtain SU values, the participants performed as many repetitions as possible within 30 seconds, as previously described [16].

Flexibility

The sit-and-reach test (SAR), which is a common form of low back and hamstring flexibility with an accuracy of 0.5 cm [17], was employed.

Statistical Analysis.

SPSS Version 24.0 was used for statistical analysis. After checking the assumptions (absence of outliers and normality), Pearson analysis was performed to obtain correlation coefficients and the relationships were interpreted by Cohen's standards.

Results

Means and SDs are presented for all the variables in Table 1 and Table 2 respectively.

The highest mean reach distances were obtained in MD, and the lowest mean reach distances were in LAT direction for both raw and normalized values.

The inconsistent correlations between variables of SEBT and selected parameters were found. There were medium positive or negative correlations between SAR and the SEBT variables of ANT, AL, PO and PM, and positive medium correlation dependences with HS and AL

Table 1. Descriptive statistics for dependent variables

Reaching Directions	Raw Scores (cm)	Normalized (% of leg length)
AM	57.3±6.4	90.0±6.1
ANT	57.8±9.6	90.5±11.2
AL	54.2±8.1	84.9±8.1
LAT	53.7±9.3	84.3±12.0
PL	57.4±10.8	90.3±15.8
PO	60.2±11.4	94.1±14.2
PM	61.1±10.2	95.4±10.1
MD	63.7±9.8	99.7±10.9

NOTE: AL= anterolateral, ANT= anterior, AM= anteromedial, MD= medial, PM=posteromedial, PO= posterior, PL=posterolateral and LAT= lateral

Table 2. Descriptive statistics for independent variables

Sprint	Flexibility	Jumps		Strength		
(20m)	SAR (cm)	CMJ (cm)	SLJ (cm)	HS (kg)	RHS(BW/kg)	SU
41.2±3.6	20.2±3.4	23.4±4.7	141.2±22.3	18.1±3.8	0.55±0.10	20.9±3.6

NOTE: SAR=Sit and reach, CMJ= Countermovement jump, SLJ= Standing Long Jump, HS= Handgrip Strength, RHS= Relative Handgrip Strength, SU= Sit-ups

Table 3. The correlations between dynamic balance and selected athletic performances

SEBT Variables	SAR (cm)	CMJ (cm)	SLJ (cm)	HS (kg)	RHS(BW/kg)	SU (30sc)	Sprint(20m)
AM	-168	296	080	025	-371	129	245
ANT	477*	436	372	093	-379	237	-409
AL	482*	373	373	508*	045	646*	-313
LAT	-187	210	019	251	117	290	-266
PL	-181	099	035	132	006	235	-155
PO	-445*	209	102	354	067	334	-254
PM	-539*	252	318	552*	082	368	-650*
MD	319	290	204	438	125	265	318

NOTE: * P<0.05 AL= anterolateral, ANT= anterior, AM= anteromedial, MD= medial, PM=posteromedial, PO= posterior, PL=posterolateral and LAT= lateral, SAR=Sit and reach, CMJ= Countermovement jump, SLJ= Standing Long Jump, HS= Handgrip Strength, RHS= Relative Handgrip Strength, SU= Sit-ups

and PM($P<0.05$). The strongest significant relationships of the variables of SEBT with selected variables were observed between AL and SU (r=646, $p<0.05$), and between PM and Sprint (r=-650). However, no other SEBT variables were correlated with SU or Sprint. No significant correlations were observed between variables of dynamic balance and CMJ, SLJ, RHS.

Discussion

The primary finding of this study is that inconsistent correlations between variables of SEBT and other selected athletic performance variables. The most surprising results were that while some relationships between SEBT variables and SAR were found positively significant, others were found negatively significant. It is difficult to explain these inverse relationships; however, it is likely that while forward reaching skills may have positive, and backward have negative associations with lower extremity flexibility. Athletes with optimum flexibility can be more capable of performing dynamic balance ability, but those with high or low flexibility may be susceptible to perform postural control ability. Since the SEBT requires strength, flexibility, neuromuscular control, core stability, ROM, balance, and proprioception [18], 1 component can cause any disruption in this test. Overmoyer GV and Reiser RF suggested in their study that when used with recreationally active adults, the Y Balance Test may be helpful to establish lower-extremity flexibility deficits and flexibility asymmetries in the ankle and hip regions but may need to be used in conjunction with additional tests to understand a broader picture [2]. Another possible reason for these inverse relationships may be attributed to factors related to soccer-specific. Soccer players are required to perform repetitive and explosive unilateral movements such as sudden acceleration and deceleration tasks, rapid changes of direction, kicking, jumping and landing [19] and these performances may bring about enhancement of anterior reach performances of postural stability, and flexibility.

The present study also reported significant relationships between some variables of strength and dynamic balance. There were positive and medium-sized correlations of AL with SU and HS, and of PM with HS. These findings were consistent with previous studies that found associations between strength and dynamic balance performances; however, is that correlation coefficients were different, with some studies reporting small-sized, some with medium-sized and some with strongly positive correlations [9]. Still, it should also be considered that much of these studies have used lower extremity strength measurements, unlike the current study. Another critical point is that those correlation coefficients are different in previous studies.

Jumping and sprinting are high-intensity performances, and also known as power performances, so it was expected that these variables would show similar correlations with dynamic balance variables. Apart from a significant relationship between 20m sprint and PM, there were no significant relationships between these parameters and any SEBT variables. Izquierdo, Aguado, Gonzalez, Lopez, & Häkkinenstated that dynamic balance is not affected by power or strength components [20]. In that study, similar jump tests (SLJ and CMJ) and different dynamic balance tests were carried out. Our findings indicate that dynamic balance and jump performances are independent of each.

Conclusions

In conclusion, strength and power performances may not necessarily be related to impaired balance directly in young soccer men. And, low back flexibility may have negative or positive influences on dynamic balance.

Conflicts of Interest

The author declare no conflict of interest.

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ORIGINAL ARTICLE

Correlation of maximum oxygen consumption with component composition of the body, body mass of men with different somatotypes aged 25-35

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection.

Abstract

Purpose: The somatotype determines not only physical development, but also the functional capabilities of the organism. Investigation of the correlation relations between the component of body and $VO_{2\ max}$ will reveal the influence of each of the components on the aerobic capacity of men in the first period of mature age. The aim of the work – to detect the peculiarities of manifestation of maximum oxygen consumption of men with different somatotypes and to investigate the relationship with the component composition of the body.

Material: The study involved 150 men aged 25-35 years. The somatotype was determined by the Heath-Carter method. The component composition of the body was determined by the bioelectrical impedance method. The $VO_{2\ max}$ indicator was determined, metered loads were performed on a bicycle ergometer. A correlation analysis of the absolute and relative $VO_{2\ max}$ values with the fat and muscle components of the body was performed.

Results: A high degree of inverse correlation between the relative $VO_{2\ max}$ indicator with body mass in men of mesomorphic somatotype was established and a high degree of inverse correlation between the relative $VO_{2\ max}$ indicator with body mass and BMI in men of endomorphic-mesomorphic somatotype.

Conclusions: For representatives of the mesomorphic and endomorphic-mesomorphic somatotype, a larger body mass and a high degree of correlation between body mass and relative $VO_{2\ max}$ indicator are characteristic. For representatives of the ectomorphic and balanced somatotype, a smaller body mass and a lower degree of correlation between body mass and relative $VO_{2\ max}$ indicator max are characteristic.

Keywords: aerobic capacity, muscular, fat component, men.

Introduction

The somatotype determines not only physical development, but also the functional capabilities of the organism [1]. The level of functional capabilities is due to its energy potential. In the overall energy potential of a man, aerobic energy is largely preponderate anaerobic energy. The power of aerobic processes of energy supply muscular activity reflects the maximum oxygen consumption indicator ($VO_{2\ max}$). Our previous researches have revealed the peculiarities of manifestation of maximum oxygen consumption in students aged 17-19 with different somatotype [2]. We also researched the level of aerobic capabilities of youth 17-19 years old living within the Podillya region [3]. Yoo-Rim Choi & Wan-Suk Choi point to the revealed features of maximum oxygen consumption among students of different somatotypes [4]. Goran Spori et al found significant differences in the $VO_{2\ max}$ values among Personnel of the Croatian Navy of different somatotypes [5]. The negative influence of endomorphy on the aerobic capabilities of men and women from Kuwait was revealed by Alkandari & Barac Nieto [6] and Rupasinghe et al [7]. We did not find scientific publications about the differences in absolute and relative $VO_{2\ max}$ values in men of the first mature age of different somatotypes.

There are publications that prove body components decisive influence on human functional capabilities. Sukanta Saha found that the component composition of the body is well correlated with $VO_{2\ max}$ [8]. Manmohan Sharma et al found the negative effects of the fat component on the aerobic capacity of men 25-35 years old. The authors established a correlation between $VO_{2\ max}$ and body mass index (BMI), the ratio of the circumferential waist size to the thigh and the percentage of fat component [9]. Bresdenyuk found that the students of 17-21 years of age who have “low” and “normal” contents of the fat component have “excellent” level of aerobic capabilities according to the criterion Ya.P. Pyarnat [10]. Neha Parve et al showed the relationship between height, body mass and age with $VO_{2\ max}$ in women of the second mature age group [11]. Kanae Oda et al established negative correlation $VO_{2\ max}$ with body fat percentage in Japanese men and women 30-52 years [12]. Setty et al found negative association of fat component with cardio-respiratory system functionality [13]. About negative effect of the fat

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component on the $VO_{2\,max}$ in obese individuals is indicated in studies M.Pourhassan and co-authors [14]. Payam Heydari et al found that demographic variables and BMI are factors that influence the determination of maximum oxygen consumption [15]. Daniel Bunout et al found that body mass without fat in men is an important predictor of maximum oxygen consumption [16].

Kaur et al point out that with the age in urban women of Punjab of age 50-80 years, the endomorphic and mesomorphic components decreases [17]. The variability of the component body composition in the process of human ontogenesis is shown by Sallnikova's study. The author argues that in the period of ontogenesis from 30 to 40 years in women, the fat component increases, and the muscle component decreases [18]. In view of the variability of the body components in the process of human ontogenesis, it is important to obtain data on all age groups.

Hypothesis: The study of maximum oxygen consumption and the body components of men in the first period of mature age will allow to determine the peculiarities of their manifestation, depending on the somatotype. Investigation of the correlation relations between the components of the body and $VO_{2\,max}$ will reveal the influence of each of the components on the aerobic capacity of men aged 25-35 years.

Purpose: to detect the peculiarities of manifestation of maximum oxygen consumption of men with different somatotypes and to investigate the relationship with the component composition of the body.

Material and Methods

Participants.

The study involved 150 men aged 25-35 years. In all subjects identified somatotype, VO2 max, component body composition. All subjects gave written consent to participate in the experiment.

Procedure.

The somatotype was determined by the Heath-Carter method [19]. For this purpose, the following anthropometric studies were performed: they determined height, body mass, girth dimensions, transverse diameters and thickness of skin-fat foods. Each component was expressed in numerical value. The membership of the somatotype was determined by the advantage of the component at 2,5 points. In the absence of such an advantage, the somatotype of the person was defined as balanced. Participants were conventionally divided into groups by belonging to the somatotype.

Component composition of the body was determined by the method of bioelectric impedance using the OMRON BF-511. The device determined the percentage of fatty tissue in the body (subcutaneous fat), the percentage of skeletal muscle in the body, the percentage of visceral fat, body mass index (BMI), and body mass.

The indicator of maximum oxygen consumption ($VO_{2\,max}$) was determined by the method of Carpman et al [20]. The men performed two loads on an ergometer for 5 minutes each (interval of rest – 3 minutes). The pedaling speed was 60 turnovers per min^{-1}. The power of the first load was 1 W per 1 kg of body mass. The power of the second load was 2 W per 1 kg of body mass. At the end of each load, the heart rate was recorded. The mathematical calculations were used to determine the value of the indicator $VO_{2\,max}$. $VO_{2\,max}$ was displayed in ml min^{-1}.

Compared the average group values of the indicators among representatives of different somatotype groups and group of men, which included all participants.

A correlation analysis of the absolute and relative $VO_{2\,max}$ values with the fat and muscle components of the body was performed.

Statistical analysis.

The statistical analysis of the data was using the Excel 2010 program. The independent samples were compared for the analysis of the studied measures. Ranks of distribution displayed indicators features according to men's somatotypes. Statistical processing was performed applying Student's t-criterion. It was defined as an average mean (X), Student's t-criterion (t), standard error of the mean (±m), number of degrees of freedom (f), significance value (p). The difference was considered significant at $p < 0,05$.

The correlation analysis was performed to determine the interrelation between the studied measures. The correlation coefficient (r) was defined. The number of degrees of freedom (k) was calculated. The *a* – is the tabular coefficient of correlation which corresponds to the certain level of significance and calculated by means of tabular data. The significance of correlation coefficient was checked in comparison the obtained data with tabular. The connection considered significant at $p < 0,05$. The gradation proposed by Cheddok was applied for the determination of constraint force. According to this technique the constraint force was estimated as follows: $0,1 \le r < 0,3$ –weak; $00,3 \le r < 0,5$ – moderate; $0,5 \le r < 0,7$ – average; $0,7 \le r < 0,9$ – high; $0,9 \le r \le 0,99$ – very high.

Experimental studies are in accordance with the directive of the Helsinki Declaration of the World Medical Association on ethical principles of medical research with human participation as the object of study (Protocol of the Commission on Bioethics at Vinnytsia State Pedagogical University No. 10 of 21.11.2018)

Results

The absolute indicator of $VO_{2\,max}$ in men of the mesomorphic somatotype is higher value relative to the representatives of the ectomorphic somatotype. According to the relative indicator of VO2 max, the representatives of ectomorphic and balanced somatotypes have higher values, while the lowest ones are representatives of the endomorphic-mesomorphic somatotype (Table 1).

In men with endomorphic-mesomorphic somatotype revealed significantly bigger of the body mass, a significantly highest percentage of fat component and visceral fat, among men of different somatotypes. Representatives of mesomorphic somatotype have the highest percentage of muscle component (Table 2).

Table 1. Maximum oxygen consumption of men with different somatotypes aged 25-35

Indicators	Representatives of the mesomorphic somatotype n = 39		Representatives of the ectomorphic somatotype n = 32		Representatives of the endomorphic-mesomorphic somatotype n = 37		Representatives of balanced somatotype n = 42	
	$\overline{X}$	m	$\overline{X}$	m	$\overline{X}$	m	$\overline{X}$	m
$VO_{2\ max}$ (ml·min^{-1})	2809.7 *	26.02	2680.7	44.19	2776.8	22.04	2792.1	47.06
$VO_{2\ max}$ (ml·min·kg^{-1})	40.2 ●●	0.46	43.5 ●●● ○○○ □□	0.52	37.3	0.77	42.8 ○○ ●●● □	0.80

Notes: The statistically significant difference: * – in relation to the ectomorphic somatotype; ○ – in relation to the mesomorphic somatotype; ● – in relation to the endomorphic- mesomorphic somatotype; □ – in relation to the all participants. The number of marks (○,*,●,□) corresponds: 1 mark – (p < 0,05), 2 marks - (p < 0,01), 3 marks - (p < 0,001).

Generalize the data in Table 1 and Table 2, we notice the following trends. The lowest value of the relative VO2 max indicator was found in men with endomorphic-mesomorphic somatotype, who have the highest percentage of subcutaneous fat in the body, the highest percentage of visceral fat and the largest body mass.

Men who belong to the ectomorphic somatotype have higher values of relative $VO_{2\ max}$ indicator, lower percentage of subcutaneous fat in the body, lower percentage of visceral fat, less body mass and body mass index.

The revealed trends have led us to put forward the hypothesis that for men of certain somatotypes, the lower values of the relative $VO_{2\ max}$ indicator are due to high values of the percentage of fat component, visceral fat, body mass, and body mass index. To test the hypothesis, we conducted a correlation analysis between $VO_{2\ max}$ and body mass, body mass index, components of body composition in men with different somatotypes (Table 3).

The correlation analysis revealed a high degree of inverse relationship of the relative $VO_{2\ max}$ indicator with body mass in men with a mesomorphic somatotype; a high degree of inverse relationship of relative $VO_{2\ max}$ indicator with a body mass and BMI in men with endomorphic-mesomorphic somatotype; a high degree of inverse correlation of the relative $VO_{2\ max}$ indicator with a body mass in the male group, which brings together representatives of all somatotypes.

Discussion

Thus, it can be argued that in men with mesomorphic and endomorphic-mesomorphic somatotype a greater body mass causes lower relative $VO_{2\ max}$ indicator. In addition, in men with endomorphic-mesomorphic somatotype, the low values of the relative $VO_{2\ max}$ indicator are associated with high BMI values. Representatives of somatotypes that are characterized by a smaller body mass (ectomorphic and balanced) have a lower degree of inverse relationship of body mass with a relative $VO_{2\ max}$ indicator. The influence of muscle and fat components, BMI on the level of $VO_{2\ max}$ in representatives of balanced and ectomorphic somatotypes smaller, because the strength of the correlation between these indicators is characterized as noticeable, moderate, or correlation is absent.

The data we received about lower relative $VO_{2\ max}$ indicator men 25-35 years of mesomorphic and endomorphic-mesomorphic somatotype is new. In the scientific literature, there is evidence of the significant role of somatotype components in influencing to exhibit aerobic productivity. Rupasinghe et al found that endomorphism-dominated medical students were found to have low $VO_{2\ max}$ levels [7]. Marangoz İrfan et al established a high degree of negative correlation between $VO_{2\ max}$ and endomorphism in handball players of 18-30 years; a marked degree of positive correlation between $VO_{2\ max}$ and ectomorphism [21]. Himel Mondal & Snigdha Prava Mishra showed of negative influence of Increasing waist size and Waist-to-height index on $VO_{2\ max}$ of men 17-25 years [22].

Studies performed by Manmohan Sharma et al found in men of 25-35 years old a very high degree of inverse relationship between the percentage of subcutaneous fat and the relative $VO_{2\ max}$ indicator. These authors also found a high degree of inverse relationship between BMI and relative $VO_{2\ max}$ indicator [9]. The data obtained by us indicate a noticeable degree of the inverse relationship of the relative $VO_{2\ max}$ indicator with a percentage of subcutaneous fat and a moderate inverse correlation with BMI. According to the established trends, the results of our research coincide with the data of the above-mentioned authors. The only difference is the degree of

Table 2. Component body composition and body mass in men aged 25-35 with different somatotype

Indicators	All participant (representatives of all somatotypes) n = 150		Representatives of the mesomorphic somatotype n = 39		Representatives of the ectomorphic somatotype n = 32		Representatives of the endomorphic-mesomorphic somatotype n = 37		Representatives of balanced somatotype n = 42	
	$\overline{X}$	m	$\overline{X}$	m	$\overline{X}$	m	$\overline{X}$	m	$\overline{X}$	m
Fat component, %	16.6 *** ○○○	0.35	14.7 ***	0.32	11.0	0.28	23.9 □□□ ○○○ ■■■ ***	0.31	16.2 *** ○	0.56
Muscle component, %	41.0 ●●● ■	0.25	44.6 ●●● ■■■ □□□ ***	0.42	40.7	0.38	38.7	0.33	39.7	0.52
Visceral fat, %	3.5 *** ■	0.23	3.2 ***	0.34	1.6	0.04	6.2 ○○○ ■■■ □□□ ***	0.46	2.9 ***	0.14
Body mass, kg	68.3 *** ■	0.96	70.1 *** ■■■	0.87	61.7	0.88	75.2 *** ■■■ □□ ○	1.91	65.5 **	0.91
BMI, kg/m^2	22.4 ***	0.72	23.2 ***	0.26	18.9	0.11	24.5 *** ○ □	0.51	22.4 *	1.54

Notes: The statistically significant difference: * – in relation to the ectomorphic somatotype; ○ – in relation to the mesomorphic somatotype; ■ – in relation to the balanced somatotype; ● – in relation to the endomorphic-mesomorphic somatotype; □ – in relation to the all participants. The number of marks (○,*,●,□) corresponds: 1 mark – ($p < 0,05$), 2 marks - ($p < 0,01$), 3 marks - ($p < 0,001$).

correlation. This difference may be due to the fact that the authors used the step-method to determine $VO_{2\ max}$, and in our research the method of bicycle ergometry was used. Also, the difference in results may be due to the region's characteristics of the residence of the participants. Consideration should also data obtained by Christina Grüne et al who found that obesity affects the growth of error in determining $VO_{2\ max}$ by not a direct method [23].

Studies performed by Mondal & Mishra found in men of 18-25 years moderate degree of negative correlation BMI with relative $VO_{2\ max}$ indicator and a high degree of negative correlation between the percentage of subcutaneous fat and the relative value of $VO_{2\ max}$ indicator [24]. Marcin Maciejczyk et al found a moderate degree of negative correlation in men of 18-30 years between the relative $VO_{2\ max}$ indicator and body mass, BMI, fat component, and the lack of correlation with the muscle component. In addition, they found a moderate degree of positive correlation between the absolute value of $VO_{2\ max}$ and the muscular component. The authors argue that

Table 3. Correlation ratio of maximum oxygen consumption indicators with component composition of the body, body mass of men aged 25-35

Indicators	Fat component		Muscle component		Visceral fat		Body mass		Body mass index	
	r	p	r	p	r	p	r	p	r	p
mesomorphic somatotype, n = 39										
$VO_{2\ max,\ abs.}$	-0.035	p > 0.05	-0.033	p > 0.05	0.346	p < 0.05	0.565	p < 0.05	0.394	p < 0.05
$VO_{2\ max,\ rel.}$	-0.241	p > 0.05	0.241	p > 0.05	-0.132	p > 0.05	-0.717	p < 0.05	-0.341	p < 0.05
ectomorphic somatotype, n = 32										
$VO_{2\ max,\ abs.}$	-0.149	p > 0.05	0.326	p > 0.05	-0.123	p > 0.05	0.677	p < 0.05	0.391	p < 0.05
$VO_{2\ max,\ rel.}$	-0.109	p > 0.05	0.338	p > 0.05	-0.431	p < 0.05	-0.372	p < 0.05	-0.220	p > 0.05
endomorphic- mesomorphic somatotype, n = 37										
$VO_{2\ max,\ abs.}$	0.086	p > 0.05	-0.125	p > 0.05	0.161	p > 0.05	0.398	p < 0.05	0.228	p > 0.05
$VO_{2\ max,\ rel.}$	-0.430	p < 0.05	0.222	p > 0.05	-0.520	p < 0.05	-0.878	p < 0.05	-0.783	p < 0.05
balanced somatotype, n = 42										
$VO_{2\ max,\ abs.}$	-0.080	p > 0.05	0.168	p > 0.05	0.035	p > 0.05	0.309	p < 0.05	0.030	p > 0.05
$VO_{2\ max,\ rel.}$	-0.521	p < 0.05	0.292	p > 0.05	-0.580	p < 0.05	-0.601	p < 0.05	-0.024	p > 0.05
all participants (representatives of all somatotypes), n = 150										
$VO_{2\ max,\ abs.}$	0.061	p > 0.05	0.125	p > 0.05	0.151	p > 0.05	0.412	p < 0.05	0.174	p > 0.05
$VO_{2\ max,\ rel.}$	-0.596	p < 0.05	0.183	p < 0.05	-0.621	p < 0.05	-0.786	p < 0.05	-0.364	p < 0.05

Notes: $VO_{2\ max,\ abs.}$ – absolute indicator of maximum oxygen consumption; $VO_{2\ max,\ rel.}$ – relative indicator of maximum oxygen consumption; r – coefficient of correlation; p – statistical significance for correlation.

low values of relative $VO_{2\ max}$ indicator are due to high body mass values, regardless of whether the fat or muscle component has an advantage [25]. The results of our research agree with this statement. Thus, it can be argued that there is a negative correlation between body mass, BMI, percentage of subcutaneous fat with relative $VO_{2\ max}$ indicator in men without somatotype consideration. However, according to various data, the degree of these correlation ranges from moderate to very high.

Conclusions

We have established the features of the manifestation of maximum oxygen consumption in men 25-35 years with different somatotypes. For representatives of the mesomorphic and endomorphic-mesomorphic somatotype, a larger body mass and a high degree of correlation between body mass and relative $VO_{2\ max}$ indicator are characteristic. For representatives of the ectomorphic and balanced somatotype, a smaller body mass and a lower degree of correlation between body mass and relative $VO_{2\ max}$ indicator max are characteristic.

Conflict of interest

The authors state that there is no conflict of interest.

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ORIGINAL ARTICLE

Moderate movement variability is optimal in massive practiced dart throws

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Abstract

Purpose: Movement variability is one of the fundamental topics concerning the control of human movement. In recent years, researches have focused on various aspects of variability, which has changed the noise to useful variable on human movement. Present study investigated movement variability level in high skilled dart players that repeated throws over many years.

Material: Seven experienced dart players (three women and four men) were threw 36 darts in three sets (each set 12 throws) from a standard distance (2.37 meters), while the kinematic features of the shoulder, elbow, and wrist were recorded during the throws. Qualisys motion capture system with six cameras was used to record the kinematics of the elbow.

Results: Entropy analysis revealed that greater variability in movement angle, velocity and acceleration resulted in better dart throwing performance but after reach to this level, throw variability was decreased. The remarkable point in these findings was that variability was constant across all samples despite the varied range of experience in throwing darts from 2.37 meters distance. Entropy analysis showed that in the throws of highly experienced individuals, variation led to greater throwing efficiency.

Conclusions: These findings suggest that variability in a throwing activity, which revealed that moderate movement variability results in optimal throwing performance when dart throw has massive amount of practice during many years.

Keywords: motor variability, dart throw, optimal performance, moderate variability, kinematics.

Glossary

Movement variability: Movement variability normal variations that occur in motor performance across multiple repetitions of a task.

Kinematic: Kinematics is a subfield of classical mechanics that describes the motion of points, bodies (objects), and systems of bodies (groups of objects) without considering the forces that cause them to move.

Generalized motor program: A generalized motor program is thought to develop over practice and provides the basis for generating movement sequences within a class of movements that share the same invariant features, such as sequence order, relative timing, and relative force.

Dynamical system theory: The basic premise is that movement behavior is the result of complex interactions between many different subsystems in the body, the task at hand, and the environment.

Kinematic variability: Kinematic variability was computed as the average SD (Mean SD) of acceleration patterns among some movement repetitions.

Uncontrolled manifold: A hypothesis proposes that the central nervous system does not eliminate the redundant degrees of freedom, but instead it uses all of them to ensure flexible and stable performance of motor tasks.

Degrees of freedom: Degree of freedom of a system is the number of parameters of the system that may vary independently.

Throwing accuracy: It refers to that throwing score that more near to triple 20.

Joint kinematic: Joint kinematics is the relative motion between two consecutive segments of the human that here is elbow joint.

Entropy: Entropy analysis is applicable to a larger class of problems than is usually studied through the use of mean square error analysis and yields the classical results when applied to Gaussian-linear systems.

Sagittal plane: The sagittal plane is an anatomical boundary that exists between the left and right sides of the body.

Trajectory: Trajectory refers to the marker elbow path during dart throw.

Round: Every three dart throws means one round in dart rules.

Triangle 20: There is one triangle of 20 score in which one dart has multiply in 3.

Introduction

Movement variability is considered as a regular change in human movement and can be defined as normal changes during repetitions of a motion [1]. If a darts player completes five dart throws from the same distance, none of the throws would be identical to one another as changes occur at different levels of the nervous system. In this regard, movement variability has been investigated and reviewed based on three general perspectives. Firstly, from the perspective of the generalized motor program (GMP), more changes in new movements, the

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greater the movement learning, and movement schemata learning will be [2]. In other words, increased movement variability is considered advantageous, and the stability of repetitions is a relatively negative factor in learning. The uncontrolled manifold (UCM) hypothesis comprises the second major viewpoint regarding movement variability. The basis of this hypothesis is the unlimited degrees of freedom and movement solutions in the nervous system, stating that the movement system always has excessive components and solutions that can easily solve any momentary problem in movement [3]. The third view on movement variability is the dynamic systems theory, which holds that the movement system is in a steady state prior to learning a new movement. When a new variable is added to the system, the system enters chaos, before arriving at another period of stability; this process is called self-organization and forms the basis of many changes in the human nervous system [4]. The commonality between all three theories on human movement variability is that whenever variability decreases, performance enhances and the system quality increases [5]. Nevertheless, some arguments have been made in the literature about whether movement variability is good or bad [6]. Findings from clinical trials indicate that movement disorders in certain diseases can increase the variability of movements. In this case, increased variability is indicative of decreased performance quality [7]

However, research findings have not always been against movement variability. Some researchers have reported that increased variability at various levels of the motor system helps to increase performance quality. Zoffoli et al [8] investigated the kinematic variability of walking, and, by placing accelerometers on C7 and S2, concluded that walking with the aid of a pole can increase walking quality and variability at different speeds. In contrast, Qiao et al. [9] investigated the kinematic variability of the gait of aged subjects, and concluded that kinematic variability depends on the phases of gait, with the greatest variability occurring during the push-up and swing phases. Aged subjects were able to correct intentional disturbances during walking, probably by changing the width of the step, by which the hip joint variability increased in the sagittal plane. The results of these two studies opposed one-another; in the first study [9], increased variability improved walking, while in the second study [8] decreased movement stability using walking poles corrected and improved gait. There has also been a lot of research on skilled performance, with results being in contradiction with the conventional idea that reduced variability tends to boost motor performance. For example, Wagner et al. [10] examined movement variability and skill level in different throwing patterns. They produced different throwing patterns using handball throws and found that the more skilled players would decrease their throwing variability by taking an additional step. This study demonstrated that decreased movement variability at higher skill levels. It should be noted that similar throwing patterns were used in the present study. In contrast to these findings, Wilson et al. [11] looked up at the variability of movements during triple-jumping. They reported that movement variability was greater in both highly skilled jumpers and beginners compared to intermediate jumpers. These results are in contrast with the conventional idea that movement variability decrease with increasing skill level. Wilson et al. [11] reported that the relationship between movement variability and skill level follows an inverse model. The findings reported in the literature vary in this regard in which some studies suggest that reduced movement variability at different levels of the system signify an increase in motor efficiency and skill [12-14], while some researchers have reported otherwise [15, 16]. In other words, movement variability is not always bad; changes in the components related to motor performance are sometimes advantageous [6]. The question that arises is how can these findings be interpreted? Is variability an advantage in the movement system or does it hinder performance in skilled players? To provide more evidences, a hypothesis can be proposed on the subject of aiming skills in which the relationship between throwing accuracy and joint kinematic changes can explain the degree of variability in a targeting task. If kinematic variations have less entropy with throwing scores, then this variability can be interpreted as an advantage for throws, and if greater entropy prevails, then variability can be considered as a flaw in movement. We used dart throwing and we enrolled skilled darts players with different levels of training to examine the issue at various skill levels.

Hypothesis. Purpose:

- High throwing scores acquire with high variability in elbow angle, velocity and acceleration.
- High throwing scores acquire with low variability in elbow angle, velocity and acceleration.
- High throwing scores acquire with moderate variability in elbow angle, velocity and acceleration.

Material and methods

Participants

Seven experienced darts players (three women, four men) with an average training experience of 6.38 years (M = 6.38, SD = 2.78) participated in this study. All players had a minimum of four and maximum of eight years of training experience. Most of the participants were involved in the national darts team, with some being members at the time of the study.

Research Design.

Materials. Qualisys motion capture system with six cameras was used to record the kinematics of the elbow. The markers, which were silver in colour with diameters of 1.5 cm, were fixed to the shoulder, elbow, and wrist using double-sided tape; these sites of marker placement were selected based on the Helen Hayes marker placement. In addition, a standard dartboard was used according to World Darts Federation (WDF) regulations. Each player used their own standard set of darts in the experiment, such that they had used the same darts for prior training sessions and competitions.

Procedure. Prior to each throw, the markers were fixed on the player's elbow and the cameras were calibrated on the throwing zone. First the players were sitting on the chair then markers were installed based on the Helen Hayes marker system. Markers position was detected by touch elbow epicondyle before two markers were installed on the players' right hand external and internal elbow, the cameras were checked again after each set (12 throws) in order to increase the accuracy of the kinematic measuring then the cameras were calibrated again if necessary. Frequency of kinematics measurement was 100 hertz. Trajectory that used to calculate angle was from starting the forearm back movement to when elbow is straight after dart release.

The participants began throwing at their own rhythm whenever they were ready. Before the actual throws, the players took several pilot throws. After declaring their readiness for recording, each participant threw 36 darts over three sets from a 2.37 meters distance. Five-minute rests were devised between each set. Every three throws were regarded as one round, and there was a brief interval between each round. Data related to the middle throw from each round was used in later analysis. Scoring was limited to triangle 20, which was divided into 15 scoring regions, each 1 cm apart. The highest score of 60 points was achieved by hitting the middle area, while the most distant regions from the centre were worth 25 points; the points decreased by five with each region leaving the centre.

Data processing and analysis. MATLAB software was used for data filtering and processing. First, data was filtered using a band pass 10-500 Hz, fifth-order. Positions of the shoulder and wrist markers were used to calculate the normalized values of the angle, angular velocity and angular acceleration of the elbow. In order to investigate the variability in the throw scores, entropy analysis of the throw angle, velocity and acceleration was conducted. SPSS was used for statistical analysis.

Results

The mean skill level of the participants can be expressed as 53%. In this regard, the percentage of throws that hit the target triangle was considered as the benchmark for skill level. For more information, see table 1.

The entropy of the throwing angle, angular velocity and acceleration was examined. In order to investigate the impact of angular variability on throwing performance, general linear regression models were used to evaluate the participants' scores. At a significance level of 5%, disregarding the y-intercept, the hypothesis that angular stability has an effect on throwing score was rejected. This means that if the players change their throwing angle in any way, the number of scores obtained will not change. On the other hand, disregarding the y-intercept, which its linear model is later described, it was found that variability in angular changes had a significant effect on the score achieved. The fitted data of the entropy related to the impact of variability in angle, acceleration and velocity on the by scores obtained darts throwers, disregarding the y-intercept, is shown in table 2.

The coefficient of determination for the three models in which the entropies of angle, acceleration and velocity were investigated were 0.53, 0.44 and 0.53, respectively, which demonstrated the suitability of the models.

Table 1. Evaluation of the skill level of the participants

Participant	Number of throws	Skill level (%)
1	12	83%***
2	10	50%**
3	12	58%**
4	10	20%*
5	12	67%***
6	12	50%**
7	11	45%**
Total / Means	79	53%**

Table 2. The fitting obtained from the linear model of scores on angle, velocity and acceleration entropy, disregarding the y-intercept

Parameter	Parameter Estimation	Standard Error	Test statistic	Significance
Angle	5.922	0.638	9.392	0.000*
Velocity	5.580	0.597	9.399	0.000*
Acceleration	2.106	0.270	7.799	0.000*

* significant entropy

Discussion

The purpose of the present study was to investigate the variability of movement in throwing at high skill levels. The results indicated that for highly skilled individuals who have trained and repeatedly performed a dart-throwing task from a specific distance, optimal throws are achieved by moderate variability. The remarkable point in these findings was that variability was constant across all samples despite the varied range of experience in throwing darts from 2.37 meters distance.

Entropy analysis showed that in the throws of highly experienced individuals, variation led to greater throwing efficiency. The efficiency of the motor system seemed to increase as the variability in throws increased to a certain limit, beyond which the performing components appeared to have trouble maintaining efficiency. The figure 1 clearly demonstrates these findings.

Fitting of the quadratic model demonstrates a U-like performance curve, which supports the idea that throws with moderate variability result in the highest scores which is supported by some previous studies [16]. Button et al. [16] reached at the unexpected conclusion that movement variability does not decrease with increasing skill levels by examining the variability of basketball free throws at different skill levels. They also reported that along with increased skill levels, the, wrist and elbow joint stabilities increased that may refer to compensation of wrist and elbow in one trial [16]. These findings are contrary to the conventional notion that regards movement variability as noise that is indicative of the human motor system's inefficiency [7, 17] The findings of the present study are in contrary with those of the recent study of Longo et al [18], who reported that as movement accuracy increases, the kinematic variability of movement decreases [18]. Considering that the dart throwing task revolves around accuracy, the present study was not support that finding since increased variability in elbow angle, angular velocity and acceleration was associated with better throwing performance. Although these changes were only effective to a certain limit, these differing findings may be related to the differences in skill levels (amateur vs. experienced participants). Another possible reason may be the difference in the task examined between the two studies (bimanual reaching vs. dart throwing).

One hypothesis was proposed by Latash et al. to explain the moderate variability as optimal [6]. The need for variation to perform better throws and earn higher scores in this system can be interpreted as the existence of different solutions for the nervous system and the existence of a kind of internal flexibility in the system for creating variables related to performance [19]. These interpretations are in regard to the effect of the internal changes occurring in the elbow on throwing scores, and, given the paired coordination between the operating muscles and joints [20], these changes must be looked at more closely. In this case, it can be said that the internal connections of the elbow markers represent a kind of cooperation between the involved muscles and motor units of the arm and forearm during throwing.

Conclusions

The results of the present study revealed that numerous repetitions of throwing at a target from a specific distance optimize the movement variability in the kinematics of the elbow joint. These findings show that with increased performance levels, variability within the system becomes a performance improvement factor, but only a moderate amount of variability causes this improvement, beyond which the system is degraded.

Highlights

- Variability of angle, velocity and acceleration have significance effects on throwing scores.
- variability was constant across all samples despite the varied range of experience
- Optimal throws are achieved by moderate variability in highly skilled individuals who have trained and repeatedly performed a dart-throwing task from a specific distance.

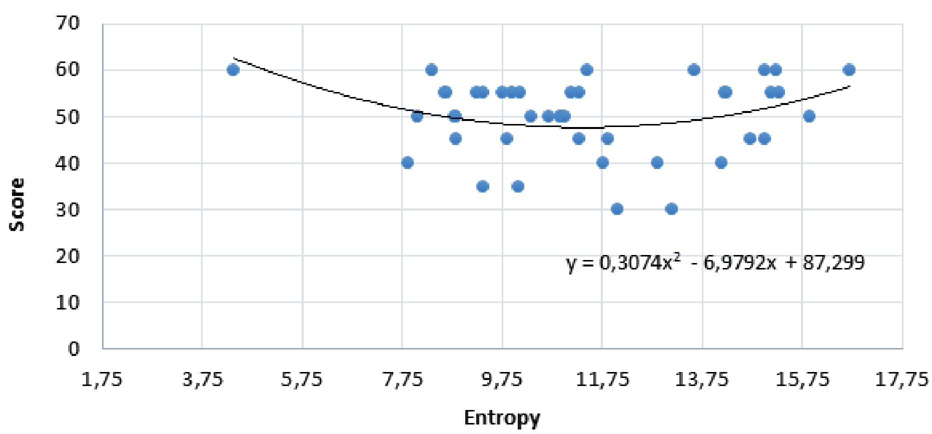

Figure 1. Entropy analysis – The quadratic model (curved line fitted to the effect of variations in throwing darts on scores achieved (blue points)

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Conflict of interest

Author declare no conflict of interest.

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ORIGINAL ARTICLE

The effect of pre-season football training on hematological parameters of well-trained young male football players

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Authors' Contribution: A –Study design; B –Data collection; C –Statistical analysis; D –Manuscript Preparation; E – Funds Collection

Abstract

Purpose: The purpose of this study was to examine the effect of metabolic stress created by 6-week football training applied in the pre-season period on circulation and hematological parameters of well-trained male football players.

Material: Fourteen male football players who competed in the U19 category of a football team in Turkish Football Super League participated in the study voluntarily. In the study, players' systolic - diastolic blood pressures and resting heart rates were measured and their blood samples were taken before and after the 6-week training period. Laboratory analysis was made to determine counts and concentration percentage of erythrocyte, leukocyte, and platelet sub-parameters. Wilcoxon Signed-Rank test was performed to determine the difference between pre and post measurements.

Results: Our findings indicated that baseline mean values of lymphocyte, mean cell hemoglobin, and mean corpuscular hemoglobin concentration were significantly higher than posttest mean values. The mean of diastolic blood pressure and resting heart rate measured before the preseason training camp were lower than their posttest mean values (p >.05).

Conclusions: It is thought that the decrease in the mean values of diastolic blood pressure and resting heart rate caused by the effect of regular training during the preseason training period, while the increase in the mean values of mean cell haemoglobin and mean corpuscular haemoglobin concentration caused by the increased oxygen demand of the metabolism during the training period.

Keywords: blood, football, hematology, heart, preseason, training.

Introduction

Football is a highly popular team sport with millions of interested people compared to other sports branches. Also, football is a sports activity that is loved by most children and youth in many countries. Most of them dream of becoming a successful footballer in the future but the realization of their dream depends on their talent, physical and motor skill development [1]. Athletic performance in football develops depending on many factors such as technical, tactical, biomechanical, mental, physical and physiological [2]. Since football is a particularly demanding sport that requires high effort and motor skill from players, long-term training plans need to be made. Especially the pre-season training period plays an important role in the success of both teams and players in football. The pre-season period in football is a critical period to maximize the physical performance of players and prepare them for an intense match season [3]. Therefore, the high-intensity endurance and strength training programmes, maximizing the physical performance of athletes during the match season, are applied in pre-season training camps during six or eight weeks in summer seasons. The training load intensity in this period creates excessive stress in metabolism and accordingly, physical, and physiological changes occur in the organism [4].

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Playing football is a physical activity that includes not only long-term physical efforts but also intermittent high-intensity physical efforts. When the studies on football players are examined, it is seen that daily intense football training positively affect various physiological systems such as musculoskeletal, nervous, immune, and metabolic systems. One of the most practical ways to examine these effects is to investigate the biochemical and blood parameters of players [5,6]. Exercise, depending on its intensity, creates several stress conditions in the human organism. These stress conditions have various physiological and metabolic effects. Cardiac output and haematological analysis are used as the most basic and practical indicator of physical stress to which an individual is exposed to during physical exercises. The levels of cells, nutrients and hormones in the blood are examined for hematological analysis while resting heart rate, systolic - diastolic blood pressure values are examined for cardiac data. Many researchers who examined the hematologic analysis of the athletes reported that regular exercises have different effects on their blood cell levels. Additionally, they stated that these differences depend on both the frequency, intensity, type and time of the exercise and the physical and physiological status of the subjects participating in the study [7-10]. Doing regular exercise provides an increase in the heart rate volume and accordingly, resting heart rate (bpm) decreases. However, the maximum heart rate (bpm) reached during the exercise does not significantly change. The main factors that determine systolic blood pressure, arterial blood pressure are cardiac output and total peripheral resistance. Peripheral resistance decreases during exercise. Although peripheral resistance decreases, systolic blood pressure increases. The reason for this increase is the increase in heart rate volume. Diastolic blood pressure may decrease or remain constant with decreasing peripheral resistance during aerobic exercise [11].

In literature, it was stated that hematological parameters are affected by the age, environment and nutritional habits of the person, as well as the frequency, intensity, type, duration and of physical activity and exercise [12, 13]. However, in the literature studies that examined the relationship between regular exercises and blood hematotology numerous researchers stated that regular exercise affects blood cells and parameters [9, 14, 15], while some researchers stated that regular exercise does not affect on blood cells and parameters [16]. This discrepancy in the literature has been one of the reasons we do this study. In this context, examining the change in hematological parameters during the intensive training period applied in the pre-season camp periods in football will provide important feedback to evaluate the effects of the training during this period on athletes. To this end, the purpose of this study was to investigate the effect of the 6-week pre-season football training that caused the metabolic stress in the young elite football players.

Materials and Methods

Participants.

Fourteen male young football players aged 17-18 participated in the study voluntarily. Participants competed in the U19 category of a football team in Turkish Football Super League. They participated in the training regularly 3 days a week in the last five years. Written informed consent forms were obtained from all participants.

Research Design.

This study was carried out in a pre-season six-week preparatory camp of a U19 football team that competed Turkish Football Super League. This research was conducted in accordance with the Helsinki Declaration

During the pre-season camp period, a six-week training program including technical, tactical and physical condition training was applied to players. This training program was prepared by team coaches and performed six days each week. Workouts of players were performed three days of a week, both morning and afternoon while other days performed as one workout in the morning (120-min daily training units). A standard diet program prepared by specialist dieticians was applied to the players throughout this camp period. The players were asked to follow the diet program during this period and not to use any medications or supplements. The data for this study was obtained from a standardized data extraction form, body height, body mass, systolic blood pressure (SBP), diastolic blood pressure (DBP) and resting heart rate (HRrest) measurements, and hematological analysis. The standardized data extraction form was used to collect demographic information.

Data Collection.

Anthropometric and cardiac measurements were made 24 hours before and after the pre-season training period. Blood samples were taken for analysis of blood hematological parameters at the same time. Body height was measured in cm by using a stadiometer and body mass was measured in kg using by a digital body weight scale. Participants' resting heart rate (HRrest), systolic blood pressure (SBP) and diastolic blood pressure (DBS) was measured with Microlife BP 3 blood pressure measuring devices [17].

Hematological parameters were obtained from blood samples taken for general health screening of athletes.

Their blood samples were taken from the forearm antecubital vein at 9:00 am following an eight-hour fast. The blood samples were taken two times both before and after the training programs. 5 ml of the blood samples were collected by using sterile EDTA vacuum tubes. Blood analysis was immediately performed included: Erythrocyte (RBC), Hemoglobin(HGB), hematocrit (HCT), mean cell hemoglobin (MCH), mean cell hemoglobin concentration (MCHC), mean corpuscular volume (MCV) and red blood cell distribution width (RDW), WBC, lymphocytes (LY%), neutrophil percentage (NE%), monocyte percentage (MO%), basophil percentage (BA%) and platelet (PLT).

Statistical Analysis.

Statistical analyses were carried out using SPSS statistic software package ver. 22.0 (IBM Corp., Armonk, NY, USA). Data are presented as means with a standard deviation (M ± SD). Shapiro-Wilk W test was used to determine that data was acceptable with regard to homogeneity. As variances showed non-normal distribution, the Wilcoxon signed-rank test was performed to compare the pre and posttest measurements. The level of statistical significance was set at 0.05.

Results

Basic demographic characteristics of the participants were present in Table 1.

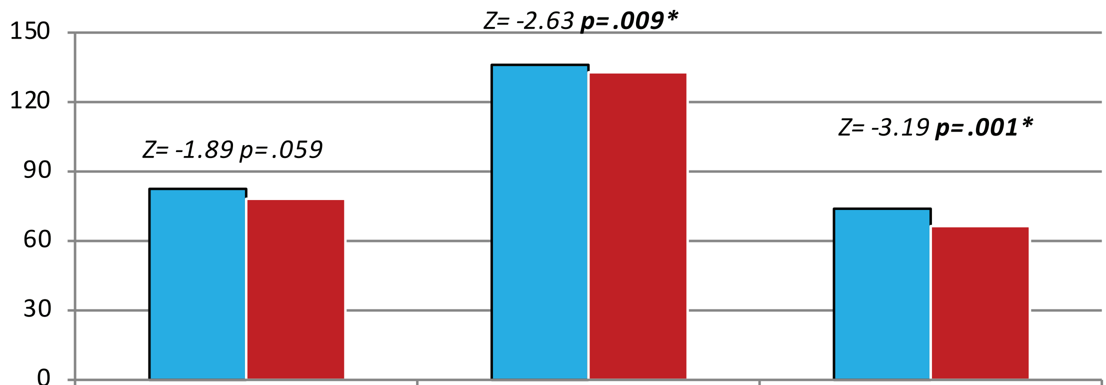
Table 1. Basic demographic characteristics of the participants (n=14)

Variables	Min	Max	Mean	SD
Age (Year)	17	19	17,89	0,62
Training Age (Year)	5	13	8,7	3,58
Heigth (cm)	164	194	177,4	6,85
Weigth (kg)	56	108	71,7	10,66

Figure 1 illustrates pre-test and post-test differences in SBP, DBP, and HRrest parameters. The results of our statistical analysis indicated that there were significant differences between pre-tests and the post-tests in DBP and HRrest mean values. However, there was no significant difference between the pre- and post-test SBP mean values (z= 1.89, p=0.58). Pre-test DBP values 136.57±7.34) was found significant decreased (z= 2.63, p=0.009) compared with the post-test means (132.79±2.66). Pre-test HRrest values (73.7±3.81) were significantly decreased (z= 3.19, p= 0.001) compared with the posttest means (67.0±3.88).

A comparison of the erythrocyte parameters for the pre- and post-tests are shown in Table 2. The results of the Wilcoxon signed-rank test indicated that there were significant differences between pre- and post-tests values in MCH and MCHC parameters. Pre-test MCH (27.93±1.46) and MCHC (32.19 ±0.45) mean values were found significantly increased compared with the post-test MCH (28.44±1.22) and MCHC (32.19±0.45) mean values (p <0.05). However, there were no significant differences between pre- and post-test mean values of RBC, HGB, HCT, MCV and RDW (p > 0.05). A comparison of the leukocyte parameters for the pre- and post-tests are shown in Table 3. The results of Wilcoxon signed-rank test indicated that there were no significant differences between pre- and post-tests mean values of WBC, LY%, NE%, MO% ve BA% parameters (p > 0.05).

A comparison of the pre- and post-tests platelet mean values are shown in Table 3. The results of the Wilcoxon



	SBP (mmHG)	DBP (mmHG)	HRrest (bpm)
Pre-test	82,5	136,57	73,71
Post-test	78,5	132,79	67

Figure 1. Comparison of mean SBP, DBP and HRrest pre-test and posttest values.

Table 2. Comparison of for the pre- and post-tests results in erythrocyte parameters

Parameters	Pre-Test		Post-Test		Z	P
	M	Sd	M	Sd		
RBC (10^6/uL)	5.20	0.45	5.08	0.38	-1.45	0.15
HGB (g/dL)	14.49	0.94	14.45	0.59	0.00	1.00
HCT (%)	45.03	3.04	43.97	2.10	-1.13	0.25
MCV (fL)	86.71	3.87	87.00	3.28	-0.31	0.97
MCH (pg)	27.93	1.46	28.44	1.22	-2.33	**0.02***
MCHC (g/dl)	32.19	0.45	32.82	0.43	-3.11	**0.02***
RDW (%)	13.67	1.18	13.57	0.42	-0.75	0.45

Note: *p < 0.05, RBC: erythrocyte, HGB: hemoglobin, HCT: hematocrit, MCH: mean cell hemoglobin, MCHC: mean cell hemoglobin concentration, MCV: mean corpuscular volume, RDW: red blood cell distribution width.

Table 3. Comparison of for the pre- and post-tests results in leukocyte parameters

Parameters	Pre-Test		Post-Test		Z	p
	M	Sd	M	Sd		
WBC (K/mm^3)	6.56	1.07	6.72	1.33	-0.38	0.71
LY%	37.14	7.26	41.31	8.27	-1.98	0.48
NE%	51.69	8.78	47.41	9.52	-1.51	0.13
MO%	7.75	2.20	7.11	1.44	-0.91	0.36
BA%	0.38	0.13	0.33	0.09	-1.37	0.17

Note: WBC: white blood cell, LY%: lymphocytes percentage, NE%: neutrophil percentage, MO%: monocyte percentage, BA%: basophil percentage

Table 4. Comparison of for the pre- and post-tests of platelet mean values.

Parameters	Pre-Test		Post-Test		Z	p
	M	Sd	M	Sd		
PLT (K/mm^3)	205,57	54,94	214,85	23,12	-1,13	0,31

Note: PLT: platelet

signed-rank test indicated that there was no significant difference between pre- and post-tests mean values of PLT (p >.05).

Discussion

The result of this study demonstrated that the 6-week intensive training program implemented in the pre-season preparatory camp for young footballers led to a decrease in HRrest and DBP, which are indicators of increased endurance. Scientific studies have indicated that there was a high correlation between increased aerobic endurance and decrease in HRrest values in many different sports disciplines [18]. In this regard, the decreasing in the players' mean of HRrest and DBP of at the end of the six-week training period consistent with the previous reports. Gökdemir et al. [19] have determined that aerobic training which is applied three days a week for eight weeks has an impact which caused a drop in HRrest and DBP values. In another study conducted to determine the effect of the aerobic training program applied for six-weeks on the parameters of HRrest, SBP and DBP in athletes are revealed that there was a decrease in HRrest and SBP values due to the effect of training [18]. Kürkçü et al. [20] have also stated that there were significant decreases in SBP and HRrest parameters of athletes after the eight-week pre-season training. The results of these studies support our findings. The increase in the heart rate in regular exercises causes to increase in the heart stork volume and cardiac output. These cardiac changes also cause a decrease in heart rate at the resting time. During the aerobic exercise, DBP may decrease slightly due to the decrease in peripheral resistance while static exercises cause an increase in DBP. On the other hand, there is an increase in SKB values, despite the decrease in peripheral resistance during exercises. It is stated that the increase depends on the volume of the beat. It is stated that this increase is related to stroke volume [11].

In this study, it was observed that the differences in the mean values of the MCH, MCHC parameters of the players before and after the training were significant while the differences in the RBC, HBG, HCT, MCV and RDW parameters were not significant. It is thought that the change in these parameters in football players depends on the level of physical activity performed and the increased oxygen demand of the metabolism during the training period. Blood volume and the amount of hemoglobin increase with exercise. While the number of hemoglobin increases, a decrease in hemoglobin concentration may occur due to the increase in plasma volume [11, 21, 22].

In the study of Hazar and Akyol [23] who examined the effect of regular training in runners, they found a significant difference between the pre and post measurements in HGB, MCV and MCHC parameters of the runners and the ski runners only MCHC parameters. In another study, Karakuş et al. [24] have stated that exercises had a positive effect on erythrocyte parameters. They also emphasized that this positive effect on erythrocyte blood parameters was due to the exercise program applied. Bezci and Kaya [25] have reported that the increases in athletes' WBC, HGB, PLT, RBC, HCT and MCH values before and after maximal training were significant. Although these increases are reported to be due to plasma losses caused by exercise, it was also stated that intravenous hemolysis as a result of trauma caused by intense exercise may be the reason for the decrease in erythrocyte values [26]. Moreover, Koç et al. [18] reported that the erythrocyte parameters of athletes were higher than sedentary individuals depending on the level of physical activity. When the findings of these studies in the literature are examined, it is seen that there are differences with our findings. These differences are thought to result from differences in the sample groups and training methods. Because depending on the participants, the type, intensity and duration of the exercise, the effect of the exercise on hematological parameters may be different [13].

In this study, it was observed that the differences in the mean values of the WBC, LY%, NE%, MO% and BA% parameters of the players before and after the training were not significant. There was an increase in WBC and LY% mean values before and after training in football players, although it was insignificant. It is thought that this increase is due to the fact that the training done during the preparation period can resist the increasing stress in the metabolism and have a positive effect on the immune functions of the athletes regardless of the infection conditions. Because blood, consisting of red blood cells, white blood cells, platelets and plasma, plays a big role in protecting and regulation in the human body [27]. When the scientific studies of leukocyte and its sub-parameters are examined, it is seen that there is no common consensus about the effects of exercise on WBC values. However, it is seen that the studies supporting our findings are in the majority.

Banfi et al. [28] have reported that there is no significant difference in male rugby players' WBC value before and after the pre-season training camp. Hazar et al. [23] determined that there was no statistically significant change in WBC parameters after regular training in athletes and ski runners. Yeh et al. [29] stated that there was no statistically significant change in female and male athletes' WBC level before and after the 12-week exercise period. Ergün et al. [30] have found that aerobic exercises which are applied regularly three days a week do not affect WBC level in middle-aged men.In the study of Boylı et al. [31] declared that there was no significant increase in taekwondo athletes' WBC parameters in the preparation period training. These results in the literature are consistent with our research results. Koç et al. [18] determined that the mean values of WBC parameters were lower in sedentary individuals compared to their peers who do regular physical activity. In another study of Koç et al. [32], they have stated that the RBC value was higher in athletes who exercise regularly for five years than sedentary individuals and the WBC value was lower.

In this study, it was observed that the differences in players' the mean value of PLT before and after the training were not significant. In the literature, even though scientific findings are indicating that acute and chronic exercises cause an increase in the mean value of PLT the findings of some studies indicating that there is no significant increase in the mean value of PLT [26, 31, 33]. In the study of Boylı et al. [33] who investigated the effect of the preparatory period training on the hematological parameters, their findings revealed that taekwondo athletes' PLT mean value decreased due to the training performed. Hazar et al. [23] have stated that the difference between the pre and post-measurement values of the WBC, RBC and PLT parameters of the athletes participating in regular training is not statistically significant. The study of Çakmakçı [13] who conducted in the Taekwondo National Team to determine the change in the hematological parameters of WBC, RBC and PLT before and after the camp, he has stated that the change in the WBC and PLT values was not significant, but the change in the RBC value was significant. Although there is no consensus in the literature, the findings of some studies support our results.

Conclusion

As a result of this research, there was a significant decrease in the DBP and HRrest values, which indicates the increase in the endurance of the intensive training program in the pre-season preparation camp for young footballers. the decreasing in these parameters is thought to be due to the effect of regular training. When the hematological parameters of young players are examined, it is seen that the mean values of the parameters with an increase, in general, are in the reference range envisaged for healthy adults. The increase in the MCH and MCHC levels of the athletes is considered as a change that occurs due to the increased oxygen demand of the metabolism during the training period.

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Conflict of interests

The authors state that there is no conflict of interest

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ORIGINAL ARTICLE

Complex control of coordination and speed-power abilities in fire-applied sports

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection.

Abstract

Purpose: To identify informative tests for complex control of coordination and speed-power abilities in fire-applied sports.

Material: 38 experienced firefighter-athletes aged 15-17, who have been doing this sport for 5-6 years, took part in the research. The survey of Russian leading coaches allowed us to make up a bank of 20 tests. The Brave-Pearson correlation coefficient was used in the statistical processing of the results. The research results were processed using the Excel program.

Results: Methods of controlling coordination and speed-power abilities with competitive result when overcoming a 100-meter obstacle course in fire-applied sports were experimentally substantiated. In accordance with the basic metrological requirements, close correlation relationship was found for 10 tests.

Conclusions: Fire-applied sports is a complex technical type, to control the development of coordination and speed-power abilities it is necessary to rely not on one test, but on a bank of them. The identified informative tests can be recommended for complex monitoring of coordination and speed-power preparedness in fire-applied sports.

Keywords: fire-applied sports, obstacle course, coordination abilities, speed-power abilities, complex control.

Introduction

Currently, testing is one of the main methods of pedagogical control of the level of physical fitness of athletes in various sports [1-3]. In studies of domestic and foreign experts, the issues of diagnosing coordination and speed-power abilities are represented quite widely [4-6]. However, various criteria are used to evaluate them, and there is no one of them that is generally accepted [4, 7].

Most researchers suggest using a different number of tests to determine athletic fitness of athletes: from 2-3 to 11-20 [7-9]. The entire selection of test tasks should be based on the most significant abilities for each sport. On the one hand, it allows getting a more reliable assessment of the level of development of each individual ability; on the other hand, the positive relationship of the test data with the competitive exercise can be determined [9].

The discussed kind of sport is determined by the peculiarities of the professional activities of firefighters and is associated with the implementation of various techniques at high speed [10, 11]. One of the sport exercises is to overcome a 100-meter obstacle course. The effectiveness of competitive activity in this discipline requires high coordination and speed-power abilities [12-14]. Therefore, the basis of pedagogical control in fire-fighting athletes is the diagnosis of coordination and speed-power preparedness [12, 15].

Despite there are some researches of this issue, we were not able to find scientifically based data for assessing coordination and speed-power abilities with competitive result when overcoming a 100-meter obstacle course in fire-applied sports. This analysis allowed us to determine the relevance of our study.

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Material and methods

Participants. The research was carried out on the basis of the Prometey sports complex in Kirov (Russia) among firefighting athletes aged 15-17. In total 38 experienced athletes participated, who have been doing this sport for 5-6 years. All procedures complied with the ethical standards of the 1964 Helsinki Declaration. All parents of participants who took part in the study signed the informed consent.

Procedure. The free interview, as one of the survey methods, made it possible to maximally adapt the questions of the previously prepared interview form. Interviews were conducted according to the professional status of the respondents. The survey involved 16 coaches (Russia) from Moscow, the Moscow region, the Nizhny Novgorod region, the Perm region, the Sverdlovsk region, the Chelyabinsk region, and the Kirov region.

During the study, 20 tests for determining coordination and speed-power preparedness in fire-applied sports were selected. However, only 10 tests showed an average statistical relationship with competitive result when overcoming a 100-meter obstacle course.

For determining the level of coordination preparedness [4, 5, 15]:

1. Shuttle run 3x10m (s), (r=0,698) [4, 5, 15].

Task conditions: from the high start by the command "Go!" the athlete ran 10 m at the maximum speed, then the athlete ran around any side of the stuffed ball. Next he came back and again ran around the ball. The third time, after 10 m, he finished. The test result - running time was measured in seconds from the command "March" to crossing the finish line.

2. Double side jump standing on both legs (sm),

(r=-0,680) [5].

Task conditions: the athlete was side standing at the line of the direction of movement. He made two jumps in a row standing on two legs. The result was measured from the beginning of the line to the place of landing. The best result of two attempts in sm was recorded.

3. Turns on the gymnastic bench (number of times), (r=-0,624) [5].

Task conditions: the athlete stood on the narrow surface of the bench. For 20 seconds, he made 360-degree turns, alternating left and right. If the athlete lost balance, then he resumed the test. The number of completed turns was recorded to the accuracy of a half-turn.

To determine the level of motor coordination of hands (“manual dexterity”) [16-18]:

4. Dashes – catching a tennis ball (number of times), (r=-0,691) [16, 18].

Task conditions: the athlete was facing the wall at one-meter distance. He held 2 tennis balls in one hand. By command, he threw one ball into the wall one after another. After each hit he tried to catch the ball. This task continued to be completed for 10 seconds. Two trial and two main attempts were given. The number of best caught balls in the best attempt was recorded.

5. Juggling a tennis racket (number of times), (r=-0,646) [17, 18].

Task conditions: the tested, by command, began to juggle the tennis ball alternately on the right and left sides of the racket for 10 seconds. Two trial and two final attempts were given. The number of punches in the best attempt was recorded.

To determine the level of development of speed-power abilities [8, 18, 19]:

6. 100 m run from crouch start (s) (r=0,633) [8, 19].

Task conditions: from the crouch start position by command, the athlete ran this distance. The time from the “Go!” command until crossing the finish line in seconds was recorded.

7. 30 m run from high start (s) (r=0,689) [8, 18].

Task conditions: from the high start by command, the athlete ran this distance. Time from the “Go!” command until the finish in seconds was recorded.

8. Standing triple jump (m) (r=0,633) [8].

Task conditions: the stood at the line, feet at shoulder length. Three jumps were done alternately from one leg to the other. Landing was on two legs. The result was measured from the line to the place of landing in sm (the heel of the athlete closest to the line). The best result of three attempts was recorded.

When receiving complex information on motor coordination, the main emphasis was on the combined tests or tests of repeated tasks, which also showed their reliability.

For complex assessment of speed-power and coordination abilities, the sport-motor test proposed by E. Zieris in the form of an obstacle course was used [7].

9. Sport-motor test (r=0,697).

This test has been modified to reflect the specifics of fire-applied sports to the greatest extent. The test with benches of Ljach is included in this course, but it has been changed since it was used for primary school children [9]. The main difference of the test was that the tested had to run on benches, and not crawl along them in the crawling position.

As a result of the modification, the sport-motor test consisted of the following stages (Fig. 1):

– acceleration;
– forward roll;
– running on the benches;
– going along the gym wall-bars at will;
– jumping over the barrier;
– running around the medball;
– crawling under the barrier;
– jump on the hill of mats;
– finish.

Task conditions. The athlete ran at maximum speed

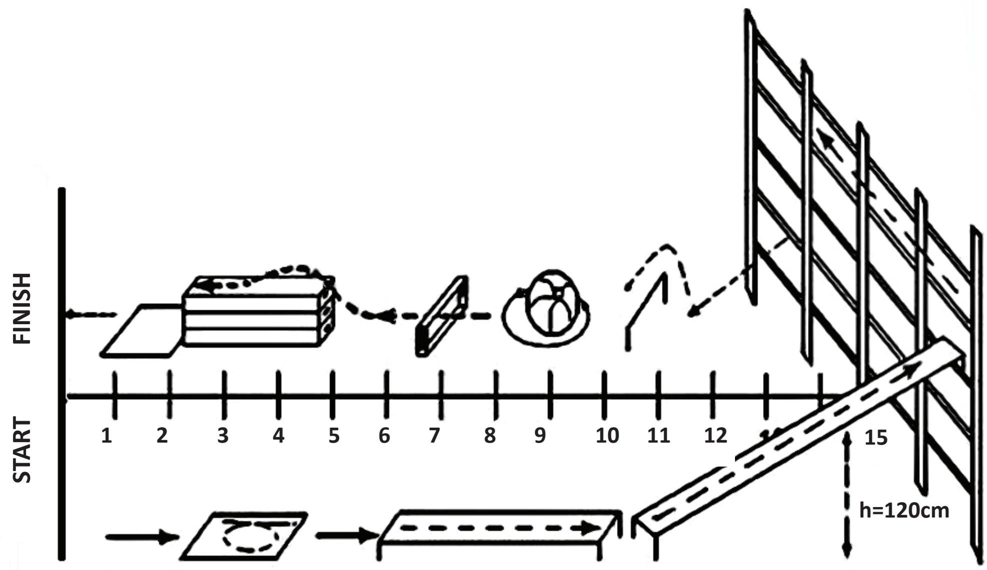

Fig. 1. Sport-motor test

all the distance. From a high start by the command "Go!" after 2 m the athlete did a forward roll. After 3 m he ran on gymnastic benches. The far edge of the second bench was fixed on the gym wall-bars at the height of 120 cm. Over the gym wall-bars he overcame 4 flights. He came down and after 3 m he jumped over the barrier 76 cm high. Again he ran 2 m. He ran around the medball. After 2 m, he crawled under the barrier 120 cm high. After 4 m, he jumped onto sport mats 120 cm high. He jumped and finished after 3 m. The best result of passing the distance in two attempts in seconds was recorded.

To assess the level of coordination, speed-power and professional abilities, the control exercise was developed in the form of a 30-meter obstacle course [12, 21, 22]:

10. Technical *course* (s).

It was assumed that this course most fully simulates the techniques of firefighters in relation to a 100-meter obstacle course. It requires complex manifestation at the maximum level of all physical and professionally important abilities.

The distance of 30 m consisted of the following tasks (Fig. 2):

- acceleration 10m;
- two forward rolls;
- connecting two blank caps;
- joining the blank cap to the fire manifold;
- finish.

Task conditions. From the high start by the command "Go!" the athlete ran 10 m. He did two forward rolls mats in a row. He connected two blank caps, which were 20 m from the start line. He ran 5 meters to the fire manifold and attached it to the blank cap, which lay to the right at the distance 50 sm from the ire manifold. Then he finished. The best result of passing the distance in seconds by attempts was recorded. If one of the combinations was not completed, then the control exercise was failed.

Statistical analysis:

The use of mathematical statistics methods showed that not a single test has a high correlation with the competitive result [22]. For calculation the Brave-Pearson correlation coefficient was used. The correlation coefficient characterized the linear interrelation, i.e. degree of crowding. The results were processed using Excel. The result was significant at P <0.05.

Results

The true interrelation was determined in 10 tests (p> 0.05). The correlation coefficient was in the range r = -0.618–0.698, which corresponds to the statistical criteria of reliability, objectivity and informativeness. Other tests showed a low correlation coefficient r = 0.3 (p <0.05). (Table).

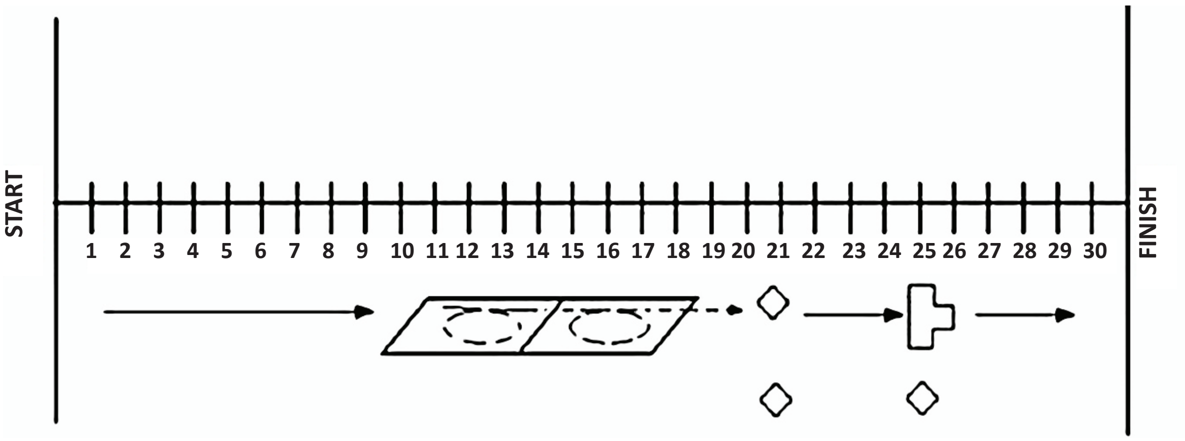

Fig. 2. Scheme of the technical course

Table. Calculation of the correlation coefficient to the competitive result (n = 38)

Control tests	r	Dependence
1. 100 m from crouch start (s)	**0.633**	**p>0.05**
2. Running around three racks (s)	0.426	p<0.05
3. 30 m from high start (s)	**0.689**	**p>0.05**
4. High thigh lift upperarm support standing at the gym wall-bars for 10 seconds	-0.496	p<0.05
5. Complex agility exercise (s)	0.499	p<0.05
6. Double side jump standing on both legs (m, sm)	**-0.680**	**p>0.05**
7. Jumps downward on markings (m, sm)	0.142	p<0.05
8. Shuttle run 3x10 м (s)	**0.698**	**p>0.05**
9. Long jump for touch-down accuracy without visual analyser (m, sm)	0.301	p<0.05
10. Shuttle run 3x10 m backward (s)	0.383	p<0.05
11. Turns on the gymnastic bench (num. of times)	-0.624	p>0.05

Table continuation

Control tests	r	Dependence
12. Accurate rolling the ball by hand (sm)	-0.256	p<0.05
13. Dashes – catching a tennis ball (num. of times)	-0.691	p>0.05
14. Jump in place and max-degree turn in the air (degrees)	-0.234	p<0.05
15. Sport-motor test (s)	**0.697**	**p>0.05**
16. Overstepping gym-sticks (**num. of times**)	-0.356	p<0.05
17. Juggling a tennis racket (num. of times)	**-0.646**	**p>0.05**
18. Technical course (shortened) (s)	0.682	p>0.05
19. Temping-test (num. of times)	0.402	p<0.05
20. Standing triple jump (m, sm)	-0.618	p>0.05

Discussion

The researches in the field of testing prove the close relationship between leading moving abilities and the competitive exercise in various sports [2, 5, 23, 24].

Some authors argue that the evaluation criteria should be indicators of the effectiveness of the implementation of Integral actions and their combination for a particular sport. However, in some literary sources, tests are presented not as a system of control tests, but as a set of tasks without proper scientific justification [4, 25, 26]. And it cannot be considered correct.

The authors argue that using one test, even a very complex one, which consists of several motor tasks, it is impossible to obtain accurate, differentiated assessments of the level of development of athletes. Also, according to the results of one or more informative tests, it is wrongful to judge the degree of formation of all abilities [5, 7, 27, 28].

In this regard Russian and foreign colleagues point to the need for complex monitoring. Applied tests should give simultaneous information on the degree of development of leading abilities and competitive results [3, 4, 27]. Thus, a number of authors indicate the influence of coordination and speed-power indicators on the technical skills of athletes in cyclic sports [5, 18].

Currently, the literature has sufficiently fully disclosed criteria for evaluating speed-power preparedness in relation to various sports [23, 26]. Nevertheless, the problem of controlling coordination abilities is not yet fully covered [9, 29].

Ljach systematized criteria for assessing coordination abilities, which are currently congruent with data received by other authors [6, 9, 18]. The researchers prove that each criterion is not a single and single-valued indicator characterizing coordination abilities, but they are quite complex and multivalue, because they are specifically manifested in various combinations with each other in any motor activity. Moreover, the quality components of correctness are adequacy and accuracy, of quickness – timeliness and speed, of rationality – expediency, of resourcefulness – initiative [5, 6, 9]. These assessment criteria are generalizing concepts that are specified in determining the appropriate special and specific coordination abilities [4, 9].

However, scientists do not consider them in conjunction with speed-power abilities. Also, in the available literature, we did not find publications containing information on assessing the level of development of speed-power and coordination abilities in fire-applied sports.

In the new study, the static processing method was applied, which allowed to identify informative tests in fire-applied sports. These tests allow diagnosing coordination and speed-power indicators and can be used in a complex study of these abilities.

Conclusion

The results revealed the informative tests for the diagnosis of speed-power and coordination abilities in fire-applied sport. The reliable correlation was found between coordination and speed-power abilities when overcoming a 100-meter obstacle course. It allows us to talk about achieving the aim and complete solution of the research tasks. The results of the study can be applied for firefighters.

Conflict of interest

The authors declare that there is no conflict of interests.

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The effects of theraband training on respiratory parameters, upper extremity muscle strength and swimming performance

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection.

Abstract

Purpose: The aim of this study was to investigate the effect of 6 weeks theraband training on respiratory parameters, upper extremity muscle strength and 50-100m swimming performance in swimming athletes.

Material: Totally 12 male swimmers participated voluntarily and were divided into two groups as control group (n=6) and experimental group (n=6). Control group did only swimming training, experimental group did theraband exercises in addition to swimming exercises. Respiratory parameters, upper extremity anaerobic performance, shoulder extension/flexion strength and swimming performance were measured. Mann Whitney-U Test was used to determine the differences between two groups. Wilcoxon Test was used to determine intra-group differences.

Results: There was no statistically significant difference between the pre and post-test values of respiratory parameters, anaerobic performance values and swimming measurements of the experimental groups ($p>0.05$). There was a statistically significant difference between shoulder extension and flexion values ($p<0.05$). As for the statistical results between the pre and post-test values of the control group, no significant difference was found in any of the variables ($p>0.05$). There was a statistically significant difference between the post-test values of the experimental and control groups shoulder extension and flexion values ($p<0.05$). There was no statistically significant difference between respiratory function parameters, anaerobic performance values and 50-100m swimming degrees ($p>0.05$).

Conclusions: As a result of the findings, it can be said that theraband training which is done as a land work with swimming training leads to positive effects in the upper extremity muscle strength and swimming performance development of youth swimmers.

Keywords: swimmer, resistance band, isokinetic strength, anaerobic performance.

Introduction

Swimming is a sports branch which is a combination of several factors such as high-level muscle strength, technical skills, rhythm requiring coordination, speed, explosive strength and correct technique [1-3]. The sport of swimming is very different than other sports due to training in a prone position and use of both arms and legs for propulsion, with 90% of the propulsive force supplied by the upper extremities [4-7]. Another main difference is that land-based sports use the ground as a reference point of movement, while swimming does not involve ground contact. Therefore, swimmers must use their core as the reference point of movement, which reinforces the need for swimmers to have a strong core to be successful in the sport [8].

The ability to apply force in water is crucial in competitive swimming [9, 10], particularly in short distances events [2, 11]. As well as high values of strength and power, mostly in the upper body, have been identified as a determinant factor for success in competitive swimming [1, 12]. Swimmers need to develop muscle strength in order to increase their swimming speed [13]. In addition to in-water exercises, dry-land strength training is used for performance enhancement and injury prevention [8, 9, 14]. Also, it can increase swimming force [1]. and technical parameters such as increased stroke length and stroke rate [15]. In land training, different materials and training methods are used to increase the strength and swimming performance of swimmers.

In swimming, there are training sessions carried out by using different materials (pedal, pallet, pull-buoy and resistance rubber) in the water in order for the swimmer to reach and maintain a higher speed. Strength training in the land, strength ball exercises, plyometric exercises, core training, body weight exercises, vasa trainer or isokinetic swim bench exercises where the isokinetic movement is applied, theraband and rubber exercises, trx training, foam-roll use and different many studies are used every semester [13]. Recently, theraband (resistance rubber) exercises have been used extensively in sports and rehabilitation medicine for increasing muscular strength and endurance [3]. Elastic bands are simple-to-use tools for multipurpose physical training. They are portable, inexpensive, and widely used to develop muscle strength and power [16].

Success in swimming, relies on swimmers' motoric properties (balance, power output, agility, jumping ability) and respiratory control. While swimming, upper limb muscles and trunk are engaged, either directly, to do hand-foot-breath coordination, or indirectly, to stabilize the core muscles along with the diaphragm, resulting in an increase in respiratory work and breathing perception [17]. Breathing has a big influence on swimming technique, balance and alignment of the body in the water,

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propulsion and muscular effort and hydrodynamics and water resistance.

One of the issues that many coaches are curious about is the differences in strength performance of athletes in addition to the dry-land training as well as the training done by using additional resistances (foot-hand) in the sets that swimming in the training. Knowing the use of resistance, that is, the differences that can be made in resistance training and swimming speed, is important in writing and practicing training. Therefore, this study was conducted to determine the effects of theraband training on respiratory parameters, upper extremity muscle strength and swimming performance in swimming athletes.

Material and Methods

Participants

This study was conducted on 12 male swimmers who training in Mavi Bilgi College Sports Club 6 experimental group (average age; 16 ± 1,41 years, mean body height; 172 ± 0,05 cm, mean body mass; 64,25 ± 6,59 kg) and 6 control group (average age; 15,5 ± 0,58 years, mean body height; 177,1 ± 0,04 cm, mean body mass; 66,43 ± 5,14 kg) participated in this study voluntarily. Exclusion criteria consisted of smoker athletes, athletes with any severe musculoskeletal, respiratory, cardiac and/or neurological pathology and athletes who did not complete 80% of the exercise sessions. The subjects were informed about the possible risks and benefits of the study and gave their informed consent to participate in this study, which was approved by the Clinical Research Ethical Committee of Pamukkale University.

Experimental Design

The swimmers were categorized into the control group (n=6) and experimental group (n=6) according to their 50 m swimming degrees. Control group did swimming training only three times a week for six weeks. In addition to swimming exercises, experimental group did theraband exercises consisting of 10 movements to the upper extremities. The study was conducted over a 1-week period, during which the players did not participate in any other training. On the first day, anthropometric measurements, respiratory measurements and 50-100 m swimming performance were done respectively. On the third day, players underwent isokinetic leg strength tests. On the fifth day, players performed the Wingate anaerobic test.

All subject's height and body mass were recorded before completing any testing. The height of the subjects was measured with a stadiometer (Seca, Germany) with a sensitivity of 1 mm and body weight measurements with a sensitivity of 0.1 kg. In the anatomical posture, the heels were combined, holding the breath, and the head was positioned in the frontal plane with the overhead table touching the vertex point and the measurement was recorded as 'cm' and 'kg'.

Anaerobic Performance Evaluation

For the Wingate test, a Monarch 894E (made in Sweden) arm and leg bike ergometer that is modified for computer connection and a compatible software were used. For each athlete, the load to be applied as external resistance in the arm ergometer during the test was calculated as 50 gr/kg. Athletes were subjected to a 5-minute warming protocol with two or three sprints of 4-8 seconds at 60-70 rev/min pedals with 20% of the calculated test load of bicycle ergometer. They were given passive rest for 3-5 minutes after warming. Athletes were asked to reach the highest pedalling speed as soon as possible without resistance. When the maximum speed was reached, the load previously calculated as 50 gr/kg was released and the test was started. The athletes pedalled against this resistance at the highest speed for 30 seconds. Athletes were encouraged verbally throughout the test. Peak power (PP) and mean power (MP) was calculated automatically by the Wingate Anaerobic Test computer program. A fatigue index was calculated by using the following equation [18]:

Fatigue Index (FI) = (PP) − (MinP) / (MP) × 100

PP is the peak power, and MinP is the minimum power that was determined during the WAnT test.

Isokinetic Testing Protocol

Participants warmed up prior to the isokinetic testing on an arm cycle ergometer pedalling at a work rate of 20 watts at 55-65 rpm for 7-minutes. An isokinetic dynamometer (Cybex Humac Norm 770, USA) was used to measure shoulder flexion and extension peak torque. The isokinetic dynamometer was calibrated at the beginning of test day. The tests were carried out in a supine position on the unit's special seat. After giving preliminary information about the test, the anthropometric data were input to the Cybex apparatus which was to be measured by the players, and the device was adjusted. Isokinetic concentric muscle strength tests were performed without gravity for specified joint movements. Participants were verbally encouraged during each test to perform at their best and participants were also allowed visual feedback during the testing. Followed by 3 repetitions submaximal trial, 5 maximal concentric contractions performed at 60°/s angular velocity. A 30 s time interval was provided between repetitions.

Swimming Measurements

The 50 m and 100 m freestyle swimming performances of the swimmers were measured with a hand stopwatch (Casio, Japan) measuring 0.01 seconds. The swimmers were warmed for 5 minutes on land and 10 minutes in water. Each freestyle swimming test started with ready-exit command by pushing the wall of the pool with its feet and when the distances was completed, the test was terminated.

Respiratory Parameters Measurements

BTL-08 Spirometer device was used to measure the respiratory parameters of the participants. Respiratory function characteristic was evaluated by forced vital capacity (FVC), forced expiratory volume in one second (FEV1), the ratio of FEV1 to FVC (the Tiffeneau index) and maximum voluntary ventilation (MVV). In spirometry measurements were made while the subject was sitting with the subjects' nose closed with a latch.

Training Programme

Subjects used There-Bands elastic resistance bands. The initial training resistance was determined during two adaptation sessions with elastic bands and training techniques. Red elastic bands were determined the initial load. All swimmers executed three sets of each exercise. The first two sets involved 20 repetitions each, with the last set performed until exhaustion. If swimmers were able to reach 30 repetitions in the final set, the level of training was increased by selecting the next resistance level (colour) of the elastic bands [19]. This procedure was independently conducted for each exercise. All subjects became familiar with the testing procedures that took place approximately one week prior to training programme. The training programme was held three times a week for 6 weeks and consisted of ten different exercises. These movements are: a) shoulder horizontal adduction, b) shoulder horizontal abduction, c) shoulder adduction, d) shoulder abduction, e) shoulder flexion, f) shoulder extension, g) shoulder internal rotation, h) shoulder external rotation, i) elbow flexion j) elbow extension. Subjects were given rest 1 minute between each set and 2 minutes between each new exercise. Set and in-set time of the exercise programme are as follows: 1st and 2nd week 3x15 sec, 3rd and 4th week 3x30 sec, 5th and 6th week 3x45 sec.

Statistical Analysis

In the statistical analysis of the data, descriptive analyses of test measurements of swimmers were calculated as mean and standard deviation. The Shapiro-Wilk Test was used to determine whether the data were normally distributed before the statistical procedures were examined. The difference between in-group test values was tested by Wilcoxon analysis. Mann Whitney U analysis was used to test the difference between the groups. The data obtained were evaluated with SPSS 23.0 program and the statistical significance was set at $p<0.05$.

Results

Table 1 shows the pre and post-test analysis of respiratory parameters, anaerobic performance, isokinetic strength and swimming measurements of the experimental groups.

There was no statistically significant difference between the pre and post-test values of respiratory parameters, anaerobic performance values and swimming measurements of the experimental groups ($p>0.05$). There was a statistically significant difference between shoulder extension and flexion values ($p<0.05$). Table 2 shows the pre and post-test analysis of respiratory parameters, anaerobic performance, isokinetic strength and swimming measurements of the control groups.

As for the statistical results between the pre and post-test values of the control group, no significant difference was found in any of the variables ($p>0.05$).

Table 1. The comparison of pre and post-test results of experimental group

Variables	Test	Mean ± Sd	z	p
FVC (L)	Pre Test	5.35 ± 1.15	-0.36	0.71
	Post Test	5.23 ± 1.23		
FEV1 (L)	Pre Test	3.68 ± 0.94	-1.46	0.14
	Post Test	4.51 ± 0.59		
FEV1/FVC	Pre Test	71.29 ± 21.3	-1.82	0.06
	Post Test	88.42 ± 14.04		
MVV (L/min)	Pre Test	111.23±36.81	-1.09	0.27
	Post Test	89.53 ± 12.59		
Peak Power (W)	Pre Test	338.8±122.65	-1.82	0.06
	Post Test	486.21±162.84		
Mean Power (W)	Pre Test	229.11 ± 68.96	-1.82	0.06
	Post Test	274.01 ± 56.25		
Minumum Power (W)	Pre Test	95.26 ± 57.61	-0.36	0.71
	Post Test	99.55 ± 59.66		
Fatigue Index (%)	Pre Test	73.91 ± 13.72	-1.82	0.06
	Post Test	80.08 ± 13.21		
50 m (s)	Pre Test	27.43 ± 1.28	-1.82	0.06
	Post Test	26.63 ± 1.07		
100 m (s)	Pre Test	59.13 ± 3.13	-1.82	0.06
	Post Test	57.67 ± 2.21		
Shoulder Flexion (Nm)	Pre Test	67.56 ± 10.61	-1.82	0.02*
	Post Test	79.12± 13.72		
Shoulder Extension (Nm)	Pre Test	99.72 ± 25.33	-1.82	0.01*
	Post Test	144.01±42.81		

*p<0.05

At the beginning of the study, groups divided into the homogeneous.

There was no statistically significant difference between the post-test values of the experimental and control groups between respiratory function parameters, peak power, average power, minimum power, fatigue index and 50-100 m swimming degrees (p>0.05). There was a statistically significant difference between shoulder extension and flexion values (p<0.05) (Table 3).

Table 2. The comparison of pre and post-test results of control group

Variables	Test	Mean ± Sd	z	p
FVC (L)	Pre Test Post Test	5 ± 0.46 5.02 ± 0.62	0	1
FEV1 (L)	Pre Test Post Test	4.22 ± 0.32 3.91 ± 0.49	-0.73	0.465
FEV1/FVC	Pre Test Post Test	84.65 ± 7.42 78.33 ± 12.01	-0.73	0.465
MVV (L/min)	Pre Test Post Test	96.24 ± 30.87 88.75 ± 29.55	0	1
Peak Power (W)	Pre Test Post Test	371.25 ± 114.17 407.37 ± 156.9	-1.095	0.273
Mean Power (W)	Pre Test Post Test	240.37 ± 80.49 255.87 ± 72.7	-1.826	0.68
Minumum Power (W)	Pre Test Post Test	122.42 ± 52.13 98.5 ± 35.19	-0.365	0.715
Fatigue Index (%)	Pre Test Post Test	67.94 ± 4.53 73.27 ± 11.47	-0.365	0.715
50 m (s)	Pre Test Post Test	30.48 ± 2.99 30.37 ± 4	-0.365	0.715
100 m (s)	Pre Test Post Test	63.32 ± 4.99 62.15 ± 6.68	-0.73	0.465
Shoulder Flexion (Nm)	Pre Test Post Test	62.56 ± 10.61 61.12± 9.72	-0.365	0.715
Shoulder Extension (Nm)	Pre Test Post Test	79.52 ± 25.33 81.01±42.81	-0.365	0.715

*p<0.05

Table 3. The Mann Whitney U analysis of post-test respiratory parameters, anaerobic performance, isokinetic strength, swimming measurements of experimental and control groups

Variables	Groups	Mean ± Sd	U	p
FVC (L)	Experimental Control	5.23 ± 1,23 5.02 ± 0,62	7	0.886
FEV1 (L)	Experimental Control	4.51 ± 0.59 3.91 ± 0.49	3	0.2
FEV1/FVC	Experimental Control	88.42 ± 14.04 78.33 ± 12.01	4	0.343
MVV (L/min)	Experimental Control	89.53 ± 12.59 88.75 ± 29.55	7	0.886
Peak Power (W)	Experimental Control	486.21 ± 162.84 407.37 ± 156.9	4	0.343
Mean Power (W)	Experimental Control	274.01 ± 56.25 255.87 ± 72.7	6	0.686
Minumum Power (W)	Experimental Control	99.55 ± 59.66 98.5 ± 35.19	7	0.886
Fatigue Index (%)	Experimental Control	80.08 ± 13.21 73.27 ± 11.47	5	0.486
50 m (s)	Experimental Control	26.63 ± 1.07 30.37 ± 4	4	0.343
100 m (s)	Experimental Control	57.67 ± 2.21 62.15 ± 6.68	4	0.343
Shoulder Flexion (Nm)	Experimental Control	79.12± 13.72 61.12± 9.72	5	0.004*
Shoulder Extension (Nm)	Experimental Control	144.01±42.81 81.01±42.81	4	0.003*

*p<0.05

Discussion

The aim of this study was to investigate the effect of 6 weeks theraband training on respiratory parameters, upper extremity muscle strength and 50-100 m swimming performance in swimming athletes. The main findings to emerge from the study were that there was a statistically significant difference between the post-test values of the experimental and control groups between shoulder extension and flexion values ($p<0.05$).

Strength training is necessary to improve the performance of swimmers and ensure continued success in competitions [20]. Strength training with resistance exercises have been shown to have performance-enhancing and injury-reducing benefits in youth athletes [20, 21]. The awareness of such benefits is demonstrated by an increasing number of swimming coaches working with different age groups that incorporate dry-land training, including theraband training, into their swimming programmes [22]. A number of studies have found a positive relationship between strength, power and swimming performance. For example, Keiner et al. [13] investigated the influence of maximal strength performance on sprint swimming performances in male and female youth swimmers (17.5 ± 2.0 years) and found there to be strong negative correlations between leg strength (1 RM squat), speed-strength and swim performance particularly for short distances (up to 25 m). They also found a correlation between the strength tests of the upper body and swim performance. The authors therefore concluded that maximal strength of both the upper and lower body can be good predictors of swim performance. Aspenes and Karlsen [4] investigated the effect of combined strength and endurance training on swimming performance in competitive swimmers. Following an 11 week training programme, the intervention group improved 400 m freestyle performance by around 4 seconds ($p<0.05$), tethered swim force ($p<0.05$) and maximal strength in bilateral shoulder extension ($p<0.05$). Shoulder rotation strength and the ratio of internal to external rotation strength are as important as relative strength measures in elevated positions, which include flexion and extension, is effective in swimming performance for the young swimmer. In this study, it is possible to say that, theraband training provided positive improvements on shoulder strength development in swimmers.

Although, strength has usually been measured through isometric and isokinetic tests, more recently, exercises that are commonly found in dryland strength training programs are being studied as predictors of swimming performance [15]. In this study, there was no statistically significant difference between the pre and post-test values of the experimental and control groups between 50-100 m swimming degrees, although showed a positive increase following the theraband training programme. It can be said that theraband trainings have positive effects on swimming performances depending on the fact that they provide muscular strength development to the athletes. There are a number of previous studies which have investigated the effect of dry-land training programmes on swimming performance with varying results. Kalva-Filho et al. [23] investigated the relationship between 50 m sprint development and strength training, and found that muscle strength acquired during 8-week strength training was an important factor for 50 m sprint capacity. Yapıcı et al. [3] investigated the effect of 6-week land and resistance training on lower extremity isokinetic strength values and swimming performance in 22 swimmers in the 13-16 age group. As a result of the study, it was determined that knee extensor and flexor muscle strength increased at 60 °/s, 180 °/s and 240 °/s after 6 weeks of training and 25 m, 50 m and 100 m freestyle swimming degrees improved. Amaro et al. [9] who found that a 6-week strength and conditioning programme significantly improved dry-land performance (vertical jump and ball throw) in male prepubescent swimmers. No significant improvements in swim performance (50 m freestyle) were found immediately following the 6-week programme, however, after a 4-week adaptation period the experimental group did improve their swimming performance ($p=0.03$). Sadowski et al. [24] implemented a 6 week dry-land power training programme in youth swimmers there were no significant improvements in 25 m freestyle swimming performance in either the experimental or control group ($p>0.05$). The duration of the training programme within this investigation, suggesting that a longer duration is needed to elicit significant improvements in swimming performance.

The anaerobic contribution has been demonstrated to be important for swimming performance especially short distance swimming branches (50 m, 100 m) [25, 23]. Considering that about 80% of swimming events are shorter than 2 min duration, the anaerobic metabolism can be considered as paramount in swimming. In fact, the anaerobic metabolism prevails in the 50 and 100 m swimming events, continuing to be of great importance in the 200 m [26, 27]. Increasing the anaerobic training emerges as a necessity to enhance training specificity and swimmers' performance in short events. In this study, there was no statistically significant difference between the pre and post-test values of the experimental and control groups between peak power, average power, minimum power, fatigue index. Stager and Coyle [11] and Kalva-Filho et al. [23], for example, found the following values, respectively: peak power 526.8 W and 513.4 W and mean power 421.0 W and 425.05 W. These values are higher than are the ones reported in the present study.

The use of theraband during training also has an important place for strength development in youth swimmers. In swimming, increased breathing frequency during exercise causes the respiratory muscles to use oxygen more [28]. Swimmers used to physical strain due to repeated exercise, more efficient ventilation is highlighted [29]. The increase of vital capacity is mostly influenced by aerobic stimuli, whereas the increase of air-flow speed is mostly influenced by anaerobic stimuli [30]. In this study, there was no statistically significant difference between the post-test values of the experimental and control groups between respiratory function parameters. Swimmers used to physical strain due to repeated exercise, more efficient ventilation is highlighted. But we can say that theraband exercises have been used with swimming training, improves respiratory function parameters. Weston et al. [8] found that the values of 17 swimmers (FIV1, FEV1) increased after inspiratory and expiratory muscle training compared to the control group. Respiratory muscle training with theraband programs have been reported to increase the performance of elite swimmers by 1% in studies [15] elite rowers and cycling athletes were found to increase performance. Gosselink et al. [28] it is observed that theraband training increases respiratory muscle strength. In one study, 28 young fin-swimmers reported significant improvement in inspiratory muscles after dry-land training [31].

Conclusion

As a result of the findings, it can be said that theraband training which is done as a land work with swimming training leads to positive effects in the upper extremity muscle strength and swimming performance development of youth swimmers. It can be recommended that swimming coaches should be involved in strength training as well as season training, taking into account the possible strength increase effects of theraband training programs on swimmers.

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Conflicts of Interest

The authors state no conflicts of interest.

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The state of preparedness of prospective physical education and sports teachers

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Authors contribution: A – Study design; B – Data collection; C – Bibliometric analysis; D – Manuscript preparation; E – Funds collection

Abstract

Purpose: This study was conducted to determine the state of readiness of prospective physical education and sports teachers, who were studying in sports education institutions in Turkey.

Material: The sample of the study consisted of 552 prospective physical education and sports teachers, who were chosen by the random sampling method. To collect the data from the sample group, the "Preparedness for Teach Scale", which consisted of 20 items and 4 subscales. The collected data were analysed for normality by using SPSS 22.0 package software. Because the data demonstrated a normal distribution, the "Independent Samples t-tests" and "One-way ANOVA tests" were conducted. To determine the level of relationship between dependent variables, "Pearson Correlation Analysis" was conducted.

Results: In the gender variable of the sample group, statistically significant differences were observed in the subscales of "Designing the instructional process" and "Understanding the learner". In the grade variable, significant differences were determined in the subscales of "Forming and effective learning atmosphere", "Designing the instructional process" and "Techno-pedagogical competence". In the variable of the department of education, significant differences were determined in all the subscales. Because of the correlation analysis, it was observed that there were positive and strong correlations between the subscales of "Forming an effective learning atmosphere" and "Designing the instructional process" (r= 0.807; p<0.05).

Conclusions: For teachers to become more confident in themselves and develop their competencies more positively, it will be beneficial to enlarge professional standards and teaching framework. Within this scope, considering the results obtained from the study, it will be beneficial to create positive classroom environments and to ensure that prospective teachers benefit from teachers' experiences to improve their preparedness to professional life. The study indicated that the competencies of prospective teachers towards the profession of teaching were generally positive. It was observed that several factors affected prospective physical education and sports teachers in their preparedness for teaching. Thus, it is important to ensure that prospective physical education and sports teachers gain acquisitions for their general competencies in the profession of teaching before they complete their undergraduate education.

Keywords: higher education, sports education, prospective teachers, preparedness, physical education.

Introduction

The advancement and development of societies are rather parallel to the quality of the education they receive. The richness of a country depends on people's effective use and development of their natural skills. Thus, the development of a nation is first the result of people's effort. Finding and using natural resources, turning capital into an investment, developing the technology, producing consumer goods, and maintaining economic relationships require the element of having skilful people. If a country cannot develop its people, it cannot establish anything and cannot sustain itself. In today's societies, when advanced and developed countries are examined, it is observed that both the ratio of the trained people to the society and the period of education with the quality of the education provided are at rather advanced levels. In contrast, in underdeveloped countries, both the ratio of trained people to society and the period of education with the quality of the education provided are observed to be at low levels. Advancements such as gaining the required consciousness to advance, producing technology and science, and adapting to tomorrow's world quickly are only possible when a certain level of education and training is provided [1].

Unless human behaviors are not changed consistently, namely validly and reliably, the ability of humanity to achieve a long-awaited lifestyle may not be a matter of discussion. Equipping people with consistent behaviors, namely problem-solving knowledge and skills, can be possible with education. This is because the most effective tool to train and channelize labor force resources is education. Teachers constitute one of the most important elements of this tool. Innovations in an education system can only be realized via teachers. No matter how well the programs are designed and the education environments are regulated, all the investment and effort are for nothing unless qualified teachers are trained. No education model can produce a service above the personnel to implement that model. Therefore, a school is only as good as its teachers. Undoubtedly, teachers are professionals who assume sacred roles such as training individuals from all professions required by societies and shaping the future of a nation [1, 2]. Countries expect incredible achievements

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from their education systems. Some of these include preparing the youth for tomorrow's roles, training them as productive and creative individuals, protecting them from any kind of bad and harmful behaviors, and ensuring that they are trained as good people and citizens [3]. Education systems can produce individuals with such qualities in classroom environments in schools. Undoubtedly, one of the most vital elements of the priorities of this production system is the teachers.

Today, the profession of teaching is a field that requires expert knowledge and experience at social, cultural, economic, scientific, and technological aspects related to education and professional competence [4]. It is of utmost importance to train qualified teachers. The quality of the opportunities provided for prospective teachers cannot solely enable them to become competent in their profession. The attitudes of prospective teachers toward their profession are also important at this point. The attitudes of individuals affect their emotions as well as affecting their thoughts and behaviors. Erdem et al. [5] stated that teachers' development of positive attitudes toward their profession enables them to become more effective while practicing the profession of teaching.

The belief that a strong education is required to set high standards and meet these standards in education resulted in the emergence of ever-increasing demands on teachers [6]. The education received before starting to practice the profession of teaching is viewed as one of the most important steps for prospective teachers to obtain theoretical and practical knowledge [7]. Everywhere in the world, the prospective teachers are expected to possess the required competencies to become an effective teacher and facilitate students' learning because of the preservice education they receive. The most important role of universities, which assume the responsibility of training teachers, to play on this subject is to develop prospective teachers' abilities to view things with a perspective beyond their own, to empathize with students and to understand the meaning of this experience in terms of learning [8-9]. However, the results of the studies related to teacher education, teacher-training programs, and teachers who started serving recently demonstrated that teacher education was not sufficient in providing them with certain competencies. Teacher education programs fall short of providing prospective teachers to acquire knowledge about real school conditions, namely turning theory into practice [10]. Today, there is a preconception about a negative relationship between the preparedness of prospective physical education and sports teachers and the outputs of prospective teachers. The study conducted within this framework aimed to determine the levels of preparedness of prospective physical education and sports teachers, who study in sports education institutions at the higher education level in Turkey. The study is of importance in terms of revealing how prepared do the prospective physical education and sports teachers feel in professional terms and providing professional contributions to teachers and prospective teachers. According to this general aim, answers to the questions, such as "*Do the preparedness levels of prospective physical education and sports teachers differ according to the variables of gender, grade level, and department of education?*" and "*Are there any relationships between the scores of subscales related to the preparedness levels of prospective physical education and sports teachers to teaching*?".

Material and Methods

Participants.

The study group consisted of 552 randomly chosen prospective physical education and sports teachers, who studied at Ağrı İbrahim Çeçen University, Bitlis Eren University, Dicle University, Fırat University, Harran University, and İnönü University. The study contained 317 prospective teachers who studied in the department of physical education and sports teaching at the 2nd, 3rd and 4th grades. The study also included students, who received pedagogical formation at Education Faculties in Turkey, from the departments of Coaching Training (135 students) and Sports Management (100 students). Because the students who study sports education at the 4th grade receive pedagogical formation education at Education Faculties for teaching, they were included in the study. As a result of this education, the students gain the status of a prospective teacher. Because the physical education and sports teaching students at the 1st grade are assumed not ready for teaching, they were not included in the study group. Furthermore, because the students who receive sports education in other departments (Departments of Coaching Training and Sports Management) did not receive a pedagogical formation education (1st, 2nd, and 3rd-grade students), they were not included in the study group.

It was determined that 526 of the prospective teachers included in the study were single while 26 of them were married. When the age variable of the study group was examined, it was observed that 173 prospective teachers were between 19 and 22 years old while 327 prospective teachers were between 23 and 26 years old in addition to 52 prospective teachers who were 27 years old and above. 395 of the prospective teachers stated that they wished to work in the public sector while 157 of them stated that they wished to serve in the private sector.

Research Design.

Data Collection Tools.

As the data collection tool in the study, a questionnaire form, which was used in a cooperative study in the city of New York in the USA, was used. This scale is called "Prepared to Teaching Scale (PTS)" and it was adapted into Turkish with validity and reliability studies by Yıldırım and Kalman [8]. This scale consisted of 20 items and 4 subscales. The Cronbach alpha reliability coefficient for the 20 items of the scale was calculated as 0.923. Additionally, the Cronbach alpha reliability coefficient for the subscale of "Forming an effective learning atmosphere (FELA)" was calculated as 0.827 while the Cronbach alpha reliability coefficient for the subscale of "Designing the instructional process (DIP)" was calculated as 0.806 in addition to the Cronbach alpha reliability coefficients of 0.838 for the subscale of "Techno-pedagogical competence (TPC)" and the Cronbach alpha reliability coefficient of 0.739 for the subscale of "Understanding the Learner (UL)". This scale form is a self-report form that is scored with a 5-point Likert scale. Each item is evaluated per a 5-point replying system (1: Quite Insufficient – 5: Quite Sufficient).

Statistical Analysis.

In the study, the collected data were analysed by SPSS 22 package software. For the data in the study, a normality test was first conducted to determine whether the "Preparedness to Teaching Scale" and its subscales demonstrated a normal distribution (Table 1).

As a result of the normality analysis, it was determined that the skewness and kurtosis values of the Preparedness to Teaching scale and its subscales were between +1.5 and -1.5 (Table 1). Tabachnick and Fidel [11] stated that the states where kurtosis and skewness values between +1.5 and -1.5 could be interpreted as the presence of normal distribution. For the variables that demonstrate normal distributions, t-test, and one-way variance analyses were conducted. To reveal the sources of significant differences between the variables, LSD tests were conducted. To determine the relationship between the variables, the Pearson correlation analyses were conducted. The relationships between dependent variables were evaluated according to Table 2 [12].

Results

According to the aims of the study, the findings obtained from the prospective physical education and sports teachers were presented below.

T-tests were conducted to determine whether the "*Preparedness to Teaching Scale*" and its subscales differed according to the variable of gender. Statistically significant differences were determined in the subscales of "*DIP*" (t= -3.068; p=0.002; p<0.05) and "*UL*" (t= -2.684; p=0.007; p<0.05). In the other subscales of the "Preparedness to Teaching Scale" (*FELA* and *TPC* subscales), no statistically significant difference was observed (Table 3).

Table 1. Results of the normality test for the preparedness to teaching scale and its subscales

Scale	PTS Scale	FELA Subscale	DIP Subscale	TPC Subscale	UL Subscale
N	552	552	552	552	552
Mean	3.684	3.657	3.713	3.763	3.547
Standard Deviation	0.680	0.724	0.776	0.797	0.836
Skewness	[0.558; 0.104]	[-0.486; 0.104]	[-0.598; 0.104]	[-0.556; 0.104]	[-0.452; 0.104]
Kurtosis	[0.304; 0.208]	[0.224; 0.208]	[0.108; 0.208]	[0.251; 0.208]	[-0.038; 0.208]

Table 2. Values regarding the correlation levels between the dependent variables

r	Correlation Level
0.00-0.25	Rather Weak
0.26-0.49	Weak
0.50-0.69	Moderate
0.70-0.89	Strong
0.90-1.00	Rather Strong

Table 3. The results of the t-test conducted to determine whether there were differences among the study group according to the variable of gender

Scale	Variable	N	$\bar{X}$	Sd	t-Value	p-Value
FELA Subscale	Male	362	3.624	0.694	-1.485	0.138
	Female	190	3.721	0.777		
DIP Subscale	Male	362	3.640	0.772	-3.068	**0.002***
	Female	190	3.852	0.766		
TPC Subscale	Male	362	3.715	0.817	-1.941	0.053
	Female	190	3.853	0.751		
UL Subscale	Male	362	3.478	0.839	-2.684	**0.007***
	Female	190	3.678	0.818		

*p<0.05

Statistically significant differences were determined between 3rd-grade and 4th-grade prospective teachers in the subscales of "*FELA*", "*DIP*" and "*TPC*". In the subscale of "*UL*", no significant difference was observed (Table 4).

Variance analyses were conducted to determine whether the subscales of the "*Preparedness to Teaching Scale*" significantly different according to the variable of the department of education (Table 5). In the "*FELA*" subscale, statistically significant differences were determined between the students of the department of Physical Education and Sports Teaching and the students of the departments of Sports Management and Coaching Training. In the "*DIP*" subscale, statistically significant differences were determined between the students of the department of Coaching Training and the students of the departments of Physical Education and Sports Teaching and Sports Management. In the "*TPC*" subscale, statistically significant differences were determined between the students of the department of Coaching Training and the students of the departments of Physical Education and Sports Teaching and Sports Management. In the "*UL*" subscale, statistically significant differences were determined between the students of the department of Physical Education and Sports Teaching and the students of the departments of Sports Management and Coaching Training.

Positive and strong correlations were determined between the subscales of "*FELA*" and "*DIP*" ($r=0.807$; $p<0.05$). The weakest correlation between the subscales of the scale was determined between the subscales of "*TPC*" and "*UL*", which was positive and at a moderate level.

Table 4. The results of the one-way variance analysis conducted to determine whether the scores of the study group differed according to the variable of grade of education

Scale	Variable	N	$\bar{X}$	Sd	F	p-Value	LSD
	(a) 2nd Grade	90	3.716	0.673			
FELA Subscale	(b) 3rd Grade	327	3.577	0.724	5.593	**0.004***	**b, c**
	(c) 4th Grade	135	3.814	0.734			
	(a) 2nd Grade	90	3.774	0.785			
DIP Subscale	(b) 3rd Grade	327	3.635	0.781	4.544	**0.011***	**b, c**
	(c) 4th Grade	135	3.864	0.735			
	(a) 2nd Grade	90	3.788	0.743			
TPC Subscale	(b) 3rd Grade	327	3.697	0.822	3.270	**0.039***	**b, c**
	(c) 4th Grade	135	3.903	0.755			
	(a) 2nd Grade	90	3.540	0.737			
UL Subscale	(b) 3rd Grade	327	3.494	0.840	2.404	0.091	-
	(c) 4th Grade	135	3.681	0.879			

* p<0.05

Table 5. The results of the one-way variance analysis conducted to determine whether the scores of the study group differed according to the variable of department of education

Scale	Variable	N	$\bar{X}$	Sd	F	p-Value	LSD
	(a) Physical Education and Sports Teaching	317	3.746	0.716			a, b
FELA Subscale	(b) Sports Management	100	3.455	0.697	6.820	**0.001***	
	(c) Coaching Training	135	3.601	0.732			a, c
	(a) Physical Education and Sports Teaching	317	3.760	0.745			c, a
DIP Subscale	(b) Sports Management	100	3.490	0.807	5.157	**0.006***	
	(c) Coaching Training	135	3.770	0.799			c, b
	(a) Physical Education and Sports Teaching	317	3.818	0.782			c, a
TPC Subscale	(b) Sports Management	100	3.506	0.806	6.478	**0.002***	c, b
	(c) Coaching Training	135	3.822	0.793			
	(a) Physical Education and Sports Teaching	317	3.633	0.804			a, b
UL Subscale	(b) Sports Management	100	3.303	0.878	6.056	**0.003***	
	(c) Coaching Training	135	3.528	0.849			a, c

* p<0.05

Table 6. The results of the correlation analysis between the subscales of the preparedness to teaching scale

Scale	Descriptive Values	1	2	3	4
FELA Subscale (1)	r	1			
	p	-			
	N	552			
DIP Subscale (2)	r	**0.807***	1		
	p	0.000	-		
	N	552	552		
TPC Subscale (3)	r	0.634*	0.656*	1	
	p	0.000	0.000	-	
	N	552	552	552	
UL Subscale (4)	r	**0.723***	0.696*	0.571*	1
	p	0.000	0.000	0.000	-
	N	552	552	552	552

* p<0.05

Discussion

According to the results of this study, which aimed to determine the state of preparedness to the teaching of prospective physical education and sports teachers in six different universities in Turkey, in terms of the variable gender, the female prospective teachers stated more positive perceptions in the subscales of "*DIP*" and "*UL*" compared to male prospective teachers (Table 3). Within this scope, it can be stated that female prospective teachers are more ready for the profession of teaching. This situation can also indicate that female prospective teachers are more inclined to the profession of teaching. It can be interpreted that female prospective teachers internalized the profession of teaching more. Some of the studies in the literature support this interpretation [13-19]. Doğan and Çoban [20] stated that the interest of females in the profession of teaching was higher compared to males while reporting that the profession of teaching is regarded as a profession for females according to the culture of the society in Turkey, interpreting that females internalized this thought. However, several studies were observed to report different conclusions. Hacıömeroğlu and Taşkın [21] conducted a study with prospective teachers and did not determine any significant difference in terms of the variable of gender. In a study that investigated the attitudes of prospective teachers toward the profession of teaching, Şahin [22] reported that there was no statistically significant difference between the attitudes of female and male prospective teachers toward the profession of teaching. Furthermore, when various studies were examined, no statistically significant difference was observed between female and male prospective teachers [23-27].

According to the study group's variable of the department of education, significant differences were determined in the subscales of FELA, DIP, and TPC. In these subscales, it was observed that the prospective teachers studying at the 4th grade reported more positive perceptions compared to the prospective teachers studying at other grades. The fact that the preparedness to teaching levels of prospective teachers at the 4th grade was at higher levels was believed to be due to reasons such as receiving more sports education and being in the process of graduation (Table 4). In several studies, the attitudes of prospective teachers toward prospective teachers demonstrated differences according to the level of grade [28-31]. Rajić et al. [9] reported that prospective teachers generally had more developed professional skills in recent years. Göktaş [32] stated that the mean scores of attitudes toward the profession of students at the 1st grade were lower compared to the mean scores of the students at the 2nd, 3rd and 4th grades. It was observed that the attitudes of students toward the profession of teaching were higher at higher grades. In another study, Özder et al. [33] determined that there was no significant difference in terms of the variable of grade. Pehlivan [34] determined that the attitudes of prospective physical education and sports teachers at the last grade were low and stated that this was due to their concerns about finding a job. Sağlam [35] determined statistically significant differences in the variable of grade. Uğurlu and Polat [11] reported that there were significant differences between the prospective teachers at the 1st grade and the 2nd grade. In another study, Gökçe and Sezer [14] reported that there was no significant difference in the attitudes of prospective teachers toward the profession of teaching according to the variable of grade.

According to the study group's department of education, in the subscales of "*FELA*" and "*UL*", statistically significant differences were determined between the students of the department of Physical Education and Sports Teaching and the students of Sports

Management and Coaching Training. It was observed that the preparedness levels of the students, who studied in the department of Physical Education and Sports Teaching, were more positive. In the subscales of "*DIP*" and "*TPC*", statistically significant differences between the students of the department of Coaching Training and the departments of Physical Education and Sports Teaching and Sports Management. It was determined that the levels of preparedness to the teaching of the students of the department of Coaching Training were more positive (Table 5). According to these findings, it can be stated that the levels of preparedness to the teaching of the students studying in the departments of Physical Education and Sports Teaching and Coaching Training were at better levels compared to the prospective teachers at the department of Sports Management. Additionally, these findings can indicate that the variable of the department is an effective factor in becoming a physical education and sports teacher. In parallel with these findings, in a study conducted by Kartal and Afacan [36] it was reported that there were significant differences between the variables of the department of education in prospective teachers. In a study conducted by Azar [37], it was reported that the department of education was a significant factor in this subject. Engin and Koç [38] determined that there were differences in the last grade students at the faculty of education according to the undergraduate program of education. In the study, no statistically significant difference was determined in the subscale of techno-pedagogical competence. Several studies also reported contrary findings [5, 24, 39, 40, 42, 43].

It was observed that there was a positive and strong correlation between the subscales of "*FELA*" and "*DIP*" ($r=0.807$; $p<0.05$). The weakest correlation was determined between the subscales of "*TPC*" and "*UL*", which was positive and at a moderate level (Table 6). Macun et al. [43] investigated the self-sufficiency levels and preparedness to profession levels of prospective teachers and determined that there were moderate and positive correlations between the levels of planning and developing teaching, forming a positive classroom environment, effective learning process, individual differences, academic development self-sufficiencies, and the levels of preparedness to professional life. According to this result, it was interpreted that as the self-sufficiency levels of prospective teachers increased, their levels of preparedness to professional life also increased.

Conclusion

The problem of today is training great teachers. Therefore, teaching is a profession of special expertise as well as an art. Because good education is provided by good teachers. Teachers who know about the needs of the society where they live, who are aware of their capacities, who can be active in teaching, who possess suitable characteristics for teaching, and who have a command of their field will achieve the identity of a teacher. For teachers to become more confident in themselves and develop their competencies more positively, it will be beneficial to enlarge professional standards and teaching framework. Within this scope, considering the results obtained from the study, it will be beneficial to create positive classroom environments and to ensure that prospective teachers benefit from teachers' experiences to improve their preparedness to professional life. The study indicated that the competencies of prospective teachers towards the profession of teaching were generally positive. It was observed that several factors affected prospective physical education and sports teachers in their preparedness for teaching. Thus, it is important to ensure that prospective physical education and sports teachers gain acquisitions for their general competencies in the profession of teaching before they complete their undergraduate education. By this means, qualified individuals who can increase the quality of sports education can be trained. In conclusion, practices that can increase the level of preparedness to teach prospective teachers can be implemented. Interactions between successful physical education and sports teachers, who still serve in education, and prospective physical education and sports teachers, who continue their undergraduate education, can be organized within the scope of "*good examples in education*". This study has several limitations. The study was conducted only with six universities. The number of participants in the study can be increased.

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Conflict of interest

The authors declare that there is no conflict of interests.

Note

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