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Contents

THE IMPORTANCE OF DIRECTLY DERIVED INFORMATION IN THE BASKETBALL JUMP SHOT. A COMPARISON OF CHANGED VISUAL CONDITIONS FROM DIFFERENT SHOOTING SPOTS

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Abstract The basketball jump shot as a movement, allowing visual feedback based corrections, can be considered as a generalized or a specialized motor skill. The purpose of this study is to look into the connection between visual perception and the specialization of a motor skill. Therefore, six male basketball players were asked to perform jump shots under different viewing conditions from their favourite spot (sweet spot) and a second, middle-distance spot. The question was, if performance is affected by the changed visual conditions and whether the shooting spot plays a role in a potentially change in performance. The different visual conditions were first, a regular basketball hoop with no adjustment, second a regular basketball hoop with a covered backboard, and third a regular basketball hoop with a covered rim. Between the different visual conditions, performance did not differ significantly, neither from the sweet spot, nor from the neutral defined spot. However, players showed a significantly better performance from sweet spot than from the neutral spot under regular viewing conditions.

Key words visual perception, basketball, jump shot, generalized motor program, especial skills

Introduction

The jump shot is an elementary component of basketball. Its accuracy decides on victory and defeat. Shot quality depends on the performer's skill, the space and time the player got to execute the shot, and the distance to the basket (Clauss, Schmidt, 1996). Specific visual information before and during the action promotes a successful shooting performance, because the shooter accesses pre-programmed movements (Vickers, 1996). Shot selection depends on player's preferences (usually, every player has his own *sweet spot*, that describes a particular spot on the court, where the athlete feels most comfortable shooting). Research has shown, that changes of peripheral visual information do not affect performance (Keetch, Schmidt, Lee, Young, 2005). Whether visual information,

derived directly from the target, affects performance has not been examined yet. Therefore, the aim of this study is to evaluate if shooting performance is affected by changed direct visual information and if there is a difference in shooting performance between the sweet spot and a middle-distance spot.

The jump shot needs to be considered as a motor action that underlies dynamic processes, as there exists the chance of variation within the movement. Schmidt (2003) re-evaluates the *schema theory*, that describes movement patterns as a co-production of two systems – the Generalized Motor Program (GMP) and the *recall schema*. The GMP is represented in memory as a structure of movement, which can be executed in different ways and situations – it is generalized. The recall schema provides parameters to scale the GMP and gives information about the success of the action. Parameters can be adjusted to particular situations.

As a dynamic movement pattern, that includes several joints, muscles and neurological tissues, the jump shot holds the possibility of motor-output variability. Whereas rapid movements, which are defined as movements of maximum 200 msec duration, do not allow visual feedback based corrections during the action, longer movements, with a duration of at least 200 msec, do (Keele, Posner, 1968; Schmidt, Zelaznik, Hawkins, Frank, Quinn, 1979). Overall, the jump shot has a duration of about one and a half seconds on both misses and hits (Vickers, 2007). Therefore, the basketball jump-shot may allow visual feedback based corrections (e.g., Schmidt Zelaznik, Hawkins, Frank, Quinn, 1979).

Visual information can be provided by the environment. Research on the topic of contextual dependencies in motor skills showed, that the environment plays a role in acquisition and retention of a difficult motor task (Wright, Shea, 1991). If the task is simple, the change of environmental stimuli has no effect on execution quality. With increasing difficulty, the contextual dependencies gain importance. Referring to the basketball jump shot, Keetch et al. (2005) conducted an experiment, where skilled players executed one half of set shots under regular conditions and the other half while the floor was completely covered with a tarp material to eliminate peripheral information from the task. The shots were performed from a distance of 9, 11, 13, 15, 17, 19 and 21 ft from the centre of the basket. The intention was to discover a specific result from 15 ft (the foul line) under regular conditions and with absence of peripheral information. In contrast to the generalization of motor actions, the results of Keetch et al. (2005) support the idea of specificity in particular motor actions as a result of practice. The shot from the foul line (free throw) is executed the most in basketball training. The performance from the 15 ft distance was significant better than predicted by regression, supporting the idea of Keetch et al. (2005) of a specified movement pattern. Consistent with these findings, the results of a review by Shea and Wulf (2005) highlights, that the size of specificity effects appears to increase when the skill is practiced in large extent.

A consecutive study provides information, that the significantly better performance from free-throw range is not a product of habituation on the distance of 15 ft, but an especial skill from this particular spot (Keetch, Lee, Schmidt, 2008). The participants performed set shots from 15 ft distance to the basket from different angles. Supporting the idea of specificity in movement patterns, the participants performed best from free-throw range.

Keetch et al. (2005) did not address the connection between the specificity of a motor skill and direct visual information. A successful shooting performance depends on pre-programmed movements supported by specific visual information taken before and during the throwing process. An examination with female elite basketball players exercising free throws exhibited a fixation of gaze relatively long at the target before initiating the free-throw (Vickers, 1996). The phase of target fixation of experts lasts more than twice as long as non-experts and seems to be critical

in shooting successfully. Further on it was stated that the information acquisition is terminated as soon as the final movements of the shot phase are reached. Thus no information is gathered while conducting free-throws. However, free-throws appertain to static self-paced exercises whereas jump shooting appertain to dynamic non-self-paced exercises. According to Ripoll, Bard, and Paillard (1986) a stable fixation with head and eyes on the target leads to a higher chance of shooting successfully on the target. By aggregating visual information, the shooter perceives the ideal point of ball release hitting the target. Due to the dynamic movement pattern of jump shooting, the eye-head stabilization is here more important than in a static movement pattern (i.e., free-throw) because there is no time to fixate the target before launching the shot.

Contrasting the study of Vickers (1996), Oudejans, van de Langenberg, and Hutter (2002) ascertained basketball players gathering necessary information shortly before releasing the shot. Under several viewing conditions ten male expert basketball players were tested in performing jump shooting while wearing Plato Liquid Cristal goggles (vision-manipulating) and OPTOTRAK markers. At the first viewing condition the basketball players solely got vision until the ball passes the line of sight (early-vision), second the players got vision when the ball just passed the line of sight (late-vision), and in the last condition there were no visual constraints (full-vision). The result stated no significant distinction between late-vision and full-vision condition, while shooting performance under early-vision was significantly worse compared to late- and full-vision.

Subsequent investigations about online visual control during jump shooting are corroborating with Oudejans et al. (2002). De Oliveira, Oudejans, and Beek (2006) stated that basketball players even affect to fixate the basket as late as possible to gather necessary information. The authors assumed accumulating visual information as late as possible is crucial for jump shooting whereas pre-programming is less important (de Oliveria, Oudejans, Beek, 2006; de Oliveira, Huys, Oudejans, van de Langenberg, Beek, 2007; de Oliveira, Oudejans, Beek, 2008).

Once the time of information gathering is determined the further question is what information sources are used by basketball players during basketball shooting. The study of de Oliveira, Oudejans, and Beek (2009) involves several parameters altered in three experiments due to examine what information is necessary to shoot successfully. The last executed experiment included three visual conditions (fully light, only one light dot, and fully dark), two positional conditions (backboard position 4.43 m or 4.78 m away from the participant) and three target conditions (basketball hoop raised, standard, and lowered) unknown by the participants. The results suggest a crucial impact of the angle of elevation. This angle describes the position relatively to the performing person. If the target is close to the participant the angle becomes larger, and if the target is far away the angle becomes smaller. Therefore, it is evidenced that basketball players use online visual control to detect information about the target and if the target differs from acquainted conditions the result of shooting is less successful.

The approaches of schema theory, online visual control and especial skills describe the basketball jump shot from different perspectives. Each of those contributes to a further, better understanding of the cognitive and motor processes of the jump shot as a motor action. The importance of direct visual information was not of primary importance in the current studies. This is why our study combines different viewing conditions and spot preferences of basketball players. We expect the changed visual information to affect the shooters performance negatively. Moreover, it will be interesting, if the excepted influence occurs also regarding the player's sweet spot, or if a specialization of that motor skill prevents the performance from decreasing.

Material and methods

As a result of an a priori power analysis, N = 6 male players of a 6th league (German: Bezirksoberliga) basketball team were recruited to take part in this study (Keetch, Lee, Schmidt, 2008). The average age of the participants was 22.5 years (range 16–27) and they had on average 11 years of basketball experience (range 2–10). Players position and height were no criteria for recruiting. Prior to the beginning of the study participants provided written informed consent. The study was conducted following the ethical guidelines of the local university.

A standard basketball backboard and hoop were used in the shooter's habitual training area. The shooting spots were marked with a 1 × 1 sq m area at the sweet spots (selected by the shooters) and the defined middle-distance spots (selected by the authors of this manuscript) at the top of the paint's edges. The middle distance spot was to be executed opposite to the sweet spot. Meaning, if the player's sweet spot was situated on the left side of the court, the middle distance spot would be determined on the right edge of the paint. The distance from the sweet spot to the basket varied depending on the players shooting preference, whereas the distance from the neutral shooting spot remained the same for each player. Thus, the distance of the sweet spot does not need to correspond with the distance of the neutral spot.

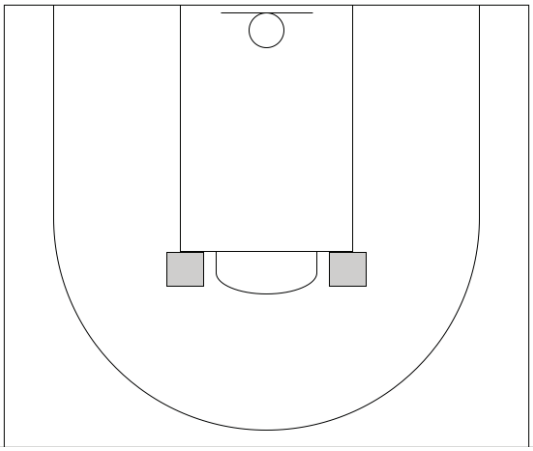

Figure 1. The experimental setup. The coloured areas represent the defined neutral shooting spots. Sweet spots are not marked. The left coloured square represents the neutral shooting spot for the players, that had their sweet spot on the right side of the court. The right coloured square represents the neutral shooting spot for the players, that had their sweet spot on the left side of the court

Three throwing conditions were chosen: In the first condition the regular basket was used (C_1). In the second condition the backboard was covered with a white sheet (C_2), and in the third condition the hoop was covered with conventional crepe tape (C_3). Vickers (2007) subdivides the movement into a *ball-up phase* and an *extension phase* plus the preparation. The participants were instructed to perform one dribble into the marked shooting area followed by the shot.

The quality of the shots was determined with a scale system, that rated the shot by its accuracy. The scale ranged from zero to six points. Six points represented the best score, where the ball was shot into the basket touching neither the backboard nor the ring. The shot was credited five points if the ball hit the inside of the ring before falling into the basket. If the ball fell into the basket bouncing off the backboard, the shooter received four points. Missed shots were credited three points, if the ball bounced off the inside of the rim and dropped out the basket. Two points were given for a shot failing the basket after touching the backboard. The shot was credited one point, if the ball hit the outside of the ring and failed the basket. Touching neither the ring nor the backboard, the participant earned zero points for the shot.

Inspired by Keetch et al. (2005) the performance scores were converted to a percentage score: [(total points)/(6 × number of shots taken)] × 100. By using the percentage score, the results are more comparable within the dataset and can also be related to similar experiences with the procedure from previous studies. Due to the research of Keetch et al. (2005), the percentage score is a known value in the field of basketball research addressing shooting issues. Moreover, does the percentage score depict the quality of the shot better than just distinguish between hit and miss. Both a miss and a hit can have different qualities (e.g., ring inside contact and out – air ball). By valuing the shot with determined criteria, a possible effect can be stated more precisely.

At the beginning of the experiment, the study's procedure and its value for the sport sciences was explained to each individually tested participant. To ensure that the participants understood the aim of our research, we received their written informed consent. After warming up, the experiment started.

Prior to the commencement of each block every player was instructed to take multiple warm-up shots. The participants performed three blocks of 20 shots, ten shots for each shooting spot. Each block was defined by one visual condition (C_1, C_2, C_3). Each visual condition was performed by every participant before switching to the next condition. Intermitting the execution prevents the shooter from fatigue and a resulting decrease of performance which could mislead the interpretation of our results.

During each block of ten shots the shooters were instructed to shoot in their own pace. The task was to make one dribble into the shooting spot, to jump up and take a jump shot. The first ten shots were performed from the personal sweet spot, the last ten shots were performed from the middle distance spot. The middle distance spot was to be executed opposite to the sweet spot. Meaning, if the player's sweet spot was situated on the left side of the court, the middle distance spot would be determined on the right edge of the paint. The players completed ten shots per shooting spot per viewing condition consecutively, in sum 20 shots per viewing condition.

A significance criterion of $\alpha = 5\%$ was defined a priori for all reported results. In order to test the main hypotheses, separate paired-samples *t*-Tests were calculated between each combination of experimental conditions. In case the *t*-Test revealed a significant difference, Cohen's *d* was calculated as effect size.

Results

It was hypothesized that the changed visual conditions affect the shooters performance negatively. Furthermore, we examined if the supposed effect occurs in both shooting spots. However, the results of an unpaired *t*-test revealed only a significant difference in shooting performance from the middle-distance spot and from the personal sweet spot under regular visual condition ($p = 0.0373$, Cohen's $d = 0.269$).

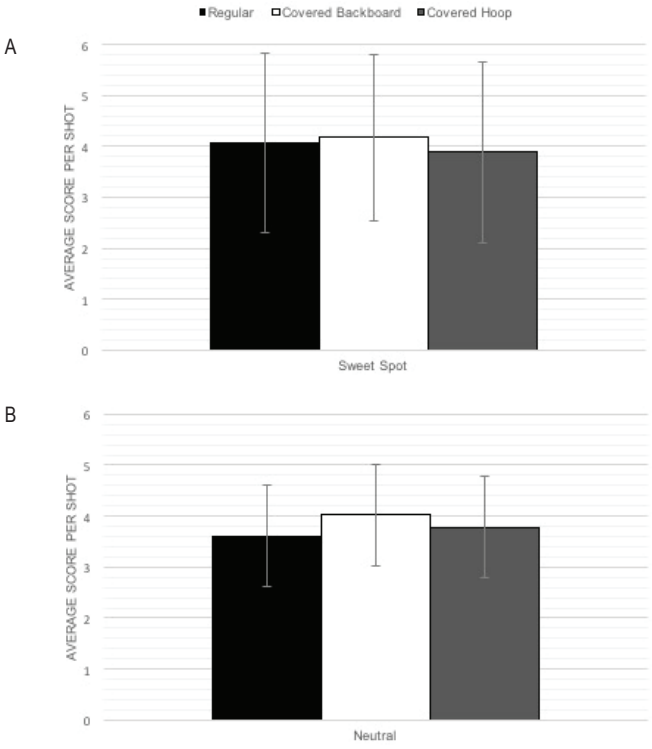

Figure 2. Average score per shot A – from the shooters personal sweet spot; B – from the neutral spot. Each bar represents one visual condition (means ± standard deviaton)

Discussion

In the present study, we examined the influence of several visual conditions on the shooters performance from its personal sweet spot and a neutral spot from mid-range. Based on previous findings (Keetch, Schmidt, Lee, Young, 2005), we hypothesized that direct visual information affects the shooters' performance. More precisely, restrictions of visual information cause a decrease in shooting accuracy. Due to the fact that information is gathered during the shooting process (de Oliveira Oudejans, Beek, 2006; Oudejans, van de Langenberg, Hutter, 2002) we assumed that the shooter receives visual information directly from the aimed target.

Therefore, the players were instructed to take shots from each spot to each visual condition. By using the six-point-scale-system, the shot accuracy was evaluated. Hence, we were able to depict small differences in shot quality. The results showed, that the changed visual conditions did not affect shooting performance. According to the participants' statements, the visual restrictions had no influence on their shots. To strengthen the restrictions for condition two, where the backboard was covered with a white blanket, the backboard could be completely removed. Through this adjustment, the shooters cannot use the backboard as a point of reference.

Same applies to the third condition, where the hoop was covered with crepe tape. If the ring is not simply covered with crepe tape, but hidden behind a blanket or screen, height and distance are the only provided information. The exact position of the basket is unidentified and needs to be estimated. By adjusting these two independent variables, the habitual shooting situation is terminated.

The data analysis revealed a significant effect between shots from the sweet spot and the neutral spot under regular condition. Players shot significantly better from their personal sweet spots. This result supports Keetch's idea of a specialized skill that is acquired through a larger amount of practice from a particular spot (Keetch, Schmidt, Lee, Young, 2005; Keetch, Lee, Schmidt, 2008). There are two concerns we are facing: First, is the better shooting performance distance-specific and second, is the better shooting performance angle-specific. To confirm, that increased performance is linked to this particular spot, its accuracy needs to be compared to the accuracy of shots from either the same distance, but different angle, or same angle, but different distance. If shot accuracy varies within the different spots, Keetch's idea of an especial skill is supported. Further research could examine the differences in kinematics, motor output and innervation of the muscular system concerning this issue.

We acknowledge that statistical power could be increased with a larger sample size. However, performance from the sweet spot as compared to performance from different spots seems to be a strong and robust effect that occurs in a wide range of participants and is specific to (regular) viewing conditions. Nevertheless it would be fruitful to assess whether this effect depends on factors such as participants playing position, basketball expertise or alike.

As there exists a link between the sweet spot and the shot accuracy a practical implication could be derived. In tactical deliberations plays could be pertinent designed, so players shoot from their particular sweet spot to increase the chance of success. Particularly in match-winning situations where the hit decides between victory and defeat.

The present results demonstrate that visual constraints seem not to affect shooting performance, but that the shooting spot does play a role in shot accuracy.

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SPORT INJURIES IN ELITE AMPUTEE FOOTBALL PLAYERS

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Abstract Despite many previous studies dealing with various aspects of physical activity in individuals with an amputation, the risk of injury in amputee footballers has not been assessed thus far. The aim of this study was to characterize the incidence and causes of sport injuries experienced by amputee football players. Furthermore, the incidence of injuries was stratified according to the players' level of competitive aggressiveness and anger, and their role in the field. The study included 21 members of the Polish National Amputee Football Team, who have been followed-up for a period of 6 months. A total of 16 injuries were recorded, including three that required a medical consultation: luxation of the left elbow, adductor strain and ankle sprain. The group of injuries that have not been consulted with a physician included muscle strains (n = 4), abrasions (n = 3), bruising (n = 3), joint subluxations (n = 2) and luxation (n = 1). The injuries turned out to be more frequent in the lower limbs (n = 10) than in the upper ones (n = 6). The risk of injury turned out to be higher during trainings (n = 9) than matches (n = 7). Amputee football seems to be associated with low risk of injury, since only several bodily contusions were documented throughout the study period. The injuries occurred in 38% of the players; this makes amputee football a relatively safe discipline which can be recommended to physically disabled persons.

Key words amputee football, sport injuries, sport games, adapted sports, disability

Introduction

Many previous studies dealt with various aspects of physical activity in individuals who had an amputation. These studies centered primarily around the beneficial effects of physical activity on cardiorespiratory performance, muscle strength and body weight of amputees (Hutzler, Ochana, Bolotin, 1998; Chin, Sawamura, Fujita, 2001). Also some biomechanical aspects have been studied as potential determinants of sport results achieved by limb amputees (Gavron, 1995; Osborough, Payton, Daly, 2009).

Amputee football, also referred to as amp soccer or crutch football, is a relatively new form of sport activity for amputees (www.ampfutbol.pl). Amputee football is a team sport for individuals who had a unilateral lower limb amputation (outfield players) or a unilateral upper limb amputation (goalkeepers). As a result of regularly organized

tournaments, this discipline gains growing popularity worldwide. Amputee football is played with seven players on each team, each using two forearm crutches. The use of prostheses during amputee football matches is forbidden (Yazicioglu, Taskaynatan, Guzelkucuk, Tugcu, 2007). Each game consists of two 25-min halves with a 10-min rest period in between. Each team is allowed a 1-min time-out per either half (Yazicioglu, 2007).

Amputee football is one of few team sports suitable to study the effects of physical exercise on body and various functional aspects of limb amputees. Previous studies dealing with the problem in question centered primarily around an association between body composition, anaerobic performance and sprint ability (Özkan, Kayıhan, Köklü, Ergun, Koz, Ersöz, Dellal, 2012), as well as around nutritional characterization of amputee football players (Gomes, Riberio, Soares, 2006). Simim et al. (2013) studied anthropometric profile and physical performance characteristics of amputee football players. Also the effects of playing crutch football on balance, strength and quality of life in unilateral below-knee amputees have been studied (Yazicioglu, Taskaynatan, Guzelkucuk, Tugcu, 2007). Yanci (2014) compared the quality of life of amputated footballers and non-footballers; the study demonstrated that this discipline exerts beneficial effects on the quality of life of disabled people. Similar conclusions were also presented by Monteiro et al. (2014) who compared the quality of life of individuals with lower limb amputations who played football and those who did not engage in any sport activities.

Although some psychological, motor and morphological aspects of amputee football were a subject of previous research, still a number of important issues, including health threats posed by this discipline, have not been addressed adequately thus far. Injuries constitute a potential adverse effect of practicing sport in both fully able-bodied and disabled persons. The issue of injuries in Paralympic sports is difficult to recognize owing small sample sizes, short periods of evaluation and lack of objective medical diagnoses (most available data originate from retrospective studies and survey-based analyses) (Willick, Webborn, 2011; Molik, Marszałek, 2013). The results of previous studies imply that the incidence of injuries among disabled and able-bodied athletes is similar, and differences between these two groups refer to the types and mechanisms of experienced contusions (Ferrara, Peterson, 2000). Willick and Webborn (2011) proposed two classifications of injuries acquired by disabled sportspersons: due to the type of practiced sport and due to the type of disability presented by an athlete.

Based on available literature, sport injury can be defined as a bodily injury that arose during training or competition, and disabled, hindered or modified athlete's participation in sport activities for at least one day (Ferrara, Buckley, McCann, 1992; Ferrara, Buckley, 1996). Such definition of sport injury was used in many previous studies dealing with the problem in question (Taylor, Williams, 1995; Bauerfeind, Koper, Wieczorek, Urbański, Tasiemski, 2015).

Previous research demonstrated that Paralympic athletes typically experience minor injuries that contribute to discontinuation of training for no more than seven days and do not require a long-term recovery (Molik, Marszałek, 2013). Previous studies of injuries experienced by physically disabled team sport athletes included primarily individuals who practiced wheelchair basketball (Danis, Mikuła, 1999), sitting volleyball (Wieczorek Wieczorek, Jadczak, Śliwowski, Pietrzak, 2007; Bolach, Bolach, Dorobisz, 2010), regular volleyball (Reeser, 1999; Bolach, Bolach, Łobos, 2010a), and wheelchair rugby (Bauerfeind, Koper, Wieczorek, Urbański, Tasiemski, 2015). These studies demonstrated that these are the injuries resulting from overstrain, rather than the so-called acute injuries linked directly to practicing sport, that represent the main problem in disabled athletes. Consequently, the authors of these studied emphasized the need to continuously improve the preventive measures. Molik and Marszałek (2013) pointed to the need to determine the underlying mechanisms of injuries in Paralympic athletes. Other authors

analyzed relationships between the incidence of injuries and the level of aggressiveness and anger in sports (Maxwell, Moores, 2007; Maxwell, Visek, 2009; Visek, Maxwell, Watson, Hurst, 2010).

Based on the review of available literature it can be concluded that the problem of sport injuries in limb amputees has not been studied thus far. In the lower limb amputee, an injury to the other, normal limb, will inevitably disable walking and not infrequently, such person will be temporarily forced to use a wheelchair. In upper limb amputees, a severe injury of normal limb will preclude involvement in basic activities of daily living, such as eating, everyday hygiene, driving, dressing up, etc. The aim of this study was to characterize the incidence of sport injuries among amputee football players. Furthermore, we analyzed the incidence of injuries according to the level of aggressiveness and anger in sports, as well as according to players' role in the field (defensive/offensive). An accurate medical diagnosis and characterization of sport injury determinants constitute the basis for efficient prevention of these adverse effects of sport activity in disabled individuals.

Material and methods

The study included members of the Polish National Amputee Football Team, 21 men aged between 17 and 44 years (mean 28.4 years, SD = 6.55). The subjects practiced amputee football for 2.7 years (SD = 1.04) on average, and their mean number of time spent for training was 230 min (SD = 124) weekly. The study group included 12 defensive players (8 defenders and 4 goalkeepers) and 9 offensive players (3 attackers and 6 midfield players). The subjects presented with two types of disability: congenital (n = 8) and acquired one (n = 13). In 16 players, hypoplasia or amputation involved the lower limb, and in 5 the upper limb. Aside from amputee football, 10 athletes have been also practicing another sport discipline (strength sports, swimming, jogging, cross country skiing, Alpine skiing, cycling). The study group included 5 persons with disability class A2, 6 and 3 with disability classes A4 and A8, respectively, and 7 with limb hypoplasia. The larger proportion of participants lived in an urban setting (n = 14) than in a rural setting (n = 7). The sample included the same number of participants with master and bachelor's degree (n = 4 each). The largest proportion of subjects had secondary education (n = 9), and the smallest primary (n = 3) or vocational education (n = 1). Most of the examined athletes were professionally active (n = 12); eight persons were still students and one remained unemployed.

The study was conducted between September 2014 and February 2015. During this period, examined athletes participated in a total of four training camps and ten amputee football games. Mean number of training and tournament days during the study period was 13.28 (SD = 7.88). The analysis included all athletes, as injuries were also recorded in those with lesser number of training and tournament days. All training sessions were preceded by a 20-min warm-up and ended with a 10-min stretching routine.

The study had a longitudinal character. The incidence and etiology of sport injuries were monitored throughout a 6-month period, with additional measurements and data collected at the beginning and at the end of the project. At the beginning of the project, in September 2014, the respondents completed sport activity, demographic and medical data questionnaires, and the levels of their aggressiveness and anger in sports were determined. Furthermore, the registers of injuries requiring/non-requiring a medical consultation have been handed out to the athletes. These registers were used to record the injuries experienced during the study period. At the end of the project, in February 2015, each participant was subjected to a medical consultation to classify any injuries that were not reported to a physician during the study period. Moreover, medical data provided by physicians in charge have been added to the records of more severe injuries. All of those who agreed to participate were informed about the

study background and objectives, and were asked to complete the consent form before entering the study. It was emphasized that their participation was voluntary and confidentiality was assured.

The study was based on a diagnostic survey with four instruments.

1. A personal survey consisted of three parts: sport activity (information on practicing amputee football: number of trainings, duration of training sessions, other practiced sport disciplines), demographic (sex, year of birth, marital status, place of residence, education, occupation), and medical questionnaire (date of diagnosis, type of disability).
2. A register of injuries that required a medical consultation (date, circumstances of the injury, date of medical intervention, conducted diagnostic tests, diagnosis, treatment and its duration, time of training absence, duration of ailments).
3. A register of sport injuries that have not been consulted with a physician. In this questionnaire, respondents provided information about the injuries (anatomical region, type) and circumstances thereof (place, type of strain, phase of a game/training, situation in the field).
4. The Competitive Aggressiveness and Anger Scale (CAAS) designated to identify athletes being prone to acts of aggression and anger (Maxwell, Moores, 2007). The scale includes 12 questions, six evaluating the level of aggressiveness and another six referring to the level of anger. Aggressiveness refers to the willingness to use physical and verbal abuse, and anger to the degree/level of irritation resulting from a loss, as well as to the degree/level of negative emotions against the opponents. The answers are given on a 5-item Likert-type scale, where 1 corresponds to “almost never” and 5 to “almost always”. The higher the score, the higher the levels of aggressiveness and anger presented by a given athlete. Maxwell and Moores (2007) confirmed high reliability of the CAAS in a group of able-bodied athletes (Aggressiveness: $\alpha = 0.83–0.84$; Anger: $\alpha = 0.78–0.83$).

Characteristics of sport injuries were presented as numbers and percentages. Overall number of injuries was expressed as a measure of central tendency (mode). The level of competitive aggressiveness and anger was expressed with descriptive statistics (mean and standard deviation). Normal distribution of studied variables was verified with Shapiro-Wilk test. The significance of an intergroup difference in competitive aggressiveness and anger levels of offensive and defensive players was verified with Student t-test. Correlation between the level of competitive aggressiveness and anger and the incidence of sport injuries was determined on the basis of Spearman’s rank correlation coefficient (r_s) values. The incidence rate for sports injuries was computed as the number of injuries divided by the number of players and the mean number of training and tournament days (Magno, Silva, Bilzon, Duarte, Gorla, Vital, 2013).

Results

8 out of 21 athletes experienced an injury during the 6-month follow-up period. A total of 16 injuries were recorded, including three that required a medical consultation: luxation of the left elbow, adductor strain and ankle sprain (Table 1). All injuries that required a medical consultation occurred in defensive players. The group of 13 injuries that have not been consulted with a physician included muscle strains (n = 4), abrasions (n = 3), bruising (n = 3), joint subluxations (n = 2) and luxation (n = 1). Analysis of data presented in Table 1 suggests that injuries were more common in defensive players (n = 10; incidence rate = 0.06) than in offensive ones (n = 6; incidence rate = 0.05). The study group included three athletes who experienced more than three injuries during the analyzed

period and a few persons with single contusions. Thirteen athletes, among them 67% of offensive players (Mo = 0) and 57% of defensive players (Mo = 0), did not experience an injury throughout the analyzed period.

Table 1. Detailed analysis of injuries experienced by amputee football players, stratified according to their position in the field

No.	Athlete	Non-consulted with a physician					Consulted with a physician	Total
		abrasion	bruising	muscle strain	luxation	subluxation		
1.	Defensive	0	0	1	0	1	1	3
2.	Defensive	0	0	0	0	0	1	1
3.	Defensive	0	0	0	0	0	0	0
4.	Defensive	0	0	0	0	0	0	0
5.	Defensive	0	0	0	0	1	0	1
6.	Defensive	1	1	1	1	0	0	4
7.	Defensive	0	0	0	0	0	1	1
8.	Defensive	0	0	0	0	0	0	0
9.	Defensive	0	0	0	0	0	0	0
10.	Defensive	0	0	0	0	0	0	0
11.	Defensive	0	0	0	0	0	0	0
12.	Defensive	0	0	0	0	0	0	0
Total (n)*		1	1	2	1	2	3	10
Total (%)*		8%	8%	17%	8%	17%	25%	14%
1	Offensive	2	0	2	0	0	0	4
2	Offensive	0	1	0	0	0	0	1
3	Offensive	0	0	0	0	0	0	0
4	Offensive	0	0	0	0	0	0	0
5	Offensive	0	0	0	0	0	0	0
6	Offensive	0	0	0	0	0	0	0
7	Offensive	0	1	0	0	0	0	1
8	Offensive	0	0	0	0	0	0	0
9	Offensive	0	0	0	0	0	0	0
Total (n)**		2	2	2	0	0	0	6
Total (%)**		22%	22%	22%	0%	0%	0%	11%
Overall in the study group (n)		3	3	4	1	2	3	16
Overall in the study group (%)		14%	14%	19%	5%	10%	14%	13%

* Offensive players.
** Defensive players.

When the injuries were stratified according to their type and anatomical region involved (Table 2), they turned out to be more frequent in the lower limbs than in the upper ones. Lower limb injuries, specifically muscle strains (n = 3), abrasions (n = 2) and bruising (n = 2), typically involved thigh and hip. Subluxations or luxations (n = 2) were typical injuries of the upper limbs; also single cases of abrasion and bruising were observed in this anatomical region.

Circumstances of the injury may refer to the place it was experienced, type of strain, phase of a game/training and situation in the field (Table 3). The majority of injuries took place on a synthetic surface, the so-called artificial turf (n = 10). The risk of injury turned out to be higher during trainings (n = 9) than matches (n = 7). Most injuries (n = 10) occurred mid-training or mid-game. Regarding the situation in the field, four injuries took place during

interaction between a player who possessed the ball and his opponent. However, amputee football players equally often experienced injuries without interaction with their opponents, either possessing the ball (n = 4) or not (n = 4). Detailed data on the circumstances of injuries experienced by amputee football players are presented in Table 3.

Table 2. Anatomical regions affected during injuries experienced by amputee football players

Non-consulted with a physician					Consulted with a physician
abrasion	bruising	muscle strain	luxation	subluxation	
upper limb (n = 6)					
– hand	– 2nd digit	– biceps brachii muscle		– proximal interphalangeal joint – radiocarpal joint	– elbow luxation
Lower limb (n = 10)					
– thigh – knee	– hip – stump	– triceps surae muscle – quadriceps femoris muscle – hip adductors	– hip joint		– adductor strain – ankle sprain

Table 3. Circumstances of injuries experienced by amputee football players

Circumstances of the injury	I	II	III	IV	V	Sum
Place of injury						
Indoor (rubber surface/tartan)	2	0	0	1	0	3
Outdoor field with a synthetic surface (artificial turf)	1	3	4	1	1	10
Outdoor field with a natural grass	0	0	1	0	2	3
Type of strain						
Game	2	1	1	2	1	7
Training	1	2	4	0	2	9
Phase of a game/training						
Early game/training (warmup)	1	0	2	1	0	4
Mid-game/-training	2	2	2	1	3	10
Late game/training	0	1	1	0	0	2
Situation in the field						
Interaction with an opponent (while possessing the ball)	1	2	1	0	0	4
Interaction with an opponent (without possessing the ball)	1	0	1	0	0	2
Without interaction with an opponent (while possessing the ball)	0	0	1	2	1	4
Without interaction with an opponent (without possessing the ball)	0	0	2	0	2	4
Injury caused by crutches	1	1	0	0	0	2

I – abrasion, II – bruising, III – muscle strain, IV – luxation, V – subluxation.

Defensive players presented with lower levels of competitive aggressiveness and anger (mean = 31.5 pts, SD = 8.1) than offensive athletes (mean = 34.2 pts, SD = 12.3), but this difference did not turn out to be statistically significant ($t = 0.6147$, $p = 0.5461$). Moreover, no significant correlation was found between the level of aggressiveness and anger in sports and the number of experienced sport injuries ($r_s = –0.095$, $p > 0.05$).

Discussion

Amputee football is a discipline addressed to relatively young persons, typically with a history of lower limb amputation and some sport experience, usually in football. Due to specific character of this discipline, players should present with high levels of general and special fitness, as well as with adequate football skills (Yazicioglu, Taskaynatan, Guzelkucuk, Tugcu, 2007; Simim, Silva, Júnior, Mendes, Mello, Mota, 2013). These are athletes with such predispositions who are sought at early stages of recruitment. On the other hand, amputee football also promotes development of the characteristics mentioned above.

The aim of this study was to characterize sport injuries experienced by amputee football players during a 6-month follow-up period. Although the study subjects experienced a total of 16 injuries, most of them did not require a medical consultation. Our hereby presented findings imply that injuries experienced by amputee football players do not differ significantly from those observed among representatives of other sport disciplines. They are neither more specific nor more harmful than in the case of other sports (Danis, Mikuła, 1999; Reeser, 1999; Wieczorek, Wieczorek, Jadczak, Śliwowski, Pietrzak, 2007; Bolach, Bolach, Dorobisz, 2010; Bolach, Bolach, Łobos, 2010a; Bolach, Bolach, Osiecka, 2010b; Bauerfeind, Koper, Wieczorek, Urbański, Tasiemski, 2015). Bolach et al. (2010b) analyzed the incidence of sport injuries among wheelchair rugby players. They showed that the incidence of injuries among representatives of this discipline is low (33%), similar to that observed in our amputee football players (38%). Similar to amputee football players, the most common types of injuries experienced by wheelchair rugby players were bruising, abrasions and muscle strains (Bolach, Bolach, Osiecka, 2010b). Aside from injuries of this type, our amputee football players suffered also from upper and lower limb sprains and subluxations.

According to Bolach et al. (2010b), wheelchair rugby players more often experienced injuries during competition than during trainings; an opposite phenomenon was observed in our present study of amputee football players who were more prone to injury during trainings. Perhaps, this should be linked to lesser popularity of amputee football and resultant lower number of played matches. Similar to amputee football players, also athletes practicing wheelchair basketball were shown to be more prone to injury during trainings, and typically experienced contusions of upper limbs. Consequently, despite many differences in specifics of these two disciplines, amputee football and wheelchair basketball seem to show some similarities in this matter (Curtis, Black, 2009).

Our study demonstrated that most injuries experienced by amputee football players took place mid-training or mid-game, typically on a synthetic surface. The latter phenomenon should be linked with the fact that most of amputee football tournaments are held on such a surface, which can be considered an important determinant of injury.

Amputee football players are more prone to experience upper limb injuries than representatives of its natural reference discipline, conventional football. While conventional footballers most commonly suffer from contusions of lower limbs and heads, nearly a half of injuries experienced by our amputee football players involved upper limbs, predominantly hand (Junge, Dvorak, Graf-Baumann, 2004, Junge, Dvorak, 2015). High incidence of hand injuries among amputee football players results from the specifics of this discipline in which upper limbs are largely involved for locomotor purposes.

In this study, we analyzed the incidence of sport injuries depending on players' position in the field. Most of defensive and offensive players did not experience an injury during the analyzed period, as confirmed by mode values equal to 0 (Mo = 0). The subset of players who experienced an injury included a greater proportion of defensive players, but the difference in the incidence of contusions among defensive and offensive athletes was

relatively small. It is noteworthy, however, that more serious injuries that required medical consultation were recorded solely among the defensive players. This observation is inconsistent with the results published by Bauerfeind et al. (2015), according to whom these were offensive wheelchair rugby players who were more prone to sport injuries. Consequently, our findings imply that amputee football, particular emphasis should be put on prevention of injuries in players with more defensive tasks.

Another objective of this study was to analyze a relationship between the level of competitive aggressiveness and anger and the players' position in the field. We assumed that depending on their aggressiveness and anger levels, amputee football players are predisposed to play as defenders or attackers, which in turn affects their risk of injury. However, we did not observe a significant difference in the competitive aggressiveness and anger levels of defensive and offensive athletes, which implies that this parameter is not related to player's role in the field. Furthermore, no significant relationship was found between the number of injuries experienced by our athletes and their aggressiveness and anger levels, which constitutes another argument for the lack of association between the risk of injury and player's personality. This finding is consistent with the results of the study of wheelchair rugby players, conducted by Bauerfeind et al. (2015).

We analyzed the risk of injury in amputee football players from a different perspective than in most previous studies dealing with the problem in question. The authors of previous studies typically analyzed the occurrence of injuries retrospectively, referring to the whole history of a given athlete (Wieczorek, Wieczorek, Jadczak, Śliwowski, Pietrzak, 2007; Bolach, Bolach, Dorobisz, 2010; Bolach, Bolach, Łobos, 2010a; Bolach, Bolach, Osiecka, 2010b). Such attitude provides an information about the overall prevalence of injuries involving specific body parts in representatives of various disciplines, but without specifying a starting point of the analysis. In contrast, we studied the incidence of sport injuries among amputee football players during the specified 6-month period. As a result, the number of injuries documented in our study may seem relatively smaller. We studied a relationship between the incidence of injuries and the number of training sessions and games. Such attitude seems reasonable as it determines the link between each injury and its cause, thus providing a rationale for implementation of appropriate preventive measures (Bauerfeind, Koper, Wieczorek, Urbański, Tasiemski, 2015). Moreover, the data on anatomical regions being particularly predisposed to injury can be included in such analysis.

To the best of our knowledge, the hereby presented study was the first one to assess the risk of sport injury among amputee football players. Although amputee football is a relatively new sport discipline in Poland, it is a subject of a dynamic development, representing an attractive form of sport activity for persons with a history of unilateral limb amputation. We are well aware of potential limitations of this study, associated with a relatively small size of the sample and its heterogeneity in terms of age. However, it should be stressed that we examined solely the members of Polish National Amputee Football Team, i.e. a selected group of elite amputee footballers representing our country during international tournaments.

It should be remembered that playing football with crutches requires high speed and dynamics, frequent sidesteps, rapid start and stop movements, which is particularly challenging in the case of disabled athletes. Consequently, such persons need to present with a specific combination of strength and endurance, as well as with a good motor coordination, balancing skills and proprioception (Yazicioglu, 2007; Yazicioglu, Taskaynatan, Guzelkucuk, Tugcu, 2007; Özkan, Kayıhan, Köklü, Ergun, Koz, Ersöz, Dellal, 2012). These skills constitute the basis for specific motor patterns characteristic for amputee football, sometimes substantially different from those typical for other team sports, including conventional football. Consequently, amputee football and conventional football

should be considered two distinct sport disciplines. The principal difference stems from the fact that amputee footballers use crutches, and as a result these are their upper limbs which play a key role during movement (Özkan, Kayıhan, Köklü, Ergun, Koz, Ersöz, Dellal, 2012). During the course of trainings, amputee players need to develop specific motor patterns that provide adequate football technique irrespective of changing fulcrum.

Consequences of sport injuries in physically disabled persons are markedly more serious than in able-bodied athletes (Bauerfeind, Koper, Wieczorek, Urbański, Tasiemski, 2015). This puts particular emphasis on monitoring of injuries experienced by physically disabled athletes during the course of training, and identification of their determinants. Such data are vital from the perspective of coaching team, medical staff and players themselves, providing information on the most common types of injuries, typically affected anatomical regions and predisposing situations in the field.

Conclusions

1. Amputee football seems to be associated with low risk of injury, since only several bodily contusions were documented throughout the study period. The injuries occurred in 38% of the players; this makes amputee football a relatively safe discipline which can be recommended to physically disabled persons.

2. Contrary to conventional football, injuries experienced by amputee football players were not limited to lower limbs, but also upper limbs were affected. Most injuries were abrasions, bruising and muscle strains. The occurrence of upper limb injuries should draw attention of coaching teams and medical staff to appropriate training and biological renewal programs aimed at proper preparation of players to competition.

3. Amputee footballers more often experienced injuries during trainings than matches, which points to their considerable involvement in preparation to sport competition.

4. Sport injuries were more frequent among defensive than offensive players; also injuries requiring medical consultation occurred solely in the former group.

5. Offensive and defensive players did not differ significantly in terms of their competitive aggressiveness and anger levels, which implies that the latter parameter is not related to athletes' function in the field. Moreover, no association was found between the incidence of sport injuries and the levels of aggressiveness and anger presented by amputee footballers.

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DIETARY INTAKE OF MINERALS IN DIETS OF ADULTS PREPARING FOR MARATHON

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Abstract The aim of the study was to evaluate the mineral content in the diets of amateurs preparing for a marathon. The examined group consisted of 92 women (W), whose average age was 30.8 ±6.7 years and 66 men (M), whose average age was 33.2 ±6.6 years. The evaluation of the mineral content of the diets of the surveyed people was done using three-day dietary records which included one day of the weekend. The average daily sodium content in the diets of women was 1,952.2 ±729.2 mg, and in the diets of men it was 3,093.1 ±1,063.3 mg whereas potassium content was 3,361.6 ±798.5 mg and 3,900.3 ±982.3 mg respectively. The potassium content of less than 90% of fulfilling the norm was observed in the diets of 84.8% of women and 66.7% of men. The average content of calcium in the diets of women and men amounted to 887.5 ±278.8 mg and 1,162.6 ± 434.3 mg/day respectively. The diets of 30.4% of women and 16.7% of men had insufficient calcium content as compared to the norms. The average daily phosphorus and magnesium content was significantly higher in men than in women (1,374.6 ±348.6 vs 1,823.5 ±473.0 mg and 373.4 ±107.1 vs 423.6 ±108.8 mg). Magnesium intake was insufficient in the diets of 14.1% of women and 28.8% of men. The average daily content of iron, zinc and copper in the group of women was: 12.1 mg, 10.1 mg and 1.4 mg, while in the diets of men respectively 14.8 mg, 13.5 mg and 1.5 mg. The highest percentage of diets not fulfilling the norm was found for calcium and potassium in women, and potassium and magnesium for men.

Key words marathon, minerals, micronutrients, macronutrients

Introduction

In recent years, running has become a very popular form of physical activity, as evidenced by the growing number of amateurs competing in marathons and half-marathons. Training in preparation for a marathon is similar to the structure of long-distance runs that best prepare for long-term physical exertion (Dzięgiel, Lubowiecki-Vikuk, 2013; Skrzypczak, Jarecka, Fąk, 2014). When preparing for a marathon, the whole functioning of the body is subject adaptation, especially cardiovascular, nervous and respiratory systems (Celejowa, 2008). Among those taking part

in the marathon, there is great interest in ways that would help to achieve the maximum efficiency of the body during prolonged exercise. One of them is the use of a properly balanced diet, which may significantly affect the sports results obtained and support the regeneration process after exercise (Figurska-Ciura, Bartnik, Bronkowska, Biernat, 2014).

The diet of physically active people during training should take into account not only the increased demand for energy and ingredients such as carbohydrates, proteins and fats, but also consider vitamins and minerals which act as the regulatory and building blocks (Żbikowski, Lebiedzińska, Czaja, 2007). The following minerals may be mentioned among the most important minerals in the diet of the athlete: calcium, phosphorus, magnesium, sodium, potassium, iron, zinc and copper. Deficiencies of vitamins and minerals in athletes results in a reduced ability to exercise. Due to irregular eating or restricting the use of certain products, many athletes consume an insufficient amount of vitamins and minerals. Training also increases the demand for these components because of the accelerated metabolism and losses associated with the loss incurred through sweat and urine (Matwiejuk, 2009; Szczepańska, Malczewska, 2003). Supplementing these minerals in their diet thus becomes a necessity. Increased food intake in order to cover the energy needs should also protect the athletes in terms of supply of dietary minerals (Maughan, 1999).

The aim of the study was to evaluate the mineral content in the diets of amateurs preparing for a marathon.

Material and methods

The study group consisted of 158 people (92 women and 66 men) who were preparing to participate in the Wroclaw marathon in 2012 and 2013. The average age of women and men was 30.8 ±6.7 and 33.2 ±6.6 years respectively. All subjects participated in the program entitled “I Ty możesz zostać maratończykiem”. Running classes lasted half a year, and their aim was to prepare the participants in the program to complete a marathon. During the preparatory period the marathoners took part in 2 organized practise sessions per week for a total average distance of 25–35 km. Additionally, they had to do 2 workouts individually in their spare time, according to the trainer’s recommendations.

The subjects had their height, weight, waist and hip circumferences measured and their Body Mass Index (BMI) was calculated.

Dietary data were collected in the preparatory period before the marathon in May and June in 2012 and 2013. The evaluation of the mineral content in the diets of people participating in the study carried out by the 3-days dietary record with the following days: one day of training, one day without training and one day of the weekend. Study participants wrote down consumed food products using household measurements (eg. a spoon, plate, cup), and then trained surveyors clarified the of mass food intake using the “Album of photographs of food products and dishes” (Szponar, Wolnicka, Rychlik, 2000). The analysis of daily food rations in terms of mineral content were performed the computer program “Food Processor SQL” containing a Polish database developed by Kunachowicz et al. (2005).

For each of the subjects, an average content of minerals such as sodium, potassium, calcium, phosphorus, magnesium, iron, zinc and copper in diet was calculated and compared it with the standards of nutrition for the Polish population at the level of Estimated Average Requirement (EAR) or Adequate Intake (AI), taking into account the age and gender of the subjects (Jarosz, 2012). The average fulfilment of norms of minerals and the proportion

of people whose diets did not meet the norms were evaluated. The proportion of diet, which fulfilled the norms for minerals within the following ranges: <90%, 91–110%, 111–150%, 151–200%, >200% were also evaluated.

A statistical analysis was performed using the software STATISTICA 10 from StatSoft, Inc. USA. Comparison of the mineral content in the diets of men and women were performed using non-parametric U Mann Whitney test, and categorical variables using the Chi^2 test. P value <0.05 was assumed as the level of significance.

Results

Table 1 shows the characteristics of the study group of women and men. Average BMI indicated that studied women were characterized by normal weight, while in men the average value was in the overweight range.

Table 1. Anthropometric characteristics of surveyed women and men

Parameter	Unit	Women (n = 92)	Men (n = 66)
		X ± SD	X ± SD
Age	years	30.8 ±6.7	33.2 ±6.6
Height	cm	166.0 ±6.1	178.9 ±7.1
Weight	kg	61.8 ±9.1	81.2 ±11.9
BMI	kg/m^2	22.4 ±2.7	25.3 ±2.8

X – mean, SD – standard deviation, n – number of people surveyed.

The study evaluated daily food rations (DFR) in terms of the content of mineral components such as sodium, potassium, calcium, phosphorus, magnesium, iron, zinc and copper, and the results are shown in Tables 2 and 3. The average intake of all dietary minerals with the exception of copper was statistically significantly higher in a group of men compared to the group of women (Table 2). Daily food rations for men and women, with an average energy value of 1,982.3 ±506.5 and 2,808.1 ±731.6 kcal/day respectively ($p < 0.05$), covered the needs of the majority of the study group to evaluated minerals, with the exception of potassium. It was found that diets of 93% of women and 80% of men did not cover the demand for this mineral.

Table 2. Average daily intake of dietary minerals in a group of men and women preparing for a marathon, and norms for selected minerals by gender and age of the respondents

Minerals	Unit	Women (W) n = 92		Men (M) n = 66		W vs M
		norms	X ± SD	norms	X ± SD	p
Sodium	mg	1,500**	1,952.2 ±729.2	1,500**	3,093.1 ±1,063.3	<0.000
Potassium	mg	4,700**	3,361.6 ±798.5	4,700**	3,900.3 ±982.3	0.001
Calcium	mg	800*	887.5 ±278.8	800*	1,162.6 ±434.3	<0.000
Phosphorus	mg	580*	1,374.6 ±348.6	580*	1,823.5 ±473.0	<0.000
Magnesium	mg	255[a]–265[b]	373.4 ±107.1	330[a]–350[b]	423.6 ±108.8	0.014
Iron	mg	8*	12.1 ±3.5	6*	14.8 ±4.7	<0.000
Zinc	mg	6.8*	10.1 ±2.6	9.4*	13.5 ±3.8	<0.000
Copper	mg	0.7*	1.4 ±0.5	0.7*	1.5 ±0.4	0.079

* EAR – Estimated Average Requirement, ** AI – Adequate Intake, [a]– EAR in the 19–30 years age group, [b]– EAR in the 31–50 years age group, X – mean, SD – standard deviation, $p < 0.05$ – statistically significant.

Table 3. The average fulfilment of norms for selected minerals and comparison of the proportion of the diets in a group of women and men who have not met the norm on selected minerals

Minerals	Women (W) n = 92		Men (M) n = 66		W vs M *p < 0.05
	percent fulfilment of norms X ± SD	percent of diets lower than the norm	percent fulfilment of norms X ± SD	percent of diets lower than the norm	
Sodium	130.1 ±48.6	26.1	206.2 ±70.9	3.0	0.0001
Potassium	71.5 ±17.0	93.5	83.0 ±20.9	80.3	0.0120
Calcium	110.9 ±34.8	44.6	145.3 ±54.3	19.7	0.0012
Phosphorus	237.0 ±60.1	0.0	314.4 ±81.6	0.0	–
Magnesium	143.9 ±41.7	14.1	124.2 ±32.3	30.3	0.0137
Iron	151.1 ±43.2	8.7	247.4 ±78.2	0.0	0.0366
Zinc	147.9 ±38.8	10.9	143.5 ±40.1	12.1	0.8071
Copper	203.7 ±67.6	1.1	217.0 ±56.3	0.0	0.8671

X – mean, SD – standard deviation, * p value for differences in the amount of diets lower than the norm between men and women.

The average intake of sodium with the diet was 1,952.2 ±729.2 mg/day in the group of women and 3,093.1 ±1063.3 mg/day in the group of men, which was 130.1% and 206.2% of the norm. The study did not take into consideration the salt added to foods during their preparation.

The average intake of calcium in the diets of women surveyed was 887.5 ±278.8 mg and 1,162.6 ±434.3 mg in the group of men, which represented 110.9% and 145.3% fulfilment of the norms. At the same time, it was observed that the diets of 44.6% of women and 19.7% of men did not cover the daily requirement for calcium.

The average intake of phosphorus in the DFR for women and men preparing for a marathon exceeded the norm and was as follows: 1,374.6 ±348.6 mg/day (237.0% of the norm) and 1,823.5 ±473.0 mg/day (314.4% of the norm). In the diets of approximately 70% of women and 86% men, phosphorus intake exceeded 200% of the norm (Table 4). In the diets of men as well as in the diets of women an abnormal ratio of calcium to phosphorus amounting 0.7 : 1 and 0.63 : 1, was noted, although the preferred ration is 1 : 1.

Table 4. Percentage of diets of surveyed women (W) and men (M), which fulfilled the norm for selected minerals at the following levels <90%, 91–110%, 111–150%, 151–200% and >200%

% fulfilment of norms	Sodium		Potassium		Calcium		Phosphorus		Magnesium		Iron		Zinc		Copper	
	W	M	W	M	W	M	W	M	W	M	W	M	W	M	W	M
<90	19.6	3.0	84.8	66.7	30.4	16.7	0.0	0.0	14.1	28.8	2.2	0.0	6.5	7.6	0.0	0.0
91–110	15.2	3.0	15.2	22.7	25.0	10.6	0.0	0.0	18.5	18.2	12.0	0.0	10.9	16.6	3.3	0.0
111–150	38.0	15.2	0.0	10.6	30.4	28.8	4.3	0.0	42.4	37.9	45.7	9.1	35.9	39.4	17.4	12.1
151–200	18.5	33.3	0.0	0.0	14.2	27.3	25.0	13.6	17.4	13.6	26.1	21.2	38.0	28.8	35.8	34.8
>200	8.7	45.5	0.0	0.0	0.0	16.6	70.7	86.4	7.6	1.5	14.0	69.7	8.7	7.6	43.5	53.1

The average intake of magnesium in DFR for women was 373.4 ±107.1 mg/day (143.9% of the norm), and a group of men 423.6 ±108.8 mg/day (124.2% of the norm). It was observed that, a high percentage of women and men's diets did not provide optimal amounts of magnesium. Magnesium intake below the norm pertained to 14.1% of women and 30.3% men.

The average percentage of fulfilment of the norm for iron in the diets of women was 151.1% (12.1 ±3.5 mg/day), and 247.4% in the diets of men (14.8 ±4.7 mg/day). Supply of iron below the norm was observed in 8.7% of women. Furthermore it was found that 69% of the diets of men exceeded the supply of iron standard twice over (Table 4).

The average intake of zinc in the DFR of the surveyed people covered daily requirement and averaged 10.1 ±2.6 mg/day for women and 13.5 ±3.8 mg/day for men. At the same time, it was found that about 10% of the diets of women and 12% of the diets of men did not fulfil this trace mineral norm. The average supply of copper in DFR was 1.4 ±0.5 mg/day in the group of women and 1.5 ±0.4 mg/day in the group of men, which in both groups exceeded the norm more than twice (Table 4).

It has been shown that the percentage of women whose diets did not cover the demand for sodium, potassium, calcium, and iron was statistically significantly higher compared to men (Table 3). On the other hand there was a statistically significantly higher proportion of men whose diets do not fulfil the standards for magnesium than women.

Discussion

The study shows that the daily food rations for both women and men preparing for a marathon were characterized by insufficient content of some minerals, especially potassium, calcium and magnesium.

The average energy value of DFR of the surveyed population for both women and men was lower than the energy demand of people of moderate physical activity (Jarosz et al., 2012). Wierniuk and Włodarek (2013) have also shown that DFR of aerobic sports-training men has too low energy value (average of 2,466 ±591 kcal/day with an average demand of 3,331 ±252 kcal/day). Similar results were obtained by Włodarek et al. (2011), who evaluated the implementation of energy demand in long-distance runners. The average energy value of the diet was 3,030 ±520 kcal for men and 2,100 ±700 kcal for women. Insufficient energy values of the diet, lasting for a long time, particularly among individuals with increased physical activity can affect the insufficient supply of nutrients, including the micro- and macronutrients.

Increased supply of minerals in the diet of sportsmen and amateurs may be necessary due to the increased loss in sweat and urine (Lombardi et al., 2013). With respect to individual components, the greatest threat to people taking part in regular physical activity is due to the low supply of dietary iron and calcium (Matwiejuk, 2009; Seidler, Gryza, 2006). Iron is a mineral which deficiency in the body significantly reduces performance during exercise. Iron is the main component necessary for the construction of myoglobin and haemoglobin involved in the transport of oxygen from the lungs to the tissues (Lombardi et al., 2013; Matwiejuk, 2009). Iron is one of the minerals that intake with diet of physically active people is too low (Lombardi et al., 2013; Seidler, Gryza, 2006). The purpose of the study conducted by Merritt (2013) was to determine the dietary iron consumption of female recreational marathon runners. In this study mean iron intake by all participants was lower than that of Recommended Dietary Allowance (RDA). The deficiencies of iron are caused mainly by low intake of meat products and its limited bioavailability from plant products. Iron deficiencies are more common for young sportswomen because of its losses associated with menstruation (Burblis et al., 2014; Christensen et al., 2005; Lukaski, 2004). Furthermore the runners are exposed to erythrocyte haemolysis as a result of mechanical damage of small blood vessels in the lower limbs. Christensen et al. (2005) estimated the supply of some minerals in the diet of Kenyan medium- and long-distance runners. An unusual feature of the diet of Kenyans was very high iron content from an average of 124–178 mg. The main source of iron in their diet were plant products such as maize and beans, which have a low bioavailability of that mineral.

In our study, it was noticed that 8.7% of the diets of women do not fulfil the standards of the EAR for this nutrient. The results obtained indicate the need to supplement the diet of women in iron, which can be obtained through the consumption of at least one meat meal a day. Among the iron sources with the greatest bioavailability the following products may be mentioned: liver (7.5–18.7 mg/100 g), beef (1.3–3.1 mg/100 g), poultry (1.2–2.4 mg/100 g), sardines (2.9 mg/100 g), hen's egg yolk (7.2 mg/100 g) (Kunachowicz et al., 2005). Bioavailability of iron from vegetable products is greatly increased by the dietary components such as vitamin C, fructo-oligosaccharides or resistant starch. Many sportsmen use supplementation to compensate for the iron deficiencies (Alaunyte et al., 2015; Nieves et al., 2002). It should be noted, however, that uncontrolled iron supplementation especially for amateur sportsmen is inadvisable. It has been proven, that excessive intake of iron preparations, reduces the concentration of other minerals such as zinc and lead thus increasing production of free radicals and the risk of cancer and heart disease (Gennari, 2001; Lukaski, 2004; Nieves et al., 2002).

Physical activity is one of the key elements that affect bone mineralization and achieve peak bone mass. Exercise slows down the rate of bone mass loss with age, preventing osteoporosis (Banfi et al., 2010; Zimmermann, 2003). In some sporting disciplines, including long-distance running, very often an insufficient supply of energy and certain nutrients including calcium is found (Lombardi et al., 2013; Maughan, 1999; Zimmermann, 2003). Women-athletes who have low oestrogen levels which is also a risk factor for accelerated bone loss are particularly at risk of osteoporosis (Maughan, 1999; Williams, 2005). Adequate intake of dietary calcium appears to be a key factor in the prevention of osteoporosis, since 99% of the calcium in the body is around the skeletal system. Calcium is involved in many physiological processes associated with muscle contraction. In addition, high-intensity exercise increases the loss in sweat (Zimmermann, 2003). Demand for calcium in athletes is estimated at about 1200 mg/day (Celejowa, 2008). Both in our study and in studies of other authors (Lombardi et al., 2013; Lukaski, 2004; Onywera et al., 2004; Seidler, Gryza, 2006) there was a particularly high proportion of women who did not meet the norm for this mineral. Christensen et al. (2005) showed that calcium intake from diets of elite runners from Kenya, was also very low (577–655 mg/day). These studies, however, suggest that high physical activity can have a more determining role in the development and maintenance of normal bone mass than high calcium intake with the diet. Simultaneously, other studies have shown a positive association with increased calcium intake from the diet with improved bone density and reduction of fractures in runners (Myburgh, 1999; Nieves et al., 2002). Myburgh et al. (1999) conducted a clinical-control study which evaluated the risk of stress fractures in long-distance runners, depending on the content of calcium in their diet. It was found that in the group of people with fractures dietary calcium intake was lower than in the control group. This group also had significantly lower bone mineral density at the lumbar spine and femoral neck, compared with the control group. Nieves et al. (2002) also studied bone density and frequency of fractures in young runners, to whom a daily intake of additional servings of skimmed milk was recommended. Higher calcium intake with the diet in the form of dairy products and milk positively correlated with a reduction in the incidence of fractures. The risk of fractures in the study group was reduced by 62%. Women who consumed less than 800 mg of calcium per day nearly had a 6-fold increased risk of fractures than other female runners who consumed more than 1,500 mg of calcium per day (Nieves et al., 2002).

Phosphorus is part of a number of compounds that are involved in energy metabolism of the body. Phosphate salts play an essential role in the use of glucose in aerobic efforts, affecting performance improvement. Through phosphorylation of these compounds, both anabolic and catabolic effects, which lead to the disintegration of molecules of ATP, from release of energy, also occur (Matwiejuk, 2009). Similarly to the studies of other authors

(Burblis et al., 2014; Seidler, Gryza, 2006), our study also reported exceeding the recommendations in the supply of phosphorus in the DFR of those preparing for the marathon. It should be noted, however, that not only the content of phosphorus in the diet is important, but the molar ratio of phosphorus to calcium as well. The optimum ratio of calcium to phosphorus should be 1 : 1, and more preferably if it corresponds to the values observed in the bones, which are 1.5 : 1. In our study, the ratio of calcium to phosphorus in the diet was invalid, as it stood at 0.6:1 in both the men and women. The unfavourable ratio between calcium and phosphorus, lasting over a long period of time can contribute to weakening of the bone and early osteoporosis in adults (Burblis et al., 2014).

Magnesium is involved in many metabolic processes by acting as a cofactor and activator of many enzymes. It is a building component of bone and is involved in the metabolism of calcium. It affects the functioning of the muscles such as oxygen uptake and maintaining electrolyte balance. It determines the correct functioning of the neuromuscular system by keeping the electric gradient in the membranes of nerve and muscle cells. Magnesium deficiency intensifies the negative effects of prolonged physical exertion, such as oxidative stress. Magnesium also plays an important role in post-workout recovery (Christensen et al., 2005). Loss of magnesium is associated with excretion through sweat and urine. The demand for magnesium at EAR is 255–350 mg per day (Jarosz et al., 2012), but in athletes it may rise to about 480 mg (Celejowa, 2008). The average intake of magnesium in DFR of the group of subjects examined fulfilled the recommendations for this nutrient. However, attention is drawn to the high percentage of diets of the studied men in which the supply of this mineral was insufficient. Similar results were also obtained by other researchers (Burblis et al. 2014; Onywera et al., 2004), who demonstrated that magnesium deficiency is a common problem in athletes and significantly affects physical fitness. Deficiency of this mineral can be relatively easily prevented by inclusion in the diet of products that are a good source, such as cereals, legumes, nuts, cocoa, dark chocolate and mineral water that contain more than 50 mg per litre of this mineral.

Zinc is a part of over 300 enzymes. It is involved in the synthesis of nucleic acids and proteins, affects the utilization of glucose as well as insulin secretion. Furthermore it regulates the activities of the endocrine, immune and digestive systems. Because of the many functions of regulating, zinc is a mineral of significant importance during exercise and post-exercise recovery of the body (Christensen et al., 2005). Most of the zinc, about 60%, is found in the muscle, and about 30% in the bones. Loss of zinc occurs through sweat and urine. The demand for zinc in adults at the EAR is 6.8–9.4 mg daily (Jarosz et al., 2012) and its deficiency occurs relatively rarely, due to the fact that zinc is present in many foods. Deuster et al. (1989) study demonstrated that long-distance runners did not obtain the recommended amount of zinc from their diets. Marginal dietary intake of this mineral affected more women than men, due to increased dietary restrictions in their diet. It should be noted, that the researchers compared their results to the higher recommended ranges of zinc amounting to 13–16 mg/day (Ziemlański, 2001). Horvath et al. (2000) showed that with the increase of the energy value of the diet and the percentage of energy from total fat, there was also an increase in zinc content in the diets of runners. In our study it was demonstrated that a relatively small percentage of the diets of women and men did not comply with the norm at the level of the EAR (Jarosz et al., 2012) for zinc (<90%; 6.5% of women, 7.6% of men).

Copper is a vital component necessary for synthesis of haemoglobin and certain peptide hormones. Deficiencies of copper are also very rare because of its high prevalence in food (liver, whole grains, legumes, nuts). The demand for this mineral in adults is 2–2.5 mg. In our study, there was no shortage of copper in DFR, which seems to be consistent with the observations of other authors (Tong et al., 2012; Williams, 2005).

In our study, the average intake of dietary sodium in both the men and women exceeded the reference values. Exceeding the norm for sodium is common among athletes which has also been documented in studies of other authors (Burblis et al., 2014; Pilis et al., 2014; Wierniuk, Włodarek, 2013). It should be noted, however, that in the case of physically active people, a significant amount of this element is excreted in sweat during exercise, in such amounts ranging from 400–650 mmol/l (Hew-Butler et al., 2006). It seems, therefore, that the demand for sodium among athletes is higher than in people who do not practise any sport because of the need to compensate for losses incurred during physical activity. During prolonged exercise, significant losses of sodium occur, causing progressive muscle weakness, impairment in maintaining acid-base balance of the body and the electric potential in the nerve cells. In accordance with the recommendations of the Scientific Committee on Food, during prolonged exercise, sodium supplementation is recommended, in the amount of 460-920 mg/l (Scientific Committee on Food Report 2001). However, in the study conducted by Hew-Butler et al. (2006) and Speedy et al. (2002), it was demonstrated in a group of people involved in a triathlon, that sodium supplementation is unnecessary, because the sodium content of the "Western diet" is sufficient to supplement its deficiencies, even during extreme physical exertion.

In our study, it was observed that the diets of 93.5% of women and 80.3% of men do not fulfil the norm for potassium. Potassium exhibits antagonist activity with respect to sodium and calcium, reducing the amount of extracellular fluid, and increases the permeability of cell membranes and muscle tension. Reduced concentration of this mineral in the blood causes rapid fatigue and muscle weakness. Pilis et al. (2014) and Kasprzak et al. (2006) also noted a deficiency of potassium in the DFR in athletes competing in long-distance and short-distance runs.

In our study, in the evaluation of the mineral content, supplementation was not taken into account. Because it is commonly believed that supplementation should provide nutritional support when the athlete is unable to meet the body's demands for specific components with a balanced diet. In many cases, assisting oneself with supplements has no effect on exercise performance, and often their improper use, particularly among amateurs, has adverse health effects (Aerenhouts, 2012; Rosenbloom et al., 2006; Williams, 2005). Knechtl et al. (2008) showed that taking vitamins and minerals (magnesium, zinc, iron, calcium) for 4 weeks prior to an ultra-marathon did not affect the achievement of better results compared to those not taking supplements.

A well-balanced diet that provides adequate amounts of vitamins and minerals is essential in order to achieve optimal performance in sports of an endurance nature. People training for a marathon should pay more attention to meeting the energy demand and consumption of high-quality products, rich in minerals. The needs of sportsmen as well as those of amateur sportsmen indicate the need for education in this field in order to improve their eating habits. A properly balanced diet is, in fact, part of supporting the achievement of satisfactory results in competition.

Conclusions

1. It was observed that a low supply of dietary minerals such as potassium, calcium and magnesium may be due to a lack of knowledge in the field of rational nutrition and points to the need for education in this area.
2. Amateurs training for long-distance running may be more vulnerable to shortages of minerals compared to those with low physical activity.
3. Due to the insufficient potassium content in the diets of both women and men preparing for a marathon, more attention should be paid to the intake of foods such as fresh and dried fruits, nuts, seeds, vegetables and potatoes.

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INFLUENCE OF FENCING TRAINING (TECHNICAL AND TACTICAL) ON SELECTED FEATURES OF SHAPE OF THE SPINE AND PELVIS UNDER LOAD

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Abstract The aim of the research was to assess influence of a 90-minute specialist fencing training on selected features of the spine and pelvis under a vertical load in a group of young competitors.
The research was carried out in 2015 among 23 fencers (mean ± SD, age: 16 ±1.20 years; body height: 168.4 ±4.68 cm; body weight: 54.7 ±8.26 kg). The method involved measurement of thirty features, describing spatially pelvis and physiological spinal curvature under a vertical load, constituting 1/3 of the body weight before and after specialist training.
Statistically significant disturbances in vertically overstretched posture occurred after the training among examined boys within the following features: increase in length of left side scoliosis, progression of lumbar lordosis and lumbosacral spine, increase of the trunk extension angle and shoulder asymmetry. Among examined girls statistically significant changes occurred only within pelvis area: increase of left pelvic tilt in the coronal plane, decrease of right pelvic tilt in the horizontal plane.
Adjustment in deficiencies within hip joints movement, increase pelvis and lower limbs muscle strength in girls' training is necessary. What is recommended for all competitors is prophylaxis of the spinal pain syndrome and expanding endurance shaping exercises during a training unit.

Key words posture, spine, pelvis, kyphosis, fencing

Introduction

Asymmetry of human body is a physiological phenomenon, the trouble – however – is to establish acceptable range of this asymmetry. Research by Kingma et al. (1998) and by Young, Andrew, Cummings (2000) show that every asymmetry, static or dynamic, is a basis for overload disturbances.

The ability to transfer vertical load is conditioned, among others, by the symmetry of the spine in the coronal plane and by the optimal values of angles of physiological curvatures in the median plane. The disturbed function of the pelvis in the median plane might lead to changes in angular values of physiological curvatures, whereas

disturbances in a coronal or horizontal plane result in an asymmetrical profile of the line of spinous processes. A proper muscle tone is essential for a correct body posture and motor activity. It should be sufficient to prevent the effect of gravitational forces and low enough to allow for smooth selective movements or isolated activity (Shumway-Cook, Woollacott, 2000). The efficiency of the system of body posture control depends on the internal and external determinants, such as fatigue, emotional states, body temperature, atmospheric pressure and other factors (Perrot, Mur, Maynard, Barrault, Perrin, 2000).

Modern training regimes in professional sports involve doing repeated strenuous exercises that require enormous endurance of the skeletal system, especially the spine. The majority of sports disciplines affect human vertebral column (Mroczkowski, Jaskólski, 2007; López-Miñarro, Muyor, Alacid, 2010; Mrozkowiak, Sokołowski, Kaiser, 2012; Rajabi, Mobarakabadi, Alizadhen, Hendrick, 2012; Flis-Masłowska, Trzaska, Wiernicka, Lewandowski, 2014). For example, tennis is a frequent cause of abnormalities in the lower lumbar spine at L 4/5 and L 5/S1 levels; lumbar pars injuries and facet joint arthroses are relatively common diseases among tennis players (Alyas, Turner, Connell, 2007). The examination of young sumo wrestlers showed a significant correlation between spondylolysis and lumbar symptoms which indicates that young sumo wrestlers give up to continue this sport because of symptomatic spondylolysis (Nakagawa, Mukai, Hattori, Nakamura, 2011).

Cervical spine abnormalities consisting of degenerative discopathy are observed in professional male rugby players aged >21 years, as shown in the study carried out among French rugby union clubs between 2002 and 2006 (Castinel, Adam, Milburn, 2010). The spine is even more exposed to injury in sports involving additional load, e.g. an opponent or partner (wrestling, judo, figure skating) or several partners (human pyramids in acrobatic gymnastics), or in disciplines which require sports equipment (weightlifting or hammer throw) (Starosta, 1993). High control of body posture is crucial in acrobatics, air racing, track and field or combat sports. The results of the studies examining effects of disturbances on the performance of the system of body posture control are useful when working with athletes and caring for their health.

The aim of research is to assess the influence of a 90-minute specialist fencing training (technical and tactical exercises) on selected features of the spine and pelvis under vertical load in a group of young competitors.

Material and methods

The research was carried out in October 2015 at the Sports and Recreation Centre in Drzonków during a sports grouping in a competition season. It is a part of longitudinal research that has been carried out since 2013 (Mrozkowiak, Kaiser, Sokołowski, 2015). It involved 23 fencers, aged 15–18 years (11 boys and 12 girls). The average body weight was 54.7 kg, height 168.4 cm, and training duration 5.5 years (Table 1).

An attempt to reach the scientific aim was resulting from the need of gaining a comprehensive outlook on vertically loaded habitual posture of competitors. Essential in this method is simultaneousness in measuring all values of spatial parameters of particular body parts. The examination was carried out before and after a training (90 minutes) with axial load of the spine adjusted individually for each competitor. It was assumed that the load of a third of a competitor's body weight, placed symmetrically on the pectoral girdle will significantly change analysed postural features. This assumption took into consideration changes in skeleton and musculature occurring in the developmental age, as well as sports profile during the start period of a training cycle.

Table 1. Sample group N = 23 (boys = 11, girls = 12)

Number	Initials	Birth	Weight (kg)	Height (cm)	Training duration (years)
1.	M.J.	1998	39	159	4
2.	K.D.	1996	67	186	7
3.	R.R.	1997	64	178	5
4.	G.M.	1996	56	170	8
5.	G.A.	1996	59	170	6
6.	K.K.	1996	74	176	7
7.	O.O.	1997	60	179	4
8.	M.A.	1996	51	156	6
9.	V.M.	1996	53	166	7
10.	M.K.	1998	48	163	4
11.	P.D.	1998	49	163	5
12.	W.W.	1999	55	159	3
13.	B.Z.	1998	49	158	5
14.	G.W.	1998	43	158	6
15.	W.Z.	1996	57	169	6
16.	M.Z.	1996	54	167	10
17.	P.R.	1996	61	176	8
18.	S.A.	1996	54	164	6
19.	L.K.	1996	66	184	5
20.	P.M.	1999	53	167	4
21.	K.F.	1998	53	167	5
22.	S.J.	1998	40	159	5
23.	K.A.	1999	54	180	4
Mean values (± SD)		16 ±1.20	54.7 ±8.26	168.4 ±4.68	5.5 ±1.41

In the evaluation a computer-based postural analysis device was used. It consists of a computer with specialist software and a camera to measure selected parameters of pelvis-spine system. Thanks to projecting lines on a patient's back, spatial visualisation is presented. Those lines, while projected on the patient's back, deform depending on the surface. The picture is then sent to the computer. Deformities of lines recorded by the computer are transformed by a numerical algorithm (Mrozkowiak, 2011). The results, in form of a spatial graphic picture, enable to describe analysed features numerically. The line values reflect the distance of selected anthropometric points on the patient's back, while the angle values describe the deviation in setting in relation to the horizontal or distance from the camera. Received picture allows for a multi-faceted interpretation of body posture. Apart from assessment of trunk asymmetry in the plane coronal, there is a possibility of determining spatial values of angle and line parameters describing pelvis, physiological curvatures and coronal asymmetry of spinous processes, i.e. the deviation of the topmost spinous process from C7-S1 line. A short time of recording helps to avoid fatigue of postural muscles, which is often while examinations performed with use of somatoscopy. The most important in this method was that all measurements of spatial parameters were carried out simultaneously (Table 2).

Table 2. Recorded parameters of the pelvis-spine system

No.	Symbol	Parameters		
		unit	name	description
			Plane median	
1.	Alpha	degrees	Lumbar-sacral curvature	
2.	Beta	degrees	Thoracic-lumbar curvature	
3.	Gamma	degrees	Upper thoracic curvature	
4.	Delta	degrees	Total value of angles	Delta = Alpha+Beta+Gamma
5.	DCK	mm	Total length of spine	Distance between C7 and S1 measured vertically
6.	KPT	degrees	Angle of trunk extension	Described in deviation of C7-S1 line from the vertical (backwards)
7.	KPT-	degrees	Angle of trunk lean	Described in deviation C7-S1 line from the vertical (forward)
8.	DKP	mm	Length of thoracic kyphosis	Distance between LL and C7
9.	KKP	degrees	Angle of thoracic kyphosis	KKP = 180 – (Beta + Gamma)
10.	RKP	mm	Height of thoracic kyphosis	Distance between C7 and PL
11.	GKP	mm	Depth of thoracic kyphosis	Distance measured horizontally between vertical lines crossing PL and KP
12.	DLL	mm	Length of lumbar lordosis	Distance between S1 and KP
13.	KLL	degrees	Angle of lumbar lordosis	KLL = 180 – (Alpha + Beta)
14.	RLL	mm	Height of lumbar lordosis	Distance between S1 and PL
15.	GLL-	mm	Depth of lumbar lordosis	Distance measured horizontally between vertical lines crossing PL and LL
			Plane coronal	
16.	KNT-	degrees	Angle of trunk tilt sideways	Determined by deviation of C7-S1 line from the vertical to the left
17.	KNT	degrees		Determined by deviation C7-S1 from the vertical to the right
18.	LBW-	Mm	Right shoulder higher	Distance measured vertically between horizontal lines crossing B2 and B4
19.	LBW	Mm	Left shoulder higher	
20.	LŁW	Mm	Left scapula higher	Distance measured vertically between horizontal lines crossing Ł1 and Łp
21.	LŁW-	Mm	Right scapula higher	
22.	OL	Mm	Interior angle of the left scapula is further	Difference in distance of the interior angles of the scapulae from the line of spinous processes, measured horizontally on lines crossing Łl and Łp
23.	OL-	Mm	Interior angle of the right scapula is further	
24.	KNM	degrees	Angle of pelvic tilt, the right ala higher	Angle between the horizontal line and a line crossing M1 and Mp
25.	KNM-	degrees	Angle of pelvic tilt, the left ala higher	
26.	UK (dex)	Mm	Maximal deviation of a spinous process to the right	The highest deviation of a spinous process from the horizontal led from S1. The distance measured along horizontal axis.
27.	UK- (sin)	Mm	Maximal deviation of a spinous process to the left.	
			Plane axial	
28.	KSM	degrees	Right pelvic tilt	Angle between the line crossing Ml, perpendicular to camera axis and the line crossing Ml and MP
29.	KSM-	degrees	Left pelvic tilt	Angle between the line crossing Mp, perpendicular to camera axis and the line crossing Ml and MP

In order to minimalize risk of error the following examination procedure was observed:

1. Marking antropometric points in habitual posture. Marking on the skin of examined person: the peak of spinous process in the last cervical vertebra (C7), spinous process marking the peak of thoracic kyphosis (KP), spinous process marking the peak of lumbar lordosis (LL), space of transition between thoracic kyphosis into lumbar lordosis (PL), lower angles of scapulae (Łl and Łp), upper back iliac crest (Ml and Mp), S1 vertebra.

2. Maintaining habitual posture during examination and, in individual cases, even distribution of weight on lower limbs. It is particularly significant for people who have the tendency of habitual overburdening of one limb.
3. Calibration of reference point, levelling the diagnostic system. An error depends on carefulness and is difficult to assess. When the arrangement: camera – back surface is not observed. The light beam sent from the projecting and receiving device, as well as the long axis of the camera must be perpendicular to the line formed by big toes.
4. Positioning on the screen the characteristic points with use of cursor. It is important to define registered pictures carefully. Report is more accurate if the examined person stands against dimly lit background, and the picture is projected on a big screen. An error depends on technician's experience, screen resolution, blackout of the room.
5. Habitual posture of patient (casual, effortless, with feet slightly apart, knee and hip joints straight, arms along the trunk, eyes directed to the front) standing back to the camera in appropriate distance. The picture for analysis is recorded in the middle phase of free exhale.
6. After completing necessary data about patient (name and surname, date of birth, weight and height, information on: knees and heels, chest, injuries, surgeries, motor organs diseases, tread, etc) the computer saves digital picture of patient's back.
7. Compilation of pictures is carried out without patient's participation.
8. After saving mathematical characteristics of pictures, 30 parameters (Table 2) describing spatially the pelvis-spinal area are printed.

Statistical analysis

In order to describe the effect of vertical load on body posture, the results were analysed with use of statistical methods determining: minimal and maximal values, mean and median, standard deviation, coefficient of variation, skewness, kurtosis, and significance of differences in values of features before and after the training with vertical load.

Results

Significance of differences in body postures before and after training with vertical load is presented in Table 3.

Among examined boys statistically significant changes in vertically loaded posture after training occurred within: increase in length of left side scoliosis, progression of lumbar lordosis and lumbosacral spine, increase of the torso inclination angle and shoulder asymmetry. At the same time, no disturbances were noted within thoracic kyphosis and lumbar lordosis (length, depth and angle), pelvis (pelvic tilt in the coronal plane and lateral in the horizontal plane). Among examined girls statistically significant changes occurred only within pelvis area: increase of left pelvic tilt in the coronal plane, decrease of right pelvic tilt in the horizontal plane. No statistically significant changes were observed in the plane median of the spine and the plane coronal of the trunk.

Table 3. Significance of differences in selected features describing spatially body postures of fencers before (1) and after (2) training N = 23 (boys = 11, girls = 12)

Symbol	M	SD	Difference in values before and after training	Standard deviation	t	df	P
			Boys				
DS 1	226.09	25.93					
DS 2	286.27	46.32	–60.180	49.510	–4.03	10	0.0023
KLL 1	163.27						
KLL 2	160.72	3.79	2.450	3.610	2.33	10	0.0416
KPT 1	19.09						
KPT 2	19.81	2.04	–0.727	1.009	–0.39	10	0.0130
KLB 1	2.09						
KLB 2	7.63	9.36	–5.540	7.630	–2.40	10	0.0367
Alfa 1	5.90						
Alfa 2	8.00	2.68	–2.090	2.300	–3.01	10	0.0130
			Girls				
KNM 1	4.08	4.87					
KNM 2	1.66	2.22	2.410	3.340	2.50	11	0.0292
KSM 1	1.75	2.05					
KSM 2	0.08	0.28	1.660	1.870	3.07	11	0.0104

Source: authors' own research.

Discussion

Numerous studies have demonstrated an increase in asymmetry in the coronal plane, with a particular focus on a position of the scapulae and pelvis. In an initial period, the asymmetry has a functional character and is not accompanied by structural changes in the area of passive locomotor system. With time, however, incorrect body posture becomes permanent which, in consequence, leads to scoliosis (Nissinen, Heliovaara, Seitsamo, Alaranta, Poussa, 1994; Nissinen, Heliovaara, Seitsamo, 2000; Poussa, Heliovaara, Seitsamo, 2005). Training-induced body adaptations to the demands of a given sports discipline typically magnify the asymmetry (Starosta, 1993). Uetake and Ohtsuki (1993) found progression in the angles of thoracic kyphosis and lumbar lordosis that increased with training experience. Similar tendency compared to control group was observed by Wojtys, Ashton-Miller, Huston, Moga (2000). Other studies have shown a statistically significant effect of long-term training on the symmetry in the coronal plane and angular values of physiological curvatures in the median plane (Perrin, Deviterne, Hegel, Perrot, 2002).

Research of Kaiser, Sokołowski, Mrozkowiak (2014) on a group of 30 wrestling women displayed that physical effort of training caused serious progression of thoracic kyphosis and lumbar lordosis with simultaneous increase in partial angles (Alfa, Beta, Gamma), size, length and progression of thoracic kyphosis and lumbar lordosis. In the coronal plane positive and significant changes were found in the trunk verticality, asymmetry of shoulders, scapulae, and pelvis, while negative was progression of left side scoliosis. Further analysis showed that negative changes occur mainly in the median plane, while line features of both curvatures (height and length) increasing their values at the same time decrease angle of thoracic kyphosis and lumbar lordosis, partial angles – while increasing – cause their progression. It is, therefore, antagonistic pressure. In so far as the thoracic-lumbar angle did not reveal any

considerable changes, the others showed substantial ones. Entirely different results were obtained in the research on a group of males from the national wrestling team, while similar ones – among judo competitors (Mrozkowiak, 2003, 2004). It was found that muscles of the pelvis-trunk area of judo competitors, similarly to female fencers, displays smaller resistance to vertical load, deepening the angle of lumbar lordosis, length of lumbar lordosis and thoracic kyphosis, and the angle of trunk extension in the median plane.

Significant disturbances in the girls' spatial parameters of pelvis symmetry indicate deficiencies within hip joints movement and muscle dystonia in that body area, decreasing the angle in the coronal plane, which influences functionality of their vertebral column.

Fencing training of boys increased unfavourably length of scoliosis, angle of lumbar lordosis, and trunk asymmetry in the median plane. This signifies decreased strength of muscles of pelvis area, lower limbs and spine. Thus, there is a real danger that with lack of exercises correcting the abovementioned disturbances of the examined group they may with time determine the final result of competition.

Conclusions

1. Specialist fencing training of girls caused substantial disturbances in spatial parameters of pelvis, with no significant changes in values of physiological spinal curvatures and trunk symmetry. Among boys, both favourable and unfavourable occurred in the median plane, within lumbar lordosis and trunk verticality, as well as in the coronal plane in the line of spinous processes and shoulders.

2. It is necessary to adjust deficiencies within hip joints movement, and increase pelvis and lower limbs muscle strength in girls' training. What is recommended for all competitors is prophylaxis of the spinal pain syndrome and expanding endurance shaping exercises during a training unit, accommodated to a competitor's developmental age.

3. In complementary fencing training muscle strength of: pelvis area, lower limbs and spine should be underlined.

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THE EFFECTS OF THE COACH-ATHLETE WORKING ALLIANCE ON AFFECT AND BURNOUT AMONG HIGH LEVEL COACHES

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Abstract Research suggests that the numbers of coaches who are suffering from burnout symptoms are considerably high among coaches in elite sport. In this study, the authors explore the effects of the coach-athlete working alliance on positive- and negative affect and burnout in a group of high-level coaches. An online survey, consisting of the Working Alliance Inventory-Short Version, the Positive and Negative Affect Schedule and the Maslach Burnout Inventory, was completed by a sample of 299 coaches working with elite athletes or junior elite athletes. Data analysis was conducted using structural equation modelling. The model explained 57% of the variance in cynicism, 32% of the variance in reduced sense of accomplishment and 26% of the variance in exhaustion. These effects mainly derived from positive affect and negative affect. However, working alliance showed a significant indirect effect on all three dimensions of burnot through the mediating variables positive affect and negative affect. These results are discussed in a cognitive activation-perspective.

Key words cognitive activation theory, cynicism, sense of accomplishment, exhaustion, coach-athlete relationship

Introduction

Coaches who are working with athletes who aim to reach a high level in their sport, are required to put a lot of effort and endeavor into their work to develop their athletes towards successful performances (Olusoga, Butt, Hays, Maynard, 2009). This makes coaching a potentially rewarding activty, due to the joy of working with aspiring athletes, the challenge of building successful performance programs, the satisfaction derived from teaching sport skills and the joy and exuberance when winning a contest or achieving ambiguous goals. Such coaching experiences should stimulate positive affect, since they are resulting from successful coaching endeavors (Reme, Eriksen, Ursin, 2008). At the same time, environments in which coaches of high performance athletes are working, are typically achievement oriented and competitive (Hanton, Fletcher, Coughlan, 2005), and coaches have

to cope with performance-associated stressors both related to their own performance and the development and performances of their athletes (Fletcher, Scott, 2010). Due to this, strain to work in such environments can potentially become a demanding and consuming endeavor, as coaches might experience performance impairments among their athletes, working with unmotivated athletes, experience goals that are not reached, performance programs that fails, and relational difficulties with their athletes and other co-workers (Price, Weiss, 2000). Thus, coaches who are working with high performance athletes can potentially experience considerable loads from negative affect responses because of being unable to handle effectively situational demands in their role (Ursin, Eriksen, 2004). Research claims that there is a close relationship between stress and affect (Hamama, Ronen, Schachar, Rosenbaum, 2013; Lazarus, Folkman, 1984), and high performance coaches might therefore be in danger of developing symptoms of burnout, because of to heavy stress loads over time. Disturbingly for elite sports, research suggests that the numbers of coaches who are suffering from burnout symptoms are considerably high among elite sport coaches (Bentzen, Lemyre, Kenttä, 2015; Hjälm, Kenttä, Hassmén, Gustafsson, 2007). This represents a possible threat with regard both to coach longevity and productivity (Kelley, 1994; Raedeke, Woodard, Granzyk, 2002), and thereby for the performance and development of their athletes (Cavanagh, 2006; Jowett, 2007).

Interestingly in this regard, coaches' relational capabilities is claimed to be one of the most crucial variables for more or less successful coaching (Cavanagh, 2006; Côté, Gilbert, 2009; Jones, 2006; Jowett, 2007). A helping and supportive coach-athlete relationship is seen as essential to achieve successful developmental and performance outcomes in athletes (Benson, Scales, Hamilton, Sesma, 2006). Based on this, the present study will aim to investigate how coaches' percedived working alliance with their athletes are associated with positive and negative affect and the burnout syndrome.

Theoretical Background

The coach-athlete relationship

The coach-athlete relationship is often defined by a mutual and causal interdependence between coaches‘ and athletes‘ feelings, thoughts and behaviors (Jowett, 2008; Jowett, Cockerill, 2002; Moen, 2012). The importance of an emotional attachment between coaches and their athletes is emphasized in sport science, and the most important tool to establish depth of the coach-athlete emotional attachment is claimed to be the coach's relational capabilities (Jowett, Ntoumanis, 2004). Interestingly, research claims that dysfunctional relationships often are missing the emotional attachment between coaches and athletes, and that such relationships are claimed to be at a dead end (Vargas-Tonsing, Guan, 2007). Several studies also show that both coaches and athletes are aware of the importance of a coach's relational capabilities (Moen, Verburg, 2012; Moen, Garland, 2012; Moen, Federici, Klemetsen, 2013; Moen, Federici, 2013; Moen, Sandstad, 2013; Moen, Federici, 2016).

With regard to the study of coach-athlete relationship in sport science, the constructs of the three C's "Closeness", "Commitment" and "Complementarity" is a well-accepted concept (Jowett, Cockerill, 2002; Jowett, Ntoumanis, 2004). Closeness describes the depth of the coach-athlete emotional attachment in the relationship, commitment reflects coaches and athletes‘ intention or desire to maintain their relationship over time, and complementarity defines to what degree the relationship is perceived as cooperative and effective (Jowett, Cockerill, 2002). Although widely used in varying sport settings, one could ague that when approaching a setting where athletes aim to develop to their very highest potential, the constructs of the three C's misses to give an explicit measure of two crucial factors: coach-athlete agreement on what goals they are working towards, and the plan of

action for how to reach these goals. Goal-orientation and task focus are crucial in a change-inducing coach-athlete relationship (Weinberg, Butt, 2014), and it would therefore be interesting to measure these factors more precisely when conducting the relationship among coach-athlete.

Interestingly, research from the clinical field claims that effectiveness and success in a change-inducing relationship is also suggested to rely on the cooperation between the person offering help and the person who seeks help (Bordin, 1979; Horvath, Greenberg, 1989). We would argue that the coach-athlete relationship in high-level sport could be considered as a change-inducing relationship. Such relationships are defined as a *working alliance* between the helper (therapist) and the person who seeks help (client), and a Working Alliance Inventory (WAI) scale is developed to measure these important characteristics (Horvath, Greenberg, 1989). It was originally designed to measure the strength of the working alliance within therapeutic relationships (Horvath, Greenberg, 1985). However, WAI is later adapted to other helping relationship contexts, like for example supervision (Bahrick, Russel, Salmi, 1991). We hereby suggest using this inventory in the field of high-level sport, with the coach considered as the "helper", and the athlete considered the "help-seeker".

WAI is based on Bordin's (1979) model of the therapeutic working alliance, which is conceptualized trough the three terms "goals", "tasks" and "bonds". In the working alliance theory, goals are the objectives for the collaboration, and are considered the desired outcome from the helping relationship that is established between the therapist and client (Bordin, 1994). The key regarding goals is to reach a high level of agreement or mutuality between the therapist and the client. Tasks are the behaviors and cognitions engaged in by both the therapist and client in the cooperation process. In the sport setting then, a functional coach-athlete relationship is where both parts perceive these tasks applicable and beneficial (Bordin, 1979). Bonding is related to the level of "partner compatibility", which develops from the interaction between coach and athlete in the activities they are involved in (Bordin, 1994). A high level of bonding is expressed as mutual liking and trusting, and a feeling of common purpose and understanding between coach and athlete (Bordin, 1994; Horvath, Greenberg, 1989).

Affect responses

As opposite to the positive effects of a well-established coach-athlete helping relationship, Goodger, Gorely, Harwood and Lavallee (2007) suggest that negative stress related to for example relationships issues or negative perceived performance outcomes of athletes, correlates positively with burnout among coaches. According to the "Cognitive Activation Theory of Stress" (Ursin, Eriksen, 2004), situations considered unfamiliar or out of control, causes an "alarm" in the body which leads to a homeostatic imbalance. If such a situation lasts over time, and the coach does not have the necessary coping resources, this stress can become negative and destructive, as stress further is linked to psychosomatic complaints, exhaustion and depression (Crawford, Henry, 2004). Based on this, it is likely to expect that the psychological strain and loss of control experienced if failing to establish a functioning working alliance, with subsequent adversely effect on the athletes development and performance, could cause negative stress responses in coaches (Cavanagh, 2006; Côté, Gilbert, 2009; Jones, 2006; Jowett, 2007). However, if the coach has the necessary resources to cope with the situational demands, short periods of stress can actually be positive and developmental (Lazarus, Folkman, 1984), and thus serve as a buffer against destructive, negative stress (Kahn, Byosiere, 1992).

Interestingly, it is previously suggested that positive stress stimulates positive affect, whereas negative stress stimulates negative affect (Hamama, Ronen, Schachar, Rosenbaum, 2013; Lazarus, Folkman, 1984; Crawford,

Henry, 2004). In this regard, negative affect refers to feelings of sadness and lethargy, anger, contempt, disgust, guilt, fear and nervousness (Watson, Clark, Tellegen, 1988). Positive affect, on the other hand, is linked to enthusiasm, being high in energy, fully concentrated and pleasurable engagement (Watson, Clark, Tellegen, 1988). With this in mind, it could be assumed that a well-functioning coach-athlete relationship will stimulate positive affect among coaches, while if the working alliance does not function well, it could lead to negative affect for the coaches. When further knowing that any factor associated with elevated stress levels may be linked to burnout (Schaufeli, Buunk, 2003), it is likely to assume a link between coach-athlete working alliance and burnout mediated by affect among coaches.

Burnout

According to Maslach and Jackson (1984), burnout is a psychological syndrome that is likely to occur in individuals who work with people in some capacity. The development of the coach burnout construct commonly focuses on three central dimensions; "emotional and physical exhaustion", "cynicism", "reduced sense of accomplishments". Exhaustion is the core component in coach burnout, and is linked a feeling of fatigue and exhaustion, both physically and emotionally, associated with their practice (Gustafsson, Kenttä, Hassmén, 2011; Raedeke, Smith, 2009). The cynicism dimension refers to a negative, unsympathetic or detached orientation to various aspects of one's practice, and is considered to be a strategy to avoid stressing situations, and make the demands of the situation more manageable (Lundkvist, Stenling, Gustafson, Hassmén, 2014). The dimension of reduced sense of accomplishment refers to a feeling of being incompetent or to an experience of lack in productivity, efficacy and achievements. Demanding work situations that causes exhaustion or cynicism is also likely to impede one's sense of accomplishment (Maslach, Schaufeli, Leiter, 2001).

The present study

Literature on occupational stress suggests that burnout occurs from exposure to chronic stress over time (Schaufeli, Buunk, 2003). Despite this, in a review of factors contributing to burnout, Schaffran, Altfeld and Kellmann (2016) did not find any studies investigating relations between coach-athlete working alliance and coach burnout.

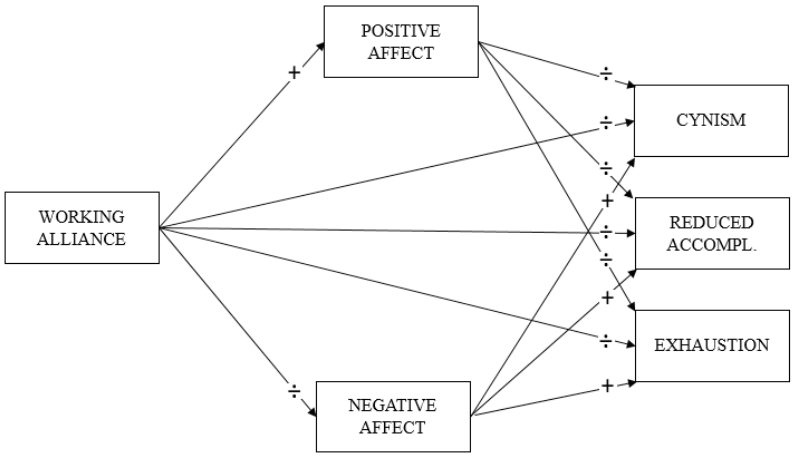

Figure 1. Hypothesized model

Therefore, the aim of this article is to explore relations between working alliance, affect and burnout among Norwegian sport coaches working with athletes on a high level. It is hypothesized that working alliance predicts positive affect positively, and negative affect negatively. Further, it is expected that positive affect predicts burnout negatively, and that negative affect predicts burnout positively. The model is shown in Figure 1.

Material and methods

Eight hundred and seventy six coaches at various levels were invited to participate in a survey. Participants were recruited from exercising databases at Norwegian Olympic and Paralympic Committee and Confederation of Sports. One week ahead of distribution of the survey, participants were contacted via email and given information about why they were selected to participate in the survey, the background and purpose of the study, that all the data would be kept confidential, that participation was voluntary, and that the Norwegian Social Science Data Services (NSD) had approved the project. Participants gave their consent to participate in the study by checking for read and accepted the consent form on the first page of the survey.

A structured questionnaire consisting of five different parts was used for the data collection. All measurements used in this study were based on previously developed scales proven to hold both satisfactory validity and reliability. The measurements were originally in English, but were translated into Norwegian and slightly adjusted for the purpose of this study by the authors. Part 1 of the questionnaire covered general variables such as gender, age, type of sport, level of coaching, years of coaching experience and hours of practice per week. Part 2 consisted of the "Working Alliance Inventory-Short Version", part 3 consisted of the "Positive and Negative Affect Schedule", while part 4 the "Maslach Burnout Inventory-General scale ".

Working Alliance Inventory

A customized version of the Short Version–Working Alliance Inventory (Tracey, Kokotovic, 1989) was used to assess coach– athlete relationship characteristics. The WAI was adapted to the coach-athlete context inspired by Bahrick et al. (1991). Terms such as "therapist" and "client" were in the case of this study changed to "coach" and "athlete," and references to "client problems" were changed to "athlete issues" or "athlete concerns". WAI contains 12 items, covering three dimensions: the "goal dimension" (i.e. My athlete and I work on mutually agreed-upon goals), the "task dimension"(i.e. My athlete and I agree about the steps the athlete need to take to improve in his sport), and the "bonding dimension" (i.e. There is mutual trust between my athlete and me). The coaches answered each item on a 7-point Likert scale ranging from 1 = "never" to 7 = "always". The construct validity of The Short Version – Working Alliance Inventory has previously been established by confirmatory factor analysis, and validation studies of the WAI scale have proven good construct validity and high reliability (Corbiére, Bisson, Lauzon, Ricard, 2006; Tracey, Kokotovic, 1989). The Cronbach's alpha for the total measurement in this study was 0.88, while for the sub-dimensions goal, task and bond it was 0.62, 0.80 and 0.80 respectively.

Positive and Negative Affect Schedule

The Positive and Negative Affect Schedule (PANAS) (Watson, Clark, Tellegen, 1988) was used to measure positive and negative affect. This scale has previously reported strong validity with measures like general distress and dysfunction, depression and anxiety (Watson et al., 1988). PANAS comprises two scales, each with ten descriptors representing different emotions, that measures positive affect (i.e. excited – strong – proud) and

negative affect (i.e. upset – nervous – irritable) respectively. The coaches were asked to rate the extent to which they have experienced each particular emotion within the last week as a coach, responding on a 5-point Likert scale ranging from 1 = "not at all" to 5 = "very much". The PANAS has strong reported validity with measures as general distress and dysfunction, depression and state anxiety (Watson, Clark, Carey, 1988). The Cronbach's alpha for the measurement in this study was 0.87 (positive affect) and 0.87 (negative affect).

Maslach Burnout Inventory

Burnout was measured with the Norwegian version of Maslach Burnout Inventory – General scale (Richardsen, Martinussen, 2005; Schaufeli, Leiter, Maslach, Jackson, 1996), consisting of three subscales. Exhaustion was measured with five items (e.g., "I feel emotionally drained from my work"), cynicism was measured with five items (e.g., "I have become less interested in my work since I started this job"), and personal accomplishment was measured with six items (e.g., "I can effectively solve the problems that arise in my work"). The latter sub scale was reversed, and labeled "Reduced Personal Accomplishment". The coaches responded on a 7-point Likert scale with respect to how often they experience each feeling, ranging from 0–6 where 0 = "never", 1 = "a few times a year or less", 2 = "once a month or less", 3 = "a few times a month", 4 = "once a week", 5 = "a few times a week", and 6 = "every day". The MBI has previously been proven as reliable and valid measure for burnout in various professions (Schaufeli, Leiter, Kalimo, 1995; Maslach, Jackson, Leiter, 1996). The Cronbach's alpha for the total measurement of burnout in this study was 0.82, while for the sub-dimensions exhaustion, cynicism and reduced personal accomplishment it was 0.86, 0.67 and 0.79 respectively.

Data Analysis

The data were first analyzed by examining the correlations between variables using Pearson correlational coefficient. Further, to investigate the quality of the measurement instruments and to determine the zero-order correlations between the variables in the hypothesized model, a confirmatory factor analysis (CFA) was used. Subsequently, the proposed model was tested with structural equation modeling (SEM). Both the CFA and the SEM was conducted using the Amos 23 program (Arbuckle, 2014). Following the standard approach in most latent variable models, the first indicator of each scale was used to set the metric of the latent variables (Brown, 2006). In the CFA and SEM analysis, a maximum likelihood estimator (MLR) was used, due to its robustness towards violations of the multi-normality assumptions a maximum (Brown, 2006).

Model fit was assessed using the CFI, IFI, TLI and RMSEA indices, as well as the chi-square test. With regard to the CFI, IFI, and TLI indices, the analysis in this study relied on Byrne (2010) and Hu and Bentler (1999), suggesting that values above 0.90 indicate an acceptable fit, and values above 0.95 indicate a good fit of the data. Further, according to Hu and Bentler (1999) and Tabachnick and Fidell (2007), a RMSEA value of 0.06 or less reflects a good fit. When the goodness of fit is adequate, the plausibility of the proposed relations among the constructs is supported.

Results

Out of the 876 coaches who were asked to participate in the investigation, 510 completed the data collection, which gave a response rate of 58.2%. Among the 510 coaches who completed a questionnaire, 299 was identified as high competitive level coaches, as they reported to be coaching elite athletes or junior elite athletes. The other 211 coaches was excluded from the analysis conducted for this particular study, as they reported to coach athletes on lower levels.

Among the 299 high level coaches, 46 were women and 253 were men. Their mean age was 41.1 ±10.4 years, and they had an average of 15.5 ±9.4 years of coaching experience. They reported to spend on average 24.0 ±17.4 hours per week on their work as a coach. 110 coaches had their role as a full time job, 94 worked part time as coaches, whereas 95 had their coacher role as volunteers. The coaches represented a broad variety of sports, with cross-country skiing (n = 75), handball (n = 55), athletics (n = 37), swimming (n = 20), cycling (n = 16), biathlon (n = 14) and soccer (n = 13) as the most frequently reported sports. <5 coaches worked with athletes in alpine skiing, wrestling, dance, golf, ice hockey, Nordic combined, orienteering, rowing, sailing, ski jumping, ice skating, snowboard, taekwondo, tennis, gymnastics, weight lifting and volleyball.

Correlations and descriptive statistics

In Table 1, the correlations between the variables in this study is presented, as well as the possible maximum scores, statistical means, standard deviations, and Cronbach's alphas. The zero order correlations between the variables in this study varies from zero (±0.09 to 0.18) to strong (±0.37 to 0.88) positive and negative relationships. The Cronbach's alphas of the variables in this study varied from excellent to acceptable. Except for the correlations between the sub-dimensions of working alliance and burnout, the strongest correlation exerted was between burnout and positive affect (negative), and reduced accomplishment and positive affect (negative), followed by the correlation between burnout and working alliance (negative).

Table 1. Pearson correlations and descriptive statistics of all the variables measured in this study

Variable	1	2	3	4	5	6	7	8	9	10
1. Working alliance	–									
2. Working alliance – Task	0.88**	–								
3. Working alliance – Bond	0.79**	0.64**	–							
4. Working alliance – Goal	0.83**	0.57**	0.42**	–						
5. Positive affect	0.29**	0.21**	0.31**	0.22**	–					
6. Negative affect	–0.31**	–0.33**	–0.15**	–0.29**	0.16**	–				
7. Burnout	–0.37**	–0.26**	–0.31**	–0.35**	–0.42**	0.38**	–			
8. Burnout – Cynicism	–0.28**	–0.21**	–0.23**	–0.25**	–0.31**	0.33**	0.78**	–		
9. Burnout – Reduced accompl.	–0.32**	–0.18**	–0.33**	–0.29**	–0.42**	0.12*	0.60**	0.20**	–	
10. Burnout – Exhaustion	–0.19**	–0.16**	–0.11	–0.20**	–0.17**	0.36**	0.76**	0.49**	0.09	–
Maximum score	7	7	7	7	10	10	7	7	7	7
Number of items	12	4	4	4	10	10	16	5	6	5
Mean	5.95	5.84	6.15	5.85	4.05	1.92	2.28	2.18	2.07	2.65
Standard deviation	0.55	0.65	0.56	0.78	0.54	0.66	0.67	0.95	0.82	1.07
Cronbach's alpha	0.88	0.80	0.80	0.62	0.87	0.87	0.81	0.67	0.79	0.86

** $p < 0.01$, * $p < 0.05$. The estimates are based on the observed data.

Measurement model (CFA)

To investigate the measurement model and the relations between the variables, a CFA of the latent variables was conducted. First, a preliminary CFA was applied for the models of each variable that was studied. A satisfactory model fit was not achieved due to high complexity in relation to sample size when Negative affect and Positive affect

were entered as first-order latent variables with ten indicators each (each indicator corresponded to an item from the PANAS scale). The same result applied for working alliance, when entered as a second-order latent variable with "task", "goal and "bond" as primary factors (each containing four indicators, conform to the items in the WAI scale). With regard to Burnout, satisfactory model fit was achieved when each of the sub-dimensions "cynicism", "reduced sense of accomplishment" and "exhaustion" was set as first-order latent variables containing five, six and five indicators respectively (conform to the items of the MBI scale).

To reduce complexity and achieve better fit for the models of positive affect, negative affect and working alliance, a parceling method was applied. Parceling involves using composite scores derived from multiple individual scale items, and is a commonly used method in structural equation modeling (Landis, Beal, Tesluk, 2000). It has with advantages such as higher sample-size-to-estimated-paths ratios, increased reliability of manifest indicators and less violation of normality assumptions (Bandalos, Finney, 2001). For the indicators of the latent variables positive affect and negative affect, three parcels constructed from item means of three to four single items was used (Landis, Beal, Tesluk, 2000). For the latent variable working alliance, parcels conform to the primary "task", "goal" and "bond" factors were used, meaning each parcel was constructed from the item means of four single items. With these adjustments, acceptable fit was achieved for all the models of variables under study.

For the final model, a covariance structure model of Figure 1 was specified. This model showed good fit to data ($\chi 2$ (171) = 118.938, $p < 0.001$, CMIN/DF = 1.601, RMSEA = 0.045, IFI = 0.969, TLI = 0.959, and CFI = 0.968), and all loadings in the model were significant at $p < 0.001$. As showed in Table 2, the correlations between the latent variables varied from low to strong, supporting the zero-order correlations presented in Table 1. The result from the CFA supports the conceptualization of six separate but correlated constructs (see Table 3).

Table 2. Correlations between the latent variables included in the covariance structure model

Variable	1	2	3	4	5	6
1. Working alliance	–					
2. Positive affect	0.32	–				
3. Negative affect	–0.39	0.18	–			
4. Cynicism	–0.39	–0.46	0.51	–		
5. Reduced accomplishment	–0.35	–0.50	0.16	0.31	–	
6. Exhaustion	–0.23	–0.21	0.42	0.77	0.13	–

Table 3. Results of the Confirmatory Factor Analysis of Working alliance, Negative affect, Positive affect and dimensions of Burnout

Indicator		Latent variable	b	S.E.	β	p
1		2	3	4	5	6
Task	←	Working alliance	1		0.87	
Bond	←	Working alliance	0.71	0.06	0.72	***
Goal	←	Working alliance	0.88	0.08	0.65	***
Neg_affect1	←	Negative affect	1		0.77	
Neg_affect2	←	Negative affect	0.82	0.06	0.72	***
Neg_affect3	←	Negative affect	0.88	0.06	0.65	***
Pos_affect1	←	Positive affect	1		0.84	

1		2	3	4	5	6
Pos_affect2	←	Positive affect	0.95	0.06	0.81	***
Pos_affect3	←	Positive affect	0.95	0.06	0.86	***
CY1	←	Cynicism	1		0.69	
CY2	←	Cynicism	1.05	0.16	0.55	***
CY3	←	Cynicism	1.27	0.21	0.52	***
RA1	←	Reduced accomplishment	1		0.69	
RA2	←	Reduced accomplishment	0.99	0.10	0.74	***
RA3	←	Reduced accomplishment	1.05	0.09	0.81	***
EX1	←	Exhaustion	1		0.84	
EX2	←	Exhaustion	0.87	0.07	0.77	***
EX3	←	Exhaustion	0.80	0.06	0.75	***

*** p < 0.001.

Structural model

When acceptable model fit was achieved in the CFA, the hypothesized model displayed in Figure 1 was further tested by means of specifying the relations between the variables as depicted in the model. Bias correction using a bootstrapping procedure with 500 bootstrap samples was applied to calculate the standard errors and confidence intervals of the model parameters.

The path model had acceptable fit to the data (χ^2 (171) = 188.938, p < 0.001, CMIN/DF = 1.601, RMSEA = 0.045, IFI = 0.969, TLI = 0.959, and CFI = 0.968). The estimates of standardized regression weights and squared multiple correlations are presented in Figure 2, whereas standardized and unstandardized regressions weights, total effects and indirect effects are presented in Table 4.

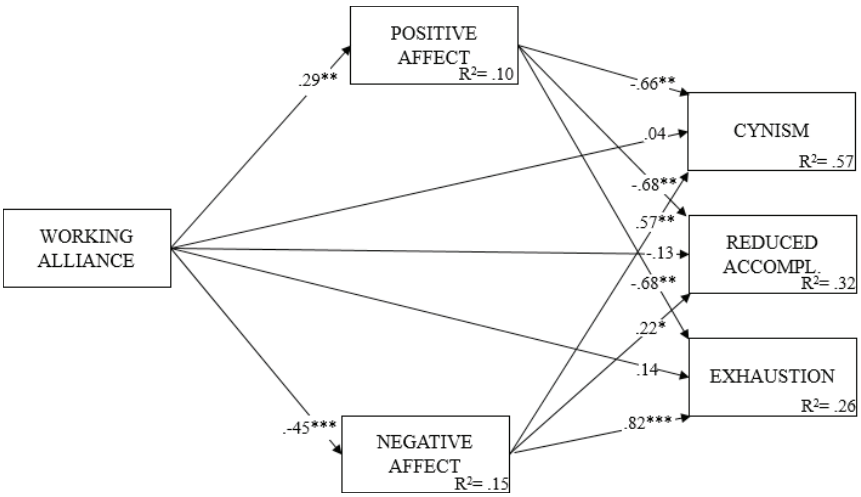

Figure 2. Structural Equation Model (Standardized Solution; N = 299), * p < 0.05; ** p < 0.01; *** p < 0.001

Table 4. Unstandardized regressions weights with its standard errors, total effects and indirect effects

	Regressions Weights				Total Effects					Indirect Effects				
	b	S.E.	β	p	b	SE	CO90		p	b	SE	CO90		p
Effects on Positive affect														
Working alliance	0.29	0.06	0.32	***	0.29	0.09	0.18	0.46	**					
Effects on Negative affect														
Working alliance	–0.45	0.08	0.39	***	–0.45	0.09	–0.61	–0.32	**					
Effects on Cynicism														
Working alliance	0.04	0.11	0.04	0.69	–0.41	0.14	–0.68	–0.20	**	–0.46	0.13	–0.71	–0.27	**
Positive affect	–0.68	0.12	–0.59	***	–0.68	0.17	–0.97	–0.43	**					
Negative affect	0.57	0.10	0.63	***	0.57	0.11	0.40	0.77	**					
Effects on Reduced accomplishment														
Working alliance	–0.13	0.10	–0.11	0.19	–0.43	0.14	–0.67	–0.21	**	–0.30	0.08	–0.48	–0.19	**
Positive affect	–0.68	0.11	–0.50	***	–0.68	0.16	–0.94	–0.41	**					
Negative affect	0.22	0.08	0.21	0.01	0.22	0.09	0.09	0.37	**					
Effects on Exhaustion														
Working alliance	0.14	0.15	0.08	0.35	–0.43	0.14	–0.66	–0.21	**	–0.57	0.14	–0.85	–0.39	**
Positive affect	–0.68	0.15	–0.33	***	–0.68	0.17	–0.97	–0.41	**					
Negative affect	0.82	0.13	0.51	***	0.82	0.14	0.59	10.06	**					

** $p < 0.01$; *** $p < 0.001$.

As seen in Figure 2, working alliance affected both positive affect (positively) and negative affect (negatively) significantly. No significant direct effect was revealed between working alliance and any of the burnout dimensions. However, as seen in Table 4, working Alliance showed significant influence by means of indirect effect and total effect on both cynicism, reduced accomplishment and exhaustion ($p < 0.01$).

With regard to the burnout dimensions, both cynicism, reduced accomplishment and exhaustion was positively and significantly influenced by negative affect, and also negatively and significantly influenced by positive affect. In total, the predicting variables explained 57% of the variance in cynicism, 32% of the variance in reduced accomplishment and 26% of the variance in exhaustion.

Discussion

The purpose of the present study was to test a theoretical model of relations between working alliance, positive affect, negative affect and burnout in a sample of high-level coaches. The findings in this study mainly confirm our hypothesis.

First, our model explained 57% of the variance in cynicism, 32% of the variance in reduced accomplishment and 26% of the variance in exhaustion. These effects are mainly derived from positive affect and negative affect. However, working alliance has a significant indirect effect on all the burnout dimensions through the mediating variables positive affect and negative affect. Further, working alliance explains 10% of the variance in positive affect and 15% of the variance in negative affect respectively.

The impact from coaches' perceived working alliance on affect

In our hypothesized model, we expected working alliance to predict negative affect negatively and positive affect positively. Both of these expectations were confirmed by our findings. A suitable theory that can explain these

relationships is the Cognitive Activation Theory of Stress (CATS). CATS predicts that if coaches are unable to meet important situational demands in their roles, such as to build-, develop and maintain healthy relationships with their athletes, it can result in negative stress (Ursin, Eriksen, 2004). This means that the physiological and psychological consequences from stress are a response to the cognitive evaluation that coaches accomplish based on their role as coaches. Research claims that there is a close relationship between stress and affect (Hamama, Ronen, Schachar, Rosenbaum, 2013; Lazarus, Folkman, 1984; Ursin, Eriksen, 2004). Thus, coaches believe they have the necessary resources to build-, develop- and maintain healthy relationship with their athletes (positive expectation of the outcome of the situation), the consequence will be a positive affect response (Moen, Federici, Abrahamsen, 2015). On the other hand, the affect response can be negative if the coaches do not expect that they have the capabilities to establish well-functioning relationships with their athletes. In other words, positive stress stimulates positive affect, whereas negative stress stimulates negative affect (Crawford, Henry, 2004; Lazarus, Folkman, 1984).

Since both researchers and practitioners highlight the importance an effective coach-athlete relationship to stimulate growth and development of athletes' talents in sport, a possible incapability to meet these demands might most likely impact the level of negative stress in coaches and hence negative affect (Jowett, 2003). More specifically, previous studies with coaches have cited lack of effective communication with their athletes, lack of control over athletes' behaviors and not being able to manage athletes' psychological needs as typical stressors (Frey, 2007; Kroll, Gundersheim, 1982; Olusoga, Butt, 2009). Another study that confirms the negative stress and affect that occurs when coaches are not being able to build healthy relationships with their athletes, shows that coaches were experiencing hurt feelings, lack of commitment and satisfaction as a consequence (Poczwardowski, Barott, Henschen, 2002).

Importantly, a coach-athlete relationship characterized by poor communication and bad relationship quality might ultimately result in interpersonal conflicts (Wachsmuth, Jowett, Harwood, 2017). An interpersonal conflict is a state of imbalance, incongruence, and incompatibility between a coach and an athlete (Hinde, 1997), and involves disagreements and negative emotions (Galtung, 1996; Putnam, Poole, 1987; Thomas, 1992; Wall, Callister, 1995). This type of experiences can be linked to negative affect (Watson, Clark, Tellegen, 1988). Eventually, they also stand as a contrast to the agreement and feeling of common purpose and understanding between coaches and athletes as emphasized in the working alliance-theory (Bordin, 1994).

A well-functioning coach-athlete relationship is, on the other hand, likely to cause positive consequences in form of developmental and performance outcomes in athletes (Benson, Scales, Hamilton, Sesma, 2006).

This represents the potentially rewarding part of the coaching role, related to the joy of building a successful program, satisfaction derived from teaching sport skills successfully and the joy and exuberance when winning a contest or achieving goals. This type of experiences can be linked to feelings like inspiration, enthusiasm, excitement and pride, which again are linked to positive affect (Watson, Clark, Tellegen, 1988).

The impact of coaches' perceived working alliance on burnout

Further, in our hypothesized model, it was expected that working alliance would predict cynicism, reduced accomplishment and exhaustion directly. These expectations were not confirmed. However, working alliance had a significant indirect effect on all three dimensions of burnout since they are mediated by positive and negative affect. A possible explanation to these results is that it is the coaches' cognitive evaluations of situational demands, such as coping with the coach-athlete relationship, that serve as a potential stressor, or a buffer against so, depending on

to what extent the working alliance is perceived as effective. For coaches working with athletes who aim to perform on a high level, which applies for the coaches in this study, the process of developing an athletes skills and achieving wanted performance outcomes is the main goal (Lyle, 2002). This puts high demands to quality at every stage of the process, as high performance sport is relying on small margins and the ability to constantly push ones' limits. In the process of developing athlete skills and performance outcomes to the wanted level, it seems important for the coach to experience high levels of task- and goal agreement, and emotional bond to the athletes. A coach who fails in establishing bond with his athletes, and struggling with clarifying goals and tasks, might on the other hand cause an imbalance and interference in the development process. Thus, the way coaches relate situational demands in their roles seems vital for the experienced load that is associated with their roles, and thus the affective response that follows. The load from the actual tasks coaches need to fulfill in their roles is not necessarily decisive.

Impact on the burnout dimensions

Finally, we expected positive affect to have a negative direct effect on cynicism, reduced accomplishment and exhaustion, and negative affect to have a positive direct effect on the same variables. All of these expectations were confirmed.

The cynicism dimension of burnout reflects the coaches' direct attitudes and feelings towards the job they do with their athletes, and is in a stress perspective viewed as an avoidance strategy to make strenuous situations more manageable for the coach (Lundkvist, Stenling, Gustafsson, Hassmén, 2014). 57% of the variance in cynicism is explained by the working alliance and affect-variables in this study. Thus, the importance of coach-athlete working alliance clearly stands out as a considerable factor to explain the burnout syndrome among elite coaches. Increased levels of cynicism involves negative, unsympathetic or disconnected orientation to various aspects the coaching practice (Lundkvist, Stenling, Gustafsson, Hassmén, 2014), and might lead coaches to distances themselves from their athletes, which again negatively will influence both the relationship bond and the performance outcome. This might be especially critical in a high-level coach athlete relationship, as the symptoms of cynicism indicate attitudes opposite from the collaboration, close interaction and mutuality emphasized in the working alliance concept (Bordin, 1979). With this in mind, the longitudinal effects of increased cynicism levels back on the working alliance are an interesting theme for further research.

The model in our study explains 32% of the variance in the reduced accomplishment dimension. The performances of coaches' are often judged by the success of their athletes (Gould, Dieffenbach, 2002). If relying on the suggestions that a helping and supportive coach-athlete relationship is essential to achieve successful developmental and performance outcomes in athletes (Benson, Scales, Hamilton, Sesma, 2006), the negative relationship between working alliance/affect and burnout is not surprising. On the road to achieve success in elite sport, well-defined and common understanding of goals, and a clear common understanding of the tasks are necessary to reach the goals. If this is not established, eventually an imbalance between expectations and outcome of the coaching process might occur, and cause a negative stress reaction for the coach (Schaufeli, Buunk, 2003).

Finally, the model in this study explains 26% of the variance in exhaustion. This is explained by the working alliance and affect-variables in the model, and thus the importance of a well-established coach athlete working alliance for coaches' physiological and psychological health and perseverance is highlighted. The exhaustion dimension directly relates to the stress part of burnout, and describes exhaustion because of prolonged work-life stress (Schaffran, Altfeld, Kellmann, 2016).

Relationships between the burnout dimensions

One interesting issue that has continued to interest burnout researchers and practitioners is the relationships between the three dimensions of burnout, and the development of the burnout syndrome. It is generally assumed that the three burnout dimensions do not develop simultaneously, and hence, knowledge about the causal order of the three burnout dimensions can be relevant for the early recognition of burnout and the identification of "high-risk" people who could be targeted for early, preventive interventions (Maslach, Leiter, 2008; Schaufeli, Enzmann, 1998). It is claimed that the associations among the three dimensions is resulting from an underlying causal process that reflects the development of burnout (Golembiewski, Munzenrider, Stevenson, 1986; Lee, Ashforth, 1996; Leiter, Maslach, 1988; Taris, Le Blanc, Schaufeli, Schreurs, 2005). A possible theory that can be used to discuss possible consequences of the results in this study is the phase model. The phase model claims that depersonalization is experienced first (cynicism) in the process of burning out, since some level of detachment is necessary in helping relationships (Golembiewski, Munzenrider, Stevenson, 1986). Following detachment is depersonalization that undermines performance and ultimately stimulates the emotional strain (Golembiewski, Munzenrider, Stevenson, 1986). Thus, based on this theory the results in this study are interesting, since working alliance, positive affect and negative affect explains 57% of the variation in cynicism. Cynicism is by some researchers claimed to be the triggering variable in the burnout syndrome, and that both reduced accomplishments and exhaustion subsequently will develop over time (Golembiewski, Munzenrider, Stevenson, 1986). This study has identified the perceived coach-athlete working alliance as an important factor that can be targeted for early, preventive interventions (Maslach, Leiter, 2008; Schaufeli, Enzmann, 1998). However, longitudinal data is needed to conform this finding.

Conclusion and limitations

It is worth noticing that this study limited by the cross-sectional design used. Such data do not support analyses in causal terms, even though our interpretations are based on previous findings and theoretical analyses. As burnout is described as a slow and gradual process that is expected to change over time, longitudinal examinations might provide greater insights into the development of burnout, and possible contributors in this regard. In addition, the cross-sectional design does not assess directly what causes the affect levels among the coaches. Other limitations should also be taken into account. For example, possible influencing factors such as gender, number of athletes coached, sport and type of professional was not considered in this study. In addition, the reliability of the sub-dimensions "goal" of the WAI and "cynicism" of the MBI showed questionable reliability, and these results should therefore be critically considered.

The effects found in this study suggest that the coach-athlete working alliance to be a significant contributor to burnout in high-level coaches. However, longitudinal research are called for in the future, to examine the effect of coaches' perceived coach-athlete working alliance on affect and burnout over time.

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EVALUATION OF THE QUALITY OF SLEEP OF THE PROFESSIONAL SOLDIERS POPULATION

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Abstract The aim of this study was to identify sleep problems in a select group of professional soldiers. For the study used a questionnaire containing the Athens Insomnia Scale by Soldatos, allowing klinimetric evaluation of sleep disorders reflecting mainly insomnia. Material Data were obtained from 200 professional soldiers. The results showed no pathological abnormalities of sleep study population, however, the results show some reduction in the prevalence of symptoms of sleep quality based on the selected factors. The health status of all the soldiers experiencing combat stress requires periodic and thorough control since the diagnosis of disorders is difficult and they can appear even after a long period of lived events. This may lead to look for other ways to deal with problems; the use of psychoactive substances or drug abuse. Therefore it is extremely important to use therapeutic activities.

Key words quality of sleep, Athens insomnia scale, professional soldiers

Introduction

With the development of civilization, people are subjected to the influence of adverse external factors that may contribute to the reduced quality of life. External stimuli, causing stimulation, stress and other negative emotional states contribute to the pathology of the functioning of the human body. A phenomenon more common among adults is reducing the quality of sleep or sleep disorders, or irregularity occurring during one of the basic physiological needs of the body.

In the literature, the most common is considered the division of sleep disorders given by Bilikiewicz et al. (2002). According to this it may appear insomnia or disorder occurring in the form of insomnia, which may be temporary for the duration of several days, due to a work shift, sudden stressful situations or sudden crossing time zone. Lasting up to three weeks insomia manifested, among others the sudden somatic disease or chronic stress

associated with other circumstances. While the chronic insomnia is diagnosed when it takes more than one month. This type of disorder is usually accompanied by malaise during the day, sleepiness, fatigue and low mood and motivation, and consequently lower the efficiency of tasks. By definition, the ICD-10 Chronic insomnia is inadequate amount of sleep, which occurs at least three times a week for at least a month. Another disorder is excessive sleepiness also known as hypersomnia. This is increased sleepiness despite the rest of the night, prolongation of sleep or sleepy in a situation requiring activity. While the disorders called parasomnias are undesirable disorder, the most common motor, occurring mainly during wake from sleep, partial awakenings, or in the transition between sleep and wakefulness, or other phases of sleep. Very important in the diagnosis of disorders of has patient declarant problems and also the appropriate tools to diagnose the disorder or other signs of demonstrating the decline in quality of sleep.

One of the goals of the functioning of the army is to conduct training and combat operations during the war. Professional soldiers forms a team undertaking often difficult and dangerous tasks that require possession of specific skills, knowledge and social competencies (Piórowski, 2008). Working in the Army requires from soldiers high responsibility for the health and life of their own and others. Execution of tasks is accompanied by a lot of stressful situations, which, in combination with specific personality traits can cause health effects such as high blood pressure, increased risk of coronary heart disease, increased cholesterol, decreased resistance to infections or develop other psychosomatic diseases (Tomaszewska, 2008; Nowicki et al., 2016). Freeman and Kimbrell (2004) showed that the main health problems in the population of the soldiers involved in the fighting, such as; depression, aggression, psychoactive substance misuse and social isolation are closely associated with posttraumatic stress disorder PTSD. The symptoms of this condition are excessive vigilance and anxiety as well as avoiding memories and recurrent thoughts (Basińska, 2004). Epidemiological studies conducted among American soldiers participating in peacekeeping missions showed that as many as 10% of them leave the area of combat operations due to mental disorders (Rasmus, 2013). For this reason it is very important to identify any signs of deterioration in the quality of life because of the experience and provide appropriate expert assistance to this population.

The aim of this study was to identify sleep problems in a selected group of professional soldiers.

Material and methods

The studies used purposeful selection and a select group of former professional soldiers. Permission to carry out tests gave Undersecretary of State in the Ministry of National Defence on the basis of Decision No 78 / MON of the Minister of National Defence of 15 February 2008.

The study material consisted data obtained from 200 soldiers, including 26 women (13%) and 174 men (87%). The respondents ranged in age from 22 to 49 years; the average age was M = 32.96 with a standard deviation SD = 5.82. The group consisted of 16 officers, 82 NCOs and 102 privates (Table 1). Job experience surveyed ranged from 1 year to 30 years (M = 8.31; SD = 5.90). The sub-group of soldiers who participated in the mission of the war consisted of 73 people, including 4 women (5.5% of the total study population) and 69 men (94.5% of the total study population) aged 23 to 49 years (M = 34, 27; SD = 5.26). Professional experience in this subgroup ranged from 1 year to 30 years (M = 11.29, SD = 4.73). Most of them (45 people; 61.6%) participated in the mission of war 1 time in two missions attended 16 people representing 21.9% of the respondents, 6 persons (8.2%) went 3 times, and 3 people (4.1%) went successively 4 and 5 times. The statistical analysis examined soldiers were divided into

3 groups: staff who have never participated in a military mission (n = 127), the soldiers who went on a mission 1 time (n = 45) and the military who participated in the mission 2 and more times (n = 28).

Table 1. Characteristics of the study population

Gender	N	Corps soldier	n
Woman	26	Oficers	16
Man	174	NCOs	82
		Privates	102

Data from respondents was obtained by diagnostic survey, the survey technique (Babie, 2009). Used tool; questionnaire containing the Athens Insomnia Scale by Soldatos (2000) allows klinimetric evaluation of sleep disorders reflecting mainly insomnia. It consists of 8 questions for which the respondent marked the one of the 4 possible answers. Each of the answers are assigned points (from 0 to 3) and the sum of their shows on the severity of the symptoms of sleep disorders. Obtaining 5 points or less indicates normal course of sleep stages, from 6 to 10 points is on the border of norms and should pay attention to the basic rules of sleep hygiene and further observation and eventual therapy, while above 10 points indicates insomnia and the necessity of detailed diagnostics and the appropriate therapy strategy (Fornal-Pawłowska et al., 2011).

Results

The results showed a good or average quality of sleep in the studied group of professional soldiers (Table 2). However, in this population they were also people of low quality requiring a detailed diagnosis and therapy.

Table 2. Distribution of the results of measuring the quality of sleep in a group of professional soldiers

	Quality of sleep		
	Good (0–5 points)	Average (6–10 points)	Low (less then 10 points)
Soldiers not participating in missions	52 (71.2%)	17 (23.3%)	4 (5.5%)
Soldiers participating in missions	97 (77.0%)	25 (19.8%)	4 (3.2%)
All	149 (74.9%)	42 (21.1%)	8 (4.0%)

In relation to the number of completed peacekeeping missions and stabilization operations, among examined soldiers observed one being statistically significant difference [X2 (df = 4) = 13.362; $p < 0.01$], which concerned the indicator sleep continuity (Table 3). The analysis shows that the problem is the smallest among soldiers who have decided to participate in peacekeeping or stabilization operation several times – as many as half of them sleeps overnight in a continuous manner, and 36% wakes up occasionally. In the subgroup of stationary soldiers prevailed occasional awakening while frequent interruptions in sleep were most common in the military, who went on a mission once and decided not to do it again. Over 22% of them are experiencing frequent awakenings during the night.

Table 3. Symptoms of sleep disorders among soldiers, depending on the number of completed military missions

	Number of military missions			Test chi-square		
	0 n = 127	1 n = 45	2 and more n = 28	x^2	df	p
The speed of falling asleep						
Fast	79 (62.2%)	26 (57.8%)	16 (57.1%)			
With a slight delay	35 (27.6%)	9 (20.0%)	9 (32.1%)	5.079	4	0.279
With delay	13 (10.2%)	10 (22.2%)	3 (10.7%)			
Awakening in the night						
None	42 (33.1%)	13 (28.9%)	14 (50.0%)			
Sporadic	77 (60.6%)	22 (48.9%)	10 (35.7%)	13.362	4	0.009
Frequent	8 (6.3%)	10 (22.2%)	4 (14.3%)			
Awakening the in the morning						
None	84 (66.1%)	22 (48.9%)	19 (67.9%)			
Little earlier	38 (29.9%)	20 (44.4%)	8 (28.6%)	4.662	4	0.324
Much earlier	5 (3.9%)	3 (6.7%)	1 (3.6%)			
Total sleep time						
Sufficient	78 (61.4%)	23 (51.1%)	16 (57.1%)			
Slightly insufficient	40 (31.5%)	18 (40.0%)	10 (35.7%)	1.498	4	0.827
Clearly insufficient	9 (7.15)	4 (8.9%)	2 (7.1%)			
Quality of sleep						
Satisfying	83 (65.4%)	26 (57.8%)	19 (67.9%)			
Slightly unsatisfying	40 (31.5%)	15 (33.3%)	8 (28.6%)	2.992	4	0.559
Clearly unsatisfying	4 (3.1%)	4 (8.9%)	1 (3.6%)			
Frame of daily mind						
Good	98 (77.2%)	33 (73.3%)	22 (78.6%)			
Slightly worse	27 (21.3%)	10 (22.2%)	5 (17.9%)	1.494	4	0.829
Clearly worse	2 (1.6%)	2 (4.4%)	1 (3.6%)			
Psychophysical efficiency by the day						
Correct	105 (82.7%)	35 (77. 8.0%)	25 (89.3%)			
Slightly disturbed	20 (15.7%)	9 (20.0%)	3 (10.7%)	1.804	4	0.772
Clearly disturbed	2 (1.6%)	1 (2.2%)	0 (0%)			
Sleepiness during the day						
None	52 (41.3%)	14 (31.1%)	12 (42.9%)			
Slight	64 (50.8%)	27 (60.0%)	12 (42.9%)	3.049	4	0.550
Significant	10 (7.9%)	4 (8.9%)	4 (14.3%)			

The degree of military showed differences in the examined soldiers under the terms of two of the eight indicators of sleep problems. In both cases, the results of the analysis seem to indicate greater severity of the problem in a group of non-commissioned officers (Table 4). Compared with other groups, often they face the problem of interrupted sleep, which complains of more than 18% of non-commissioned officers. In addition, 12% of them estimated the total time of their sleep as definitely insufficient. However, the results suggest that these ailments are the smallest among the officers. Half of them sleeps all night in a continuous manner, and nearly 63% believed that the time spent on sleep during the day for them is entirely satisfactory. Satisfying sleep time was characterized by the almost 68% privates.

Table 4. Symptoms of sleep disorders of soldiers, depending on the military rank

	Military rank			Test chi-square		
	Oficer n = 16	NCOs n = 82	Private n = 102	x^2	df	p
The speed of falling asleep						
Fast	10 (62.5%)	47 (57.3%)	64 (62.7%)			
With a slight delay	3 (18.8%)	19 (23.2%)	31 (30.4%)	7.559	4	0.109
With delay	3 (18.8%)	16 (19.5%)	7 (6.9%)			
Awakening in the night						
None	8 (50.0%)	28 (34.1%)	33 (32.4%)			
Sporadic	7 (43.8%)	39 (47.6%)	63 (61.8%)	10.026	4	0.040
Frequent	1 (6.2%)	15 (18.3%)	6 (5.9%)			
Awakening the in the morning						
None	11 (68.8%)	43 (52.4%)	71 (69.6%)			
Little earlier	4 (25.0%)	34 (41.5%)	28 (27.5%)	6.419	4	0.170
Much earlier	1 (6.2%)	5 (6.1%)	3 (2.9%)			
Total sleep time						
Sufficient	10 (62.5%)	38 (46.3%)	69 (67.6%)			
Slightly insufficient	5 (31.2%)	34 (41.5%)	29 (28.4%)	10.069	4	0.039
Clearly insufficient	1 (6.2%)	10 (12.2%)	4 (3.9%)			
Quality of sleep						
Satisfying	13 (81.2%)	45 (54.9%)	70 (68.6%)			
Slightly unsatisfying	3 (18.8%)	32 (39.0%)	28 (27.5%)	6.243	4	0.182
Clearly unsatisfying	0 (0%)	5 (6.1%)	4 (3.9%)			
Frame of daily mind						
Good	15 (93.8%)	60 (73.2%)	78 (76.5%)			
Slightly worse	1 (6.2%)	18 (22.0%)	23 (22.5%)	5.748	4	0.219
Clearly worse	0 (0%)	4 (4.9%)	1 (1.0%)			
Psychophysical efficiency by the day						
Correct	13 (81.2%)	69 (84.1%)	83 (81.4%)			
Slightly disturbed	3 (18.8%)	11 (13.4%)	18 (17.6%)	1.542	4	0.819
Clearly disturbed	0 (0%)	2 (2.4%)	1 (1.0%)			
Sleepiness during the day						
None	7 (43.8%)	28 (34.1%)	43 (42.6%)			
Slight	8 (50.0%)	44 (53.7%)	51 (50.5%)	2.547	4	0.636
Significant	1 (6.2%)	10 (12.2%)	7 (6.9%)			

Experience of direct participation in the fighting and exchanging fire with the enemy during the event of military missions was associated with total sleep time per day (Table 5). All the soldiers who have not experienced such an event, judged as sufficient sleep time, or slightly less than satisfactory. In contrast, every tenth military, who survived contact with the enemy fire rated total time of his dream as very insufficient.

Table 5. Symptoms of sleep disorders among soldiers who participated in direct combat while military mission

	Participation in the fighting		Test chi-square		
	YES n = 56	NO n = 17	x^2	df	p
The speed of falling asleep					
Fast	32 (57.1%)	10 (58.8%)			
With a slight delay	15 (26.8%)	3 (17.6%)	0.855	2	0.652
With delay	9 (16.1%)	4 (23.5%)			
Awakening in the night					
None	20 (35.7%)	7 (41.2%)			
Sporadic	26 (46.4%)	6 (35.3%)	0.693	2	0.707
Frequent	10 (17.9%)	4 (23.5%)			
Awakening the in the morning					
None	32 (57.1%)	9 (52.9%)			
Little earlier	20 (35.7%)	8 (47.1%)	1.693	2	0.429
Much earlier	4 (7.1%)	0 (0%)			
Total sleep time					
Sufficient	33 (58.9%)	6 (35.3%)			
Slightly insufficient	17 (30.4%)	11 (64.7%)	7.196	2	0.027
Clearly insufficient	6 (10.7%)	0 (0%)			
Quality of sleep					
Satisfying	36 (64.3%)	9 (52.9%)			
Slightly unsatisfying	16 (28.6%)	7 (41.2%)	0.960	2	0.619
Clearly unsatisfying	4 (7.1%)	1 (5.9%)			
Frame of daily mind					
Good	43 (76.8%)	12 (70.6%)			
Slightly worse	11 (19.6%)	4 (23.5%)	0.332	2	0.847
Clearly worse	2 (3.65)	1 (5.9%)			
Psychophysical efficiency by the day					
Correct	47 (83.9%)	13 (76.5%)			
Slightly disturbed	8 (14.3%)	4 (23.5%)	1.070	2	0.586
Clearly disturbed	1 (1.8%)	0 (0%)			
Sleepiness during the day					
None	21 (37.5%)	5 (29.4%)			
Slight	28 (50%)	11 (64.7%)	1.289	2	0.525
Significant	7 (12.5%)	1 (5.9%)			

Like in the case of direct participation in the fighting, the fact of physical injury during military mission was associated with shorter total sleep time (Table 6). Slightly more than 13% of soldiers who have been injured or involved in the incident in which someone was injured or killed, rated sleep duration as clearly insufficient, while the problem has not occurred at all among respondents who participated in the mission, but not suffered physical damage.

Table 6. Symptoms of sleep disorders among soldiers during a military mission were injured or involved in the incident in which someone was injured or killed

	Physical injuries		Test chi-square		
	YES n = 45	NO n = 29	x^2	df	p
The speed of falling asleep					
Fast	24 (53.3%)	19 (65.6%)			
With a slight delay	14 (31.1%)	4 (13.8%)	2.889	2	0.236
With delay	7 (15.6%)	6 (20.7%)			
Awakening in the night					
None	14 (31.1%)	14 (48.3%)			
Sporadic	23 (51.1%)	9 (31.0%)	3.096	2	0.213
Frequent	8 (17.8%)	6 (20.7)			
Awakening the in the morning					
None	25 (55.6%)	17 (58.6%)			
Little earlier	17 (37.8%)	11 (37.9%)	0.367	2	0.832
Much earlier	3 (6.7%)	1 (3.4%)			
Total sleep time					
Sufficient	27 (60.0%)	13 (44.8%)			
Slightly insufficient	12 (26.7%)	16 (55.2%)	8.405	2	0.015
Clearly insufficient	6 (13.3.%)	0 (0%)			
Quality of sleep					
Satisfying	27 (60%)	19 (65.5%)			
Slightly unsatisfying	14 (31.1%)	9 (31%)	0.859	2	0.651
Clearly unsatisfying	4 (8.9%)	1 (3.4%)			
Frame of daily mind					
Good	35 (77.8%)	21 (72.4%)			
Slightly worse	9 (20%)	6 (20.7%)	1.022	2	0.600
Clearly worse	1 (2.2%)	2 (6.9%)			
Psychophysical efficiency by the day					
Correct	37 (82.2%)	24 (82.8%)			
Slightly disturbed	7 (15.6%)	5 (17.2%)	0.676	2	0.713
Clearly disturbed	1 (2.2%)	0 (0%)			
Sleepiness during the day					
None	16 (35.6%)	10 (34.5%)			
Slight	23 (51.1%)	17 (58.6%)	0.866	2	0.649
Significant	6 (13.3%)	2 (6.9%)			

Discussion

The study group of soldiers was characterized by good or slightly reduced quality of sleep. The results of statistical analysis showed a reduced quality of sleep in a group of non-commissioned officers. However, the results suggest that these problems are the slightest among the officers. The results are consistent with studies available in the literature (Chou et al., 2016), in which the officers were characterized by the lowest intensity of sleep problems than the remaining military personnel. This may be due to greater resistance, better professional

preparation, experience as well as specific personal qualities of officers that meet the protective function, making them more resistant against mentally difficult and stressful situations. An example of such factor may be a sense of coherence, a type of resource resistance unit when it has a conviction that stimulus coming from the external and internal environment are consistent, clear and explicable and access to appropriate resources allows you to cope with them. This feature has been determined by the author of the theory Antonovskiego "resourcefulness". Sense of coherence, as research has shown, reduces the risk of mental disorders caused by job stress (Basińska, 2007). Another feature affecting the functioning of the human being is emotional intelligence. It is the ability to correct perception, assessment and expression of emotions. High levels of emotional intelligence may be a factor in protecting the physical and mental health. It also helps to overcome the effects of stress experienced in life (Martowska, 2012).

Research Nowicki et al. (2016) demonstrated that reduced sleep quality is very widespread phenomenon in the adult population of Poles and the most frequently mentioned is the difficulty in falling asleep. Sleep disorders affect women more often than men. They are also an integral part of various forms of depressive disorders (Heitzman, 2009). Epidemiological studies conducted among American soldiers (Strelau, 2009) have shown that PTSD and depression were more frequent among those taking part in the mission in Iraq (19%) and Afghanistan (11.3%). Studies Ulmer et al. (2015) involving 1,238 participants; veterans and active duty military soldiers show a higher prevalence of various symptoms of sleep disorders among war veterans, compared with the general population. Epidemiological data from employees of military service on these disorders presented by the Mysliwiec et al. (2013) demonstrate the occurrence of mild obstructive sleep apnea (called. Obstructive sleep apnea – OSA) in 27.2% surveyed, moderate or severe in 24.0% and insomnia in 24.7% of the surveyed soldiers.

Results of studies Rusch et al. (2015) emphasize the importance of raising the quality of sleep in reducing symptoms of depression, trauma and cognitive performance among military personnel. Group of soldiers diagnosed with insomnia was defined as a group of high risk for the development of disturbances coexisting: depression, posttraumatic stress disorder, and other due to sleep disorders. The aim of this study was to examine whether improving sleep quality soldiers will be associated with the weakening of the symptoms of post-traumatic stress, depression, and improve the quality of life of patients. Also checked whether are there changes in the concentration of neurotrophic factor brain derived neurotrophic factor – BDNF and insulin-like growth factor-1 – IGF-1. The initial stage involved in conducting clinical trial and laboratory analysis of the blood. Then, cognitive-behavioral disorders was conducted. The results showed a significant decrease in symptoms of depression and post traumatic experience and a significant increase in IGF-1 which suggests that the action applied effectively improve the quality of sleep and are an effective method of reducing the symptoms of depression and post-traumatic stress disorder. The positive results of cognitive-behavioral therapy in reducing sleep disturbance also highlights the publication Bramoweth and Germain (2013).

The soldiers participating in military activities are exposed to many negative consequences as a result of sustained combat stress, which in turn can decrease in quality of life by the occurrence of problems disrupting daily functioning. Over the last years, the expression of perceiving the needs of psychological support was developed and implemented documents regulating procedure, scope and forms of psychological help. There are among others The Act of 19 August 2011 by veterans of activities outside the country, Regulation of the Minister of National Defence of 12 March 2012 on psychological assistance given to veteran soldier or veteran injured soldier and the closest family members, Decision No. 44 / MON of the Minister of National Defence of December 29, 2009 on the

prevention of psychological in the Armed Forces of the Republic of Polish or protective program of psychological peacekeepers outside the country and their families, Secretary of State for. Social and Professionalism MON of 20 July 2010. Currently, each mission participate specially trained specialists, especially psychologists who have specific tasks, among other things, participate in the tasks contingent support commanders in resolving conflicts, organize meetings and serve to support the soldiers participating in traumatic events, conduct individual and group consultations.

The health status of all the soldiers experiencing combat stress requires periodic and thorough control because diagnosis of disorders is difficult and they can appear even after a long period of time after the event lived. Many people also suppresses her fear, anxiety and other problems fearing further service in the army and the future of employment (Dudek, 2003). This in turn may lead to look for other ways to deal with problems; use psychoactive substances or drug abuse (Korzeniewski, 2008). Therefore it is extremely important to use therapeutic actions.

Conclusions

The respondents did not show soldiers pathological symptoms of sleep disorders, however, the results show some symptoms of reduction sleep quality based on the selected factors. The mere fact of a mission not decide the intensification of sleep problems and their greatest intensification was observed in those soldiers who have decided on a mission only once and among non-commissioned officers. The high military rank and the fact that multiple participation in the military mission seemed to be associated with better quality of sleep (more continuity and satisfactory duration), which may indicate a greater psychological resistance and coping strategies in difficult situations among the more experienced military. In addition, noted the relationship between the decrease in the quality of sleep and the fact traumatic experiences during military mission. Soldiers who have experienced fire contact with an opponent and / or suffered physical injury or participated in the event in which a man was injured or killed on the battlefield often evaluated a total sleep time as too short.

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SUCCESSFUL AGEING: THE ROLE OF PHYSICAL ACTIVITY AND ITS BARRIERS IN POLISH MEN OF ADVANCED AGE

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Abstract One of the most important factors of successful ageing is a sufficient level of motor independence, which is strongly associated with an appropriate level of activity. It was decided to determine the relationship between barriers to physical activity and physical activity and health self-assessment in healthy and chronically ill men, among 206 men aged 65–83 years. A relationship was found between kinesiophobia, physical activity and self-assessment of health, and the differences between health self-assessment in the healthy and chronically ill. No differences were found regarding activity. Important factors affecting the health of older men are self-awareness of being chronically sick, BMI and level of physical activity. A relationship exists between kinesiophobia, physical activity and self-assessment of health. The awareness of being chronically sick, BMI and level of physical activity are the most significant factors affecting the health self-assessment of older men.

Key words advanced age, barriers to physical activity, kinesiophobia, successful ageing

Introduction

The problem of an ageing population is increasing in many countries. This is a result of longer life expectancy and a decline in fertility. The lengthening of life expectancy in many countries appears to be relatively stable, and its dynamics in recent decades is growing. In the last 50 years, the average life expectancy in Europe has risen from 66 to 75 years, and it is forecast to reach 82 years in 2050 (Economist Intelligence Unit, 2012). In Poland, an increase in life expectancy of three years compared to 2000 along with a drastic decline in the birth rate, results in the fact that the proportion of people aged 65 years and older is more than double the seven per cent threshold adopted by the United Nations, which classifies this society as 'old' (Central Statistical Office, 2013). The effects

of this process relate to the functioning of almost the whole structure of society, in all areas, from politics and the economy to culture and education. In this context, the problem of determinants of successful ageing is important (Rowe, Kahn, 1997).

The social dimension of the problem of old age affects many areas: medical–biological, psychological, and socio-economic. On an individual level, the key appears to be the efficiency of the body, defined subjectively as the 'sense' or self-assessment of health. It is always associated with the possibility of functioning, irrespective of the area, whether self-care, functioning in the family or in society. Functional efficiency is a function of activity, and its base in old age is a sufficient level of motor independence (Clarke, Bennett, 2013). The optimal level of physical activity and health status in the light of previous studies, are mutually positive correlates (Bokovoy, Blair, 1994; Knapik et al., 2009). The need for natural activity in living beings, including humans is reduced by technology development. Increasingly, activity levels are lower than biological needs. This deficit of activity – hypokinesia – with age shows an increasing trend, representing a serious threat to health (Blair, 2009). Epidemiological data indicate the prevalence of this problem (Berk et al., 2006; Haley, Andel, 2010; Moschny, Płyt, Klaassen-Mielke, Trampisch, Hinrichs, 2011; Vašíčková, Roberson, Frömel, 2011). Studies demonstrating the possibilities for intervention in preventing hypokinesia by increasing physical activity indicate the need for an analysis of the barriers to physical activity in older people (Sebastião et al., 2013). Investigation of the relationship: activity barriers – activity – self-assessment of health, can explain many important aspects of successful ageing. It may also provide a basis for working out programmes to increase activity among the elderly. Possible gender differences could be an important problem. Although the average life expectancy of women is higher than that of men, increased life expectancy is also occurring among men. Therefore, the aim of the research presented here is an evaluation of the above-mentioned dependencies among men.

Materials and methods

The study involved 206 men aged 65–83 years (70.51 ±4.16 years). The body mass index (BMI) was 27.63 ±3.92. Selection of the test was purposeful. Selection criteria were volunteering to participate, age 65 years or more (the threshold of old age, according to the UN), a sufficient level of mental capacity to understand and complete an anonymous questionnaire used in the survey as well as motor independence in terms of movement and self-care in everyday activities.

The study was carried out using the pencil and paper method in several provinces of southern Poland. The investigator answered any doubts about the questions where necessary. The study used an anonymous questionnaire consisting of personal data and three research tools: the Kinesiophobia Causes Scale (KCS), Baecke Activity Questionnaire (BAQ) and short form 36 (SF-36) health survey questionnaire supplemented with questions about age and the occurrence of chronic diseases associated with regular visits to the doctor, and the use of medication, allowing a distinction between two groups of respondents, not suffering (NSF) and suffering (SF).

The KCS questionnaire is a tool designed to diagnose barriers to physical activity. The questionnaire includes closed questions. Answers to these questions are scored on a scale of 0 to 100 (percentage); the higher the score, the greater the severity of barriers to activity – kinesiophobia. It consists of two domains: biological (BD) and psychological (PD). Each domain contains four factors. For BD these are: morphological, individual need for stimulation, energetic substrates and power of biological drives. The PD also consists of four factors: self-acceptance,

self-assessment of motor predispositions, state of mind and susceptibility to social influence. Domain score is the average of the sum of the factors that make up the domain, while the overall rate of kinesiophobia (Kinesiophobia index [KI]) is the average of two domains (Knapik et al., 2011; Knapik et al., 2012).

BAQ is used for the subjective assessment of an individual's activity. It contains two open questions concerning occupation and sport and 14 closed questions. Closed questions relate to the frequency of activities performed and physical intensity. The answers to these questions, presented in a simple adjective form, are ranked on a scale of 1–2–3–4–5. Such questionnaire design allows grading/evaluation in points for the physical activity level of the respondent in three areas of activity: work (work indicator [WI]), sports activities (sport indicator [SI]) and leisure, excluding sport (leisure time indicator [LTI]). The sum of these areas of activity allows global, usual activity (HPA index [habitual physical activity]) to be specified (Baecke, Burema, Frijtes, 1982; Hertogh, Monninkhof, Schouten, Peeters, Schuit, 2008; Ono et al., 2007). Taking into account the age of respondents, one of the selection criteria for testing, the area of professional activity was abandoned in this study.

SF-36 is a widely used tool to measure quality of life related to health. A questionnaire containing 36 closed questions determines health status in its two components: physical (PC) and mental (MC). Scoring answers to questions from 0 to 100 allows the health status in both components to be determined, each of which contains the following four factors. PC factors are: physical functioning, role limitations due to physical health, pain and general health. MC consists of: role limitations due to emotional problems, energy/fatigue, emotional well-being and social functioning. Scoring of each component is by the average sum of the factors that make up a component (Ware, Sherbourne, 1992; Żołnierczyk-Zreda, Wrześniewski, Bugajska, Jędryka-Góral, 2009).

The study was conducted according to the provisions of the Helsinki Convention, and also the Bioethics Committee of the Medical University of Silesia Katowice expressed its approval (Decision no.: KNW/0022/KB/74/14).

Non-parametric tests were used in all the analyses. Spearman's rank correlation was used to determine the relationship between variables. U Mann-Whitney test was used to compare the group of chronically ill respondents to the healthy group. Limit values for the lower (Q1) and upper (Q2) quartiles were calculated for components of self-assessment of health, and in order to compare the designated quartile, the Kruskal-Wallis test was used as well as multiple comparisons of mean values ranked in the Kruskal-Wallis test. This type of analysis is used to explain an experimental unbalanced system and lack of homogeneity of variance, which was checked with Levene's test. The accepted level of statistical significance was $p < 0.05$.

Results

Statistical analysis showed a negative correlation between health self-assessment of respondents (questionnaire SF-36) with body weight and BMI, except for the factor general health. There was no correlation between age and body height and health self-assessment (Table 1).

Correlation analysis demonstrated that the results of the BAQ questionnaire significantly correlated with age and height of the subjects. There were no such associations in the case of body weight and BMI. Considering the sum of the scores of the KCS questionnaire, a significant relationship was observed for height, weight and BMI. The results are shown in Table 2.

Table 3 presents the results of the correlation of the physical activity barriers (KCS) with indicators of activity (BAQ), which in most cases demonstrated a significant relationship.

Table 1. SF-36 self-assessment of health and the result of correlation with age, height, body weight and BMI

Components and factors of health	Mean ± SD	R-Spearman correlation			
		Age	Height	Body mass	BMI
PC	52.8 ±24.6	–0.10	–0.10	–0.26**	–0.28**
Physical functioning	57.9 ±30.5	–0.09	0.01	–0.21**	–0.31**
Role limitations due to physical health	51.9 ±42.3	–0.12	–0.10	–0.26**	–0.26**
Pain	53.7 ±25.8	–0.12	–0.12	–0.21**	–0.18*
General health	48.1 ±19.6	–0.03	–0.05	–0.11	–0.10
MC	58.3 ±24.4	–0.08	–0.08	–0.24**	–0.26**
Role limitations due to emotional problems	59.3 ±22.2	–0.08	–0.06	–0.22**	–0.26**
Energy/fatigue	58.4 ±42.8	–0.13	–0.10	–0.20**	–0.19**
Emotional well-being	53.8 ±20.2	0.00	–0.09	–0.15**	–0.16*
Social functioning	61.5 ±27.5	–0.07	–0.06	–0.21**	–0.23**

PC – physical component; MC – mental component; *p < 0.05; **p < 0.001 (correlations statistically significant).

Table 2. Barriers to activity and physical activity and the result of correlation with age, height, body weight and BMI

	Variable	Mean ± SD	R-Spearman correlation			
			Age	Height	Body mass	BMI
KCS	BD	40.1 ±18.5	0.09	–0.05	0.27**	0.30**
	Morphological	29.3 ±27.7	0.02	0.06	0.45**	0.44**
	Individual need for stimulation	48.8 ±22.3	0.11	–0.13	0.19*	0.26**
	Energetic substrates	36.0 ±23.2	0.15	–0.06	0.14	0.14
	Power of biological drives	46.2 ±27.1	–0.04	–0.07	0.02	0.06
	PD	47.0 ±16.2	0.16*	–0.23**	0.04	0.16*
	Self-acceptance	33.6 ±22.8	0.03	–0.35**	–0.25**	–0.10
	Self-assessment of motor predispositions	46.0 ±24.3	0.06	–0.18*	0.08	0.18**
	State of mind	50.3 ±22.0	0.10	–0.15	0.01	0.08
	Susceptibility to social influence	58.3 ±26.2	0.16*	–0.00	0.15	0.16*
	KI	43.6 ±15.9	0.12	–0.17*	0.17*	0.25**
BAQ	SI	2.0 ±0.8	–0.23*	0.36**	0.05	–0.06
	LTI	2.8 ±0.8	–0.23*	0.12	–0.04	–0.04
	HPA	4.7 ±1.5	–0.24*	0.27**	–0.02	–0.10

KCS: BD – biological domain; PD – psychological domain; KI – kinesiophobia index; BAQ: SI – sport indicator; LTI – leisure time indicator; HPA – habitual physical activity.
*p < 0.05; **p < 0.001 (correlations statistically significant).

Table 3. The result of R-Spearman correlation barriers to activity (kinesiophobia) and indicators of physical activity

Kinesiophobia Causes Scale	BAQ – activity indicator		
	SI	LTI	HPA
1	2	3	4
BD	–0.48**	–0.54**	–0.58**
morphologic	–0.42**	–0.39**	–0.46**
individual need for stimulation	–0.31*	–0.24*	–0.31*
energetic substrates	–0.57**	–0.72**	–0.73**
power of biological drives	–0.05	–0.15	–0.01

1	2	3	4
PD	–0.32*	–0.52**	–0.47**
self-acceptance	–0.15	–0.12	–0.16
self-assessment of motor predispositions	–0.15	–0.32**	–0.27*
state of mind	–0.16	–0.27*	–0.24*
susceptibility to social influence	–0.35**	–0.50**	–0.48**
KI	–0.45**	–0.59**	–0.59**

BD – biological domain, PD – psychological domain, KI – kinesiophobia index; SI – sport indicator; LTI – leisure time indicator; HPA – habitual physical activity.
*p < 0.05; **p < 0.001 (correlations statistically significant).

A comparison between health self-assessment, kinesiophobia and activity factor of people reporting no chronic disease and people suffering from chronic disease is presented in Table 4.

Table 4. Mean ± SD of questionnaires for groups NSF and SF, and the result of the comparison using U Mann-Whitney test (Z)

	Dependent variables	Mean ± SD		Z
		NSF (n = 76; 36.9% total)	SF (n = 130; 63.1% total)	
SF-36	PC	62.74 ±25.5	47.12 ±22.2	4.26**
	physical functioning	70.00 ±28.2	50.81 ±29.6	4.25**
	role limitations due to physical health	63.49 ±44.2	45.10 ±39.7	2.75**
	Pain	65.47 ±25.8	46.77 ±23.2	4.69**
	general health	51.99 ±21.6	45.80 ±18.0	1.91
	MC	70.72 ±20.9	50.97 ±23.3	5.62**
	role limitations due to emotional problems	76.75 ±39.3	47.61 ±41.2	4.56**
	energy/fatigue	61.05 ±19.7	49.62 ±19.3	4.14**
	emotional well being	68.76 ±17.5	53.81 ±22.9	4.50**
	social functioning	76.32 ±22.1	52.83 ±26.6	5.86**
KCS	BD	36.66 ±18.2	41.30 ±18.6	–1.25
	morphological	22.55 ±24.9	31.74 ±28.3	–2.05*
	individual need for stimulation	42.21 ±20.8	51.19 ±22.4	–2.71**
	energetic substrates	32.70 ±24.4	37.18 ±22.7	–1.36
	power of biological drives	49.18 ±24.8	45.10 ±27.9	1.15
	PD	48.02 ±17.0	46.68 ±15.9	0.45
	self-acceptance	37.20 ±22.8	32.29 ±22.7	1.33
	self-assessment of motor predispositions	42.93 ±23.7	47.02 ±24.5	–1.10
	state of mind	52.17 ±24.1	49.62 ±21.3	0.43
	susceptibility to social influence	59.78 ±25.5	57.80 ±26.5	0.65
	KI	42.34 ±16.4	43.99 ±15.8	–0.39
BAQ	SI	2.29 ±0.98	1.79 ±0.59	2.33*
	LTI	2.81 ±0.81	2.83 ±0.74	–0.08
	HPA	5.15 ±1.68	4.62 ±1.17	1.52

SF-36: PC – physical component; MC – mental component; KCS: BD – biological domain; PD – psychological domain; KI – kinesiophobia index; BAQ: SI – sport indicator; LTI – leisure time indicator; HPA – habitual physical activity.
*p < 0.05; **p < 0.001 (differences statistically significant).

The greatest observed significant differences concerned the SF-36 questionnaire. The quartiles of health self-assessment were also calculated in accordance with the adopted methodology of the study. For PC, the lower quartile was: Q1 – 32,291; upper: Q3 – 76,042. MC quartiles were: lower Q1 – 34,875; upper Q3 – 79,000. As a result of the ANOVA rank Kruskal-Wallis analysis, both physical and mental health components showed significant intergroup differences for BD, PD, KI and HPA (each, $p < 0.01$). Multiple comparisons of the average ranks showed significantly lower (except HPA) results of people in the third quartile compared to the second quartile. Detailed results for all comparisons are shown in Table 5.

Table 5. The results of post hoc tests for kinesiophobia and physical activity

Variable		Mean value			Intergroup differences – p‡		
dependent	grouping†	Q1	Q2	Q3	Q1/Q2	Q2/Q3	Q1/Q3
BD	PC	45.2	45.1	25.9	0.88	<0.001*	<0.001*
	MC	42.9	45.6	26.6	0.37	<0.001*	<0.001*
PD	PC	49.4	49.9	39.4	0.92	<0.001*	0.07
	MC	45.3	52.4	38.8	0.001*	<0.001*	0.62
KCS	PC	47.3	47.5	32.6	0.53	<0.001*	<0.001*
	MC	44.1	49.0	32.7	0.01*	<0.001*	0.01*
HPA	PC	4.8	4.2	6.0	0.06	<0.001*	0.04*
	MC	5.0	4.4	5.8	0.09	0.01*	0.91

†Introduced quartiles (Q) for physical component (PC) and mental component (MC) of SF-36 questionnaire; KCS: BD – biological domain, PD – psychological domain; BAQ: HPA – habitual physical activity.
‡The level of significance of differences Kruskal-Wallis test; *differences statistically significant.

Discussion

The results presented on self-assessment of health indicate generally good health self-assessment of respondents, as evidenced by the average of the two components, and all factors except for the factor 'health – generally' were above 50 points. A High value for standard deviations is typical for old age, indicating high variability of the individual. These figures are lower than in previous studies, which probably resulted from a higher average age and selection criteria (Knapik et al., 2011). Also of interest is the factor 'general health' with the lowest average and the smallest standard deviation. Both the lowest average and highest homogeneity of this factor confirm earlier observations on the importance of cultural background for the perception of the relationship between age and general health (Franklin, Tate, 2009).

The observed lack of correlation between PC and MC with age and SD values of health self-assessment indicates its high individual variability, where age is not a determining category of well-being. It also highlights the role of non-biological factors in the ageing process, and thereby justifies exploring the determinants of positive ageing. Negative correlations between PC and MC and BMI and body mass (Table 1) confirm the importance of the modifiable factors of diet and physical activity which are associated with lifestyle (Franklin, Tate, 2009).

The occurrence of chronic diseases, typical for old age, was variable, highly differentiating the health self-assessment by the respondents (Table 4). This shows that the awareness of being chronically ill in elderly people is a factor strongly influencing self-assessment of health. However, this variable did not differentiate respondents in terms of activity (HPA) and its barriers (BD, PD and KI). Cohen-Mansfield et al. in their research indicated that the

feeling of being sick and low efficiency are the main hurdles to activity in the elderly (Cohen-Mansfield et al., 2003). The resultant set of results and cited studies suggest that the source of passivity in mobility of the elderly can often be the mental sphere, and not the actual limitations of disease. This is important from the point of view of preventive care. The results of multivariate analysis of Meisner et al. (2010) performed in a large population of people aged 60 years and more, support this argument. According to these authors, hypokinesia is a factor that has a stronger influence on functional limitations than the occurrence of chronic diseases (Meisner et al., 2010).

Research on barriers to physical activity in older people mention the nature of biological factors (low levels of energy resources), as well as psychological (fear of falling and personal injury) and socio-cultural (Clark, 1999; King et al., 2000). This problem is analysed using a variety of methodological approaches. The tool used in this study is based on analysis barriers to activity such as kinesiophobia, which is understood as the fear of physical and mental discomfort resulting from physical activity. The authors define it as a relatively constant psychological disposition, depending on biological and psychological factors (Knapik et al., 2011, 2012).

The results of this study indicate that psychological factors are greater barriers to activity than biological factors. Susceptibility to social influence has the greatest value among these factors (Table 2). In the light of previous studies, there is a certain repeatability independent of age, highlighting the importance of the aforementioned context of cultural and social barriers to physical activity (Clarke, Bennett, 2013; Knapik, Rottermund, Myśliwiec, Plinta, Gruca, 2012).

Strong negative correlations of barriers to activity and its indicator (HPA) confirmed their role as determinants of passivity in mobility (Table 3). The factor 'level of energy resources' shows the strongest negative correlation with HPA, which seems to confirm the observations of King (King et al., 2000). The self-assessment of health was a variable highly differentiating both physical activity and its barriers (Table 4). Men in the upper quartile (PC and MC) of health self-assessment definitely have the highest rates of HPA and the lowest value of BD, PD and KI. These differences confirm the accepted hypothesis that the barriers to physical activity, activity and health self-assessment are the correlates.

Multidimensionality of the causes of the ageing process can be analysed in terms of biology, medicine or the social sciences (Błędowski, 2012; Diener, Scollon, Lucas, 2003). Longer duration of age results in changing perceptions of this period of life. An earlier focus on the negative effects of old age gave way to the search for determinants of 'successful ageing'. Rowe and Kahn (1997) defined the three key elements of successful ageing as the absence of disease and disability, good physical and mental functioning and participation in society. In a review of studies on successful ageing factors, Depp and Jeste (2006) reported as many as 29 different factors that promote successful ageing. The ability to function independently and the lack of physical disability occurred as conditions for successful ageing in almost all the studies analysed (Depp, Jeste, 2006). Slightly different conclusions resulted from the study of Montross and co-authors conducted among people living in community care homes, which provided a full spectrum of care and participated in the activities of institutes of further education (Montross, 2006). The authors of this study noted a high percentage of people satisfied with their lives in spite of old age. For these people, existing chronic diseases and disability were not overriding. Optimism, self-efficacy and participation in community life were important for a sense of successful ageing. Recitation of the results of these two papers provides a broad spectrum of conditions for the process of successful ageing. A cultural and social context also appears to be very important (Hank, 2011). A sense of material, social and medical security can, to a certain extent, move efficiency in movement and self-care to the next level. However, motor independence is the most

important aspect for most older people. A manifestation of this independence is function-based, regardless of the context (activities of daily living, participation in family life, social life, etc.) for at least a sufficient level of physical activity. Studies on the possible barriers to this activity can be helpful in developing intervention programmes aimed at potentially successful ageing.

In conclusion, a relationship exists between kinesiophobia, physical activity and self-assessment of health. The awareness of being chronically sick, BMI and level of physical activity are the most significant factors affecting the health self-assessment of older men. Developing programmes aimed at enabling older people to be more active should take into account existing barriers to physical activity.

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EFFECT OF REPEATED COLD WATER SWIMMING EXERCISE ON ADAPTIVE CHANGES IN BODY WEIGHT IN OLDER RATS

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Abstract The aim of this study was verification whether an 8-week-long swimming exercise training would induce adaptive changes in body weight in rats and whether possible changes would depend on aquatic environment temperature and animal sex. The exercise-trained groups swam 4 minutes a day, five days a week during eight week of housing. Exercise was performed by swimming in glass tanks containing tap water maintained according to group at 5 ±2°C (cold group) and 36 ±2°C (thermal neutral group). Before and after each week of the experiment, rats were weighed. When comparing the nature of changes in the body weight of rats exposed to swimming exercise training in cold water, attention should be paid to their dependence on sex. There were statistically significant changes in the nature of changes in body weight between male rats and female rats of the cold group (5°C) as early as experimental week 2 until the end of the experiment ($p < 0.001$). Interestingly, the females exposed to swimming exercise training at 5°C were the only group in which an increase in body weight occurred during experimental week 8 in relation to baseline values.

Key words cold-acclimation, exercise training, swimming exercise, body weight, rats

Introduction

One of the most important processes that allow an organism to survive in a changing environment is the ability to regulate body temperature. In warm-blooded animals, the ability to maintain a relatively constant internal body temperature is a prerequisite for their proper functioning (Moran, Mendal, 2002). Exposure to cold is one of the strongest physiological and psychological environmental stressors and leads to significant physiological responses of the body. In particular, the aquatic environment is a challenge for thermoregulation processes of a living organism. Cold water immersion leads to immediate physiological responses collectively known as the "cold shock response", as well as to long-term physiological, biochemical, hormonal and metabolic responses and cardiovascular system response, documented in the experiments on both animals and humans (Kolettis, Kolettis,

2003; Akhalaya, Platonov, Baizhumanov, 2006; Agrawal, Jaggi, Singh, 2011). During a prolonged exposure of the organism to extremely low temperatures, especially in the aquatic environment, metabolic heat production is unable to compensate its loss (Teległów et al., 2008). In the aquatic environment at 5°C, the resting rectal temperature decreases within 20 minutes by 1.2°C, whereas at the same time it decreases by 1.8°C during a swimming exercise (Keatinge, 1961). The heat loss in water is 250 times higher than in air, at the same time water as a thermal energy carrier has a heat capacity 4 times higher than air, while its thermal conductivity is 25 times higher that that of air. Consequently, hypothermia due to immersion in water takes place 2–3 times faster than in the atmospheric air with a comparable temperature (Straburzyńska-Lupa, Straburzyński, 2008).

The response of organism to exercise in cold water may depend largely on such individual characteristics as the metabolic rate and the volume of subcutaneous adipose tissue which is an important insulative factor due to low thermal conductivity and vascularisation. Research shows that subcutaneous adipose tissue being 1 mm thick allows the body to tolerate well its cooling by 1–2°C (Wilmore, Costill, 2008; Chukroun, Varene, 1990). Intensive physical exercise in cold water environment, due to excessive heat loss to external environment, leads to increased secretion of the hormones that stimulate metabolism; the sympathetic-adrenal-medullary axis is being stimulated, as well as noradrenalin, adrenalin and cortisol secretion. Both cold and physical exercise are stress factors that stimulate the sympathetic system through which the mechanism of shivering and non-shivering muscular thermogenesis are activated, also taking place in adipose tissue, inducing increased heat production. As skeletal muscle makes up nearly 40% of the body weight and is aerobically active, it is a primary contributor to thermogenesis during cold exposure via both shivering (ST) and non-shivering thermogenesis (NST) (Block, 1994). In rodents, the initial reliance on shivering thermogenesis is replaced over time with NST by the BAT (brown adipose tissue) (Sellers, Scott, Thomas, 1954). There is some evidence that cold stimulation, as well as cold swimming, affects lipoprotein metabolism (Tsopanakis, Tesserommatis, 1991; Lubkowska et al., 2010a). WAT (white adipose tissue) and BAT are two main types of fat in mammals. WAT is the primary energy depot that stores energy as triglyceride-enriched lipid droplets. By contrast, BAT is considered as an efficient energy dispenser that consumes chemical energy toward thermogenesis (Cannon, Nedergaard, 2004; Richard D, Picard, 2011; Kozak, Harper, 2000). In order to remain normothermic during the periods of cold exposure warm-blooded organisms must produce metabolic heat. Because small animals have the highest ratio of heat-dissipating surface area to heat-storing volume, it is not surprising that they have evolutionarily retained (or developed) a separate tissue for thermogenesis. This thermogenic task in small placental mammals is primarily accomplished by brown adipose tissue. In warm-blooded mammals BAT is regarded as the primary effector organ of non-shivering thermogenesis (Villarin, Schaeffer, Markle, Lindstedt, 2003; Foster, Frydman, 1978). The body defends itself against heat losses in two ways: by increasing the insulative properties of body surface area and through thermogenesis. In cold environments, the integument primarily acts as an insulator, whereas in high temperatures it is the main route of removing heat from deeper tissues of the body due to changes in blood flow (Benarroch, 2007).

It seems important to determine the scope of adaptive changes that occur in the organism following the exposure to cold and physical exercise in cold environment, also the aquatic one. Our previous studies have shown that repeated exposure to cold stimulates the immune system, improves the activity of antioxidant system, and modifies the lipid profile (Lubkowska, Szygula, Klimek, Torii, 2010b; Lubkowska et al., 2013; Lubkowska, Dołęgowska, Szyguła, 2012).

If exposure to cold persists long enough to produce adaptive mechanisms, changes in body composition may occur, primarily the insulative subcutaneous fat layer may increase. Given that both physical exercise and cold water immersion are the factors that intensify metabolism, we decided to verify in this study whether an 8-week-long swimming exercise training would induce adaptive changes in body weight in rats and whether possible changes would depend on aquatic environment temperature and animal sex.

Material and methods

Sixty-four 15-month-old male and female albino Wistar rats were randomly allocated to three groups. The first group (old sedentary control), kept in cages at room temperature, was composed of male (n = 8) and female (n = 8) rats. The second group included old-trained animals, swimming in cold water (5 ±2°C; 12 male rats; 12 female rats). The last group were animals swimming in thermal neutral water (36 ±2°C; 12 male rats; 12 female rats). All rats were given standard rat chow and tap water ad libitum and were housed two to four per cage (23 ±2°C, 40% air humidity, 12-hour light/dark cycle). One animal from old sedentary control and three animals from old-trained group died before the end of the experiment. The study was approved by the Local Ethical Committee on Animal Experimentation (Decision No. 38/2015).

The exercise-trained groups swam 4 minutes a day, five days a week during eight week of housing (between 09:00 and 11:00 h on each training day). The control rats were housed under the same conditions as the swimming rats and they were handled as often as the exercise group. Exercise was performed by swimming in glass tanks (length 100 cm, width 50 cm, depth 50 cm) containing tap water maintained according to group at 5 ±2°C (cold group) and 36 ±2°C (thermal neutral group). A maximum of only two rats was allowed to swim together. The duration of the first swimming experience was limited to 2 min and increased by 0.5 min daily in the first week until it reached 4 minutes. Before and after each week of the experiment, rats were weighed. At the beginning and after 8 weeks of the experiment, the resting rectal temperature of rats was measured. Additionally, in the fourth week of experiment, we examined the temperature effects of a single swimming exercise session in all animals. All protocol of experiment was presented in Table 1.

Statistical analysis was conducted with STATISTICA software package (version 12.5 PL). The normality of distribution of the parameters being analysed was determined using the Shapiro-Wilk test. In the case of data demonstrating that their distribution differed from normal one, a Friedman's ANOVA and a non-parametric Mann-Whitney U test were used. For all statistical analyses mentioned above, the accepted level of significance was defined as $p < 0.05$.

Table 1. Summary data related to swimming exercise training of rats, including group size, duration of swimming exercise and water temperature

Sex	N	Age (months)	Duration of experiment	Water temperature	Duration of swimming exercise	
♂	10	15	8 weeks (5 day/week)	5 ±2°C	1st week (1–4 min)	2nd–8th week (4 min)
	12			36 ±2°C		
	7			Non-swimming control group		
♀	12			5 ±2°C	1st week (1–4 min)	2nd–8th week (4 min)
	11			36 ±2°C		
	8			Non-swimming control group		

Results

During the study, significant changes in the body weight of rats exposed to swimming exercise training were observed. Table 2 summarises the changes in the body weight of rats during the experiment in relation to baseline values in respective test groups and the control group whereas Table 3 presents both the differences in body weight changes between respective weeks of swimming exercise training for the test groups and the significance of intergroup differences of these changes.

When analysing the group of male rats exposed to swimming exercise training in water at 5°C, a decrease in their body weight was observed as early as the first week of swimming. The highest decrease in body weight, by 32.25 g on average, was recorded between experimental week 1 and 2 (*ΔT_1–T_2; Table 3); the rats were characterised then by body weight being lower by 46.75 g in relation to baseline values (Table 2). Next, in successive weeks, their body weight remained at a comparable level, with minor fluctuations in its increase and decrease, but at the end of the training it was still significantly lower, by 45 ±38.56 g on average, than baseline values ($p < 0.05$).

Table 2. Changes in the body weight of rats during successive weeks of swimming exercise training

BW[g]	♂[5°C] n = 10	♂[36°C] n = 12	C°ntr°l♂ n = 7	♀[5°C] n = 12	♀[36°C] n = 11	C°ntr°l♀ n = 8
			$\overline{x}$			
ΔT_0–T_1	–14.5 ±17.16	–19.25 ±11.15	–5.63 ±25.28	–8.25 ±12.49	–4.75 ±7.52 ***♂36°	–5.00 ±8.86
ΔT_0–T_2	–46.75 ±19.35 *ΔT_0–T_1	–19.25 ±11.15 ***♂5°	+10.00 ±16.26 ***♂5° ***♂36°	–8.25 ±12.49 ***♂5°	–10.00 ±5.62 **♂36°	+4.38 ±16.35 *♀5° **♀36°
ΔT_0–T_3	–37.75 ±23.20	–9.75 ±13.81 ***♂5°	–5.63 ±27.96 **♂5°	+0.25 ±11.75 ***♂5°	–1.50 ±34.53	–1.25 ±15.76
ΔT_0–T_4	–37.25 ±31.81	–20.25 ±17.28 **♂5°	–1.88 ±55.96 **♂5°	+4.50 ±8.57 ***♂5° **ΔT_0–T_1 **ΔT_0–T_2	–10.75 ±23.07 ***♀5° **♂36°	–8.75 ±10.26 **♀5°
ΔT_0–T_5	–45.00 ±30.35 *ΔT_0–T_1	–19.00 ±16.35 ***♂5°	–9.38 ±25.13 **♂5°	+4.50 ±9.58 ***♂5° **ΔT_0–T_1 **ΔT_0–T_2	–18.25 ±21.35 ***♀5°	–4.38 ±12.66 *♀5°
ΔT_0–T_6	–37.50 ±33.54	–17.75 ±21.24 **♂5°	–5.00 ±13.89 **♂5°	+9.25 ±7.67 ***♂5° ***ΔT_0–T_1 ***ΔT_0–T_2	–17.75 ±22.91 ***♀5°	–0.63 ±13.21 *♀5° *♀36°

BW – body weight;* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

In the case male rats swimming in water at 36°C, a decrease in their body weight was also observed as early as experimental week 1, by 19.25 g on average, and this was the highest decrease observed during the whole experiment (Table 3). Next, their body weight remained at a comparable level in successive weeks, with minor fluctuations in its increase and decrease. The body weight of rats of this group at the end of the experiment was lower, by 28 ±22.68 g on average, than baseline values (Table 2). When comparing the dynamics of changes in body weight between the groups of tested male rats, it was observed that a decrease in body weight in the first two weeks

was higher in the group of male rats swimming in water at 5°C, while in the next weeks it already demonstrated similar trends (Table 2). It should be noted that body weight in the control group of rats during the experiment remained at a comparable level in successive weeks, with minor fluctuations in its increase and decrease. Only experimental week 2 was characterised by a significant increase in body weight compared to other experimental weeks (*ΔT_1–T_2, Table 3). Significant differences in the course of body weight changes between the control group and the test groups were observed as early as experimental week 2, but they were significantly higher in the group exposed to swimming exercise training in water at 5°C (Table 2).

Table 3. Comparison of the significance of differences in body weight changes between groups

BW[g]	♂[5°C] n = 10	♂[36°C] n = 12	C°ntr°l♂ n = 7	♀[5°C] n = 12	♀[36°C] n = 11	C°ntr°l♀ n = 8
			$\overline{x}$			
ΔT_0–T_1	–14.50 ±17.16	–19.25 ±11.15	–5.63 ±25.28	–8.25 ±12.49	–4.75 ±7.52 ***♂36°	–5.00 ±8.86
ΔT_1–T_2	–32.25 ±18.60 *ΔT_0–T_1	–0.3 ±0.7 ***♂5° ***ΔT_0–T_1	+15.62 ±14.00 ***♂5° ***♂36°	–1.5 ±0.3 ***♂5° *ΔT_0–T_1	–5.25 ±8.19 ***♀5° ***♂36°	+9.38 ±9.43 ***♀5° ***♀36° *ΔT_0–T_1
ΔT_2–T_3	+9.00 ±22.75 ***ΔT_0–T_1 ***ΔT_1–T_2	+9.50 ±8.26 ***ΔT_0–T_1 *ΔT_1–T_2	–15.59 ±18.41 **♂5° ***♂36° **ΔT_1–T_2	+8.50 ±13.48 ***ΔT_0–T_1 **ΔT_1–T_2	+8.50 ±34.07	–5.63 ±6.78 **♀5° *♀36° *ΔT_1–T_2
ΔT_3–T_4	+0.50 ±14.59 ***ΔT_1–T_2	–10.50 ±6.26 ***♂5° *ΔT_0–T_1 **ΔT_1–T_2 ***ΔT_2–T_3	+3.75 ±8.35 ***♂36°	+4.25 ±5.45 ***ΔT_0–T_1	–9.25 ±24.99 ***♀5° **ΔT_2–T_3	–7.50 ±8.45 ***♀5° *♂C **ΔT_1–T_2
ΔT_4–T_5	–7.75 ±14.73 ***ΔT_1–T_2 *ΔT_2–T_3	+1.25 ±8.41 **♂5° ***ΔT_0–T_1 *ΔT_2–T_3 ***ΔT_3–T_4	–7.50 ±7.07 **♂36° *ΔT_1–T_2	0.3 ±5.62 **♂5° *ΔT_0–T_1 **ΔT_2–T_3	–7.50 ±6.79 **♀5° ***♂36° *ΔT_2–T_3	+4.38 ±4.96 *♀5° ***♀36° **♂C
ΔT_5–T_6	+7.50 ±20.93 **ΔT_0–T_1 ***ΔT_1–T_2	+1.25 ±11.34 ***ΔT_0–T_1 *ΔT_2–T_3 ***ΔT_3–T_4	+4.38 ±18.02	+4.75 ±5.95 ***ΔT_0–T_1	+0.50 ±3.94 ***♀5°	+3.75 ±5.18 *♀36°
ΔT_6–T_7	+2.50 ±12.51 *ΔT_0–T_1 ***ΔT_1–T_2	+3.25 ±7.66 ***ΔT_0–T_1 ***ΔT_3–T_4	+4.38 ±3.20	–3.50 ±4.01 *♂5° ***ΔT_2–T_3 *ΔT_3–T_4 *ΔT_5–T_6	+8.25 ±4.67 ***♀5° **♂36° *ΔT_3–T_4 *ΔT_4–T_5	0.00 ±7.07 *♀5° **♀36°
ΔT_7–T_8	–10.00 ±12.14 ***ΔT_1–T_2 *ΔT_2–T_3 ***ΔT_5–T_6	–13.50 ±9.61 ***ΔT_1–T_2 ***ΔT_2–T_3 ***ΔT_4–T_5 ***ΔT_5–T_6 ***ΔT_6–T_7	–8.75 ±7.91 *ΔT_1–T_2	–1.25 ±3.19 **♂5° **ΔT_2–T_3	–4.75 ±3.80 **♀5° ***♂36°	–1.25 ±13.30

BW – body weight; * p < 0.05, ** p < 0.01, *** p < 0.001.

Considering the female rats from the cold group (5°C), a decrease in body weight, by 8.25 ±12.49 g on average, was observed, remaining during the first two weeks, as in the male rats, but as early as experimental week 3 to the last week of this experiment an increase in body weight was recorded in relation to baseline values, with the highest increase, by 8.5 ±13.48 g on average, occurring at experimental week 3 ($p < 0.001$). In the female rats participating in swimming exercise training at thermal comfort temperature, a decrease in body weight was observed in relation to baseline values, but it was the highest after experimental week 4, by 9.25 g on average (Table 3). In the first three weeks of this experiment, no statistically significant differences were recorded in the observed trends between the experimental groups (5°C vs. 36°C), whereas after week 4 of the experiment, until its end, there were differences in body weight changes between the groups ($p < 0.05$), with the female rats from the cold group (5°C) demonstrating an increasing trend in their body weight and those from the thermal neutral group (36°C) a decreasing trend. In the case of the control group of female rats, their body weight remained at a comparable level in successive weeks of this experiment. Only experimental week 2, as in the case of male rats, was characterised by an increase in body weight compared to other weeks of the experiment ($*\Delta T_1–T_2$), but the final weight of the rats was comparable to its baseline value. At experimental week 2, highly significant differences in body weight changes were recorded between the test groups and the control group. During the experiment, changes in the body weight of rats in the control group were much smaller than in the case of the test groups (Table 2).

When comparing the nature of changes in the body weight of rats exposed to swimming exercise training in cold water, attention should be paid to their dependence on sex. There were statistically significant changes in the nature of changes in body weight between male rats and female rats of the cold group (5°C) as early as experimental week 2 until the end of the experiment ($p < 0.001$). Interestingly, the females exposed to swimming exercise training at 5°C were the only group in which an increase in body weight occurred during experimental week 8 in relation to baseline values. The body weight of all rats from the groups swimming at 36°C was decreasing, being more significant in the male rats (28 ±22.68 vs. 14 ±24.72, Table 2).

The resting rectal temperature in the rats of respective groups did not differ significantly and amounted to 35.81 ±2.32°C on average. When analysing the thermal response of rats to swimming exercise sessions, a transient decrease in their rectal temperature was observed only in the group of animals swimming at 5°C (by 3.8°C on average; $p < 0.05$), whereas no significant change in their resting rectal temperature was showed after the end of the experiment.

Discussion

In the presented study, an attempt was made to evaluate the possible occurrence of adaptive changes of an insulative nature in rats exposed to swimming exercise training at 5°C. Under such circumstances, changes occur in the dynamics of microcirculation and metabolic responses, as well as in the dynamics of collateral circulation. Cold and physical exercise are stress factors that stimulate the sympathetic system, adrenal glands and thyroid gland, stimulating metabolism and, at the same time, increasing the quantity of food consumed. Body weight depends on energy intake, energy consumption and digestion (Knopper, Boily, 2000; Powell et al., 2002; Ernest, 2005). A seasonal change in body weight results from adaptation to energy intake and energy demand in many small mammals (Wang, Wang, Wang, 2001; Speakman, 2003). A change in body weight is an adaptive response in the ability to adapt to cold environment in mammals (Swanson, 2001). The response of small mammals to cold stress differs, as is the case of Dicrostonyx groenlandicus and Mesocricetus auratus, the body weight of which

increased during cold acclimation (Nagy, Negus, 1993; Janský, Haddad, Pospísilová, Dvorák, 1986). However, the body weight of Apodemus sylvaticus and Acomys cahirinus was not affected by cold acclimation (Klaus, Heldmaier, Ricquier, 1988; Khokhlova, Krasnov, Shenbrot, Degen, 2000; Gunduz, 2002); on the contrary, the body weight of Phodopussungorus, Microtusochrogaster, M. pennslvanicus and Clethrionomysglareolus decreased during cold acclimation (Klaus et al., 1988; Wiesinger, Heldmaier, Buchberger, 1989; Voltura, Wunder, 1998; Wang, Wang, 1990). In the study by Arnold, Richard (1987), cold exposure had no additional effect on body composition in physically active rats. Compared to rats trained at 24°C, exercised cold-exposed animals did not utilise more of their fat or protein stores in providing substrate for exercise. Interestingly, although a 5°C exposure and exercise were estimated to produce similar energy expenditures, both exercised groups of rats had significantly lower body fat gains. It seems probable that the greater energy intake of sedentary cold-exposed rats accounted for most of their extra fat reserve. Appetite suppression has been observed previously in exercised male rats (Arnold, Richard, 1987; Richard, Arnold, Lleblanc, 1986) and, since this phenomenon has not been observed in exercised female rats, is believed to be linked to sex hormones.

Some recent work by Hoffman-Goetz, German (1986) has suggested that physical exercise improves cold tolerance in aged mice, although the mechanism behind the improvement remains unexplained. The study by Richard et al. (1986) has indicated that brown adipose tissue capacity for non-shivering thermogenesis is unimproved by exercise training. However, exercise training, by increasing insulin sensitivity (Berger et al., 1979; Mondon, Dolkas, Reaven, 1980), may prevent the age-related increase in tissue insulin resistance and therefore aid in preserving the brown adipose tissue thermogenesis. That is, as insulin resistance has been suggested to be a possible cause of impaired brown adipose tissue thermogenesis in obese mice (Mercer, Trayhurn, 1984), exercise training, by decreasing insulin resistance, may actually improve cold tolerance. Further work is needed to understand the improved tolerance to cold in exercised rodents. It appears that metabolic heat production in exercised cold-exposed rats was sufficient to offset the cold stress without which increased brown adipose tissue non-shivering thermogenic capacity cannot occur (Arnold, Richard, 1987).

Smith, Roberts (1964) have demonstrated that multilocular brown adipose tissue in the rat is shown to increase in both respiratory rate and mass, in vitro, during cold acclimation. By vascular convection the resulting heat is directly conducted to the thoracocervical regions of the heart, the spinal cord and other thoracic organs. The vasculature is so arranged as to exercise a fine order of thermogenic control over the brown fat and temperature of the peripheral venous returns to the thorax, facilitated in part by a “reverse” type of countercurrent heat exchange apparently not previously described. In humans, acclimatisation to cold develops over the period of about 10 days, and in the essential change is an insulative, hypothermic type of response. This reflects the nature of most occupational and athletic exposures to cold. Nevertheless, with more persistent exposure to cold, humans can seemingly develop the humoral type of acclimatisation described in small mammals, with an increased efficiency of noradrenaline or thyroxine. Using of winter sport may be method of treating obesity due to associated mobilisation of free fatty acids. In men, a combination of temperate exercise and facial cooling induces a significant fat loss over a 1- to 2-week period, with an associated proteinuria, ketonuria and increased body weight. Current limitations for the clinical application of such treatment include doubts regarding appropriate environmental conditions, concern over possible pathological responses to cold, and suggestions of a less satisfactory fat mobilisation in female patients (Adams, Heberling, 1958). William et al. (1992), when examining sex differences in response to physical exercise conducted in cold water environment, demonstrated their dependence on the content of lean body mass (63.5 kg

in men vs. 49.5 kg in women). This difference in lean tissue favours heat conservation by men compared to women during rest (Veicsteinas, Ferretti, Rennie, 1982). Also, at low absolute exercise intensities it is likely that for men, compared to women, a larger amount of muscle tissue remains minimally perfused. This would provide men with lager resistance to heat that moves from the core to the skin surface during exercise in cold water. For women, even mild exercise appears to remove the insulation provided by muscle mass. Consequently, the added heat generated by exercise is offset by the reduction in insulation (William et al., 1992). Mozaffarieh et al. (2010) found that women had significantly higher TDCE (thermal discomfort with cold extremities) scores than men. These results confirm that nearly every third woman between 20 and 40 years suffers from cold extremities, with men suffering 4.5 times less frequently (Kräuchi et al., 2008). Numerous investigators have reported that women have colder mean skin temperatures during rest in cold air than men (Cunningham, Stolwijk, Wenger, 1978; Wyndham et al., 1964; Wagner, Horvath, 1985). While this has been imputed to differences in body fat by some authors (Wyndham et al., 1964; Wagner, Horvath, 1985), others have not been able to prove a correlation between fatness and mean skin temperature (Stevens, Graham, Wilson, 1987). Facultative interactions between metabolic responses to cold and physical fitness remain controversial. However, it is obvious that short term cold exposure induces a humble increase of physical working capacity. Long term effects of cold upon fitness are probably mediated largely through associated changes in habitual physical activity (Shepard, 1985). Regular physical activity not only increases energy expenditure directly, but also modulates gene expression patterns of metabolic regulators. Gene expression patterns induced by a sedentary lifestyle result in metabolic patterns that are the precursors of metabolic diseases prevalent among humans. Cold exposure combined with exercise combined with promotes uncoupling of oxidative phosphorylation by increasing the expression of UCP1 in BAT. Increased expression of UCP1 increases the proportion of energy derived from fatty acid oxidation that is released as heat, seldom being deposited as white adipose tissue. This provides an important entrance by which exercise simplify increased energy expenditure and counteracts obesity. Obesity, although complicated by social and cultural influences, is due to an excess of energy intake over energy expenditure. Brown adipose tissue therefore plays an important role in the energy balance of the whole organism including adult humans, but exercise is a necessary condition for this role to be realised (Seebacher, Glanville, 2010).

We examined a suitable swimming exercise programme at different water temperatures that could induce changes in body weight in 15-month-old rats. In all test groups, we observed the effect of physical exercise and ambient temperature on changes in body weight. In the male rats, swimming exercise training at low temperature induced a significance decrease in body weight, which is linked to energy expenditure on exercise and thermoregulation processes. In the case of swimming at 36°C, a decrease in body weight resulted solely from physical exercise, which was also observed in the female rats swimming at the same temperature. The fact that in the female rats swimming at 5°C a decrease in body weight was observed for the first two weeks, and then its increase until the end of the experiment, seems to be interesting. Davies, Packer, Brooks (1987) have observed that female rats are known to maintain body weight better than male rats. It has been reported that a prolonged exposure to cold raises the metabolic rate in mammals, which leads to increased hypotrophy of metabolically active tissues, like for example brown adipose tissue (BAT), liver, kidneys, small intestine, and heart (Krebs, 1950; McDevitt, Speakman, 1994; Konarzewski, Diamon, 1994). Another possible type of adaptive changes in response to cold is the hypothermic type when there is a decrease in body temperature and the body adapts to a lower temperature. Although our results indicate a substantial decrease in the body temperature of rats exposed to a single swimming

exercise in water at 5°C, no such adaptive changes were showed in the test rats as a consequence of 8-week-long swimming exercise training in cold water.

Conclusions

Inter-sexual difference in body weight changes being observed during an 8-week-long experiment indicate that adaptive mechanism of an adaptive nature, in the form of increased accumulation of adipose tissue or hypertrophy of metabolically active tissues, developed earlier in female rats, which was not observed in male rats, despite exposure to cold to the same extent. The next stage of our research will be to estimate selected metabolic parameters and oxidant-antioxidant equilibrium of rats in order to evaluate the extent of "cold shock" responses to physical exercise, depending on the temperature at which it is performed.

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THE DIFFERENCES BETWEEN TEAMS IN MEN'S AND WOMEN'S MEDALLISTS AND NON-MEDALLISTS AT THE 1996–2016 OLYMPIC GAMES ARTISTIC GYMNASTICS TOURNAMENT

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Abstract The aim of this study is to determine the differences between the medallists and non-medallists in male and female artistic gymnastics at the Olympic Games from 1996 to 2016. Basic procedures: Data concerning the athletes were obtained from the "Official documents of the International Olympic Committee" which include the athlete's date of birth and date of competing. The total number of analysed OG participants in men's artistic gymnastics amounted to n = 419 and the women's artistic gymnastics was n = 417. Main findings: With men the t test for small independent samples has determined statistically significant differences between medallists and other competitors in 2000 and 2012. Among women no significant statistical differences have been found in all the mentioned variables. Conclusions: The differences between male medallists and non-medallists are manifested through the age of the competitors: 2.57 years in 2000 and 3.57 years in 2012. Compared to other OG a higher level of homogeneity and smaller age difference is noticeable. In difference to men, women had no similar differences within a period of 20 years. In artistic gymnastics in the last couple of years there is a recurring trend of a late specialisation because with each new scoring Code of Points the conditions demanded from the competitors become harder.

Key words t-test, Olympic Games, artistic gymnastics, trend

Introduction

The Fédération Internationale de Gymnastique (FIG) is the governing body for gymnastics worldwide. It is the oldest established international sports federation (1881) and has participated in the Olympic Games (OG) since their revival in 1896. The basis of all competitions in men's and women's artistic gymnastics are all-around which include many different apparatuses routines, within a team or individually. Artistic gymnastics is a typical multidisciplinary

sport with six disciplines in men's artistic gymnastics: Floor (FX), Pommel horse (PH), Rings (RI), Vault (VT), Parallel bars (PB), High bar (HB) and four disciplines in women's artistic gymnastics: Vault (VT), Uneven bars (UB), Balance beam (BB) and Floor (FX). The competition rules are defined in: Statutes of the FIG, Technical Regulations FIG, Code of Points (CoP), Apparatus norms which are changed and perfected by the FIG's commissions for each Olympic cycle.

The Olympic Games and World Championships (WC) represent the crown of every athlete's career, so is the case with gymnasts. The OG and WC, as the most important competitions in a career of every athlete, are subjected to multiannual preparations. This is why it can be concluded with certainty that only the best competitors can take part.

Up until 1981 the minimum age for participating in senior competitions was 14 years of age. At the 58th FIG Congress held in July 1980, a short time before the OG in Moscow, the minimum age rose from 14 to 15 years of age. This rule came into force in 1981 and the gymnasts had to be at least 15 years old, within a calendar year, in order to take part in the competition as seniors. These age requirements have not changed until 1997 when the minimum age raise from 15 to 16 years of age (Anderson, 1997). Since 1997, the gymnasts had to be at least 16 years old or to be turning 16 within the calendar year in order to take part in the competition as seniors.

Practicing gymnastics on a top level in early years can be damaging and dangerous to the gymnast's health (Paul, 2010). Younger gymnasts, especially the ones who have not went through puberty yet, have a tendency to be lighter, smaller, more flexible and bendable which aids them in performing more complex elements and routines and gives them a better relation between strength and weight. When a female gymnast enters puberty her growth and weight gain can affect her center of mass gravity which causes mental and physical stress that needs adjustment and in some cases she has to learn her moves again in order to compensate for them (Paul, 2010). Besides that, older gymnasts may be more prone to injuries caused by bone and muscle overstraining. Younger gymnasts have a smaller chance of such problems or a greater possibility to work through the pain during their injury (Paul, 2010).

In the 1950s and 1960s, the senior competition was dominated by athletes in their mid-to-late twenties. At the time, the CoP centred on artistry and was largely inspired by ballet. As a result, more seasoned gymnasts found success in the sport by bringing elegance to their routines. However the age limitations were introduced to gymnastics for: physiological reasons, protecting children from harmful exposure, time training, early growth, growth of body segments, pubertal growth and maturation, sex characteristics, menarche, nutritional status, weight-for-height, gymnastics training environment, familial factors. There is also the concern that imposed training limits could lead to more injuries (Anderson, 1997; Paul, 2010).

Design

A historical analysis of the chronological age trend of all teams of men's and women's artistic gymnastics who have participate in the period between 1996 and 2016 has been made. The main problem of the research was determining the differences in the age structures between particular competitions and disciplines in male and female artistic gymnastics in last 20 years decade.

Material and methods

The sample of the examinees also included all the participants in Men's artistic gymnastics (MAG) in the following competitions: OG 1996, n = 83; OG 2000, n = 72; OG 2004, n = 72; OG 2008, n = 72; OG 2012, n = 60;

OG 2016, n = 60; and in Women's artistic gymnastics (WAG): OG 1996, n = 82; OG 2000, n = 71; OG 2004, n = 72; OG 2008, n = 72; OG 2012, n = 60; OG 2016, n = 60. The total number of analysed OG participants in MAG amounted to n = 419 and the WAG was n = 417.

The intent was to collect current data of female and male gymnasts from recent years. All data for this study was obtained from the Official Website of the Olympic Games Results 1996–2016 https://www.olympic.org/olympic-results (1.09.2016). We started collecting data from the 1996 and ended with the 2016 OG. The following variables were included: date of birth, qualification date of the OG.

Data processing in this research and the application of the statistically mathematical procedures were conducted in the programme package of Microsoft Office Excel 2013 and SPSS 23.0 (SPSS Inc., Chicago, IL, USA). For calculating the chronological age the following formulas from the Microsoft Office Excel 2013 package were used.

For the total number of days of one's age since the date of birth until the first day of the competition qualifications: *Calculation formula* = DATEDIF (A1; B1; "d").

For the total number of years of one's age since the date of birth until the first day of the competition qualifications: *Calculation formula* = DATEDIF (days × 0.0027397260273973 years).

For the total number of years, months and days since the date of birth until the first day of the competition qualifications: *Calculation formula* = DATEDIF (A1; B1; "Y") & "years", &DATEDIF (A1; B1; "YM")&" months, "&DATEDIF (A1; B1; "MD") &" days".

Descriptive statistics (mean and standard deviation) are presented for team and competition years in Tables 1–2. In order to check for any deviation from normality, a number of methods can be used. One method is to use skewness and kurtosis. Skewness assesses the extent to which a variable's distribution is symmetrical. If the distribution of responses for a variable stretches toward the right or left tail of the distribution, then the distribution is referred to as skewed. Kurtosis is a measure of whether the distribution is too peaked in a very narrow distribution with most of the responses in the centre. Normality can be a problem when the sample size is small (<50). As can been seen in Tables 1 and 2, for the purposes of conducting a t-test (i.e., Skewness <|2.0| and Kurtosis <|9.0|; Schmider, Ziegler, Danay, Beyer and Bauhner, 2010. Additionally, the assumption of homogeneity of variances was tested and satisfied via Leven's F test. An independent t test was conducted to determinate if a difference existed between the chronological age of the participants of the Olympic Games. For significance 5 percent level of ($P < 0.05$).

Second order curve-fitting regression methods were used to determine the best fit for the time series of variables addressed in this study. Several time-series analysis methods were calculated and fitted to the historical data along with the resulting regression equations and R2 values using Microsoft Excel 2013. The best model fit for the historical data was determined by the highest R2 value. Second-order polynomial equations are presented in the Table 5.

Results

In (Table 1) the central and dispersal result parameters from the OG MAG games had the highest result span in 2004 of 18.05 years and the lowest span in 1996 of 13.30 years. Analysing the parameters of the central tendency of minimum and maximum values it can be established that the lowest value was in 2004 of 16.81 years and the highest was in 2008 of 35.08 years. Inspecting the results in arithmetic environments of all variables the highest

values were recorded in 2016 of 25.11 years and the lowest in 1996 of 23.49 years. The highest value of standard deviation was in 2012 of 3.70 years and the lowest in 1996 of 2.56 years. Observing the variability of the results of the chosen variables from the aspect of differentiation, skewness parameter – curvature coefficient and kurtosis – elongation coefficient, we can determine that the symmetrical variables of the resulting frequencies (Skewness) had a somewhat equal positive (epicurticle) and negative (hypocurticle) sign. The values indicate that the result distribution is normal.

Table 1. Descriptive Statistics Men's Artistic Gymnastics

Year	N	R	Min	Max	M	SD	Skew	Kurt
1996	83	13.30	17.70	31.00	23.49	2.56	0.12	0.01
2000	72	14.72	17.99	32.71	23.74	3.09	0.45	0.23
2004	72	18.05	16.81	34.86	24.35	3.26	0.28	0.59
2008	72	16.30	18.78	35.08	24.95	3.19	0.46	0.08
2012	60	15.49	18.35	33.84	24.06	3.70	0.65	0.02
2016	60	13.83	19.49	33.32	25.11	3.46	0.22	–0.54

Abbreviations: N – the number of of participants; R – range; Min: minimum; Max – maximum; M – Mean; SD – standard deviation; Skew – Skewness; Kurt – Kurtosis.

In (Table 2) the central and dispersal result parameters from the OG MAG games had the highest result span in 2004 of 21.51 years and the lowest span in 2000 of 8.12 years. Analysing the parameters of the central tendency of minimum and maximum values it can be established that the lowest value was in 1996 of 14.35 years and the highest was in 2012 of 37.13 years. Inspecting the results in arithmetic environments of all variables the highest values were recorded in 2016 of 19.70 and the lowest in 1996 of 17.29 years. The highest value of standard deviation was in 2012 of 3.85 years and the lowest in 2000 of 1.91 years. Observing the variability of the results of the chosen variables from the aspect of differentiation, skewness parameter – curvature coefficient and kurtosis – elongation coefficient, we can determine that the symmetrical variables of the resulting frequencies (Skewness) had a somewhat equal positive (epicurticle) and negative (hypocurticle) sign. One variable has a slightly higher positive sign in 2012 (Skewness 2.14) and (Kurtosis 6.52). This shows us that the Gaus curve had a hypocurticle appearance and that the results were higher and larger in number than the arithmetical environment. All other values of the parameter point out that the variables were within the allowed limits.

Table 2. Descriptive Statistics Women's Artistic Gymnastics

Year	N	R	Min	Max	M	SD	Skew	Kurt
1996	82	9.44	14.35	23.79	17.29	1.99	1.03	1.20
2000	71	8.12	15.72	23.84	18.07	1.91	0.73	–0.14
2004	72	11.72	14.46	26.18	18.33	2.50	1.45	2.02
2008	72	17.45	15.71	33.16	18.92	3.24	1.85	4.48
2012	60	21.51	15.62	37.13	19.69	3.85	2.14	6.52
2016	60	16.32	15.61	31.93	19.70	3.30	1.25	1.87

Abbreviations: N – the number of participants; R – range; Min – minimum; Max – maximum; M – Mean; SD – standard deviation; Skew – Skewness; Kurt – Kurtosis.

The results in (Table 3) of independent t test were significant, t test (70) = –3.24, p = 0.002, d = –0.77, r = 0.36, indicating that there significant difference between OG 2000 medallist (M = 21.81, SD = 2.27, n = 18) and the scores at the OG 2000 non medallist (M = 24.38, SD = 3.08, n = 54). The effect size, r was medium. The results of independent t test were significant, t test (58) = –3.53, p = 0.001, d = –0.92, r = 0.42, indicating that there are significant differences between OG2012 medallist (M = 21.38, SD = 2.00, n = 15) and the scores at the OG 2012 non medallist (M = 24.95, SD = 3.72, n = 45). The effect size, r was medium. We can state that there are no statistically important differences in the chronological age between male athletes who have and who have not won medals in the OG except in 200 and 2012. In (Table 4) which refers to the female artistic gymnastics we have not determined statistically relevant differences between certain ages and rankings of the competitors. When it comes to girls we are talking about the same population of the examinees and there are no age differences regarding to the ranking.

Table 3. Descriptive Statistics and Independent Samples Test Men's Artistic Gymnastics

Year	Group Statistics				Levene's Test for Equality of Variances		*t*-test for Equality of Means			Calculate *d* and *r* using *t* values and *df*	
	R	N	M	SD	F	Sig.	t	df	Sig. (2-tailed)	d	r
1996	1	21	22.67	2.57	0.231	0.632	–1.706	81	0.092	–0.37	0.18
	2	62	23.77	2.52							
2000	1	18	21.81	2.27	1.884	0.174	–3.248	70	0.002*	–0.77	0.36*
	2	54	24.38	3.08							
2004	1	18	24.66	2.71	0.508	0.478	0.461	70	0.646	0.11	0.05
	2	54	24.25	3.43							
2008	1	18	24.47	3.29	0.163	0.688	–0.738	70	0.463	–0.17	0.08
	2	54	25.11	3.17							
2012	1	15	21.38	2.00	3.763	0.057	–3.531	58	0.001*	–0.92	0.42*
	2	45	24.95	3.72							
2016	1	15	24.20	2.77	2.814	0.099	–1.188	58	0.240	–0.31	0.15
	2	45	25.42	3.64							

Abbreviations: N – the number of participants; M – means; SD – Standard Deviation; Skew – Skewness; Kurt – Kurtosis; t – T Test Value; df – Degrees of Freedom; * – indicates a significant difference; d – Cohen's d Value (Standardized Mean Difference); r – Effect Size [(±0.1 = very small, Sawilowsky, 2009); (±0.20 = small, Cohen, 1988); (±0.50 = medium, Cohen, 1988); (±0.80 = large, Cohen, 1988); (±1.2 = very large, Sawilowsky, 2009); (±2.0 = huge, Sawilowsky, 2009].

Table 4. Descriptive Statistics and Independent Samples Test Women's Artistic Gymnastics

Group Statistics					Levene's Test for Equality of Variances		*t*-test for Equality of Means			Calculate *d* and *r* using *t* values and *df*	
Year	R	N	M	SD	F	Sig.	t	df	Sig. (2-tailed)	d	r
1	2	3	4	5	6	7	8	9	10	11	12
1996	1	20	17.51	1.59	1.217	0.273	0.562	80	0.576	0.12	0.06
	2	62	17.22	2.11							
2000	1	18	18.19	2.02	0.688	0.410	0.297	69	0.768	0.07	0.03
	2	53	18.03	1.89							
2004	1	18	18.28	3.05	0.033	0.856	–0.092	70	0.927	–0.02	0.01
	2	54	18.35	2.33							
2008	1	18	18.63	3.33	0.224	0.637	–0.436	70	0.664	–0.10	0.05
	2	54	19.02	3.24							

1	2	3	4	5	6	7	8	9	10	11	12
2012	1	15	18.19	1.75	4.065	0.048	–1.770	58	0.082	–0.46	0.22
	2	45	20.19	4.23							
2016	1	15	18.81	2.12	3.352	0.072	–1.194	58	0.237	–0.31	0.15
	2	45	20.00	3.63							

Abbreviations: N – the number of participants; M – means; SD – Standard Deviation; Skew – Skewness; Kurt – Kurtosis; t – T Test Value; df – Degrees of Freedom; * – indicates a significant difference; d – Cohen's d Value (Standardized Mean Difference); r – Effect Size [(±0.1 = very small, Sawilowsky, 2009); (±0.20 = small, Cohen, 1988); (±0.50 = medium, Cohen, 1988); (±0.80 = large, Cohen, 1988); (±1.2 = very large, Sawilowsky, 2009); (±2.0 = huge, Sawilowsky, 2009].

Table 5. Linear and Second-Order Polynomial-Regression Equations for Each Variable With the Olympic Games Year

Variable Age (yrs)	Linear equation	r^2	Second-order polynomial equation	r^2
MAG Team 1996–2016	y = 0.2761x + 23.323	0.629	$y = –0.0357x^2 – 0.5259x + 22.99$	0.652
WAG Team 1996–2016	y = –0.4996x + 16.923	0.962	$y = –0.0327x^2 – 0.7285x + 16.617$	0.971

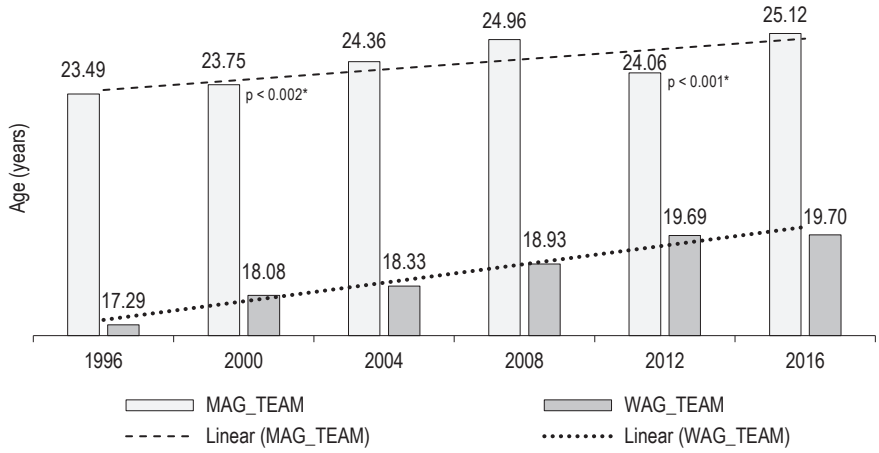

Figure 1. Olympic gymnastics teams' (men's and women's artistic gymnastics) second-order polynomial curve, 1996–2016

Discussion

Researches on age in a timeline from 1964 to 1980 were conducted by Rozin and Čeburaev (1981) and showed age of top male gymnasts at the OG [OG 1964 (M = 25.6, SD = 2.9); OG 1968 (M = 24.2, SD = 3.4); OG 1972 (M = 24.6, SD = 2.8); OG 1976 (M = 23.3, SD = 4.0); OG 1980 (M = 23.2, SD = 3.1)]. Minimum age for participants was 13.0 years at the WC 1987 and rose to 16.0 years at the 1997 WC. Mean ages have since increased: 16.5 (WC 1987), 17.4 (WC 1997), 18.0 (OG 2000), and 18.8 (OG 2008) years (Claessens, 2007; Malina et al., 2013). The demands of the Olympic gymnastics have continued to escalate, and currently, a light, powerful, and usually, petite athlete is optimal (Arkaev, Suchilin, 2004).

Some researches were aimed to find the connection between anthropometry, age and sport success in gymnastics (Caine, Lindner, 1985; Baxter-Jones, Helms, Maffulli, Baines-Preece, Preece, 1995; Damsgaard, Bencke, Matthiesen, Petersen, Muller, 2001). One of these researches had the aim of measuring the anthropometry of a gymnast at two major competitions in Ljubljana, 5th Regional Sokol Meeting in Ljubljana in 1933 and World Cup in Ljubljana 2000. In this research all the gymnasts taking part were measured. The results showed that in 1933 the average age was 21.86 years (Škerlj, 1934). The results from 2000, by authors Čuk and Karácsony showed that the gymnasts were a bit shorter and older, and the average age was 23.40 years (Čuk, Karácsony, 2002; Čuk et al., 2007). Comparing this to the acceleration process of the population's body growth and weight gain, it is evident that this process has not affected the growth of the professional gymnastics population. Unfortunately, Škerlj (1934) did not provide measures of standard age deviation in order to make calculations of statistical differences between then and now.

A similar research methodology of comparing two time periods but with a newer date was used again (Možnik, Hraski, Hraski, 2013). The first aim of that research was to determine the differences in height, weight and age of the top-level male gymnasts in relation to their classification at the WC in year 2007. The second aim was to determine whether there has been a change in height, weight and age of the elite gymnasts at the WC in year 2011, after one Olympic period. Comparing the arithmetic mean between the first seventy (thirty on vault) gymnasts in each gymnastics discipline at the WC 2007 and WC 2011 it can be concluded that there are no statistically significant differences between gymnasts in height, weight and age in any discipline.

Authors (Sands, Slater, McNeal, Murray, Stone, 2012) state in the conclusion that the US Women Olympic gymnasts were apparently getting smaller through the 1980s and early 1990s. Since then the size of these gymnasts has increased. The minimum age rule modifications may have played a role in the athlete size changes along with a shift from the near dominance of the former communist Eastern Bloc (Sands, Slater, McNeal, Murray, Stone, 2012).

According to the first FIG CoP 1964 to the present, the MAG and WAG has already gone through 14 versions or cycles CoP. Atiković (2014) emphasizes that the changes in the regulation of men's and women's artistic gymnastics occur from one cycle to another by changes in the evaluation of the difficulty value (DV) from cycle to cycle. The increased complexity of CoP in terms of the difficulty value and an increased number of deductions need a longer competitive internship to be successful. Some gymnasts and gymnasts such as Oksana Chusovitina and Yordan Yovchev succeeded at the age of 40 to be ranked high in major competitions. Oksana Chusovitina is competing at her seventh Olympics in 2016, another record, at the age of 41. Bulgaria's Yordan Yovchev, 39, became the first ever male gymnast to compete in six OG.

According to the (Balyi, Cardinal, Higgs, Norris, Way, 2005) introduced the notion of early or late specialization sports. Early specialization sports (mostly acrobatic and artistic sports such as diving, figure skating, and gymnastics) are defined as sports in which early sport-specific training (by ages 5 to 7) is necessary for future excellence. Bompa (1999) states that gymnasts achieve the best results in the WAG at the age of 14–18 and in MAG at the age of 18–25. Children and young gymnasts that start their preparation today should only reach their maximum performances after at least 9 years of training (Hofmann, 1999; Bompa, 1999, Arkaev, Suchilin, 2004). Since in artistic gymnastics each Olympic cycle becomes more demanding in terms of complexity and difficulty value of the elements, it is an expected fact that gymnasts need more time to acquire stability, experience and safety when performing such complex exercises.

We can compare our results with the McCready (2016) research "For Olympic Athletes, Is 30 the New 20?". According to McCready it's no secret that gymnasts across the board and country are getting younger, but we were not aware of the magnitude. Although they have an average age of 23.4 years, which is almost the same as the full study average, it was mainly boosted in the first half of the century. For instance, the average age of gymnasts before the 1960s was above 26 years of age, bringing the average age up significantly. But that trend was about to be busted in a big way in just a few years. During the latter half of the 1960s, we first see the downward trend starting at 23 years of age and continuing until it hits rock bottom at 18 years of age in 1992. After that low point in 1992, the average age settled in at around 21 years of age for the next 20 years. He predicts that the trend will continue into 2016, with the average gymnast being closer to 20 years of age. He looked at the 1952 Olympics and onward because women were not able to compete in Gymnastics prior to 1952. Male gymnasts have been well above the average age trend line since 1952. It almost mirrors the average age trend line in slope for the entire graph, starting with an average age of close to 27 and finally settling at the predicted age of about 22 years of age for 2016. On the other hand, the trend line for female gymnasts takes a more serious and maybe even controversial downward push. Starting at almost the exact same age as the combined trend line of 24.4 years, their trending ages drop almost nine years before finally settling on a projected average of about 16 yrs of age in 2016 (McCready, 2016).

Since the work of treating the growth trend of the age in the Olympic cycle and the changes that occur systematically from cycle to cycle. Based on the arguments presented in the text, it is evident that there has been an increase in the age of more women's artistic gymnastics than in men's artistic gymnastics.

Conclusions

According to the results presented and discussed herein, the following conclusions can be drawn:

- the differences between male medallists and non-medallists are manifested in the age of the competitors: 2.57 years in 2000 year and 3.57 years in 2012 year,
- the men from 1996 to 2016 years are on average older for 1.7 years and for women it is 2.4 years of age and the growth trend continues,
- in the upcoming period we do expect (with apparatus specialization) the age to be slightly higher,
- changes in the General Rules and Code of Points by FIG have significantly influenced the age rise compared to the previous Olympic cycles,
- male and female gymnasts ended their careers in the past earlier, while today we have some athletes in professional gymnastics who are over 35 years of age.

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HABITUAL PHYSICAL ACTIVITY IN ADULTS MEASURED BY ACCELEROMETER IN COMPLIANCE WITH SELECTED HEALTH RECOMMENDATIONS

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Abstract The aim of the present study was the evaluation of habitual physical activity in adult members of health promoting associations in compliance with selected health recommendations. Physical activity was monitored for 7 consecutive days using accelerometer ActiGraph GT3X+. It was observed that the percentages of individuals with sufficient physical activity differ depending on health-oriented recommendation used in the evaluation. The results indicated that despite appropriate weekly volume of physical activity expressed in energy expenditure (on the average, twice as high as the recommended minimum) and the number of steps taken daily, the prevailing majority of participants (60%) demonstrated an inadequate level of it when assessed in the context of recommendation by World Health Organization.

Key words accelerometry, health recommendations, physical activity associations, adults

Introduction

Reasonable physical activity (PA) has positive impact on the functioning of human body, with the positive changes in individual systems and organs occurring, due to both aerobic or anaerobic physical efforts. Regular aerobic physical activity causes positive adaptive changes in the cardiorespiratory system and in metabolic processes. By contrast, regular anaerobic exercise primarily stimulates adaptive functions of the locomotor system and increases muscular strength and enhances the osteoarticular system (Li, Siegrist, 2012; Molmen--Hansen, Stolen, Tjonna, Aamot, Ekeberg, Tyldum, 2012; Westcott, 2012, Van Roie, Delecluse, Coudyzer, Boonen, Bautmans, 2013)

Physical activity has a comprehensive positive impact on human body only when it meets certain quantitative and qualitative characteristics. Major quantitative PA characteristics is its volume indexed by the duration, energy expenditure, and distance covered, among other things. An important qualitative PA characteristic is its intensity, looking at: the pace of activity, the number of the Metabolic Equivalents of Task (MET), post-exertion heart rate (HR), level of fatigue and other factors.

Characteristics necessary for one's health to improve are referred to in the global body of research as health recommendations. Any health recommendation may be defined on the basis of a single PA characteristic such as the number of steps – 7,500 steps a day, energy expenditure connected to PA – 2,000 kcal/week or two or more characteristics, e.g. the duration and intensity of an activity – 5 × 30 minutes × 4–6 METs (Tudor-Locke, Hatano, Pangrazi, Kang, 2008; Tudor-Locke et al., 2011; Rahl, 2010). The most frequently discussed recommendations for PA characteristics as regards health benefits have been thoroughly reviewed in Rahl's research (2010).

The varying general or specific nature of particular recommendations and differences between PA characteristics that these recommendations are based on inevitably raise the question of the agreement between assessments of individual's PA models against different recommendations. It is not by coincidence that results of individual's habitual PA in compliance with diverse health recommendations examinations have recently been presented in specialist literature (El Ansari, Khalil, Crone, Stock, 2014; Martinez-Gomez et al., 2010). No research projects such as those have been carried out in Poland yet.

The aim of the present study was the evaluation of habitual physical activity in adult members of health promoting associations in compliance with selected health recommendations. We wanted to answer the following questions in this manuscript:

1. Does the majority of members of examined associations meet the physical activity health recommendations?
2. Do various criteria of physical activity evaluation (weekly energy expenditure on PA, number of steps taken, duration of moderate-to-vigorous PA) differentiate the percentages of subjects meeting them?

Materials and methods

The study was approved by Jerzy Kukuczka Academy of Physical Education Research and Ethics Committee (2/2012). All subjects have provided written consent for the use of information collected during examination.

This study involved 50 participants: 16 women and 34 men – members of health promoting associations in Dąbrowski Basin (Poland). The selection of the study group was intentional – we assumed that members of above-mentioned associations were more physically active than general population. The majority of participants had a normal physique (BM 57.9 ±7.5 [kg] in women and 74.2 ±8.9 [kg] in men, BF 21.9 ±6.6 [%] in women and 14.5 ±6.0 [%] in men, BMI 21.9 ±2.5 in women and 23.6 ±2.8 in men, WHR 0.79 ±0.05 in women and 0.89 ±0.06 in men).

Data was collected with the use of indirect observation as a method and accelerometry as the technology. PA characteristics were assessed for 7 consecutive days using accelerometer ActiGraph GT3X+ in April and May 2014. The prevailing form of activity undertaken by members of examined associations was jogging.

The below characteristics of basic weekly physical activity were measured:

- the number of steps taken for 7 consecutive days of the monitoring,
- weekly energy expenditure on PA [kcal/week],
- weekly duration of total moderate physical activity (MPA [min]),
- weekly duration of moderate physical activity accumulated in 10 minute bouts (MPA in 10 min. bouts [min]),

– weekly duration of total vigorous physical activity (VPA [min])
– weekly duration of vigorous physical activity accumulated in 10 minute bouts (VPA in 10 min. bouts [min]).

The values of those variables were evaluated in the context of recommended weekly energy expenditure on PA (respecting global volume of PA) (Paffenbarger, Hyde, Wing, 1990) daily number of steps (respecting global volume and frequency of PA (Tudor-Locke, Hatano, Pangrazi, Kang, 2008, Tudor-Locke, Hatano, Pangrazi, Kang, 2011) and the duration of moderate-to-vigorous PA as recommended by World Health Organization (WHO, 2010). For that purpose, the data was compared with:

1. Recommended weekly energy expenditure on PA, which should be the minimum of 2,000 kcal in any 20–59 year-old with a body mass of 70 kg (Paffenbarger, Hyde, Wing 1990). Individual values of it were derived with the following formula:

$$RWEE = 2{,}000\ [kcal/week] \times BM\ [kg]/70\ kg,$$

where: RWEE – recommended weekly energy expenditure [kcal/week] on PA in people aged 20–59, BM – body mass (kg).

2. The five-step scale of physical activity by Tudor-Locke et al. (2011), who defined the following classification of the individual's PA volume based on the number of steps taken daily: 5,000 – individuals with sedentary lifestyles, 5,000-7,499 – individuals with low PA, 7,500–9,999 – individuals with moderately active lifestyles, 10,000–12,499 – individuals with high PA (the minimum for health benefits to occur), ≥12,500 – individuals with very high PA.
3. WHO's recommendation, providing that the individual should engage in at least 150 minutes of aerobic MPA per week or at least 75 minutes of aerobic VPA per week or an equivalent combination of moderate and vigorous intensity activity just to sustain or improve health (150 min MVPA). This physical activity should be accumulated in bouts of at least 10 minutes (WHO, 2010).

The principal descriptive statistics ($\overline{x}$, SD, max, min) of analyzed variables and percentage rates (%) of participants satisfying and not satisfying PA health recommendations were calculated in Statistica 10 Statsoft Inc.

Results

Individually estimated recommended weekly energy expenditure on PA ranged from 1377 to 2797 [kcal]. The actual value of this parameter estimated from accelerometer was between 1443 to 8522 [kcal]. On the average, the participants expended 4,257.2 [kcal] on physical activity per week, more than twice as much as the minimum recommended for the individual to sustain or improve their health (Table 1). The mean weekly duration of MPA (735.2 ±337.1 [min]) was more than eight times longer than VPA (83.8 ±81.5 [min]). Meeting the criterion of accumulating PA in at least 10 min. bouts reduced MPA volume throughout the week five times (137.8 ±124.0 [min]). Vigorous physical efforts with such a minimum duration (VPA in 10 min. bouts) occured in less than half of all participants (20) (Table 1).

All men and women (100%) demonstrated proper weekly PA volume expressed in energy expenditure [kcal]. The prevailing majority of participants (98%) took recommended number of steps (10,000) each day, a criterion was not fulfilled by just 2% of all participants (1 woman) (Table 2). Less than half of all subjects (40%) satisfied WHO's recommendation for the weekly volume of PA specified as total duration time and intensity (150 minutes of MVPA [min/week]). This guideline was met merely by 41.2% of men and 37.5% of women (Table 2).

Table 1. The principal characteristics of participants' physical activity

Variable	n	$\bar{x} \pm SD$	min–max
Weekly energy expenditure on PA [kcal/week]	50	4257.2 ±1628.8	1443.0–8522.0
RWEE on PA [kcal/week]	50	1989.0 ±330.9	1377.0–2797.0
Number of steps taken daily	50	10653.0 ±4000	6732.4–25404.3
MPA [min/week]	50	735.2 ±337.1	311.0–1864.0
MPA in 10 min. bouts [min/week]	47	137.8 ±124.0	10.0–388.0
VPA [min/week]	48	83.8 ±81.5	2.0–349.0
VPA in 10 min. bouts [min/week]	20	101.6 ±85.5	11.0–296.0

RWEE – recommended weekly energy expenditure, MPA – moderate physical activity, VPA – vigorous physical activity.

The reason why the majority of participants failed to satisfy recommendation by WHO was that they rarely took up activities accumulated in at least 10 minutes bouts – a precondition defined in this health-oriented guideline. An evident trend was observed that the degree to which all health-oriented PA recommendations considered in this study were fulfilled in men was slightly higher than in women (Table 2).

Table 2. Compliance with selected health recommendations for physical activity

Recommendation	Women	Men	General
Recommended weekly energy expenditure on PA (Paffenbarger i in., 1990)	(16) 100%	(34) 100%	(50) 100%
7.500 steps each day (Tudor-Locke et al., 2011)	(15) 93.8%	(34) 100%	(49) 98%
150 min MPA or 75 min VPA or equivalent (WHO, 2010)	(6) 37.5%	(14) 41.2%	(20) 40%

Discussion

The aim of this study was to investigate habitual physical activity in members of health promoting associations in compliance with basic health recommendations. The evaluation of physical activity in the context of getting health benefits in members of such associations has not been the aim of domestic studies yet.

The prevailing number of domestic studies related to PA assessment are conducted with the use of subjective methods (Bergier, Bergier, Soroka, Kubińska, 2010; Biernat, Piątkowska, 2012; Nawrocka, Prończuk, Mynarski, Garbaciak, 2012). These methods consist in estimating PA parameters from questionnaires and their results tend to be overestimated (Biernat, 2011, Pate et al., 2015). In our research, we used the three-axial accelerometer ActiGraph GT3X+ in order to raise the quality of results of PA monitoring. Objective tools of PA assessment, which validity and reliability are high (Lipert, Jegier, 2009; Rothney, Brychta, Meade, Chen, Buchowski, 2010; Butte, Ekelund, Westerterp, 2012; Thomas, Silverman, Nelson, 2015), are commonly used by foreign researchers (Colley et al., 2011, Ruiz et al., 2011, Evenson, Buchner, Morland, 2012; Sheers, Philippaerts, Lefevre, 2013; Mutikainen, Helander, Pietilä, Korhonen, Kujala, 2014). In Poland, research on PA characteristics based on impartial measurement tools is still scarce (Mynarski, Nawrocka, Rozpara, Garbaciak, 2012; Włodarek, Majkowski, Majkowska, 2012).

The results of our research indicated that the weekly energy expenditure on habitual physical activity among examined members of health promoting associations was high, because it exceeded on average twice the recommended level (RWEE). Additionally during the week of monitoring, a vast majority of participants (98%) took an adequate number of steps to fulfill the recommendation by Tudor-Locke et al. (2011). The results of authors' own research are pretty optimistic in the light of those demostrated in another researches (Chastin et al., 2009, Bassett, Wyatt, Thompson, Peters, Hill, 2010; Hirvensalo et al., 2011; Biernat, 2011; Colley et al., 2011; Pate et al., 2015). The possible reason of that is the fact that our study looked exclusively on members of health promoting associations, who seem to be more physically active than the general population.

Despite high weekly energy expenditure on PA and number of steps taken less than half of participants (40%) met the criterion of recommended weekly duration of moderate-to-vigorous PA in the context of WHO guideline. It indicates that low intensity physical activity was dominant in the members of examined associations' typical week. The percentage rate of individuals meeting WHO criterion of PA was high in comparison with the results of Canadians conducted by Colley et al. (2011) (15,5%) and similar to these indicated in Finnish employees by Multikainen et al. (42%) (2014). It should be emphasized that citizens of above mentioned countries are recognized as one of the most physicaly active all over the world. More optimistic results (73%) were indicated in Flemish by Scheers et al. (2013).

The main reason for the high percentage rate of men and women not satisfying health recommendations for PA as defined by WHO was that the activities undertaken by research participants were rarely accumulated in minimum 10 minutes bouts (WHO, 2010).

What points to that are authors' own observations, as only 40% of women and men participating in this study satisfied WHO PA recommendation (including duration and intensity 150 min MVPA), whilst regarding less complex criteria by Paffenbarger et al. (1990) (including only volume) or Tudor-Locke et al. (2011) (including volume and frequency) all of them or mostly all meet health-oriented recommendation. The consequences of various basic criteria of physical activity assessment, included in health-oriented recommendations, are quite significant differences in PA evalutaion even in the same study group (percentages of compliance with PA guidelines are unlike). A similar trend was observed in research conducted by Chastin et al. (2009), Scheers et al. (2013) and Chaix et al. (2014) where the degree to which a PA recommendation was satisfied differed depending on the criterion used in the evaluation. There are still only few publications investigating this problem.

In relation to the results of this manuscript and the fact of existing diversified criteria of health-oriented PA assessment, it seems to be important to evaluate habitual PA of certain social group in compliance with different recommendations simultaneously in order to receive an overview of the proportion of people being sufficiently active.

Conclusions

The aim of this study was to investigate habitual physical activity in adult members of health promoting associations in compliance with selected PA characteristics recommended for health benefits to occur. The below conclusions summarize the results of this study:

1. Despite appropriate weekly volume of PA expressed as energy expenditure (on the average, twice as high as the recommended minimum) and the number of steps, the prevailing majority of participants demonstrated an inadequate level of PA when assessed according to WHO's recommendation.

2. It was observed that the percentage rate of individuals with appropriate physical activity differs depending on the criterion used in the evaluation.

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MOTIVES FOR CHOOSING STUDIES AS PREDICTORS OF CAREER PLANS OF TOURISM AND RECREATION STUDENTS

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Abstract The decreasing number of students at the Polish education system, the expectations of the labor market and the needs of employers are forcing the higher education system to make changes in programs and models of teaching. Upon graduation, a student should be prepared to meet the increasing demands of the employment market, which expects graduates to have high professional and language competencies, related to, among others, modern technologies.

The aim of the research conducted at the Faculty of Physical Culture and Health Promotion of the University of Szczecin was to ascertain the motives for the students' choice of studies in the field of Tourism and Recreation in the context of their career plans.

49 first-cycle students and 39 second-cycle students aged between 20 and 25 were examined. In the study the diagnostic survey was employed, with the use of the techniques of questionnaire, observation and interviews. For the statistical inference frequency of characteristics, chi-square test of independence and multiple correspondence analysis were applied.

It was found that the most important motives for studying Tourism and Recreation were interest in physical recreation, love of traveling, and desire to explore the world and disseminate a healthy lifestyle through active recreation. Students who chose the field of study consistent with their interests were planning to find jobs in a profession consistent with their education.

Key words motives for studying, career plans, tourism and recreation

Introduction

Poland's accession to the European Union in 2004, apart from political and economic changes, had its consequences in Polish people's social life and education. Open borders and freedom to settle and earn income abroad have contributed over the years to significant migration movements of Polish citizens. Projections indicate that the population of our country – not only because of emigration – will be decreasing until 2035. As in other Western European countries, a favorable trend of lengthening the average life span of the population is observed in Poland, but it is accompanied by a change in the pattern of fertility, which includes a declining birth rate, fewer marriages being contracted and an increasing average age of women giving birth to their first child (Trzpiot, 2013).

Human resources are a great asset of every country, and building a knowledge – based economy is a vital strategy of the European Union. Investing in education is a challenge which our society must face. The most important element of regional economy is technological knowledge and development. Employees and their creativity, entrepreneurship and level of knowledge and skills are a significant source of new knowledge (Łubkowska, Eider, 2014a). As far as higher education is concerned, Poland's EU accession resulted in the necessity to implement the so-called Bologna Process (Piasecka, 2014), which aimed at creating by 2010 a coherent European Higher Education Area through a system of ECTS credits, implementation of two-cycle studies, education quality control (systems of accreditation, certification, internal quality assurance systems), promotion of mobility programs for students and lecturers (Cieśliński, 2009) and promotion of lifelong learning (Nowak, 2008). It seems, therefore, that commencing first-cycle and later second-cycle studies is not only a possibility, but often a necessity (Ferenz, 2010), enabling a young person to find a suitable job more easily in future (Drozdek-Małolepsza, Michalski, Rodziewicz-Gruhn, 2010). Knowledge of foreign languages and confirmed additional professional competencies, for example related to handling modern technologies, significantly increase one's chances of being offered an attractive and rewarding position (Nadobnik, Trzeciak, 2011). The system of education is responsible for shaping the curriculum in such a way that it corresponds as much as possible to the modern labor market (Drozdek-Małolepsza, Michalski, 2011). Equally important is also monitoring of graduates' professional activity (Eider, 2009; Buchta, 2009; Czerepaniak-Walczak, 2013; Radzińska, Nowak, Nowak 2016a, 2016b).

In the academic year 2010/11 the number of students at Polish universities amounted to more than 1.8 million. As a result of the ongoing demographic decline, in the years 2023–2025 the number of students will drop to approximately 1.25 million. It is anticipated that the relative decrease in the number of students in Poland will be one of the largest in Europe (Kwiek, 2015). The academic community in Zachodniopomorskie Province in 2007 numbered 79,027 people, while in the academic year 2012/2013 there were 62,470 students (a 20.95% drop). A similar reduction in the number of students was reported at that time in the city of Szczecin – 21.04% (Łubkowska, Eider, 2014b).

A drastic decrease in the number of students will not be experienced equally by all Polish universities. In the fields of medicine, law, information technology or philology of some languages, there are several times as many candidates as places available at particular faculties. Graduates from these fields of study are likely to find attractive offers in the labor market. Numerous job opportunities are an important determinant of high popularity of some (trendy) fields of study (Płowiec, 2010). Motives influencing young people's choice of study programs have for many years been the object of scientific inquiry (Łukaszewski, Doliński, 2002). A survey carried out in 1974 (Liberska, 1974) showed that for the majority of students in the early 1970s the main motive for commencing studies was the desire to gain more knowledge, while in 2004 (GUS, 2005) for nearly 70% of students under 30 years of age it was the possibility of finding employment after graduation. Further research published in 2013 (GUS, 2013) indicated that when choosing a course of study, candidates considered prospects of finding a job which would be in line with their interests.

At the Faculty of Physical Culture and Health Promotion of the University of Szczecin, students can, among others, choose the program in Tourism and Recreation, which is offered in two cycles. The undergraduate course with the general academic profile features the specialization of *Animator of physical recreation and ecotourism* (studies conducted jointly with the Faculty of Management and Economics of Services of the University of Szczecin), and in the Master's course with the practical profile students major in *Health basis for tourism and recreation*.

The authors of this publication decided to try to answer the questions of, firstly, whether the students' decision to choose these fields of study was made in a thoughtful way, secondly, what their career plans are, and, thirdly, whether – in the assessment of the students – the study programs that they chose will help them in carrying out those plans. In light of the above-mentioned research results, the endeavor to find out whether undertaking the hardships of studying is a fully thought out action that facilitates the realization of one's aspirations related to their trained profession needs to be continued.

The aim of the study was therefore to ascertain the motives for the choice of studies in the field of Tourism and Recreation in the context of the students' career plans.

The following hypothesis was formulated:

The motives for choosing studies which are directly related to tourism and recreation are predictors of the students' career plans.

Material and methods

Since 2016 comprehensive research has been conducted at the Faculty of Physical Culture and Health Promotion among students majoring in Tourism and Recreation into the quality of education, motives for commencing studies and studying, assessment of the level of acquired knowledge, competencies and professional skills, and students' career plans. This paper presents results of the research related to motives for the choice of studies and career plans of students of Tourism and Recreation.

Among the respondents (49 students in the first and 39 in the second cycle) there were 69 women and 19 men aged 20 to 25, 54.4% of whom were under 22 years of age. Students of Tourism and Recreation (hereinafter TAR) were mostly urban dwellers (79%), 92% were single. 61.4% of the students graduated from comprehensive high school, 22.3% from technical high school (16.3% did not answer). 75% of the respondents had experienced permanent or temporary employment. Over 95% of the subjects declared having left Poland before (at least several times). Respondents were characterized by a high level of physical activity: 88.9% of them reported practicing high-performance or recreational sport during their studies.

In the examination, the diagnostic survey was employed, with the use of the technique of questionnaire (Babbie, 2008), verified by the academic and research staff constituting the minimum required number of faculty members for the TAR program. The information obtained was supplemented with the results of observations and uncategorized interviews carried out among students. The qualitative and quantitative analysis was based on standard statistical methods: frequency of characteristics, chi-square test of independence and multiple correspondence analysis (van Burren, de Leuve, 2010). These analyses are available in the statistical software package Statistica 12 [StatSoft, inc. 2015 Statistica for Windows]. For the correlations tested, statistical significance at $p \leq 0.05$ was adopted. In the graphical interpretation of the results, Microsoft Excel was used, from the suite Office 2013 by Microsoft.

Results

For the respondents, the most important motives for commencing studies and studying Tourism and Recreation were interest in physical recreation (59.1%), love of traveling and desire to explore the world (54.8%) and desire to promote a healthy lifestyle through active recreation (50.9%) (Table 1). The next two motives indicated by the subjects were desire to work in a recreational institution (46.1%) and prospect of an interesting job connected with tourism and recreation, e.g. a tour organizer, a recreation animator, etc. (38.9%). For about a third of the subjects

the following were of great importance: the necessity of obtaining a higher education, desire to work in a tourism institution, e.g. in a travel agency, a hotel, etc., conviction of the attractiveness of the studies, and having personal predispositions to work with people.

Almost every fifth respondent pointed to the possibility of developing their own business in the field of recreation, their conviction of easiness of getting into university and studying, and desire to work in other institutions, not connected with tourism and recreation, The possibility to develop one's own undertaking in the field of tourism, personal (domestic and foreign) tourist experience, and perceived great opportunities for growth in the tourism industry were in turn important motives for about 15% of the subjects. 15.1% of the students were not sure about choosing this field of study, but had succumbed to the persuasion of their friends, acquaintances or parents. Few respondents indicated motives associated with a lower cost of living in comparison with other cities, experience in qualified tourism, and conviction of high social prestige attached to the profession of specialist in the field of tourism and recreation.

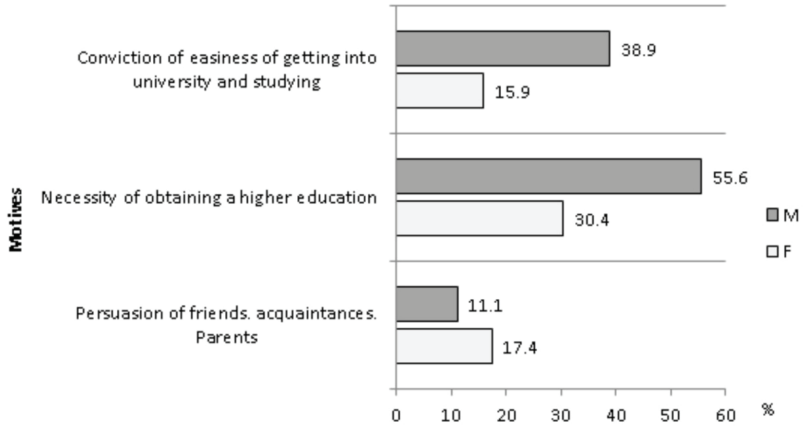
Table 1. Motives for choosing studies and studying Tourism and Recreation in relation to the cycle of studies and sex (independence χ^2 test)

Motives for choosing studies and studying Tourism and Recreation	Study cycle		Sex		Total (88)
	I (n = 49)	II (n = 39)	F (n = 69)	M (n = 19)	
	%				
Interest in physical recreation	59.2	59.0	58.0	61.1	59.1
Love of traveling and desire to explore the world	63.3	46.2	53.6	61.1	54.8
Desire to disseminate a healthy lifestyle through active recreation	53.1	48.7	46.4	72.2	50.9
Desire to work in a recreational institution	40.8	51.3	42.0	55.6	46.1
Prospect of an interesting job (tour organizer, recreation animator, etc.)	36.7	41.0	40.6	27.8	38.9
Necessity of obtaining a higher education	44.9	23.1	30.4*	55.6*	34.0
Desire to work in a tourism institution (travel agency, hotel etc.)	28.6	38.5	30.4	38.9	33.6
Conviction of the attractiveness of the studies	32.7	30.8	31.8	33.3	31.8
Having predispositions to work with people (e.g. tourists)	28.6	33.3	34.8	16.7	31.0
Possibility of developing one's own business in the field of recreation	16.3	28.2	20.3	22.2	22.3
Conviction of easiness of getting into university and studying	28.6	10.3	15.9*	38.9*	19.5
Desire to work in other institutions	22.4	12.8	21.7	5.6	17.6
Possibility of developing one's own business in the field of tourism	24.5	7.7	14.5	27.8	16.1
Personal tourist experience (foreign)	16.3	15.4	14.5	22.2	15.9
Great opportunities for development in the tourism industry	18.4	12.8	15.9	16.7	15.6
Personal tourist experience (domestic)	20.4	10.3	15.9	16.7	15.4
Persuasion of friends, acquaintances, parents	22.4	7.7	17.4*	11.1*	15.1
Lower cost of living in comparison with other cities	14.3	5.1	10.1	11.1	9.7
Experience in qualified tourism	8.2	10.3	8.7	11.1	9.3
Conviction of high social prestige of this occupation	4.1	2.6	4.4	–	3.4

* Statistical significance at $p \leq 0.05$ was adopted.

No differences in the motives for the choice of studies were observed in the first-cycle or second-cycle students of TAR. However, in the analysis of relationships between certain factors unrelated directly to the selected program

of study (necessity of obtaining a higher education, conviction of easiness of getting into university, persuasion of friends or family) and sex, statistically significant dependences were found (in each case $p \leq 0.05$ for the χ^2 test) (Figure 1).



* Statistical significance at $p \leq 0.05$ was adopted. Source: own research.

Figure 1. Selected motives of students for commencing studies in the field of TAR (independence χ^2 test)

The respondents reported on their career plans which they would like to carry out after completing the TAR studies (Figure 2). First-cycle students most often indicated: desire to work in a recreational institution (31.8%), in a tourism institution (25%), in a holiday resort (21.5%), and in another profession related to physical culture (17%).

Career prospects in the opinions of students in the second cycle of the TAR studies were different. 46.6% of the second-cycle students did not have any plans for future employment. The same proportion (46.6%) intended to work in a profession unrelated to the field of study. About 44% of the prospective Masters of Arts considered permanent emigration and obtaining additional education (44.3% and 43.2% resp.). 41% of the second-cycle TAR students planned to work in other institutions connected with tourism and recreation, and the same number of them did not see a chance of finding a job in their acquired profession. Living abroad temporarily, working in a profession connected with physical culture or in a holiday resort was mentioned by approximately 30% of the subjects.

Statistically significant correlations were found between career plans and the cycle of study in which the respondents were (Figure 3). First-cycle students more often planned to work in recreational institutions ($p \leq 0.05$ for the χ^2 test) and slightly more often in tourism institutions ($p \leq 0.05$ for the χ^2 test). Second-cycle students more often associated their career plans with employment in a holiday resort ($p \leq 0.05$ for the χ^2 test), wanted to work in a profession not connected with their field of study ($p \leq 0.05$ for the χ^2 test), desired to obtain additional education ($p \leq 0.05$ for the χ^2 test) or planned to live abroad permanently ($p \leq 0.05$ for the χ^2 test). Second-cycle students did not have any plans for their future careers many times more often than their first-cycle counterparts ($p \leq 0.05$ for the χ^2 test) (46.6% and 1.2% resp.).

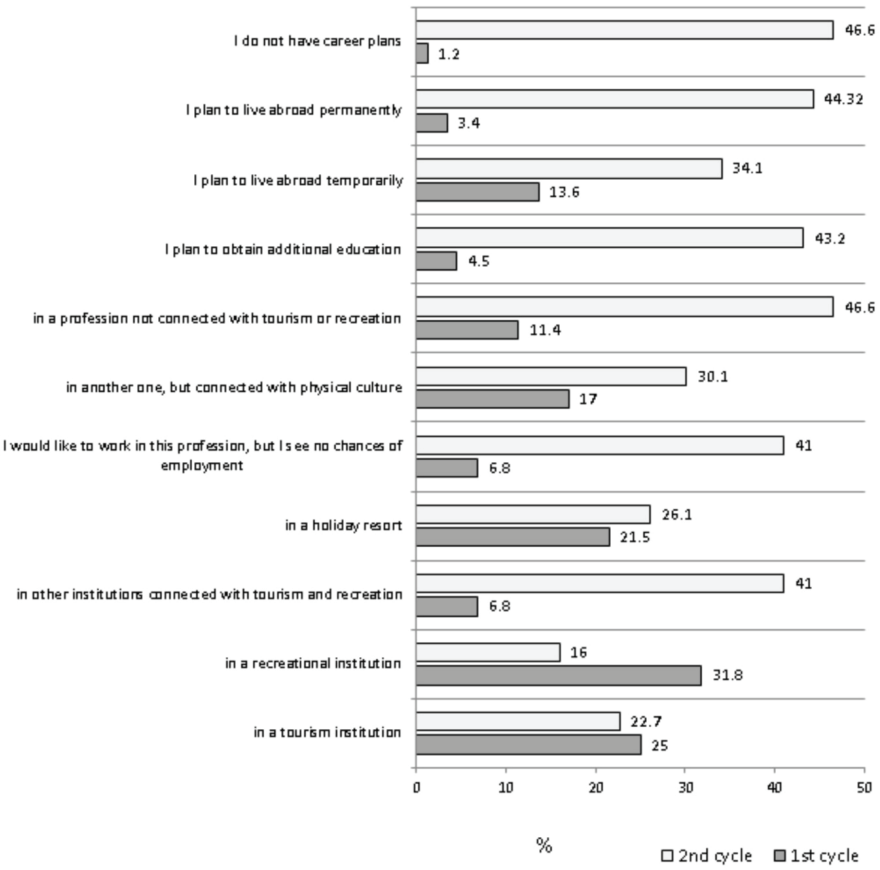
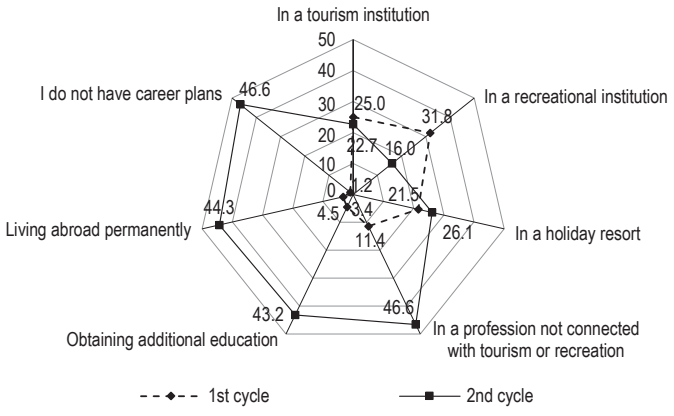
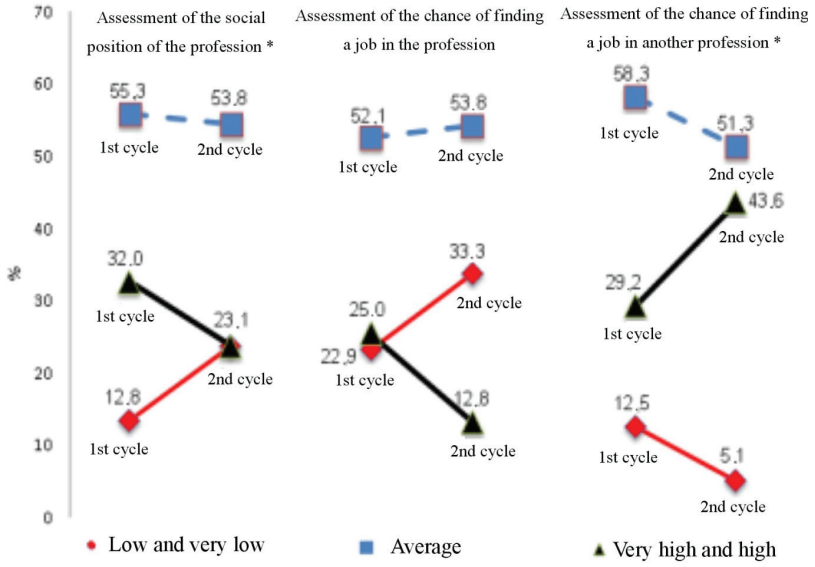


Figure 2. Respondents' career plans in relation to the cycle of study (%). Source: own research



* Statistical significance at $p \leq 0.05$ was adopted. Source: own research.

Figure 3. Respondents' career plans with respect to the cycle of study (independence χ^2 test)



* For the dependences tested, statistical significance at $p \leq 0.05$ was adopted.

Figure 4. Assessment of the social position of a TAR-related profession, and the chance of finding a job in this profession or in a different one, not connected with TAR, made by the respondents – first and second-cycle students (independence χ^2 test)

The prestige of the profession of specialist in the field of tourism and recreation in the opinion of students in both the first and second cycle of study was at an average level (55.3% and 53.8% resp.) (Figure 4). 12.8% of the first-cycle students and 23.1% of the second-cycle students rated the social position of the profession as low and very low, while 32% of students in the first cycle and 23.1% of those in the second cycle considered it to be high and very high. First-cycle students were characterized by a higher assessment of the social position of the profession which they were trying to acquire ($p \leq 0.05$ for the χ^2 test).

Students in the first and second cycles of study did not differ significantly about the assessment of the chances of finding employment as a specialist in the field of tourism and recreation. Average and low ratings dominated.

A statistically significant correlation was found between the perceived chances of finding a job in another profession and the cycle of study ($p \leq 0.05$ for the χ^2 test). Second-cycle students much more often saw the chance of finding a job in another profession (43.6% and 29.2% resp.), although both groups mainly assessed it as average.

Associations between the motives for the choice of a study program which were directly linked to the interest in tourism and recreation and career plans and the respondents' cycle of study were presented comprehensively on the basis of multiple correspondence analysis (Figure 5) in conjunction with the results of the independence χ^2 test (Table 1, Figure 2, 3). Two dimensions were selected (first and second), which explained 42.51% of the total value of χ^2.

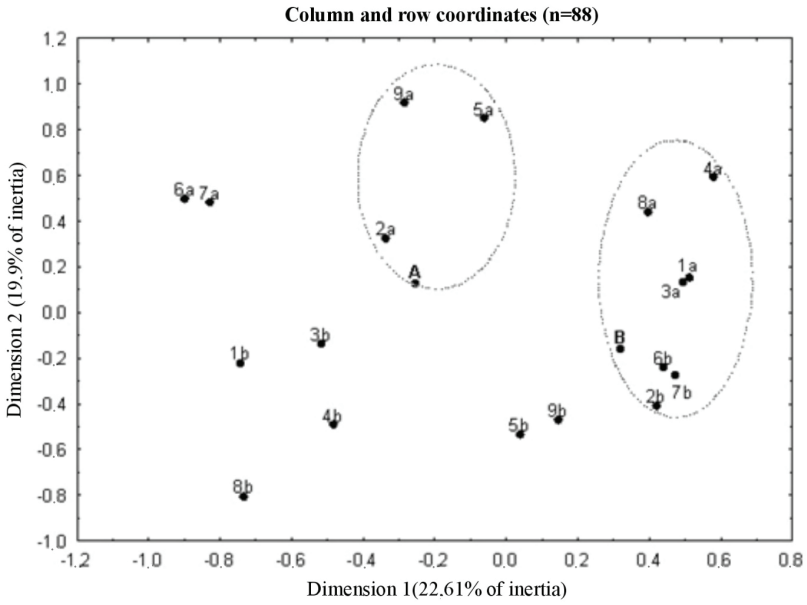


Figure 5. Relationships between the motives for the choice of a study program which were directly connected with the field of study and career plans and the subjects' cycle of study (MCA)

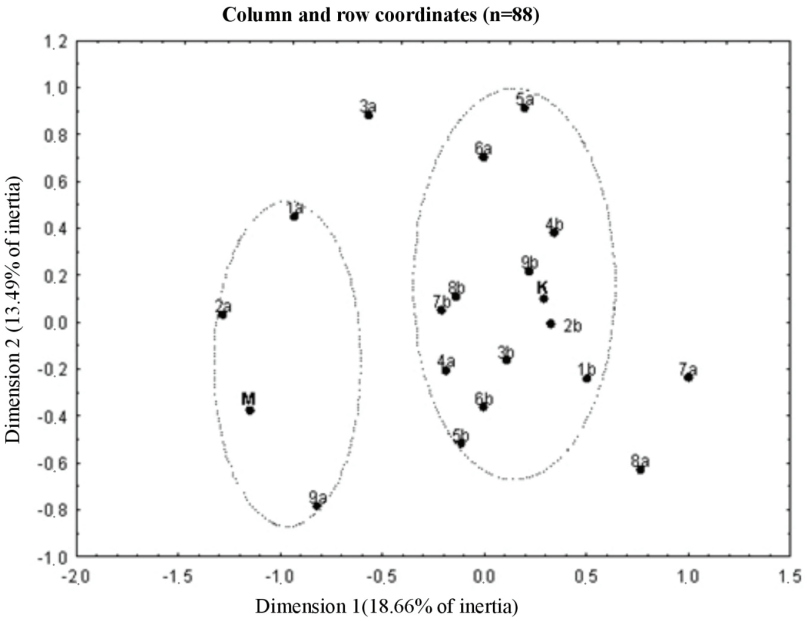


Figure 6. Relationships between the motives for the choice of a study program which were not directly connected with the field of study and career plans and the subjects' sex (MCA)

In a graphical analysis of the results of the correspondence analysis in relation to two dimensions, the first cycle (A) and the second cycle of study (B) were distinguished. Students in the first cycle of the TAR program (A) chose this field because they were interested in traveling (2a) and having an interesting job (5a). They also would like to work in holiday resorts in the future (9a). For those studying in the second cycle (B) the main motives were their interest in physical recreation (1a) and the possibility of working in the area of physical recreation (4a). These subjects clearly associated their career plans with physical recreation (8a).

The respondents who were motivated to undertake the studies by their interest in employment in tourism (6a) and planned to work in an occupation connected with tourism (7a) occupied peripheral location.

Among both the first-cycle (A) and the second-cycle students (B) of TAR, there was a group of people who did not report motives for the choice of the program which were directly connected with this field of study (1b, 3b, 4b, 5b), and did not see their future in the occupation of specialist in the area of tourism and recreation (8b, 9b).

Associations between the motives for the choice of a study program which were not directly linked to the interest in tourism and recreation and career plans and the respondents' sex were presented comprehensively on the basis of multiple correspondence analysis (Figure 6) in conjunction with the results of the independence χ^2 test (Table 1, Figure 2, 3). The dimensions selected (first and second) explained 32.15% of the total value of χ^2.

In a graphical analysis of the results of the correspondence analysis, a group of females (F) and males (M) were distinguished. Women (F) less often reported motives not related to the field of study (1b, 2b, 3b). They mainly based their career plans to the desire to work in recreation (4a), tourism (5a) and in holiday resorts (6a). For men (M) who chose this program of study in order to obtain any kind of higher education (1a), being also driven by the easiness of studying (2a), an important element in their career plans was to obtain additional education (9a). Peripheral location was occupied by the respondents who decided to study TAR at the suggestion of the closest people (3a) and associated their career plans with work in another profession (7a) or settling abroad permanently (8a).

Discussion

According to information provided by the Central Statistical Office in 2012 concerning the path of education and professional situation of Poles, the proportion of university students who declared compliance of the field of study which they had entered with their interests amounted to 53% for the entire country (GUS, 2013). In the case of TAR at the Faculty of Physical Culture and Health Promotion in Szczecin, students declared their interest in physical recreation at the level of 59.1%, which may suggest high compliance of the undertaken study program with personal preferences of the respondents. Further education or willingness to obtain additional qualifications after graduation were declared, according to the same findings by the Central Statistical Office, by 20% of students in the whole country, while for the students of TAR at FPCHP surveyed in 2016, the proportion was 4.5% in first-cycle program and 43.2% in second-cycle program. These results indicate the necessity of continued research into the causes of disparities between students in the first and second cycles in their perception of the need for further education and acquiring new professional skills (Nadobnik, 2014).

In 2013, the proportion of people aged between 18 and 24 interested in going abroad to work amounted to over 60% (Kowalczuk, 2013). In the present study, the desire to go abroad to work was reported by 34.1% of second-cycle students and only 13.6% of first-cycle students. Perhaps so few first-cycle students showed willingness to leave the country because they were waiting with the decision about possible emigration until the completion of

Master's studies. It is also possible, however, that the reasons are more complex: second-cycle students, who often already have some work experience, have a different assessment of the socio-economic situation and their chances of finding employment in Poland. This problem also requires constant monitoring.

The findings of the present study clearly show that further functioning of the study program of Tourism and Recreation at FPCHP requires actions aimed at reorganization, modification of the learning content, and enrichment of the educational process with competencies enabling TAR graduates to increase their chances of success on the labor market. According to the report "Barometer of professions", published in 2015 in cooperation with the Ministry of Family, Labor and Social Affairs and coordinated by the provincial labor offices (Bruzda, 2015), there is a large surplus of travel agency staff and tourist service organizers in relation to potential jobs in West Pomeranian Province and the neighboring provinces. A relative balance is observed however between vacancies and the number of tourist guides, tour leaders, professional culture animators and event organizers, including recreational, tourist and sports events.

Bearing in mind the above information concerning the labor market in West Pomeranian Province and the neighboring provinces, it is worth taking a look at the offer of FPCHP addressed to the students of TAR. Its aim is to develop key competencies of future graduates under the European Social Fund "OPERATIONAL PROGRAMME KNOWLEDGE – EDUCATION – DEVELOPMENT" (POWR.03.01.00-IP.08-00-PRK/16). The main effect of the project launched in 2017 is to be the students' acquisition of professional qualifications related to their field of study, raising qualifications connected with entrepreneurship, supplementation of language competencies in professional practice. The project encompasses specialized training and workshops featuring diplomatic protocol, event management, study visits, certified Nordic Walking course, and others.

Very good results and numerous achievements of the offered study program were confirmed by winning twice the first place in the rankings of Polish higher education institutions holding programs in tourism-related fields in 2015 and 2016, as well as the second place in the category "Public schools – scientific potential" (according to the trade magazine "Wiadomości Turystyczne" (*Travel News*) No. 4/2016). In their evaluation, the committees took into account and gave a large number of points for the scientific potential of schools, practical preparation of students for their profession, as well as studying conditions. Using innovative methods of effective education of students in the area of social competence and social capital deserves attention, for example group exercises in a rope park (Łubkowska, Tarnowski, 2015). The place of FPCHP of the University of Szczecin among the best educating universities in tourism-related fields in the whole country can be an additional motivation for potential candidates interested in the area of tourism and recreation, as well as for those who wish to obtain professional competencies in broadly understood physical culture.

As shown, motives directly related to the field of study can be predictors of taking a job in one's learned profession. Given the successes and achievements of the Faculty, the expectations of employers and the needs of the labor market, the program of study is worth promoting in the local environment in order to reach the largest possible number of candidates and convince them to study at the Faculty, showing the achievements and opportunities for development.

Conclusions

1. The most often reported motives for commencing studies in the field of Tourism and Recreation were the students' interest in physical recreation, love of traveling and desire to explore the world, need to promote a healthy lifestyle through physical recreation and desire to work in a recreational institution.

2. The first-cycle students most often reported being interested in traveling and interesting jobs associated with it, however in the future they would like to work in holiday resorts. For those studying in the second cycle, the main motives for commencing studies were their interests in physical recreation and the possibility of working in the physical recreation area. Their career plans were clearly linked to physical recreation.

3. Women, more often than men, associated their career plans with their desire to work in recreation, tourism or a holiday resort. Men, for whom it was important to obtain additional education, more often reported that they had chosen the program in order to obtain any kind of higher education, being also driven by their opinion of the easiness of studying TAR.

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