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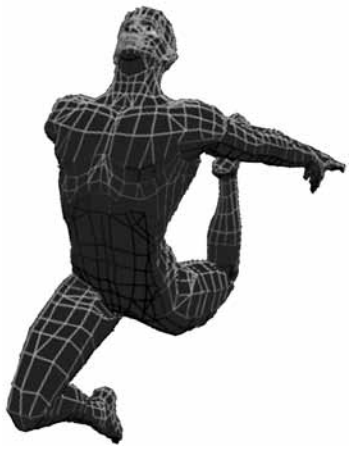

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CONTENTS

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THE VERTICAL JUMP HEIGHT OF SOCCER PLAYERS AFTER STATIC OVERSTRETCHING

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ABSTRACT
Purpose. The purpose of this study was to assess the effect of static overstretching on performing a vertical jump. **Methods.** A methodological model was used, using descriptive and comparative methods on 45 randomly selected under-15-year-old male soccer players. Three jump test measurements were taken over a period of several days, where the first measurement included a pre-test in order to familiarize the athletes with using a contact mat, where maximum vertical jump height was recorded as a control. The second measurement had the athletes perform a vertical jump after static overstretching of the lower limbs. The third test had the athletes perform another vertical jump with no overstretching as another control. **Results.** The results found a significant difference in vertical jump heights ($\Delta\% = 34.1\%$, $p < 0.05$), with jumps performed after static overstretching to be much lower. **Conclusions.** The usage of such a static overstretching method negatively influences the vertical jump within the tested group of under-15 male soccer players.

Key words: soccer, overstretching, vertical jump

Introduction

Soccer is a sport where performance is based on the proper development of a set of factors, among them flexibility. Flexibility depends on both muscular elasticity and joint mobility, and it is represented by the maximum amplitude of the necessary movements that are needed, in this case, to optimally perform in a soccer match [1]. Feland et al. [2], mention two distinct methods that can be used to promote flexibility, where both methods are directly influenced by the joint-amplitude ratio. When the movement amplitude is submaximal, there is a total use of the movement arch and this movement is known as stretching. When the movement amplitude is caused by an outside force, the expanded arch achieved by this movement is called overstretching.

Stretching, in itself, has become an increasingly controversial topic over the last few years regarding its practical application. However, the classical recommendation of stretching before and after physical exercise is still upheld as fact [3]. Nonetheless, many studies have shown conflicting and even opposing results regarding the use of stretching as a protective remedy against lesions [4–10], in reducing muscle soreness post-exercise [7, 11] and the benefits it has on increasing performance, particularly with producing maximum power and muscular strength [3, 10, 12–18].

In this regard, muscular power, strength and velocity are important physiological characteristics for soccer players, as they are required to perform numerous jumps, sprints and kicks [19]. In particular, the muscular power of the lower limbs is significantly connected to vertical jump height as well as sprint performance, in terms of velocity [19, 20].

Several studies on the effects of flexibility on muscular power have already been performed, finding a correlation between static overstretching and strength reduction, but whether this reduction in strength could have an impact on the performance of a vertical jump is unknown. Therefore, the purpose of this study is to assess the acute effect of static overstretching on vertical jump performance. It was decided to first question if there is in fact a reduction in vertical jump height after a period of static overstretching, and if so, if the reduction could be considered significant.

Material and methods

A descriptive, comparative study was carried out on 45 male soccer player volunteers, with a mean age of 14 years (± 0.66). The subjects were randomly selected among the nine clubs that participated in the under-15 Rio de Janeiro State Championships in 2009, in which took part a total of five hundred soccer players.

In compliance to Resolution 196/96 of the National Council of Health, the guardians of the participating soccer players in the study signed an Informed Con-

* Corresponding author.

sent Waiver and their clubs provided their consent in an Institution Information Form. The project was approved by the Ethics Committee of the Castelo Branco University under study number 0178/2008.

The vertical jump (VJ) was performed on a Jumptest contact mat (Hidrofit LTDA, Brazil) which had been previously validated by Ferreira et al. [21]. The contact mat determines the jumping height by an athlete's jump air time, using the equation: $height = 1/8\ gt^2$, where g is the acceleration of gravity (9.81 m/s^2) and t is the flight time in the air (s). A photoelectric system of receptors that respond to light, found within the jump platform, counted the flight time from the moment the athlete left contact with the ground.

Three separate vertical jump measurements were taken over a period of 48 hours in order to not influence the results. All of the test volunteers received instructions about the procedure and participated before each jump with a 10 minute warm-up, which constituted of a run that included small sprints and jumps over obstacles. At the end of the warm-up, each volunteer performed three jumps, where free movement of the upper limbs was permitted, with a minimum interval of 45 seconds between each of the jumps. Only the highest recorded result was considered in the study

On the first day of the experiment a medical questionnaire was given and anthropometric measurements (height and body mass) were taken to check for sample homogeneity. In addition, the soccer players performed a pre-test jump on the contact mat in order to become familiarized with the procedure.

On the second day the first vertical jump test was performed without static overstretching (VJ PRE), with the procedure as stated above. On the third day the vertical jump height was assessed after performing static overstretching (VJ STATIC). The static overstretching method used in this test was as follows: The test subject slowly reached their flexion limit, noted by approaching their pain threshold, with one of the study's researchers then smoothly forcing the joint beyond this limit for six seconds, then increasing the tension again in order to reach the highest possible movement arch beyond the pain threshold. This position was then held for another 10 seconds. This overstretching method was performed another three times with a rest interval of five seconds between each stretch. Six different static overstretching exercises of the lower limbs were performed. The chosen exercises were, in a seated position: (1) hip and lumbar flexion; (2) flexion of the hip and lumbar spine with the hip abducted with knee flexion, once for each side; (3) hip abduction; then in lateral decubitus position: (4) knee flexion, once for each side; then in a standing position: (5) hip and lumbar flexion with open legs; and finally, in a crouching position (6) abduction of the hip and arms between the legs holding the ankle.

The third and final vertical jump height measurement (VJ POST) occurred 48 hours after the VJ STATIC test was performed with the purpose of assessing whether the vertical jump could be used as a re-test procedure. This was done in order to evaluate if there was a difference among the initial non-static overstretching jump height results.

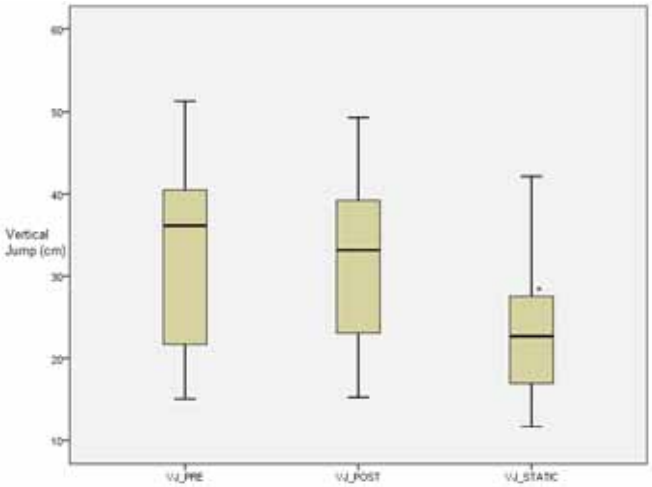
All statistical analysis was calculated using SPSS Statistics ver. 18.0 statistical software (IBM, USA). The Kolmogorov-Smirnov test found that the data could be represented by the Gaussian probability distribution function (at $p > 0.05$). For analysis of the difference between the means of the data groups, ANOVA was used for repeated measures as well as the Post Hoc Bonferronni test. The confidence level for all tests was set at 0.05.

Results

Figure 1 shows the values of the VJ STATIC measurements, which were found to be 34.1% lower than the jump height at VJ PRE, while VJ POST finds jump height to be 5.3% lower than at VJ PRE. In addition, when the means were compared by using inferential statistics (ANOVA for repeated measures), a significant difference was noted among the results ($F_{1.205} = 70.258$

Table 1. Characteristics of the tested soccer players ($n = 45$)

	Weight (kg)	Height (cm)	BMI (kg/m^2)
Mean	59.47	168.36	20.95
Standard deviation	± 6.47	± 7.39	± 1.42
Minimum	48.6	152	18.14
Maximum	78.1	188	25.5
Standard error	0.97	1.1	0.21
Coeffcient of variability (%)	10.89	4.39	6.80



In this figure the mean and standard deviation of the sample is presented.

Figure 1. Average of the vertical jump heights after overstretching using the static method in young soccer players

and $p < 10^{-5}$). In order to identify which groups were different, the Bonferroni Post Hoc Test was used and found a significant difference in the measured values ($p > 0.05$) when comparing VJ PRE and VJ STATIC but did not find a significant difference ($p > 0.05$) when comparing VJ PRE to VJ POST. These results found that static overstretching does in fact influence an athlete's vertical jump, especially in this case of under-15 male soccer players.

Discussion

An explanation for the results could come from the duration and intensity of static overstretching, which could be long enough to stimulate the Golgi tendon organs, reducing agonist muscular action and could explain the difference in the vertical jump heights. This could be intense enough to produce a laxity of the plastic components which then generates a higher contraction time during the concentric phase of the jump [13]. The mostly soft muscle-tendon system would have a rapid period of decreasing length with an absence of overload, dislodging the contractile component to a less favorable position for power production [22]. Also, according to Cramer et al. [13], there is a possibility that static overstretching can act on the Golgi tendon organs and cause the release of a inhibitory neuromediator in the spinal marrow, reducing power.

Behm et al.'s [23] study on 12 physically active men found a decrease in strength after passive and static stretching of the quadriceps. Five sets of stretching were performed, each for 45 seconds. The tests consisted of three maximum isometric contractions of the quadriceps, performed before stretching and then six and ten minutes afterwards. It was found that the maximum contraction rate reduced by 12.2% after stretching. Behm et al. also concluded that, instead of making the muscle-tendinous unit more complacent, stretching reduced maximum contraction due in part to muscular inhibition. This conclusion also seems to be applicable in this study. Although the measurements of Behm et al.'s study were taken at larger time intervals than the ones used in this study, it can be determined that the results of this study are credibly representative due to the intensity of the static overstretching.

This study found, when compared to the previously mentioned one, a shorter muscle-tension time, but where a higher muscle-tension was imposed. It can suggest that the decrease in the vertical jump height is related to the imposed tension of the muscle during static overstretching. Altogether, several factors can influence strength after stretching, such as increasing muscular extension and reducing muscle-tendinous rigidity, which can influence contraction due to the necessity of a higher performance time of contraction strength based on the higher laxity of the muscle's elastic components [24].

However, one of the limitations of this study was that the phase of muscle tension was not performed more gradually and slower, which could therefore ensure that this tension would be significantly higher, as was in other studies.

Conclusion

It can be concluded that static overstretching influences vertical jump performance, as based on the group of tested under-15 male soccer athletes, and the differences were found to be significant. Even though the control results (VJ PRE) presented different values than the post-control values (VJ POST), this difference was found to be not significant and can even be considered as a variance of the test itself. However, we recommend future studies take into consideration a different numbers of series as well as different durations and intensity of the measured performance benchmark, including a sample population different from the subjects used in this study.

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AN EVALUATION OF KINESTHETIC DIFFERENTIATION ABILITY IN MONOFIN SWIMMERS

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ABSTRACT
Purpose. The aim of this study was to compare the ability of monofin swimmers in reproducing the bending forces that act on a monofin's surface through the specific leg movement present in swimming as well as the forces that the swimmers generated on a kinesthesiometer as part of a dry-land simulation trial. **Methods.** Six men, members of the National Monofin Swimming Team, took part in the study. The level of the swimmers' kinesthetic response was defined by examining their repeatability in producing the bend forces that act on a monofin's surface as a reaction to water resistance and by investigation on the pressure force generated by a swimmer's lower limbs during dry-land tests on a kinesthesiometer. **Results and conclusions.** It was established that a high level of kinesthetic response, estimated in the group of monofin swimmers, was the result of an adaptation evoked from the specificity of their sensory stimulus perception, received in the form of feedback from the monofin's large surface area.

Key words: swimming, monofin, kinesthetics

Introduction

The term kinesthesis refers to the ability to perceive bodily movement as well as the movement of specific segments of the human body. Kinesthesis is associated with the concept of spatial attitude, it is generally understood as a lasting and unchanging attribute of healthy humans [1] and is considered to be an additional sense, whose use does not require conscious participation [2]. An analogy between kinesthetic and sensual perception is paradoxically inclined towards the opinion that the perception of position and spatial body movements are a process emanating from learned experience. An example could be the differentiation between scent and taste when recalling sensory impressions from the past. A similar basis exists in the development of balance through the perfection of various forms of locomotion during the ontogenetic development of a human being (from crawling to balanced walking). By accepting the above arguments, discussion can be permitted on the adaptive movement of the human being as a process that makes physical activity possible, i.e., through the engagement of individual motor abilities as well as the kinesthetic transformation of one's own body. Treating kinesthetics as an adaptive process, controlled by humans, is crucial in understanding the issue undertaken in this study.

Within the aspects of didactics (undertaken in the study herein) it seems crucial that attention be paid to the role of conscious and controlled kinesthetic perception within the process of learning and teaching motor skills. Kinesthetic perception, which occurs during changes of tension force and muscle length, as well as in the quickness of these changes, is treated herein as an indispensable, polysensoral element when encountering new movement activity. Peripheral receptors, which are central in the supply of information related to the positioning of specific body parts, are composed of proprioceptors, found in the structure of muscle, ligaments, fascia and joints (nero-muscular spindles), as well as mechanoreceptors and skin, which all react to pressure, touch and vibration (Meissner's corpuscles). As described in previous research, the mechanism for forming movement sensation in humans distinguishes receptors and single-track activity, being responsible for individual bodily perception and movement, as well as two-track control of both forms of information simultaneously [3]. It likewise demonstrates a dependency between the perception of touch and kinesthetic sense, as well as the individual ability to control these sensations [4–6]. Movement perception is then an undisputed factor regulating the process of control of movement behavior, whether within the confines of one joint or the complicated coordination of a series of sequential movements [5, 7].

A measure of the efficiency of kinesthetic sense is movement response – identified as kinesthetic sensitivity. Individual kinesthetic sensitivity is connected with the phenomenon of kinesthetic memory [8]. Kinesthetic memory is associated with the cerebellum, which is responsible for movement planning and muscle tension [9]. The role of the brain stem is also relevant in the formation of kinesthetic sense [10]. Thanks to kinesthetic memory, the peripheral and central nervous

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system controls the activity of the muscles and generates additional indicators that were collected in previous motor experiences [11, 12]. However, according to some physiologists, kinesthetic information is employed by humans as unconscious information. Some existing research implies that conscious orientation towards its perception (as a result of concentration and an adequate mindset) might trigger specific sensations. These sensations improve the efficiency of learning (the teaching process) [13, 14] because they are necessary in the formation of movement imagination, which itself is a necessary factor in constructing the program to perform it. On the other hand, kinesthetic interaction verifies the propriety of the movement structure when performed in natural conditions [15]. Such a statement can be confirmed by, for example, pointing to the the irrationality of learning/teaching swimming with only dry-land exercise. Therefore, through consciously received kinesthetic interaction, one can influence not only the efficiency of the learning process or teaching motor abilities, but also their improvement in sport [14]. In a large variety of sport activities, where motor activity is performed under specific environmental conditions, the colloquial meaning of the concept of equipment "feel" or "sense" (e.g. skis, skates), base (e.g. snow, ice) or environment (aerodynamics in ski jumping or feel of the water) seems not to be accidental. The subject of this study was to focus on swimming technique, in which the "feel of the water" defines a specific and multi-aspectual type of human adaptation involving the response sensitivity of movement feeling in a water environment as well as the modification of motor behavior by control and regulation in neuromuscular coordination processes [16].

The accuracy of movement reproduction is a measure of the quality of technique and is a factor that determines competitive performance in swimming as a cyclical sport [17]. Investigation into movement precision has brought the issue of the level of kinesthetic response ability to the forefront, for they determine an individual's ability to perform multiple repetitions of torque [14]. Previous studies have shown that higher levels of kinesthetic response have an impact on improved levels of movement control. These results are of great applicational significance in sport, which is confirmed by the dependencies between the level of kinesthetic response and the level of mastering a sport [13, 18]. As such, the study presented here was narrowed down to focus on the subject of modifying swimmers' movement behavior, specifically those equipped with a monofin, by considering the effective and economic employment of it being used as a source of propulsion.

Monofin swimming technique is, according to its rules, a water-based sporting activity aimed at the efficient and economical use of a single fin surface as the main source of propulsion [7]. Monofin swimming technique consists of performing undulatory movements with particular body segments, including the chest, in the sagittal plane. The scope of these movements, whose trajectory is similar to a sinusoid curve, increases from the pelvis towards the knee and then feet. The feet are bound together by the monofin, which transmits torque generated through the legs directly to the surface of the monofin, whose surface area can be up to 0.8 m^2. The two-dimensional structure of this propulsive movement and the surface area on which reactive forces are generated (in relation to water resistance) allows the monofin to be used as the main source of propulsion by the swimmer [19].

The necessity in overcoming the water resistance generated by the monofin's large surface area causes the swimmers to receive a powerful dose of kinesthetic stimuli. Thus, swimmers who excel in monofin swimming could be characterized by having a high level of kinesthetic response ability. Therefore, the main focus of this study was the verification of such a hypothesis. Its goal was to compare monofin swimmers' abilities in reproducing the bend forces that act on the monofin, caused by the lower limb movement present in swimming, as well as compare the forces generated by similar limb movement in laboratory dry-land conditions.

Material and methods

Six male swimmers agreed to participate in the study. As members of the National Monofin Swimming Team, all of the swimmers displayed a high level of monofin swimming proficiency. In the first stage of the study, swimmers were asked to swim a distance under water by using only twelve monofin strokes; this was the only task required of the swimmers in the first part of the trials. All swimmers used the same monofin, which was specially modified for measuring the monofin's bend as a reaction to water resistance. This fin was equipped with strain gauges glued to both sides of the fin's surface, mounted where the plate connects to the boots (Fig. 1). A connection cord was used to link the parts to the measuring equipment, which was shielded for protection. The raw data collected by the gauges was expressed as a voltage change in time function, defined by the moment of direction change by the monofin when it bends due to water resistance (Fig. 1). The results of previous studies justified treating the recorded forces as the result of propulsive force that determines swimming speed [19].

The second part of the study involved dry-land imitation of the propulsive downward leg movement similar to the movement structure enacted when swimming with a monofin. The task of each of the examined monofin swimmers was to use their thighs to press a resistant lever-arm of a kinesiometer. Similar to the in-water test, the participants were to complete twelve strokes by trying to generate exactly the same pressure force used when swimming. The kinesiometer used was a prototype device constructed on a bench (160 cm in

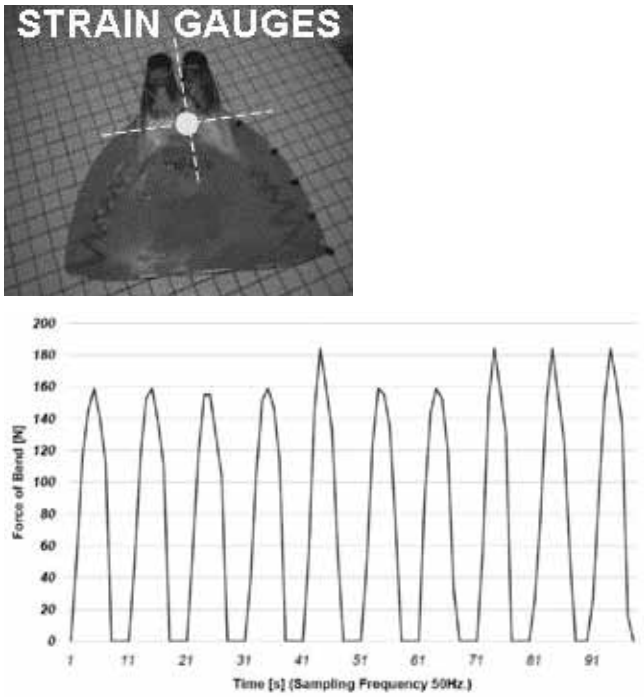

Figure 1. Pictured is the monofin used in the study, equipped with a set of strain gauges, as well as an example of the results recorded for the force (as a moment of time) that bends the monofin due to water resistance. Only the sections of the movement cycle that illustrated downward movements were analyzed; the forces registered during the upward movement phase were disregarded

length, 40 cm in width and 50 cm in height) and strengthened by a rigid permanent foot rest (Fig. 2). Strain gauges were mounted onto plates constructed of spring steel (50 HRC hardness; length 20 cm; width 5 cm; thickness 0.5 cm). The construction of the bench allows for the gauges and pulleys to be arranged in a specific position that permits the registration of the movement and forces of the particular joints of the lower limbs. Raw data was obtained in a time-dependent series, which was illustrated as a voltage change defined by the bend of the monofin's profile at the moment when pressure was registered on the measurement unit (Fig. 2). Previous studies allowed for the interpretation of these changes in the amount of torque, among a unit of time, as an effect of human consciousness on motor activity [20]. The individual ability expression to exhibit conscious response to kinesthetic sensation is based on an interpretation of the reproduction accuracy of the torque generated by the knee joint flexors, as this muscle group is of great significance when generating the propulsion used in monofin swimming [21].

All of the participants in the experiment assumed a lying position which stabilized the lower limbs (non-elastic belts attached to the bench were fixed at the hips in order to keep movement isolated to the axis of the knee joint) (Fig. 2). Stabilization of the thigh and calf allowed for the knee joint's bend angle to be precisely established, as well as eliminating any unnecessary movement other than the flexing and extending of the calf at the axis of the knee joint. All testing was carried out in static conditions. The knee joint's bend angle during the experiment was 70 degrees, which created optimal conditions to generate torque through the knee extensors [22]. Owing to the specific nature of monofin swimming, measurements were taken on both the left and right limbs. Before each measurement, three trials were carried out in order for the participants to become acquainted with the equipment.

With the aim of creating an objective premise in comparing the raw data obtained from the water and dry-land measurements, the following procedures were applied: the instructions given to the participants for both tasks consisted of only one requirement, which was to repeat each of the twelve repetitions in the in-water and dry-land tests as precisely as possible. Data that recorded the bend of the monofin during the upward movement phase (as a consequence of lower limb flexion at the knee joint) were excluded from analysis. In addition, in order to reduce random error, the first and last movement cycles were disregarded.

The original registered measurement of the moment when the monofin was bent (at a frequency of 50 Hz) was converted in order to obtain the same sampling frequency in the dry-land trials (at 100 Hz). The same strain gauges (HBM, 120 Ω K = 2.09) were used on the monofin and the arm of the kinesiometer in order to ensure a high reproduction accuracy and to maintain the shape and elasticity of the movements, regardless of the number of deformations. In both experimental trials, the stain gauges were connected in a half-bridge

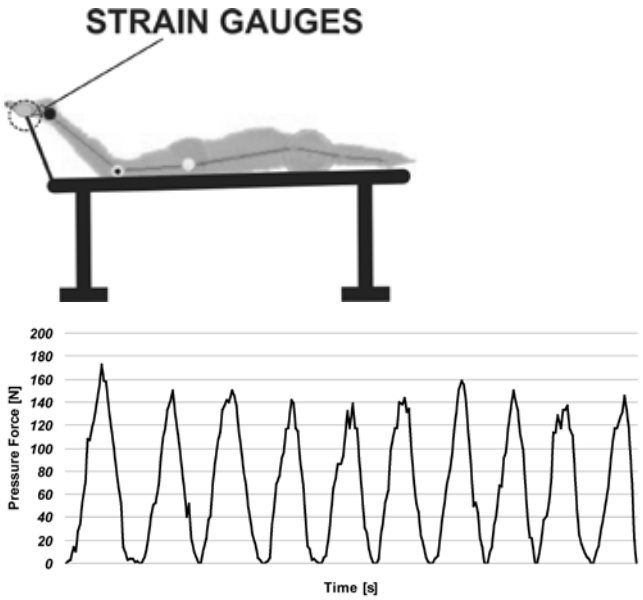

Figure 2. Pictured is the kinesiometer used in this study and an graphic example of the recording of pressure force (as a moment of time) triggered by the extensors in the knee joints of both legs

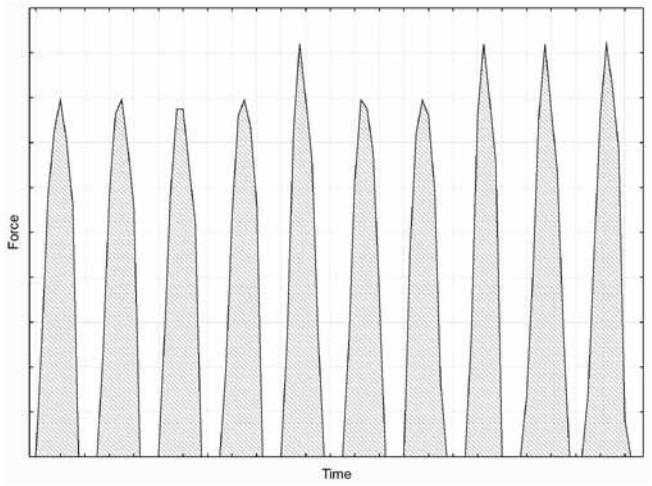

Figure 3. An illustration of the procedure quantifying the recorded forces as a function of time

configuration. The upper sensor was glued in a parallel symmetry axis to the monofin (or at the arm of the kinesiometer). The second sensor, glued at the opposite site of the measuring equipment, was perpendicular to the symmetry axis of the fin plate (or the arm of the kinesiometer). Compensatory strain gauges were used to avoid interference. During both procedures, the direct current impulses registered from the strain gauges were amplified, converted and recorded on a computer.

The following scaling procedures were employed: a five-point scale along the axis of symmetry of the fin was delineated (with the assumption that the fin plate is stiff in its longer dimension). The first point was located as near to the strain gauges as possible. The last point was placed at the rear edge of the fin. The distance between each point was found to be the same. A mass (1 kG = 9.81 N) was suspended from each scaling point separately. Next, the changes in the voltage values caused by the fin's bending at the different points were recorded. Then the mean values of the recorded voltage for each sample and scaling coefficient were calculated. The scaling procedure for the kinesiometer was carried out in the same way as mentioned above. Therefore, the recorded pressure applied to the kinesiometer and the bend force acting on the monofin are the effects of torque generated by the muscles as a function of time. In order to accurately evaluate the kinesthetic response, the values of the registered moments of time were quantified in the form of surface area, estimated from the values transcribed from the diagram of the recorded moments (Fig. 3).

On this basis, an evaluation of a swimmer's kinesthetic response abilities was carried out by using a Repetition Accuracy Factor (RA) at the moment of bend force acting on the monofin's surface during swimming, and similarly, the Repetition Accuracy Factor (RA) for moments of pressure acting on the kinesiometer [3], given by the equation:

$$RA = \sqrt{\frac{\sum_{i=1}^{10} (\bar{M} - Mi)^2}{10}} \quad (1)$$

where:

M – is the mean value of the moments of the recorded forces and,

Mi – as the moment of the registered forces in the i sample.

The RA factor values were expressed by using a point-based scale describing error level. Lower RA values correspond to a higher level of kinesthetic response abilities. A RA equaling zero denotes a minimal accuracy error value in repeating the moments of pressure forces generated in the dry-land test and at the moment of bending the monofin's surface during real swimming. The RA factor (being dimensionless) used in this study defines the swimmer's individual ability in precisely repeating the force when generating propulsion during swimming [20].

In addition, the anthropometric parameters of the tested swimmers (body height and mass) were measured and found to have significant correlation with the results obtained during the trials. The value of the Pearson's correlation coefficient between body height and the value of the RA factor during the water trials equaled $r = 0.81$, while in the land trials it was found to be $r = 0.86$. The value of Pearson's correlation coefficient, between body mass and the RA value for the participants was the same ($r = 0.91$) on land as in water. The critical correlation coefficient for $n = 6$ amounted to $r = 0.81$ ($p = 0.005$). On the basis thereof, it can be assumed that the somatic parameters of the group of swimmers tested had no impact on the obtained results. This fact, when considered together with the overall high level of the participants (as being members on a national team) allows the group to be considered homogenous.

The information presented above leads to confidence in the reliability of the testing procedures as well as on the objective nature of this study's preliminary analysis. It was hoped that all the conditions for eliminating the risk of error during data collection were met. In addition, the construction of the measuring equipment, as well as its calibration, were done in such a way as to minimize the influence of error on the quality of the input data. This is especially pertinent as they served to analyze the process (the repetition of kinesthetic perception) and did not form a basis for analysis, in which the most relevant was the individual value of the main research parameter (as the RA value itself is non-dimensional). The entire study was conducted by using the employed research procedures fulfilled by ISO-9001–2001 quality standards, while the methods used in this study have attained the full acceptance of the scientific community, as confirmed in numerous publications [i.a. 20, 23, 24].

Results

The results in Figure 4 present a comparison of the RA values calculated for the study group (as well as the group mean) which gives the impression of an equal precision of movement repetition recorded in both of the trial measurements. Analysis of the RA value in dry-land tests reveals that four of the examined swimmers obtained similar values. These values fluctuated between 6 and 10 points. Interpretation of the abovementioned results, according to a point-based coefficient scale, finds that four swimmers are characterized by a high level of kinesthetic response. Swimmers numbers IV and VI obtained results exceeding 20 points, which translates into a lower level of kinesthetic response in dry-land conditions. Analysis of the RA value calculated on the basis of the bend force impulses acting on the monofin reveals that almost all of the examined swimmers show a high level of kinesthetic differentiation (except for one swimmer, with a RA of 13) during the actual propulsive movement performed in water, which exceeds the level of kinesthetic response performed in dry-land conditions.

A preliminary analysis of the Repetition Accuracy Factor (RA) suggests that, in the studied group of swimmers, the level of precision in the repetition of the force generated to bend the monofin is higher than the level of precision in the repetition of force generated in the dry-land exercise.

A graphic reproduction of the RA factor values (Fig. 5) shows a tendency within the swimmers who obtained lower results in the level of repetition precision in the dry-land trials to be able to better duplicate the force used to bend the monofin during real swimming.

The observed regularities were confirmed by ANOVA statistical analysis conducted on the measurement layout. Using the Wilks' Lambda Test (Fig. 6), a hypothesis on the homogeneity of variance was rejected, as the differences turned out to be relevant for $F_{(10,106)} = 40{,}56$ at $p < 0.001$. The stated lack of variance between the average values speaks to the existence of differences between the Repetition Accuracy Factor (RA) in the dry-land trials and the water trials. In order to definitively state that all of the measurements influenced the variability of the results, Tukey's Post-hoc Test was carried out several times. The results of this test confirmed the expected variability in terms of the RA values of both trials. Significant differences occurred within the compared groups (within the scope of the RA coefficient values obtained from the water and dry-land trials) as well as between them. Only two dry-land measurements (with swimmers II and III) had no significant variation. The largest difference between RA values were noted in the case of subject IV. The existence of a variance at $p < 0.001$ also confirms the average range (Fig. 6).

An objective analysis of the results leads to the conclusion that the level of precision in the repetition of

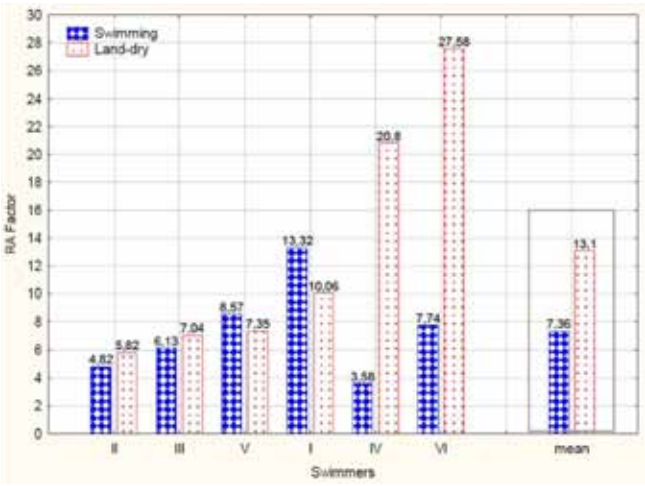

Figure 4. The value of the Repetition Accuracy Factor (RA) of force generated by the limbs in the dry-land trials and the bend forces acting on the surface of the monofin in water. The results are arranged not by the order of the swimmers but by ranking the RA values obtained in the dry-land trials

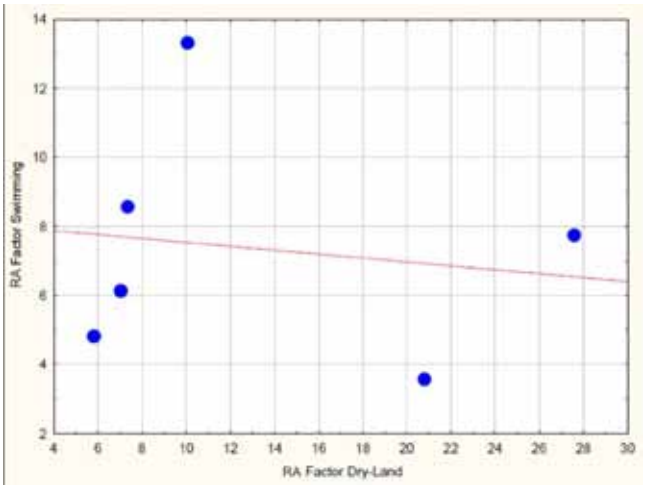

Figure 5. Line-graph showing the values of the RA factors registered during the dry-land and water trials

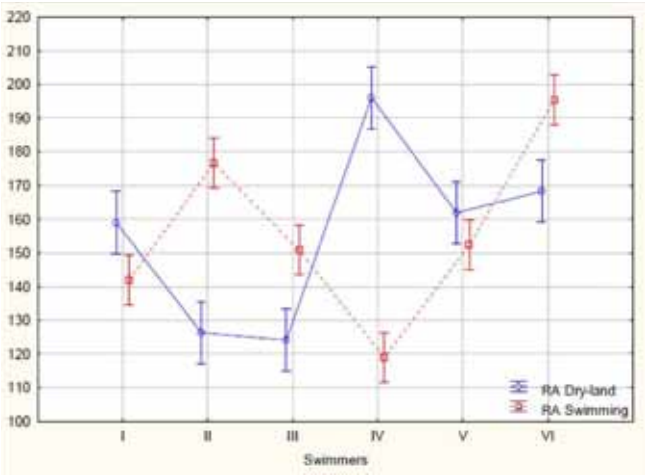

Figure 6. A graphic interpretation of the results of the analyzed variants (averages were not considered, only the Wilks' lambda). The vertical bar equals 0.95 confidence intervals

bend force on the monofin during actual swimming is greater than the one in dry-land simulation trials.

Discussion

The kinesthetic response level of the examined group was investigated by means of a method that evaluated torque/moment of time repeatability. The wide use of this method validates it as a tool for in-depth diagnosis of certain abilities in various kind of sport [13, 25]. The basis for the comparison of the torque generated under conditions of isometric (torque causing forces of pressure on the kinesiometer) and auxotonic (torque causing bend forces on the monofin) contraction has been emphasized in research [26]. The results provided by Klarowicz and Zatoń [20] proved the relevance of the application used in this study in the evaluation of swimmers' kinesthetic response abilities.

The applicational dimension of the established objective in this study manifests itself in the didactic premise resulting from an assumption that the measurement of an individual's ability to control movement is an error, defined as the conflict between the execution of a current movement task and its original intention [27]. A reduction of errors is of course possible, as are correctional changes during the process motor learning [13]. An error therefore, is treated as a chain, combining the objective measurement of precise movement with the application of actual active movement results, thus qualifying it as having an educational role. If one assumed that both trials in this study objectively determined the individual level of precision control in a movement system, this would quantify the level of kinesthetic response of the studied group. It would therefore fulfill a role as an educational tool aimed at improving swimming technique. The above context deepens the justification for comparing the values of repetition accuracy (RA) in trials performed in both natural conditions and as a dry-land simulation. This is regardless of the fact that both trials differed not only in the environment in which they were conducted, but also in the manner of executing the movement task.

The results indicate significant inter-group differences in terms of the range of the measured parameters. Differentiation among individuals in the level of kinesthetic response is a normal phenomenon and depends on individual human predisposition [13]. It may be then accepted that monofin swimmers exhibited characteristics of a high level ability in differentiating kinesthetic impression while executing tasks in "natural" conditions, and that the level of the tested ability was higher when compared to the results obtained while producing imitative movements on dry-land. The incidence of such a differentiation is, in itself, curious. As is the fact that two of the examined swimmers achieved a low level of kinesthetic differentiation on dry-land.

A subjective reason for this, which accentuates the results, may be a lack of concentration during testing. Such a cause was not considered in this study, as, aside from the precise instructions given on the tasks that needed to be executed and the regulation of how they were carried out in both the water and dry-land trials, there were no tools used for monitoring the swimmers' attitude and motivation in reliably executing the task. Therefore, the causes for such disparity must be considered.

The first reason may be related to a change in spatial orientation, brought on by the disparate conditions in completing tasks in water and on dry-land. The simulation of movement on dry-land is not a counterpart to the range of movement that a swimmer performs in the water [28]. Additionally, the dry-land trials consisted of measuring the force exerted while simulating the torque generated by extensor muscles of the knee joint in static conditions, while simulation of the torque generated in water involved the dynamic movement of the entire lower extremity. These in itself may have had an influence on the level of kinesthetic response, particularly in the dry-land trials, which only imitated the propulsion movements. In essence, the dissimilarity in the spatial orientation of movements executed in both trials may lie in the specific nature of the physical properties of water. Water density is 820 times greater and a thermal conductivity is 25 times greater than air [29]. For movement, in conditions where resistance is lessened, the receptors of a swimmer are very susceptible and sensitive to kinesthetic stimuli (a very similar reaction can be seen in an organism experiencing weightlessness). Research carried out by Lackner and DiZio [30] shows that an increase in movement precision can be summoned by a change of environment. In such an environment, the feeling of resistance perception is far more distinct when compared to similar activity on dry-land with regard to the flow of additional mass, which is far more precise when concerned with movement speed and the perception of the limbs' spatial positioning [3]. It can then be assumed that for these monofin swimmers it was this very feedback that eased the precise execution of the tasks in the study within the natural conditions of swimming in water.

Based on the differences of the repetition accuracy factor in the water and dry-land trials, another argument stemming from physiological aspects can also be presented. It has been found that maintaining muscle tension for longer periods of time can lead to a disruption of the muscle spindles' functioning [31]. Clearly this aspect would be the cause of a less precise differentiation of kinesthetic performance in static conditions than in the more dynamic conditions found in the water trials. One could likewise interpret the fact that effort placed on large muscle groups causes an individual decrease in movement precision and kinesthe-

tic perception, which brings about a limit in the control of motion [32], particularly in conditions where the limbs are partially stabilized.

Other factors influencing the results (particularly in swimmers IV and VI) might also result from an interruption of the kinesthetic information flow that was present in the dry-land trial. As other studies have found [33], the foot and ankle joints, as the most distant parts of the biomechanical chain that make up the lower limbs, bear a very high overload caused by the monofin's large surface area resistance. As a result of this overload, structural and functional changes could occur in the feet and ankle joints, which in consequence might also lead to changes in the functioning of some receptors. Regardless of the negative nature that these changes may have, the swimmers' feet might individually differ in terms of kinesthetic perception. In the case of the present study, these differences might result from different feet and knee joint load when exerting the single-point pressure load on the kinesiometer in the dry-land trial.

During analysis of the results, it was noticed that there was also an apparent tendency in the swimmers who obtained the highest (negative) repetition accuracy factor values to precisely replicate the force used when bending the monofin during real swimming as they did in the dry-land simulation. Such high level kinesthetic response abilities (noted in the swimming trials) could be the result of the subjects' specialization in monofin swimming and experience gained over many years of training, giving them a greater edge in their ability to shape a conscious response of kinesthetic impressions. This learned form of ability has been defined as "stability of kinesthetic response" [34].

The errorless – efficient and economical – transfer of torque generated by the leg muscles to the monofin is one of the hallmarks of the practical usage of kinesthetic response abilities. From a kinesiological standpoint, the transfer of nerve impulses along the successive parts of the biomechanical chain (i.e., parts of the swimmer's body to the monofin) initiates feedback from this channel to the swimmer's proprioceptors and skin receptors. The ability to receive this sensual information through selective kinesthetic interaction is regarded as necessary to initiate the processes of movement control and regulation within the areas of the swimmer's consciousness as well as outside of it. This suggests that the quality of the described "kinesthetic dialogue" between the swimmer, the water and the surface of the monofin (as a source of propulsion) seems to determine swimming speed. In this context, a high level of kinesthetic response stability, obvious in its most advanced form – the stabilization of kinesthetic response – becomes indispensable in meeting the dynamic criteria of proper technique in monofin swimming [16]. These criteria include: 1) the high stability of the forces bending the monofin's surface as a response to water resistance and the consistency of the entire process throughout a period of time, 2) the equal proportions between the forces generated on the surface of the monofin during both upward and downward movements, 3) the intensification of upward fin movement in order to generate higher water resistance forces on the monofin's surface, 4) and the ability to perform monofin movement so that the distribution of the bend forces acting on the monofin is as close as possible to a sinusoidal curve. In the abovementioned context, the ability of having precise perception and kinesthetic response emerges as a key link in the process of improving technique of propulsive movement in monofin swimming.

Conclusions

The results of the comparison of the repetition accuracy of forces that act on bending the monofin, originating from lower limb movement during swimming, and the forces generated by limb movement in dry-land laboratory conditions did not entirely support the hypothesis that monofin swimmers would be characterized by a high level of kinesthetic response stability. However, what was confirmed was that, in the group of swimmers tested, the accuracy level in reproducing the force that bend the monofin during real swimming was greater than the accuracy displayed in the dry-land simulation trials. On this basis, it could be stated that the swimmers in the group exhibiting a high level of kinesthetic response only did so when executing actual propulsion movements in the water. What is more, the subjects who attained higher values of error (measured by the RA Factor) in the simulated dry-land trials also repeated the force used to bend the monofin during real swimming with lower precision. The presented conclusion can lead to the generalization that a high level of kinesthetic response in swimmers is due to individual attributes and it results from a specific adaptation in the perception and the creation of kinesthetic impressions in water based on the flow of precise stimuli from the large surface of the monofin.

The rather modest size of the group of swimmers does not allow for the drawing of explicit conclusions. The results rather pointed to a tendency that requires additional research on a larger group of monofin swimmers. Nevertheless, there are rational justifications for using individual kinesthetic abilities in technical monofin training, particularly in the case of raising the consciousness of swimmers and by encouraging them in the ability to feel the monofin working, as opposed to plainly controlling propulsive movements in order to obtain maximal swimming speed.

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THE KINESTHETIC DIFFERENTIATION ABILITY OF TABLE TENNIS PLAYERS

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ABSTRACT
Purpose. The aim of this study was to evaluate the differences between two groups of table tennis players (differing by their level of play) in terms of the kinesthetic differentiation ability of their so-called spatial component. **Methods.** The study was conducted using a goniometer which assessed the accuracy of performing an arm movement, specifically, the pronation and supination of the forearm at the elbow. The study analyzed the accuracy rate of performing this movement, where a smaller value indicated a higher level of kinesthetic differentiation ability. **Results.** In all four tasks, the more advanced (skill-wise) group of players obtained lower arithmetic mean and median values of accuracy than the group that played at a lower skill set. This may suggest the importance of the tested variable as an important component of table tennis. However, the tested groups did not significantly differ from each other in the accuracy of performing the studied movement. Nonetheless, the variability of the accuracy rate of the lower skill level group was considerably larger than the more advanced and skilled group. **Conclusions.** It can be assumed that the more advanced group is more homogeneous in terms of accuracy production. This could be the result of specific training exercises.

Key words: kinesthetic differentiation ability, table tennis, precision of movement

Introduction

Kinesthetic differentiation ability is the total coordination of motor abilities. As found in literature on the subject, this ability allows for the perception and control of body movements. It enables one to have the conscious and accurate perception of the strength, timing and spatial parameters of a range of movement, which leads to various motor skills being more efficient and fluid [1, 2]. The essence of kinesthetic differentiation ability is its capability in positioning the body's joints (the spatial component), activating the strength of the involved muscles (the strength component) and the speed of the involved movement (the temporal component) [2–4].

Kinesthetic differentiation ability has been identified as one of the most important factors of motor coordination [2 ,3]. Previous literature has emphasized its importance in sport, but also stressed its complex and variable character which depends on a number of factors, including the difficulty in selecting which methods can be used to assess such an ability [5, 6]. Many studies have made reference to the fact that kinesthetic differentiation ability should be based on the ability (performance) level found in national sport competition and, as such, be considered in the selection process of sport disciplines.

Previous studies have also reported on kinesthetic differentiation ability and its relationship with the level of play depending on which sport disciplines were considered. Starosta conducted a study on figure skaters and found an interdependence between their kinesthetic sensibility and their skill level, and also showed that a higher skill level in sport is associated with greater movement accuracy (in performing specific moves) [4, 5, 7]. In addition, Zając et al., in a study of basketball players, found that an increasing level of competition is accompanied by a higher level of upper limb strength [8], confirmed by similar observations made by Ji and Huang [9]. Starosta et al. found a significant increase in the differentiation movement levels between the ready phase and start phase of kayakers, noting the strong relationship found between their differentiation ability level and the achieved sport results as well as their technical preparation [10]. Stefaniak, examining different martial art athletes, concluded that a higher kinesthetics differentiation level is characterized by a higher level of sport sophistication and that these athletes perform various motor tasks, which judge kinesthetic differentiation, far better than those who do not take part in competitive sport [11]. It was also demonstrated, through analysis on the relationship between the results of stress tests and force repetitiveness tests that kinesthetic sensitivity can be a useful tool in monitoring the training process in many sports [12].

According to the opinions of coaches and players, table tennis is a game in which the tactile sensitivity of one's muscles (and the "feeling the ball" that goes with it) is a very important aspect of this sport [13]. The importance of kinesthetic differentiation ability as well as all of its associated properties, defined as "sensation", is something that is paid close attention to by the authors of theoretical studies and training materials [14, 15]. These authors state that differentiation movement ability is critical in a number of table tennis

game moves, such as the skill needed in feeling the rotation of a served ball, changing the direction of the ball during gameplay or modifying the speed at which a ball is hit (as well as adjusting to the movement rate and change in direction of the flying ball) [15]. Additionally, the selection and grip of a paddle at a specific angle (whether the paddle is "open" or "closed") is also a skill that has been connected to kinesthetic differentiation ability.

All of the above-mentioned skills heavily depend on the level of feeling and differentiation of muscle tone as well as the sensory control of arranging the individual parts of the body in gameplay and effect performance. What may also play a more prominent role here is the tactile-hold feeling of the hand (when holding the paddle). Thus, the differentiation of the spatial, strength and movement parameters in table tennis can determine many important aspects of player performance such as game accuracy, move capability, and the adaptation and control of game play. What is also clear is the importance of kinesthetic differentiation ability in shaping and improving a player's technique, which in table tennis is described as being very difficult and complex [14, 15]. Therefore, the study of kinesthetic differentiation ability and the ability to assess its significance in this discipline of sport appears to be of great importance.

However, there are few studies on kinesthetic differentiation ability or an assessment on the relevance of this ability in table tennis. The few studies that did consider this issues concluded that kinesthetic differentiation ability is a very individual ability, where, for example, no significant differences were found between various athletes (tennis and football players) and individuals who did not practice any sport [16, 17]. Similar studies found that the individual components of kinesthetic differentiation ability (strength, spatial and temporal) are relatively independent with no relationship to a player's age, and the stability of these parameters was also found to be very small. The level of each of these components was suggested to depend on the momentary physical, emotional and motivational disposition of an individual [18]. However, previous research conducted by the author of this study and other individuals did in fact suggest a relationship between kinesthetic differentiation ability and the level of play in regard to table tennis [19–21].

One of the components of kinesthetics differentiation ability is the measurement and performance of a range of movements through which one is able to optimally arrange the individual parts of their body [1–5]. Many studies that assessed kinesthetic differentiation ability used a method in which the accuracy of a specific range of movement was measured [2–5, 10]. As such, this study decided to adopt a similar method, and focus on measuring the forearm's range of movement in table tennis (whether holding a paddle in the "open" or "closed" position and the switch between backhand and forehand shots). It is hoped that measurement of the spatial components of kinesthetic differentiation ability, by also comparing and finding any connections with a table tennis players' level of play, could be a useful criterion in monitoring the training progress in table tennis. Therefore, the aim of this study was the evaluate the differences between two (differing in level of play) groups of table tennis players by comparing the level of their spatial components' kinesthetic differentiation ability.

Material and methods

Research was conducted on 24 table tennis players of varying skill levels. The players were divided into two equal groups: the first group consisted of participants from the Central Training Center for Table Tennis in Gdańsk (mean age 14.75 years) and the second group was composed of members of the Dolnośląski provincial team from Brzeg Dolny (mean age 14.08 years). Some of the table tennis players from Gdańsk were ranked in the top 12 in Poland in their age categories (cadet, junior). The team from Brzeg Dolny had four players in the top 16, while the rest of the players had a lower national ranking.

The study was conducted with the use of a goniometer in assessing the accuracy of performing a specific range of movement [2–5, 10]. The test stand (Fig. 1) was fitted with a specially designed device that allowed the subjects to pronate and supinate the arm from the elbow up (Fig. 2). This device consisted of a fixed housing with a movable handle. The handle could roll to the left or right and was connected by a Teflon bearing to a cylinder found inside the housing. A rotary potentiometer that registered force linearly was attached to the end of the cylinder, which would then record the change in position. The subject was placed in a sitting position on an adjustable chair and asked to grab the handle of the device in such a way that the forearm of the tested arm formed a right angle and so that the elbow was next to the subject's torso. In accordance with the requirements necessary to measure the range of movement [22], the experiment made sure that the forearm axis coincided with the movement axis and the top of the third metacarpal bone aligned with the rotation axis. The change in angle was recorded by a computer program (Labview ver. 2009, National Instruments, Poland), which was connected by a NI USB 6008 analog-digital card (National Instruments, Poland) to the cylinder.

The subjects were not allowed to familiarize themselves with the equipment. Each test subject in each of the series of tests was asked to perform only two tasks. The first task was performed blindfolded, where the subject was asked to pronate and supinate their dominating forearm (in a movement pattern) three times,

Figure 1. Test stand with goniometer

Figure 2. Goniometer

starting from an "intermediate position" (at an angle of zero degrees) and twisting their arm until they reached an angle of 45 degrees. Upon reaching the 45 degree angle a bell automatically sounded. The subject was then asked to immediately perform the same movement five additional times "from memory" (with the blindfold on but without the use of the bell). The subject was given a maximum of 30 seconds to produce the five repetitions. They then performed the same task with their non-dominant hand. The computer program logged the maximum range of movement in each direction through the "twist" angle produced by the test subject. The starting position of the handle was checked and adjusted by the author before each test.

The level of kinesthetics differentiation was determined for both the dominant and non-dominant hand by finding the accuracy rates of performing the set tasks, which was calculated as a standard deviation from the "set" 45 degree angle. For more in-depth analysis, the following variables were adopted: NP1 (pronate accuracy of the dominant limb), OP1 (supinate accuracy of the dominant limb), NL1 (pronate accuracy of the non-dominant limb) and OL1 (supinate accuracy of the non-dominant limb). A lower value in the accuracy rate of performing a movement pointed to a higher level of kinesthetic differentiation ability (specifically the spatial component of this ability).

Statistical analysis of the recorded results was performed using Statisca for Windows (Statsoft, Poland), descriptive statistics were calculated as well as statistical significance using the Mann-Whitney *U*-test.

Results

In all of the performed tasks, the group from the Central Training Center in Gdańsk was found with lower arithmetic mean (and median) accuracy rates than the group from Brzeg Dolny (Tab. 1 and 2, Fig. 3): for the supination of the dominant limb the arithmetic mean for the Gdańsk group was 4.55, while for the Brzeg Dolny group it was 5.96. For the pronation of the dominant limb the arithmetic mean for the Gdańsk group was 4.48, for the Brzeg Dolny group, 6.41. Similar differences were observed with the non-dominant limb. The arithmetic mean for the supination task in the Gdańsk group was 5.34, for the Brzeg Dolny group,

Table 1. The indicator values of accuracy (in degrees) of the Gdańsk group: the arithmetic mean, median, minimum, maximum and standard deviation

Variables	Number of subjects	Arithmetic mean	Median	Minimum	Maximum	Standard deviation	Coefficient of variation (%)
OP1 (supination of the dominant limb)	12	4.55	3.94	1.93	9.16	2.29	50.24
NP1 (pronation of the dominant limb)	12	4.48	4.30	3.07	6.77	1.25	27.86
OL1 (supination of the non-dominant limb)	12	5.34	4.55	2.46	9.50	2.23	41.75
NL1 (pronation of the non-dominant limb)	12	4.27	4.01	0.87	9.32	2.32	54.33

Table 2. The indicator values of accuracy (in degrees) of the Brzeg Dolny group: the arithmetic mean, median, minimum, maximum and standard deviation

Variables	Number of subjects	Arithmetic mean	Median	Minimum	Maximum	Standard deviation	Coefficient of variation (%)
OP1 (supination of the dominant limb)	12	5.96	4.87	3.20	14.58	3.17	53.17
NP1 (pronation of the dominant limb)	12	6.41	8.33	1.42	12.08	3.59	55.99
OL1 (supination of the non-dominant limb)	12	6.92	5.10	1.42	16.99	4.56	65.79
NL1 (pronation of the non-dominant limb)	12	7.84	5.10	1.69	44.76	11.75	149.92

6.92; the mean for the pronation task in the Gdańsk group was 4.27, for the Brzeg Dolny group, 7.84.

After applying the Mann-Whitney *U*-test, no statistical significance was found. The test results are shown in Table 3. The indicator values of accuracy of the Brzeg Dolny group are more diverse than the ones of the Gdańsk group, a group that plays at a higher level. This is evidenced by the much higher coefficient of variation in the Brzeg Dolny group, from 3% for OP1 to more than 20% for NP1 and OL1 and up to nearly 100% higher for NL1 than in the group from Gdańsk (Tab. 1 and 2). In all the tasks, the standard deviation (SD) for the values of accuracy were substantially higher in the group from Brzeg Dolny. Similarly, the difference between the minimum and maximum accuracy values were significantly higher in the Brzeg Dolny group than in the Gdańsk group.

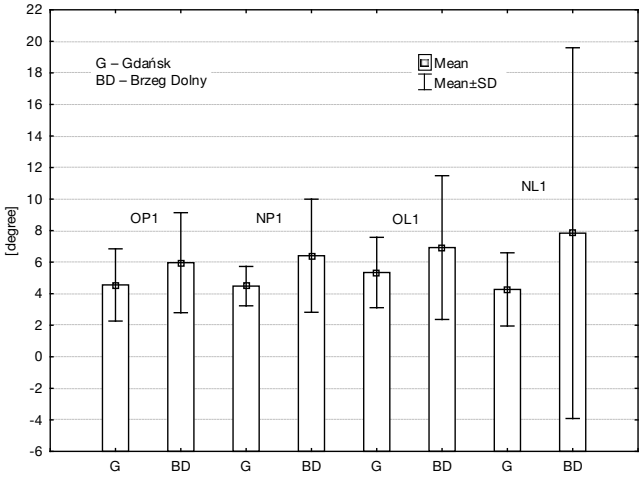

Figure 3. The results of performing a range of movement (in degrees) of the supination of the dominant limb (OP1), pronation of the dominant limb (NP1), supination of the non-dominant limb (OP1) and pronation of the non-dominant limb (NL1) of both the Gdańsk (G) and Brzeg Dolny (BD) groups

Table 3. The significance level (p) of the differences between the groups in the different tasks as calculated by the Mann-Whitney *U*-test. Statistical significance is $p \leq 0.05$

Variable	p level
OP1 (supination of the dominant limb)	0.24
NP1 (pronation of the dominant limb)	0.31
OL1 (supination of the non-dominant limb)	0.54
NL1 (pronation of the non-dominant limb)	0.47

Discussion

Research on kinesthetics differentiation ability (and its spatial components, differentiating the range of movement) is considered by many authors as an ability that is extremely important to accurately and efficiently perform motor functions [1–5, 7]. Its fundamental nature is the perception of movement while it is happening, allowing such a movement to be better controlled. Literature that studied and assessed the level of differentiation ability and its determinates and relationships often find that the level of this ability determines, to a large extent, success in many sport disciplines. Such a dependency was found by Starosta in figure skaters, by Starosta et al. in kayakers, by Zając et al. in basketball players and by Stefaniak in martial art athletes [4, 5, 7, 8, 11]. The high level of kinesthetic sensitivity found in these athletes especially applies to the particular body limbs most involved in that sport's physical movement: the lower limbs for figure skaters, the upper limbs for boxers or the lower limbs for karate practitioners [4, 5, 10, 11].

Ji and Huang also observed a high level of kinesthetics sensitivity in the hands and elbows of basketball players [9], which was similar to what Zając et al. observed [8]. Some researchers also claimed to find a relationship between kinesthetic differentiation and high-level training technique. Such dependencies were

found by Cynarski et al. in karate practitioners [23], by Buraczewski et al. in football players [24] and by Starosta et al. in kayakers [10]. Also, many correlations have been found between kinesthetic differentiation ability and the level of sport played or advanced sports techniques used in gameplay; thanks to a high kinesthetic sensitivity one can more accurately control their movement [1–3]. In addition, through kinesthetic impression, the "focus" [2, 4, 5, 7] on one's bodily movement is far more fuller and richer, where the functioning of one's telereceptors is supplemented by proprioceptor stimuli [1]. Thanks to this "extra" information, learning new motor skills is more precise. However, as has been found in relevant research, the importance of visual and kinesthetic information is still disagreed upon [25, 26].

This study assumed that the sport of table tennis requires a high level of kinesthetic differentiation ability [15, 19–21]. This ability is manifested in table tennis due to the numerous skills needed to be effective in this game, above all, the ability to sense and adapt to game dynamics (the speed of the game, the spinning of the ball, correctly landing the ball on the table, etc.) [15]. Adjusting the angle of one's paddle when hitting a ball (something which occurs in a split second) most probably is also a derivative of kinesthetic differentiation ability. This study found a tendency to perform the required tasks better by the group with a better skill level. This trend manifested itself in the lower (and thus providing better accuracy) arithmetic averages (as well as median) values of accuracy. Such higher values (presented in this study as pointing to a lower kinesthetic differentiation level) were observed in the Brzeg Dolny group. However, these differences were found not to be statistically significant after statistical analysis. Nonetheless, the above-mentioned tendencies should lay ground for further research in this area, especially when considering the results of other studies that indicate the importance of kinesthetic differentiation ability in table tennis players [20, 21].

Some specific characteristic differences can also be observed in the analysis of the coefficient of variation and the size of the standard deviation of the studied variables, as well as the dispersion of the results in both groups. In addition, a greater variability of the results was observed in the Dolny Brzeg group, a group which had an overall lower skill level in table tennis; the group from Gdańsk was found to be far more homogeneous skill-wise. It may be postulated that this could be the result of more specific, time-consuming practice sessions as well as more all-round, varied training exercises which these players engage in.

Conclusions

1. Both groups did not differ significantly in the accuracy of performing a specific movement (as found by the test). In all four tasks, the more advanced group of players obtained lower arithmetic mean and median values of the studied variables than the group that played at a lower level. This may suggest the importance of this test in table tennis and lead to future studied performed on a larger population sample.

2. The variability and dispersion of the values of accuracy in performing a specific movement in group of players who are at a lower skill level was far greater than in the group which is more skilled. It can be assumed that the more advanced group is more homogeneous in terms of their accuracy. This could be the result of specific training exercises.

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IMPROVING FLEXIBILITY AND ENDURANCE OF ELDERLY WOMEN THROUGH A SIX-MONTH TRAINING PROGRAMME

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ABSTRACT
Purpose. Advancing age is associated with predictable sensory, motor and cognitive changes, which may have a potential impact on an older person's ability to function effectively in society. The purpose of this study was to assess whether two slightly different half-year-long regular training programmes had a positive effect on flexibility, range of motion and endurance in a sample population of elderly persons. Also analysed was which programme was found to be more effective. **Methods.** A group of women (N = 42, M = 67.1 ± 4.5 years) was chosen from retired persons clubs from Eger, Hungary. They were randomly divided into three groups. The first group (N = 15, M = 66.2 ± 3.8 years) took part in a one-hour-long Pilates training session three times a week, the second group (N = 15, M = 67.1 ± 5.9 years) took part in an aqua-fitness class twice a week with one Pilates class once a week and the third group (N = 12, M = 68.2 ± 3.2 years) was the control group. Pre-and postmeasurements were conducted on: flexion of the right shoulder and hip, lumbar spine flexion, thoracolumbar spine flexion, trunk lateral flexion on the right side, a 6-minute walk test, and a 30-second sit-to-stand test. Significant inter-group differences could be found in all of the measurements. Data were analysed using statistical software with the Paired-Samples T-test and Multivariate Analysis of Variance ($p < 0.05$). **Results.** After the six-month regular training programmes no differences were found in the control group. For the two groups subjected to the training programmes all the other variables showed significant differences. The most remarkable results for the Pilates group were with the 6-minute walk and sit-to-stand test, while for the aqua-fitness and Pilates group shoulder and hip flexion. **Conclusions.** A half-year-long training program can considerably improve the physical performance elderly adults need in everyday life.

Key words: flexibility, range of motion, endurance, Pilates, aqua-fitness

Introduction

The structure of our society is changing, causing remarkable social and sociological age related problems all over the world. It is no surprise that the 21th century has been labelled as "the century of an aging people", as older adults represent the fastest growing population segment in the world [1].

Advancing age is associated with predictable sensory, motor and cognitive changes, many of which can potentially impact an older person's ability to effectively function in society [2]. These age-related physiological changes – reductions in muscle mass, muscle strength, flexibility, vital capacity, bone mineral density, etc. – affect a broad range of body tissues, organ systems and functions, which cumulatively can affect activities of daily living (ADLs) and upholding the physical independence of older adults [3].

Not only the aging process but a sedentary lifestyle can lead to negative changes in posture, which itself can lead to contractures in connective tissues and muscles. The bones are restructured by ageing; this process can be easily seen on the structural and functional changes in vertebras and discusses [4]. Kyphosis has been shown to increase by 6% to 11% per decade for those over 55 years, and even in women without previous vertebral fractures, there is a significant risk factor for future fractures. A similar situation can be found in the case of lumbar lordosis. In addition, an important factor affecting the potential to alter the shape of the spine through exercise was found to be the flexibility of the vertebral column [5].

Decline in maximal aerobic capacity (VO_{2max}) and skeletal muscle performance with advancing age are two examples of physical ageing. Regular physical activity produces a series of physiologic responses leading to the long-term adaptation of the cardiovascular and neuroendocrine systems. The primary aim of these changes is to provide the working muscles with oxygen and nutrients [6, 7].

Experience has proven that regular physical activity is important in the prevention and management of pathological conditions [8–11]. According to the Centers for Disease Control and Prevention (CDC) and the American College of Sports and Medicine (ACSM) in 1995, it was suggested that every American needs to do at least 30 minutes of moderate exercise just three times per week [12]. This suggestion was amended with what

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types of exercises were recommended by the ACSM and American Heart Association (AHA) in 2007. A combined training programme was suggested, which contained endurance, strength, flexibility and balance training for the elderly population [13].

Therefore the purpose of the study was to assess if a half-year long regular training programme would have a positive effect on the flexibility, range of motion (ROM) and endurance in a population sample of elderly women. Furthermore, this study also analysed which of the suggested programmes were found to be more efficient – either a Pilates programme or an aqua-fitness programme combined with Pilates.

Material and methods

42 female volunteers were chosen from retired persons associations in the Hungarian town of Eger. The women were randomly assigned into three groups. The participants in the first and second groups took part in three one-hour long training sessions every week for a total of six months. The first group (N = 15, M = 66.2 ± 3.8 years) performed Pilates three times a week while the second (N = 15, M = 67.1 ± 5.9 years) took part in an aqua-fitness class twice a week with one Pilates session. The third group was a control group (N = 12, M = 68.2 ± 3.2 years). A questionnaire was filled out by the participants before the study on their physical condition (evaluated as low, moderate or vigorous), if they had any existing diseases or medical problems. The participants who did not do any sport or recreational activity were classified as those in the low physical activity (PA) group. A moderate PA was defined as participating in regularly sports activity of a moderate intensity less than three times a week, whereas a vigorous PA meant regularly taking part in a training programme at least three times a week for a minimum of 60 minutes.

Two measurements were performed on the subjects: Measurement (1) – prior to the six-month training programme, Measurement (2) – on completion of the programme. The following variables were measured: flexion of right shoulder and hip, lumbar spine flexion, thoracolumbar spine flexion, trunk lateral flexion on the right side, a six minute walk test, and 30-second sit-to-stand test. Data were analysed using IBM SPSS 17.0 statistical analysis software for Windows with a Paired-Samples T-test as well as Multivariate Analysis of Variance (MANOVA). The differences between Measurements (1) and (2) were figured by boxplots, which represented the mean, minimum and maximum values.

Flexibility was assessed by five types of active joint ROM measurements. The 6-minute walk and sit-to-stand test were chosen from the Fullerton Functional Fitness Test (FFFT) to assess endurance. The FFFT was specially developed for older adults as based on the research conducted at the Lifespan Wellness Clinic at the California State University in Fullerton, California [14]. The tested variables, in more detail, were:

1. *Flexion of right shoulder* (ROM) was measured by a goniometer (°). The humerus was moved in an anterior direction to the limit of motion in elevation (180°). This movement represented a scapular and glenohumeral motion. The goniometer's axis was placed over the centre of the humeral head.

2. *Flexion of right hip* (ROM) was measured by a goniometer (°). The subject laid down flat. The measured hip was flexed to the limit of motion (120°) while flexing the knee. The goniometer's axis was placed over the greater trochanter of the femur.

3. *Lumbar spine flexion* (ROM) was measured with a tape measure (cm). The start position was when the participant stood with feet shoulder-width apart and flexed their trunk until they reached their limit of motion. The tape measure was then used to measure that distance and then mark a point 10 cm above the spinosus process of the S2. A measurement was taken at the start position and the limit of motion, which found the lumbar spinal ROM (18 cm).

4. *Thoracolumbar spine flexion* (ROM) was measured with a tape measure (cm). The participant stood with their feet shoulder-width apart and flexed their trunk toward the limit of motion. The tape measure was then used to measure the distance between the spinosus processes of the C7 and S2. Measurement was taken at the start position and at the limit of motion. The difference between the two measures was found to be the thoracolumbar spinal ROM (10 cm).

5. *Trunk lateral flexion on the right side* (ROM) was measured with a tape measure (cm). The patient stood with their feet shoulder-width apart and laterally flexed their trunk to the limit of motion. The tape measure was then used to measure the distance between the tip of the third digit and the floor.

6. *6-minute walk test* (aerobic endurance). The subject was asked to walk around in a marked path. The subjects were allowed to stop or sit a chair if they needed rest or lost their balance and were allowed continue walking when they physically able to do so. The distance was then measured with a tape measure(m).

7. *Sit-to-stand test for 30 seconds* (endurance and lower body strength).The participant sat in a chair and was asked to stand and sit down, repeating this process for 30 seconds. The numbers of repetitions (pc) were counted.

As previously mentioned, two types of training programmes were chosen in the study by a group of physical education teachers, physiotherapists and Pilates instructors. Pilates is a form of physical training that focuses on posture, flexibility, segmental alignment and core control though posture and movement exercises [5, 15–17]. A number of strength, stretching, range of motion and balance exercises were chosen for all of the participants. The second type of training programme

was one of aqua fitness, especially considered for the elderly because moving in water is often easier and less painful than on land. The buoyancy of water provides support to the joints and muscles and allows people with musculoskeletal problems to exercise with less effort and a greater range of motion. Sensory input from water pressure and temperature may decrease feelings of pain and also promotes relaxation which decreases muscle spasm and tightness. Finally, exercise intensity can be controlled by adjusting the velocity of movement in water [18].

Results

A self-made questionnaire was filled out by the participants before the programme regarding their PA (whether low, moderate, vigorous) and medical status. The two most common types of diseases noted were cardiovascular (high blood pressure, artherio- and athero- sclerosis, heart attack, etc.) and musculoskeletal (osteoporosis, arthrosis, rheumatoid arthritis, etc.). These variables were examined by physical education teachers and a physiotherapist. Based on these specialists' opinion, contraindications were established and the participants were then divided into sub-groups according to their level of physical activity and medical status (Tab. 1).

Descriptive statistics (minimum, maximum, mean and standard deviation) of the sample is presented in Table 2. When comparing the results of Measurement (1) and Measurement (2) with MANOVA among the groups, significant differences can be found in shoulder flexion ($F = 3.4$; $p = 0.044$), lumbar flexion ($F = 9.104$; $p = 0.001$) and thoracolumbar flexion ($F = 8.708$; $p = 0.001$) before the six-month training period. All these results were better in the control group (Tab. 3). This could be the result of that group's active lifestyle and their overall better physiological and medical status as based on the administered questionnaire. Regarding Measurement (2), here lumbar flexion ($F = 9.104$; $p = 0.016$), the 6-minute walk test ($F = 6.103$; $p = 0.005$) and the sit-to-stand test ($F = 4.232$; $p = 0.022$) show significant differences. Lumbar flexion was still better in the control group, but the 6-minute walk and sit-to-stand test performance was the most exceptional among the Pilates group.

On the basis of the results of the T-test, significant improvement can be found in all variables of the training programme groups, but none in the control group (Fig. 1–5). Shoulder flexion in the Pilates and aqua fit-

Table 1. Physical activity and medical status of the participants in each group

Group		Physical activity status			Medical problems		
		Low (%)	Moderate (%)	Vigorous (%)	Cardio-vascular (%)	Musculo-skeletal (%)	None (%)
Training Programme	Pilates	53	27	20	30	40	30
	Pilates & aqua-fitness	33	53	14	47	36	17
Control		33	33	34	23	27	50
Total		40	38	22	36	33	31

Table 2. Descriptive statistics and Measurements (1) and (2)

Parameter	*N*	Minimum	Maximum	Mean	SD
Age (years)	42	60	78	67.07	4.53
Shoulder flexion 1 (°)	42	105	180	137.14	22.82
Shoulder flexion 2 (°)	42	100	180	152.00	16.99
Hip flexion 1 (°)	42	60	120	95.48	14.13
Hip flexion 2 (°)	42	75	125	107.24	9.99
Lumbar flexion 1 (cm)	42	2	15	4.83	3.22
Lumbar flexion 2 (cm)	42	2	15	5.85	2.99
Thoracolumbar flexion 1 (cm)	42	0	11	4.33	2.44
Thoracolumbar flexion 2 (cm)	42	1	11	5.60	2.02
Lateral flexion 1 (cm)	42	5	21	12.43	3.76
Lateral flexion 2 (cm)	42	7	22	14.64	3.94
6' walk 1 (m)	42	255	540	398.81	80.97
6' walk 2 (m)	42	260	680	482.67	111.72
Sit-to-stand 1 (pc)	42	10	26	16.71	4.14
Sit-to-stand 2 (pc)	42	10	28	21.43	4.53

Table 3. The significant inter-group differences between Measurements (1) and (2)

Group	Parameter	*N*	Minimum	Maximum	Mean	SD
Pilates	Shoulder flexion 1 (°)	15	110	180	138.00	24.039
	Lumbar flexion 1 (cm)	15	3	5	3.67	.900
	Thoracolumbar flexion 1 (cm)	15	0	8	4.07	2.187
	Lumbar flexion 2 (cm)	15	4	5	4.73	.458
	6' walk 2 (m)	15	390	640	528.80	67.709
	Sit-to-stand 2 (pc)	15	20	28	23.87	2.532
Aqua + Pilates	Shoulder flexion 1 (°)	15	105	160	127.00	16.125
	Lumbar flexion 1 (cm)	15	2	6	3.73	1.223
	Thoracolumbar flexion 1 (cm)	15	1	5	3.00	1.069
	Lumbar flexion 2 (cm)	15	4	7	5.37	1.043
	6' walk 2 (m)	15	320	680	503.33	115.429
	Sit-to-stand 2 (pc)	15	15	24	20.67	3.519
Control	Shoulder flexion 1 (°)	12	105	180	148.75	24.227
	Lumbar flexion 1 (cm)	12	2	15	7.67	4.830
	Thoracolumbar flexion 1 (cm)	12	2	11	6.33	2.807
	Lumbar flexion 2 (cm)	12	2	15	7.83	5.024
	6' walk 2 (m)	12	260	620	399.17	112.449
	Sit-to-stand 2 (pc)	12	10	28	19.33	6.257

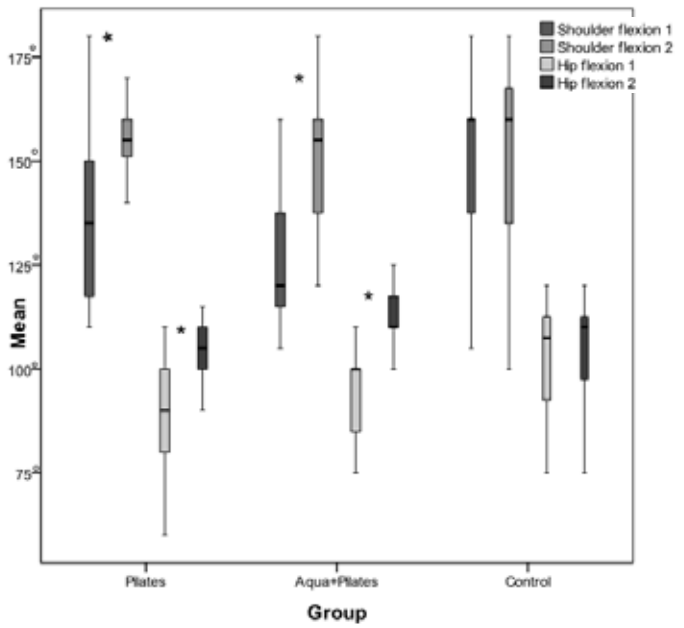

Figure 1. The boxes represent the results of the Paired Samples T-test for shoulder and hip flexibility (°).
* denotes $p < 0.05$

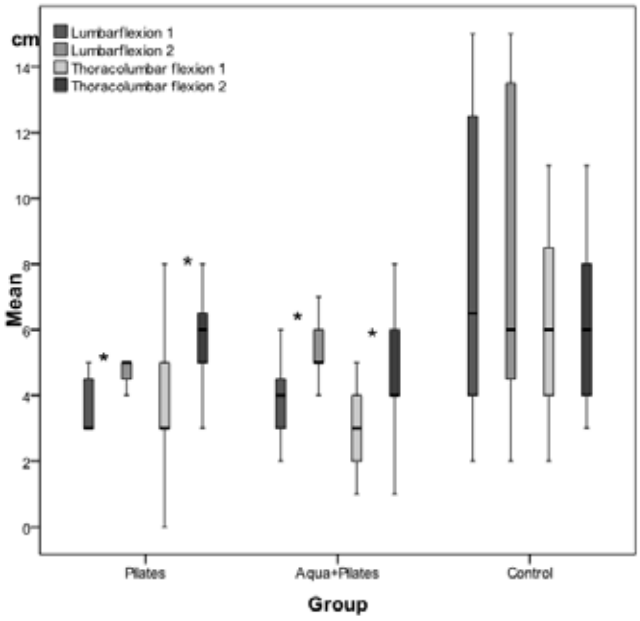

Figure 2. The boxes represent the results of the Paired Samples T-test for lumbar and thoracolumbar flexibility (cm).
* denotes $p < 0.05$

ness group showed the largest improvement as well as in hip flexion. The spinal ROMs were found to have approximately the same results. The most remarkable improvement was the Pilates group's 6-minute walk test and in their sit-to-stand test.

Discussion

Numerous studies can be found about improving flexibility and endurance or other motor abilities that are needed in ADLs [5, 8, 15–18]. As was proved through our training programme, people over 60 years of age can improve their physical condition by using a combined training programme, which should include aerobic, muscle strengthening and flexibility exercises [19]. Both of our training programmes were categorized into strength, stretching, range of motion, and balance training. They included exercises for thoracic extension, general back and abdominal strengthening, lumbar (core) stabilization exercises for the deep abdominal

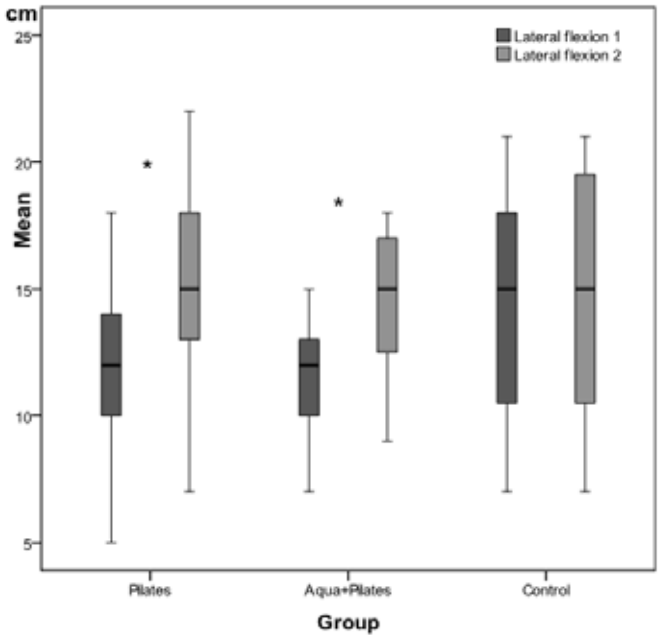

Figure 3. The boxes represent the results of the Paired Samples T-test for lumbar flexion of the right side (cm). * denotes $p < 0.05$

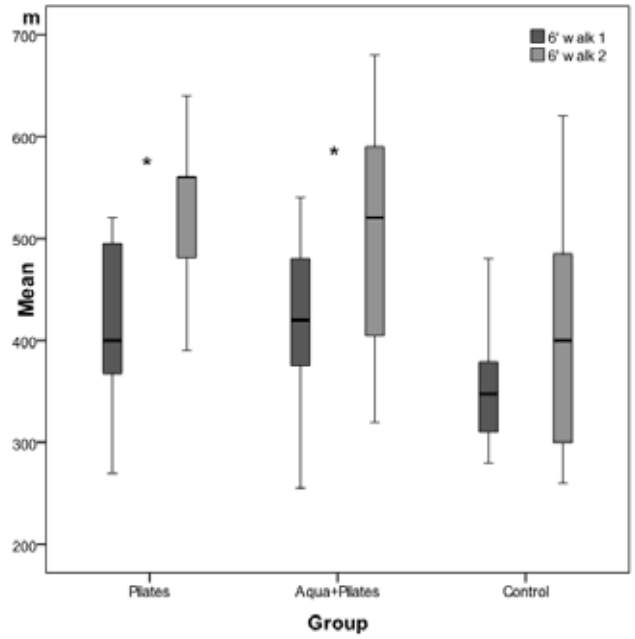

Figure 4. The boxes represent the results of the Paired Samples T-test for the 6-minute walk test (m). * denotes $p < 0.05$

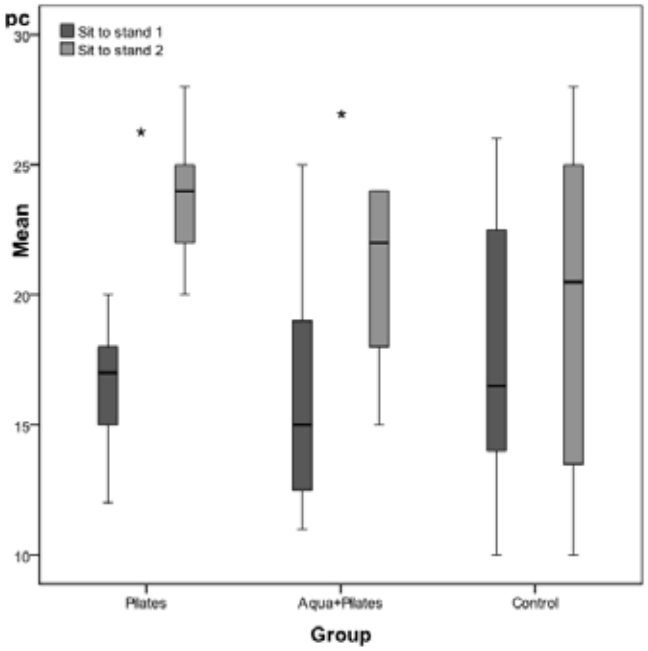

Figure 5. The boxes represent the results of the Paired Samples T-test for the sit-to-stand test (pc). * denotes $p < 0.05$

muscles, and Pilates to promote lumbo-pelvic control in various positions. As the study results show, it can be stated that modified Pilates training and Pilates combined with aqua fitness had a significant effect on all of our variables.

The Pilates approach focused on developing control of the pelvic and shoulder girdles using specific muscle recruitment strategies. As control improves, emphasis is moved to segmental alignment during movement, improving spine stability and mobility during sit to stand [15]. This control can make movement, for example during sit to stand or walking, safer and faster. The 6-minute walk and sit-to-stand test improved significantly in the Pilates group in our study, which is not only the result of endurance exercises but also of improved muscle control. As Emery et al. pointed out in 2010 [15], a Pilates training program is effective in improving abdominal strength and upper spine posture as well as in stabilizing core posture as shoulder flexion movements were performed.

On the other hand, Pilates combined with aqua fitness showed better results in the variables where flexibility was concerned. This might be the result of providing support to the joints and muscles by the natural buoyancy of water, which allows people with musculoskeletal problems to exercise with less effort and a greater range of movement. Wang et al., in 2007, [18] also found significant improvements in hip and knee flexion after a 12-week aquatic training programme.

Conclusions

The regular physical exercise programme was found to be feasible for older adults, and the high attendance rate supports the suitability of such an exercise programme for a long period of time. According to participant feedback, both training exercises – Pilates and aqua fitness – were found to be very useful for their activities of daily living, and the pleasant interaction with the instructors kept them interested and motivated throughout and after the 6 month period of the study.

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THE PREDICTIVE VALUE OF ON-ICE SPECIAL TESTS IN RELATION TO VARIOUS INDEXES OF AEROBIC AND ANAEROBIC CAPACITY IN ICE HOCKEY PLAYERS

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ABSTRACT
Purpose. The main goal of this study was to determine the predictive value of the indexes of aerobic and anaerobic endurance in relation to specific on-ice tests performed by hockey players that focus on strength, power, speed as well as speed and strength endurance. **Methods.** Ice hockey players, who were members of the U20 (under 20 years of age) Polish National Ice Hockey Team, were selected from the Athletic School in Sosnowiec, Poland. Parameters that determine anaerobic and aerobic capacity were evaluated and a special physical fitness assessment was made based on a battery of ice-hockey specific tests. The degree and direction of correlations between the individual parameters of anaerobic and aerobic endurance and the special physical fitness test were calculated. **Results.** The obtained results found significant correlations between maximal power obtained from the Wingate test and certain aspects of the special physical fitness test, specifically the 6 × 9 turns, 6 × 9 stops and 6 × 30 m endurance tests. Significant correlations of the above-mentioned special physical fitness tests were also observed with the aerobic capacity parameter, VO_2max. **Conclusions.** The obtained results could be considerably useful in training, as well as providing much more information on athletes which can then be suited for more personalized forms of training.

Key words: aerobic capacity, Wingate test, special physical fitness tests, ice hockey

Introduction

Scoring takes great technique and accuracy, but it also requires an aggressive attitude, good decision making and opportunities resulting from solid team play. Historically, coaching intervention has been based on subjective observations of athletes. However, several studies have shown that such observations are not only unreliable but also inaccurate. Although the benefits of feedback and the knowledge of results are well accepted, the problems of highlighting memory and observational difficulties result in the accuracy of coaching feedback being very limited. Nowadays there is a necessity to apply statistical analyses in sport sciences.

Hockey is widely considered to be an aerobic activity accentuated with several repeated bouts of anaerobic exercise [1]. A longitudinal study by Cox et al. [2] gathered physiological data on over 170 players from the National Hockey League (NHL) from 1980 to 1991. Over this time period VO_2max was found to increase from an average of 54 ml/kg/min in 1980 to just over 62 ml/kg/min (N = 635) in 1991 in this group of studied players.

A similar longitudinal study by Montgomery [3] looked at physiological data, including size, strength and aerobic fitness of the Montreal Canadiens of the NHL, beginning in 1917. Compared to players from the 1920s and 1930s, today's players were an average of 17 kg heavier and 10 cm taller with an average BMI increase of 2.3 kg · m^{-1}. Aerobic fitness (VO_2max) was also found to increase from 54.6 to 59.2 ml/kg/min between 1992 and 2003, but the variability of the data made it impossible to determine if this increase was significant.

Green et al. [4] conducted a study on an NCAA Division I hockey team and how their physiological profiles, including VO_2max, blood lactate, and percent body fat, related to their performance. Using a discontinuous protocol in which blood lactate was measured between three-minute stages of treadmill running, blood lactate levels averaged 8.9 ± 2.1 mmols · L^{-1} at the end of the fourth stage, the last stage completed by each of the subjects. This stage was tested at 12.9 km · h^{-1} and a seven-percent grade on the treadmill. Aerobic fitness (VO_2max) accounted for 17% of the variance in performance, which was based on overall scoring chances while a particular player was on the ice. It was concluded that only VO_2max significantly predicted performance.

While some previous literature suggests that increased aerobic capacity would benefit performance in sports such as ice hockey, which is a game of high intensity interval bouts of exercise, there is literature suggesting otherwise.

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Each year the National Hockey League (NHL) Entry Draft Combine tests approximately 110 to 120 players to determine a variety of fitness measures that may affect the order of draft selection [5]. Both anaerobic and aerobic capacities are currently measured during cycle ergometer protocols [5, 6]. Anaerobic and aerobic metabolism is often unrecognized in a traditionally known anaerobic-based task such as ice hockey. As a result, aerobic power has only been examined over the past 35 years in ice hockey [7–9] based on physiological data involving, for example, portable gas analysis [7], cycle ergometry [10] and running treadmills [11].

It has been suggested in previous training literature that to be successful at an elite level in ice hockey, it is necessary to maintain a highly developed aerobic system with a relative aerobic capacity of approximately 50–60 mL/kg/min [12]. This is consistent with recently published aerobic power values in well-trained elite-level hockey players [4, 13, 14].

Therefore, measuring anaerobic endurance and anaerobic power is of great importance for elite hockey players based on which training has a greater influence on the physical performance of hockey players. The development of an elite hockey training program should focus on improving each of the fitness components (i.e. flexibility, strength etc.) and include some on-ice short intervals, multi-directional directional skating as well as puck, technical skating and movement skills. These three phases need to be further broken down into macro-cycles of 2–6 weeks and with micro-cycles of weekly or daily lesson plans.

Training for hockey players must be developed with a thorough understanding of the game itself. Players often go beyond their understanding and knowledge of the physiology of hockey leading to overtraining, injury and a decrease in performance. The sport of ice hockey is physically demanding at the elite level, requiring trained aerobic and anaerobic energy systems. The sport demands not only significant glycolytic activity, which occurs during bursts of intense muscular activity, but also aerobic power and endurance [11]. Appropriate training and maintenance of fitness levels may help prevent hockey injuries and the onset of premature fatigue [2].

Studies on other sports have shown that physiological variables can be related to individual performance [15–17]. Therefore, the goal of the present study was to determine the predictive value of the indexes of control of anaerobic and aerobic endurance in relation to specific tests performed by ice hockey-players in terms of their strength, speed, power, as well as speed and strength endurance. The objectives of this research rested in posing the following questions:

1. Are there any significant correlations between the parameters of anaerobic capacity and special physical fitness tests?
2. Are there any significant correlations between the parameters of aerobic capacity and special physical fitness tests?
3. What is the strength and direction of these relationships?

Material and methods

In order to verify the above-mentioned objectives, investigation was carried out in September 2009, just before the Ice Hockey U20 World Championships, on 21 hockey players aged 19–20 years from the Athletic School in Sosnowiec, who were members of the U20 (under 20 years of age) Polish National Ice Hockey Team. Due to the necessity in obtaining information on the level of aerobic power among the studied group of hockey players, exercise with unequally rising intensity was performed on a Cyclus 2 bicycle ergometer (RBC Elektronik-Automation GmbH, Germany). The exercise test was based on seven exercise stages, with the first three stages taking two minutes each using a load of 1.5, 2.25 and then 3 W/kg. The remaining four stages took one minute each where the load was increased to 3.5, 4, 4.5 and then 5 W/kg. Some modification in relation to the exercise test used for testing NHL competitors was introduced. Constant values of power were replaced with load values that correspond to body mass. This modification was based on the considerable differentiation of the studied group in terms of body mass reaching 30 kg, which accounted for 30–50% of intergroup differentiation. The assumptions of the test predicted that the subjects would reach anaerobic threshold (AT) in the first part of the exercise and the response of the circulatory and respiratory systems would correspond to the intensity of VO_2max. A fundamental advantage of taking this modification into consideration in an exercise test is due to the typical nature of performance in hockey (intervals with frequently changing intensity) and high body mass, which limits the ability to continue activity for a longer period of time.

Blood samples were taken during the exercise in order to determine the level of lactate concentration before exercise (LArest), after the 1st increase in load (LA1), at the end of the exercise (LAmax) and in the 4th (LA4) and 8th (LA8) minute of recovery.

After 24 h of rest, all of the subjects preformed the 30-secound Wingate test to determine anaerobic capacity on a Monark cycloergometer (Monark, Sweden). A 5-min warm-up was performed with a resistance of 50 W and pedal frequency of approximately 70 revolutions per minute. Next, the Wingate test was performed with the resistance of the cycloergometer adjusted to the athlete's body weight (9% of body mass). All of the athletes were instructed to cycle as quickly and powerfully as possible throughout the entire test's duration.

In addition to the above-mentioned tests, special physical fitness tests on ice were also carried out. A set of measurable hockey skills which provide informa-

tion on speed and endurance were used, composed of the 30 m Forward Sprint, the 30 m Backward Sprint, 6 × 9 m Hockey Stops, 6 × 9 m Turns, and an Endurance Test (6 × 30 meters).

The measured variables, based on a method of direct participant observation, were then subjected to empirical and exploratory analyses. Descriptive statistics were calculated to include mean ± standard deviation (SD) and min and max values with all of the variables examined for normal distribution. Normality was confirmed using measures of kurtosis and skewness. In order to answer the research questions set out in this study, Pearson's linear correlation analysis was also carried out.

This study was approved by the Bioethics Committee of Scientific Research at the Academy of Physical Education in Katowice (Study No. 16/06). It was part of the framework of "The Multicriterion Optimization of Investigative Problems of Sports Training" project, headed by the Ministry of Science and Higher Education in Poland. The authors of this study declare no conflict of interest.

Results

The average values of the physiological variables and performance measurements taken in this study are presented in Table 1. Analysis of the obtained results on aerobic and anaerobic capacity revealed that they were similar to the results obtained by other researchers worldwide [3, 5, 18, 19].

Based on the analyses conducted on the measured variables (Tab. 2), significant negative correlations between the indexes of anaerobic capacity and the special physical fitness tests on ice were observed only between maximal power (measured in Watts per kilogram) and the variables: 6 × 9 m Stops, 6 × 9 m Turns, Endurance (6 × 30 m). Correlation was also observed between LA8' and the variables: 6 × 9 m Stops and 6 × 9 m Turns. In the case of other variables of anaerobic capacity, no statistically significant relationships with the special physical fitness tests on ice were observed.

In the case of relationships between the indexes of aerobic capacity and the special physical fitness test on ice (Tab. 3), significant negative correlations were observed between VO_2max with the variables: 6 × 9 m Stops and Endurance (6 × 30 m), correlation between HRmax and the 30 m Backward Sprint, correlation between LA1 and the variables: 30 m Sprint Forwards, 6 × 9 m Stops and Endurance (6 × 30 m), and correlation between LA4 and 6 × 9 m Stops. As a side note, LA4 was previously used as an indicator of aerobic endurance in Green's research [4]. Coaches may prefer players who are leaner and have a lower lactate at a given VO_2, which enables players to play at high intensity without fatigue. With regard to the other variables of aerobic capacity, no significant relationships with the special physical fitness tests on ice were found.

Table 1. Physiological and performance measurements

	Variables	Mean	SD	Min	Max
Special tests on ice	30 m Forward Sprint (s)	4.63	0.31	4.25	5.36
	30 m Backward Sprint (s)	5.66	0.55	4.98	7.29
	6 × 9 m Turns (s)	13.7	0.58	12.73	14.62
	6 × 9 m Stops (s)	13.29	0.56	12.45	14.38
	Endurance (6 × 30 m) (s)	33.03	1.16	31.9	36.58
Anaerobic Capacity	Pmax (W)	1030.83	93.3	814	1378.5
	Pmax (W/kg)	12.97	0.57	11.5	14.1
	LArest' (mmol/l)	2.02	0.82	1.01	3.66
	LA4' (mmol/l)	13.17	1.4	11.67	16.76
	LA8' (mmol/l)	13.77	1.03	11.69	15.81
Aerobic Capacity	VO_2max (ml/kg/min)	57.88	4.94	45	66
	HRmax (bpm)	186.69	9.16	170	203
	LArest (mmol/l)	2.18	0.61	1.39	3.39
	LA1 (mmol/l)	4.43	1.46	2.53	7.87
	LAmax (mmol/l)	10.29	1.29	7.17	12.17
	LA4 (mmol/l)	10.97	1.58	6.79	12.89
	LA8 (mmol/l)	10.06	1.85	5.32	13.75

Pmax (W) – Absolute peak power, Pmax (W/kg) – Relative peak power, LArest' (mmol/l) – Lactate concentration before the Wingate test, LA4' (mmol/l) – Lactate in the 4th minute of recovery in the Wingate test, LA8' (mmol/l) – Lactate in the 8th minute of recovery in the Wingate test, VO_2max (ml/kg/min) – Relative VO_2max, HRmax (bpm) – Max heart rate, LArest (mmol/l) – Lactate concentration before the VO_2max test, LA1 (mmol/l) – Lactate concentration after the 1st stage of load increase in the VO_2max test, LAmax (mmol/l) – Lactate concentration after the VO_2max test, LA4 (mmol/l) – Lactate concentration in the 4th minute of recovery in the VO_2max test, LA8 (mmol/l) – Lactate in the 8th minute of recovery in the VO_2max test

Table 2. Correlations between the indexes of anaerobic capacity and the special physical fitness tests on ice

	30 m Forward Sprint (s)	30 m Backward Sprint (s)	6 × 9 m Turns (s)	6 × 9 m Stops (s)	Endurance (6 × 30 m) (s)
Pmax (W)	–0.13	0.22	–0.42	–0.26	–0.27
Pmax (W/kg)	–0.20	0.06	–0.64*	–0.58*	–0.57*
LArest' (mmol/l)	–0.15	0.02	–0.27	0.03	–0.14
LA 4' (mmol/l)	–0.24	–0.18	–0.08	–0.26	–0.22
LA 8' (mmol/l)	0.10	–0.39	–0.48	–0.62*	–0.34

* significant correlations $p \leq 0.05$

Pmax (W) – Absolute peak power, Pmax (W/kg) – Relative peak power, LArest' (mmol/l) – Lactate concentration before the Wingate test, LA4' (mmol/l) – Lactate in the 4th minute of recovery in the Wingate test, LA8' (mmol/l) – Lactate in the 8th minute of recovery in the Wingate test

Discussion

The physiological profiles of elite hockey teams reveal the importance of aerobic endurance, anaerobic power and endurance, muscular strength and skating speed. Although field hockey is played on a similar sized course with the same number of players and for a similar

Table 3. Correlations between the indexes of aerobic capacity and the special physical fitness test on ice

	30 m Forward Sprint (s)	30 m Backward Sprint (s)	6 × 9 m Turns (s)	6 × 9 m Stops (s)	Endurance (6 × 30 m) (s)
VO_2max (ml/kg/min)	–0.46	–0.32	–0.49	–0.68*	–0.62*
HRmax (bpm)	0.15	0.23	–0.10	0.13	0.27
LArest (mmol/l)	0.11	–0.39	–0.21	–0.32	–0.45
LA 1 (mmol/l)	0.60*	0.39	0.31	0.61*	0.66*
LAmax (mmol/l)	0.19	–0.02	0.19	–0.06	0.32
LA 4 (mmol/l)	–0.12	–0.37	–0.15	–0.58*	–0.12
LA 8 (mmol/l)	–0.02	–0.34	–0.06	–0.47	–0.05

* significant correlations $p \leq 0.05$

VO_2max (ml/kg/min) – Relative VO_2max, HRmax (bpm) – Max heart rate, LArest (mmol/l) – Lactate concentration before the VO_2max test, LA1 (mmol/l) – Lactate concentration after the 1st stage of load increase in the VO_2max test, LAmax (mmol/l) – Lactate concentration after the VO_2max test, LA4 (mmol/l) – Lactate concentration in the 4th minute of recovery in the VO_2max test, LA8 (mmol/l) – Lactate in the 8th minute of recovery in the VO_2max test

duration, it is physiologically closer to soccer and does not allow for cross-sectional comparison. While game play is similarly intermittent in field hockey, players must perform continuously for 70 minutes with just one 5–10 minute interval. This places a high demand on the aerobic system and good aerobic endurance is required to support repetitive bouts of high intensity exercise [11].

For elite ice hockey players, anaerobic power and anaerobic endurance is of critical importance [2], making strength an important part of a hockey training program. Although players are not required to meet certain physical challenges (when compared to other multi-sprint sports), power is required for acceleration, to maintain speed and for quick direction changes. Upper body strength allows players to shoot more powerfully and pass over a greater range of distance.

All in all, the bio-energetic demands of the sport require heavy bouts of high-intensity whole-body exercise characterized by high-speed explosive skating and sudden changes of direction, coordinated with spontaneous bursts of muscular strength and power [12]. In an average hockey game, there are typically 5–7 bursts of maximal skating per shift, leading to an average of 4–6 min/game of high-intensity bouts of maximal effort [4], and an average heart rate intensity of 70–90% of maximum heart rate (HRmax). Although intermittent, the game of ice hockey does require approximately 15–20 min of both aerobic and anaerobic energy expenditure per game at a competitive level [14] and repeated back-to-back sprints make speed and tolerance changes in acid-base balance an important characteristic of elite players [15].

In elite level hockey, there has been a long-standing debate among scouts, coaches, strength/conditioning specialists and physiologists as to the relative utility of on-ice tests for aerobic and anaerobic power prediction. Nonetheless, having access to ice-specific special physical fitness tests, which are good predictors of the most important indexes of aerobic and anaerobic capacity, might minimize the number of expensive off-ice tests and minimize disturbance to training cycles, particularly during the competitive season or play-offs.

The obtained results allow us to identify the significant relationships between the indexes of anaerobic and aerobic capacity and these special physical fitness tests on ice. The athletes who were faster in 6 × 9 m Stops, 6 × 9 m Turns, Endurance (6 × 30 m) tests achieved higher power values in the Wingate test and showed higher VO_2max. Significant negative relationships were also found between the level of lactate after the Wingate test and the variables 6 × 9 m Stops and 6 × 9 m Turns. These results allow for the conclusion that higher degrees of acidification correspond to shorter trial times. Similar results were obtained when analysing the results of negative correlation between the acidification in the aerobic capacity test in the 4th and 8th minute and the variable 6 × 9 m Turns. In contrast, positive correlation was observed for the level of acidification measured after the first stage of load increase in LA1 and between the 30 m Sprint Forwards, 6 × 9 m Turns, and Endurance (6 × 30 m) variables. The higher acidification showed by the tested athletes in the first part of the aerobic capacity test corresponded to poorer results obtained in the special physical fitness test on ice.

The results presented here are also confirmed by those reported by other authors [20], which state that aerobic and anaerobic capacity are important physiological characteristics for ice hockey players [2, 21]. Because of the relatively short but intense work intervals found in an ice hockey game (from 30 to 60 seconds), the ability to produce anaerobic energy might dictate performance within a given shift when playing on ice [2, 21]. Although a variety of on-ice skating tests have been developed, the Wingate test on a cycle ergometer (from 15 to 45 seconds) remains the most commonly used test for assessing anaerobic power and capacity in hockey players [22]. Even if such short shifts predominate in ice hockey, the physiological demands are not limited to anaerobic pathways. In fact, aerobic capacity is responsible for the recovery from such high-intensity intermittent exercise and, therefore, acts as a buffer against fatigue and minimizes the attenuation of power output during subsequent shifts [20].

Conclusion

Ice hockey is a physically demanding contact sport involving repeated bouts of high intensive effort, with players' shifts lasting from 30 to 80 seconds [23–25].

Given the anaerobic nature of these sprint-based phases (69% anaerobic glycolysis) and the aerobic recovery (31% aerobic metabolism) between shifts and periods, as well as the physicality of the game, success at the elite level requires players to develop a well-rounded fitness level that includes anaerobic sprint ability, a strong aerobic endurance base, and high levels of muscular strength, power and endurance [2, 23, 24, 26].

The athletes who performed better in the 6 × 9 m Stops, 6 × 9 m Turns and Endurance (6 × 30 m) tests achieved higher power values in the Wingate test as well as showing higher VO_2max. Therefore, the most important findings of this study suggest that the best predictors of aerobic and anaerobic capacity are the 6 × 9 m Stops, 6 × 9 m Turns and Endurance (6 × 30 m) tests. Such knowledge might be considerably useful in the frequent control of training process, as well as providing much more information on athletes which can then be suited for more personalized forms of training.

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THE USE OF THERMAL IMAGING TO EVALUATE BODY TEMPERATURE CHANGES OF ATHLETES DURING TRAINING AND A STUDY ON THE IMPACT OF PHYSIOLOGICAL AND MORPHOLOGICAL FACTORS ON SKIN TEMPERATURE

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ABSTRACT
Purpose. The aim of this study was to assess the temperature changes of selected body surfaces (the arm and forearm) as a response to 90-minute physical exercise as well as to analyze the impact of physiological and morphological factors on the dynamics of temperature change. **Methods.** A study group that consisted of 12 professional volleyball players was subjected to endurance training which lasted 90 minutes. Numerous physiological and morphological factors were measured, with mean temperatures registered from the body surface of the upper extremities before, immediately after, and ten min after physical effort by a thermal camera (SC500 ThermaCAM camera) at room temperature. **Results.** After physical exercise, a fall in skin temperature resulting from prolonged sweating during the dynamic exercise tests was observed. The temperature changes in volleyball players, recorded in a series of tests, were found to be larger on the front surfaces of their upper extremities when compared to the rear. In addition, statistically significant positive correlation between maximum oxygen uptake (VO_{2max}) and $\%HR_{max}$, calculated with the decrease in skin temperatures, was found. **Conclusions.** The strong and statistically significant influence of maximum oxygen uptake on the drop in surface temperature of the upper extremities (arm and forearm) immediately after the exercise indicates that thermography can be used as an additional, non-invasive method that provides information on a player's fitness level in comparison to other athletes.

Key words: thermography, thermoregulation, physical activity

Introduction

The human body can be separated into an always warm-blooded thermal core and a cold-blooded shell, where the average core body temperature is 37°C, while the body surface is commonly found to be 33°C. These temperatures depend on a number of variables and are a function of the internal organs' temperature as well as the thermal properties of the tissues that separate an organ from the surface of the body, including, among others, the muscle tissue and fat content, as well as blood flow, blood temperature, skin moisture and the amount of energy produced during regulated homeostatic metabolic processes [1–4].

The surface of the human body is a rich map of isotherms with a very wide temperature range that is influenced by endogenous and exogenous changes. Body surface temperature can be evaluated and analyzed thanks to thermal emission, which can be recorded using thermal imaging (an infrared camera) as a non-invasive and non-contact method that captures the heat emitted by human skin, allowing one to record the temperatures of selected areas of the body. Thermography has found a wide application in medicine, but in the area of sports no comprehensive study has been conducted on the possibility of its use.

Physical activity naturally increases muscle metabolism, which can lead to a rise in both muscle and body temperature by the generation of heat. In such circumstances, the body's surface temperatures changes as a consequence of thermoregulatory homeostatic mechanisms that attempt to prevent hyperthermia and release excess heat from the body. Although a small amount of the heat produced by the working skeletal muscles is passively conducted by surrounding tissues to the outer skin, the majority of this heat is transferred by convention through the venous blood flowing from these muscles which is then directed to superficial veins [5].

A trained body must have an efficient mechanism for eliminating heat. In the available literature on the subject, some studies reported that trained individuals had an overall smaller increase of rectal temperature [5–8]. One of the important physiological benefits of physical training is an increased ability to dissipate heat from the body (as an increase to reaction rate and sweating dynamics and a decrease in the allowance of internal temperature rise). Afanacewa et al. [9] stated that not only internal body temperature but also surface temperature indicates the thermal state of a human body. Changes in body surface temperature provide information on the efficiency of the endogenous heat removal systems generated during exercise as well as the metabolic changes associated with the body's return to homeostasis after exercise. On this basis, the possibility of using thermal imaging as way to monitor

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these changes and use it as a tool for sports trainers becomes increasingly apparent [10], as the efficiency of the thermoregulatory system is an important component of the body's adaptation to exercise.

Some studies also reported on drops in body surface temperature after exercise [11–14]. However, these studies were conducted on very small sample groups. Merla et al. [15] provided information on the surface temperature of the forearm, thigh and torso of 15 runners during a progressive treadmill exercise. The authors recorded drops in the surface temperature of those areas of the body after beginning exercise, with the largest decrease in the peripheral parts of the body, namely, the forearm, rather than the central parts of the body (torso). In addition, the rise in body temperature after exercise was observed to be faster in the isotherms of the peripheral parts of the body.

However, no comprehensive knowledge exists on temperature change dynamics, which could be recorded by thermal camera, of the body's surface when subjected to physical activity (and which changes are the consequence of thermoregulation) or the dependency of these changes on physiological parameters, body composition and morphological features. One of the facets considered in this study was the assumption that thermoregulatory mechanisms may be dependent on the training level (endurance) of the tested subjects. It was also presumed that body composition (especially fat content) and the skin-fold thickness of the analyzed areas of the body could act as an endogenous insulator of heat and may therefore impede heat dispersal.

In addition, this study attempted to assess a thermographic method at analyzing the efficiency of the thermoregulation system. This study is a continuation of a research project on the dynamics of body surface temperature changes when subjected to physical activity (recorded by infrared camera), as well as the dependencies of these changes on the physiological parameters, body composition, and morphological features of various sports groups in relation to their different training environments. Thus far, research has been conducted on handball players [16], water polo players [17] and basketball players [18].

Therefore, the aim of this study was to assess the changes of specific body surfaces (the arms and forearms) on a group of volleyball players before 90 minutes of physical exercise (as a training session performed in a sports gym), immediately after exercise, and 10 min after its completion, as well as assess what influence physiological and morphological parameters have on temperature change.

Material and methods

This study was conducted on 12 athletes (all men) who professionally played volleyball in a second-league team (the Morze Bałtyk Szczecin Sports Club). The study took place during the beginning of the 2008 season. The physical exercise component of the study included speed-endurance training with certain game elements (aerobic exercise, running with changes in pace and as a race; games such as a paced attack/block exercise) which lasted for 1.5 h.

Each of the test subjects were measured with three thermograms taken in a standing position of the front (PP) and rear (PT) upper limbs (KG), specifically the right (P) and left (L) arms and forearm in three series:

Series 1 (S.1) – Before training (in this case the subjects remained in a room for 20 min at 25°C in athletic wear that was all made of the same material before the thermal images were taken)

Series 2 (S.2) – Immediately after the 90-minute long training session

Series 3 (S.3) – 10 min after the end of the training session

The players started and finished their training in turn in order to ensure that each player performed the same amount of exercise and had their temperature measurement taken at identical intervals.

Digital thermal images (thermograms) were recorded in each of the sessions for the front and rear surfaces of the upper limbs (the arm and forearm). Both of these areas were continuously exposed during exercise. The study used a TMSC500 ThermaCAM thermal camera (Flir, USA), with measurements analyzed by AGEMA computer software (AGEMA, Poland). The mean temperature of the selected areas of the body were recorded and retained for later analysis. The study was performed in accordance with the standards set forth by the European Society of Thermography. The skin's emissivity was assumed to be 0.98. All thermograms were taken in a room with a humidity of 60%, at 25°C and at a distance of 3 m.

In addition, anthropometric measurements were taken of the studied group of players, including: height, body mass, skin-fold thickness of the right (P) and left (L) arm. The players' BMI (Body Mass Index) was also calculated. In addition, all of the players taking part in the study were found to be right-handed. Bioelectrical impedance analysis (Bodystat 1500 analyzer, AKEM, Turkey) was used to find the basic body composition of the players, namely: the percentage of Lean Body Mass and water and fat content. The surface area of the players' bodies was calculated using the Dubois method, whereas the surface area of the upper limbs was calculated using Wallace's rule of nines.

Evaluation of the athlete's aerobic capacity (taken one week prior to the study) was performed by measuring VO_{2max}, the maximum oxygen uptake, using the direct method. The subjects were subjected to a progressively increasing amount of resistance (until maximum) on a Monark ergometer (Monark, Sweden). During the test, respiratory rates were recorded using an Oxycon Alpha analyzer (Jaeger, Germany). Heart rate

Table. 1. Physical characteristics of the studied volleyball team (N = 12)

Characteristics	Min–max	M	± SD
Chronological age (years)	19–24	21.7	1.23
Player seniority (years)	4–12	8.7	2.54
Body height (cm)	186–203	192.5	4.642
Body mass (kg)	75–92	81.83	5.132
Average skin-fold fat thickness of the right and left arm (mm)	6–15	9.25	2.221
BMI (kg/m^2)	20.61–23.95	22.07	0.794
Surface area of the right and left upper limbs (m^2)	0.07–0.08	0.07	0.003
LBM% (the percentage of lean body mass)	85.2–92.6	90.02	1.908
FAT% (the percentage of fat body mass)	7.4–14.8	9.98	1.908
Water % (the percentage of body water content)	56.3–63.9	61.10	2.185
Maximum oxygen uptake (VO_{2max}) (mL/kg/min)	41.7–53	47.46	3.514
HR_t (%HR_{max})	73.44–78.15	75.80	2.750
Energy expenditure (kcal)	750–820	790.67	25.520

measurements taken during both rest and restitution after exercise were made by using a sport-tester (Polar, Poland) that established maximum heart rate values (HR_{max}).

During the physical exercise component of the study, the athletes' heart rates were monitored (using the Polar sport-testers) to determine individual average heart rate during training (HR_t), which was used to calculate what percentage of maximum heart rate was obtained during training as a marker of training load [HR_t (%HR_{max})]. In addition, the energy expenditure during exercise was measured, in the number of burned calories, using a Caltrac accelerator (Muscle Dynamics Fitness Network, USA).

In Table 1 the physiological characteristics of the studied athletes are presented. In addition, the following statistical procedures were applied to the collected data:

1. The arithmetic mean and standard deviation were calculated for the studied traits.

2. The Shapiro-Wilk's test was used to examine the distribution of the studied traits (in all cases normal distribution was found).

3. The significance of the temperature T_{mean} changes of the front and rear upper limbs (the right and left limbs were analyzed both separately and together) by using the non-parametric Friedman test post-hoc Nemeny.

4. Multiple linear stepwise regression analysis (post-hoc last significance differences – LSD) were performed between the series of body surface temperatures readings and the obtained morphological and physiological parameters.

Results

Figure 1 presents the individual temperature drops (T_{mean}) immediately after completing the 90-minute training session with respect to the stasis temperature (T_{mean}) of the separate right and left upper limbs at rest. The difference in the drop in temperature between the right and left limbs (both arm and forearm) did not exceed more than 0.5°C in any of the tested subjects. Larger differences were expected due to the greater functional asymmetry of the right and upper limb during training. In Table 2–4 the minimum and maximum values as well as mean temperature changes (T_{mean}) during the test series are presented.

The largest body surface temperature decreases of the analyzed body areas were recorded in Series 2, immediately after the completion of the physical training session, when compared to the pre-exercise values. The average temperature T_{mean} drop was similar for both right and left upper limbs. Larger drops in average temperatures T_{mean} were recorded at the front of the upper extremities than at their rear (Tab. 2). The average temperature T_{mean} rise of the analyzed isotherms in Series 3, when analyzed in relation to Series 2, were also found to be higher for the front rather than at the rear (Tab. 3).

The significance of the temperature T_{mean} changes of the front and rear surfaces of the upper limbs were analyzed separately as well as together by the non-parametric Friedman test, with Nemeny post-hoc analysis (Tab. 5). The results found that the changes in temperature of the upper limbs' surface in the three series of tests were all statistically significant.

In order to search for the relationships between the changes in surface temperature of the front and rear upper limbs in the series of tests and the analyzed morphological and physiological factors, multiple stepwise regression analysis (post-hoc LSD) was performed. The results of the regression analysis (Tab. 6) found that two factors had a statistically significant effect on the temperature changes in the series of tests: maximal oxygen uptake and HR_t (%HR_{max}). The results found no relationships between the isotherms' temperature changes and the morphological features of the study participants.

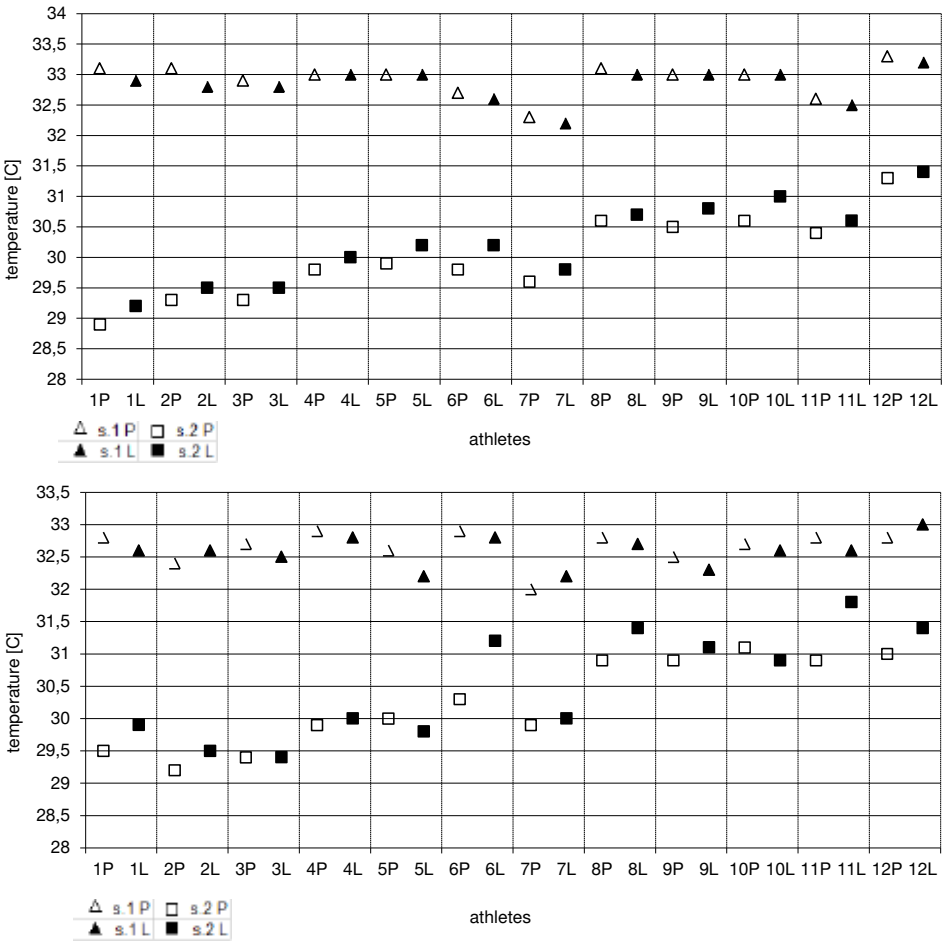

Figure 1. A graphical presentation of the individual temperature T_{mean} drops immediately after the training session (90 min) in relation to the temperature T_{mean} at rest for the right and left upper limbs (P – right, L – left)

Table 2. Minimum and maximum values (min, max) and the arithmetic mean (M) of temperature (°C) change of the selected areas of the body: the front and rear surface of the upper limbs (arms and forearms) before training and immediately after completing the training session (Series 1 – Series 2)

Front surface	min–max(P)	M(P)	± SD	min–max(L)	M(L)	± SD	min–max(LiP)	M(PiL)	± SD
	2–4.2	2.92***	0.676	1.8–3.7	2.59***	0.619	1.9–3.95	2.76***	0.645
Rear surface	min–max(P)	M(P)	± SD	min–max(L)	M(L)	± SD	min–max(LiP)	M(PiL)	± SD
	1.6–3.3	2.41***	0.669	0.8–3.1	2.04***	0.781	1.35–3.2	2.23***	0.701

*** Significant difference of temperature change in the series of tests at $p = 0.0001$, according to Friedman (post hoc LSD)
P – the right upper limb; L – the left upper limb; PiL – the right and left limbs together

Table 3. Minimum and maximum values (min, max) and the arithmetic mean (M) of temperature (°C) change of the selected areas of the body: the front and rear surface of the upper limbs (arms and forearms) immediately after completing the training session and 10 min after completing the training session (Series 2 – Series 3)

Front surface	min–max(P)	M(P)	± SD	min–max(L)	M(L)	± SD	min–max(LiP)	M(PiL)	± SD
	1.2–2.7	1.99***	0.494	1.4–2.7	1.92***	0.456	1.35–2.7	1.96***	0.462
Rear surface	min–max(P)	M(P)	± SD	min–max(L)	M(L)	± SD	min–max(LiP)	M(PiL)	± SD
	0.8–2.5	1.67***	0.547	0.2–2.3	1.39***	0.687	0.7–2.3	1.53***	0.586

*** Significant difference of temperature change in the series of tests at $p = 0.0001$, according to Friedman (post hoc LSD)
P – the right upper limb; L – the left upper limb; PiL – the right and left limbs together

Table 4. Minimum and maximum values (min, max) and the arithmetic mean (M) of temperature (°C) change of the selected areas of the body: the front and rear surface of the upper limbs (arms and forearms) before the training session and 10 min after completing the training session (Series 1 – Series 3)

Front surface	min–max(P)	M(P)	± SD	min–max(L)	M(L)	± SD	min–max(LiP)	M(PiL)	± SD
	0.3–1.9	0.93***	0.51	0.1–1.2	0.67***	0.387	0.2–1.55	0.8***	0.433
Rear surface	min–max(P)	M(P)	± SD	min–max(L)	M(L)	± SD	min–max(LiP)	M(PiL)	± SD
	0.1–1.3	0.74***	0.345	0.1–1.4	0.65***	0.442	0.1–1.05	0.7***	0.345

*** Significant difference of temperature change in the series of tests at $p = 0.0001$, according to Friedman (post hoc LSD)
P – the right upper limb; L – the left upper limb; PiL – the right and left limbs together

Table 5. The results of the Friedman test (with post hoc LSD performed on the temperature changes in the series of tests)

	p	Critical difference: 0.9773		
		S.1	S.2	S.3
kgpLiP	0.0001	S.1 0	2.000	1.000
		S.2 –2.000	0	–1.000
		S.3 –1.000	1.000	0
		S.1	S.2	S.3
kgtLiP	0.0001	S.1 0	2.000	1.000
		S.2 –2.000	0	–1.000
		S.3 –1.000	1.000	0
		S.1	S.2	S.3
kgpL	0.0001	S.1 0	2.000	1.000
		S.2 –2.000	0	–1.000
		S.3 –1.000	1.000	0
		S.1	S.2	S.3
kgpP	0.0001	S.1 0	2.000	1.000
		S.2 –2.000	0	–1.000
		S.3 –1.000	1.000	0
		S.1	S.2	S.3
kgtL	0.0001	S.1 0	2.000	1.000
		S.2 –2.000	0	–1.000
		S.3 –1.000	1.000	0
		S.1	S.2	S.3
kgtP	0.0001	S.1 0	2.000	1.000
		S.2 –2.000	0	–1.000
		S.3 –1.000	1.000	0

kgpP – right upper limb, front surface
kgpL – left upper limb, front surface
kgtP – right upper limb, back surface
kgtL – left upper limb, back surface
kgpLiP – both upper limbs, front surface
kgtLiP – both upper limbs, back surface

Table 6. A summary of the results after progressive stepwise regression analysis (only the significant correlations are shown at $p < 0.05$)

Variable	R2%	Variable $p < 0.05$
kgp s.1-s.2(LiP)	91.84	VO_{2max} (+) $p = 0.003364$ HR_t (%HR_{max}) (+) 0.040761
kgp s.2-s.3(LiP)	47.67	HR_t (%HR_{max}) (+) $p = 0.012940$
kgp s.1-s.3(LiP)	69.64	VO_{2max} (+) $p = 0.003168$
kgt s.1-s.2(LiP)	96.22	HR_t (%HR_{max}) (+) $p = 0.004587$. VO_{2max} (+) $p = 0.041781$
kgt s.2-s.3(LiP)	72.46	VO_{2max} (+) $p = 0.001583$
kgt s.1-s.3(LiP)	43.52	VO_{2max} (+) $p = 0.00871$

kgpLiP – both upper limbs, front surface
kgtLiP – both upper limbs, rear surface
s.1 – the series of thermal images taken before the training session
s.2 – the series of thermal images taken immediately after the training session
s.3 – the series of thermal images taken 10 min after the end of the training session

Discussion

The decrease in skin temperature after physical exercise is due to the prolonged act of sweating that takes place during dynamic exercise. It is known that shortly after physical exertion, one of the responses of the vascular system is the redistribution of blood flow and a reduction of blood flow to the skin [19]. During prolonged exercise an increase in core body temperature is due to metabolic heat production, which is dependent on its intensity and effort.

Trained individuals, as a result of the body's adaptive changes to physical exercise, are found with a lower internal temperature rise with an increased intensity of perspiration, which is able to better cool the body. At the same time, the body surface temperature decreases [20], as was confirmed by the research presented in this study on volleyball players.

The most effective mechanism for the elimination of heat produced by muscles is sweating and evaporation of sweat from the body surface, with the evaporation rate depending on the humidity level and ambient air temperature. In the study, the 90-min training session resulted in sweating, which eliminated endog-

enous heat and, consequently, led to the observed decrease in skin surface temperature. Therefore, it can be indirectly concluded that the efficiency of the thermoregulatory mechanisms of trained individuals allows them to continue physical exertion without a rise in internal temperature, which could be a factor limiting the physical performance of athletes. What is more, the recorded temperature changes in the series of tests were found to be greater on the front surface of the upper limbs. This can be attributed to the fact that the front surface of the arms and forearms has smaller body fat distribution than on the rear.

In addition, the temperature changes in the series of tests on the symmetrical right and left surfaces of the upper limbs did not differ from each other by more than 0.5°C, even though all of the studied players were right-handed (which led to this limb being more frequently used in training). Similar results were also obtained in other studies [10]. Conducting original research, this group of scientists directed a stress test on an ergometer in which all of the tested subjects were found to demonstrate significant changes of not only the surface temperature of their lower limbs but also in the less-involved upper limbs.

It was found that physical exercise does not only cause local changes of the working muscles' temperatures but also affects the temperature of areas not directly involved in physical effort. During an intense physical workout, the amount of heat dissipated by the body can increase five to six times, that is, an adult of average body weight, with a resting value of 290 kJ/h can produce up to 2000–3000 kJ/h during intense physical activity [21].

Regression analysis found that the variable that had the largest statistically significant effect on temperature change in the series of tests was maximal oxygen uptake. An important aspect of the body's adaptation to physical effort is possessing an efficient thermoregulatory system and is known, from literature on the subject, that trained individuals have a greater ability to remove excess heat from the body. Thanks to these adaptive changes, a trained individual would have lower core temperature and an increased intensity of perspiration, which allows the body to better cool itself down as well as decrease the surface area temperature of the body [5, 22].

Heat loss, generated through the excretion and evaporation of sweat, is necessary to maintain thermal equilibrium during physical exercise, where the heart is used to transport heat to the skin and sweat glands [8, 22]. Therefore, the overall better efficiency and physical tolerance of the tested subjects should be a factor that improves this process, which allows for better heat transfer during the production of excess heat and would allow the body to return to homeotermia during restitution. There is, therefore, the possibility of using thermal imaging as a tool for coaches as a fast, non-invasive assessment of the dynamics of players' body surface temperature changes, which can provide indirect information on the efficiency of the mechanisms responsible for heat removal, enabling athletes to continue performing at their highest level.

Additionally, the decrease in temperature of the analyzed isotherms was also influenced by the percentage of maximum heart rate during training HR_t ($\%HR_{max}$), which was calculated individually for each player. This was also confirmed by literature, where a larger decrease in surface temperature, along with the body's "activation of the cooling process", depends on the fitness level and training intensity of an individual. Coh and Sirok [23] analyzed the surface temperature of the thighs before and during physical effort of varying intensity. The authors found that temperatures changes are adequate in their response of the "inflicted effort", that is, the greater amount of physical effort, the greater the change of the body's surface temperature.

This proves, first of all, the dependence between the intensity of the thermoregulatory processes and the stress load on an individual (dependent on $\%HR_{max}$ during physical exercise) and the overall efficiency of the body, estimated by maximum oxygen uptake. It seems that athletes with higher VO_{2max} are characterized by having a better thermoregulatory response by their circulatory system, which would result in a more intensive elimination of heat and, consequently, a greater decrease in skin surface temperature after 1.5 h of exercise.

The presented results are derived from pilot studies as part of a program studying the dynamics of body surface temperature and its interdependencies with various physiological and morphological factors, all taking place during physical activity by athletes of different sports disciplines. These studies, which take advantage of thermal imaging, may provide a deeper understanding of the body's thermoregulatory processes as well as its effects in specific training programs (as such, no information was found on this subject in available literature).

Conclusion

1. The strong, statistically significant correlation found between maximum oxygen uptake and a decrease in the surface temperature of the upper limbs (arm and forearm) immediately after physical training suggests that thermography can be used as an additional, non-invasive method of informing the efficiency of an athlete's thermoregulatory processes (being a component of gauging fitness level) against other athletes.

2. The front surface of the arms and forearms, rather than the rear, seems to be more suitable in assessing the dynamics of temperature changes. This is due to the decreased fat distribution of these areas, which can act as an insulator to the heat generated by the body. There-

fore, using the front surface of the forearms could allow one to more precisely capture temperature changes.

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GENDER IDENTITY IN FEMALE FOOTBALL PLAYERS

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ABSTRACT
Purpose. The aim of this study was to define the relationship between gender identity, the perception of the body, depressiveness, and aggression in female football players who represent different levels of competence (playing in the premier league *vs.* second league) and seniority in sport. **Methods.** Research was carried out on female football players (aged 16–31 years) playing in the premier league (N = 49) and second league (N = 45). Data were obtained with the use of: the Body Image Evaluation Questionnaire by Mandal, developed on the basis of Franzoi's concepts; Kuczyńska's Gender Assessment Inventory (IPP) adapted from the *Bem Sex Role Inventory* (BSRI), which diversifies individuals in terms of their gender identity in accordance to the Gender Schema Theory by Bem; the *Beck Depression Inventory*, translated by Lewicka and Czapiński; and the *Buss-Durkee Inventory*, adapted by Kosewski with comments from Stanik. To find a relationship between the mentioned variables, statistical analysis was carried out by use of ANOVA, the t test, the χ^2 test and correlation coefficients. **Results.** The obtained research results indicate that, among female football players, the following occurs: a predominance of androgynous gender identities and a deficiency of its other types, a higher level of masculinity than among non-training women, a more favorable perception of body-as-process, a higher evaluation of body-as-object, along with an increase of masculinity and a decrease in indirect aggression at higher competition levels. **Conclusions.** The application of the masculinity dimension by female football players with androgynous gender identity is probably an effective strategy for survival in conditions that are unsuitable and gender-inappropriate in typical masculine sports.

Key words: gender schema, psychological sex, football

Introduction

Gender identity with sex and gender itself are all elements constituting human sexuality. Each of the above mentioned notions are connected with a description of sex from a psychological, biological and social perspective [1]. The psychological phenomenon of gender identity has been aptly explained in the Gender Schema Theory by Sandra L. Bem. According to this theory, culture provides an individual with obligatory definitions of femininity and masculinity creating a so-called gender schema.

The gender schema is a general, mental representation of a part of knowledge about the reality responsible for classifying human experiences as feminine *vs.* masculine. An internalization of the content of gender schemata in the process of sex typing triggers our special knowledge on sex to be used not only with the aim of orientation in the world, but also in the purpose of building on its basis a concept of one's self as well as controlling one's behavior. Bem distinguished six possible gender identities mirroring the unique inclinations represented by an individual to use the dimensions of masculinity and femininity. The first four types of personalities use the gender schema for the purposes of constructing an identity and regulating one's behavior. They are *sex typed* (feminine women and masculine men – femininity predominates over masculinity in women and masculinity predominates over femininity in men) and *cross sex typed* (masculine women and feminine men – a predominance of femininity over masculinity in men and masculinity over femininity in women, respectively). The other types of gender identity fall "outside" the standard gender schema dichotomizing the world into the feminine or masculine, transcending it in relation to *androgynous individuals* (where women and men simultaneously representing a high intensity of femininity and masculinity use both dimensions for the purpose of processing information) and those undifferentiated in terms of gender (women and men displaying the same low intensity level of femininity and masculinity) by almost ignoring gender schemata and not organizing such a cognition process around them [2, 3].

As such, culture allows people to use gender schemata with various levels of intensity in evaluating the environment and themselves, which diversifies them in terms of psychological sex. Men sustain the stereotypical division of masculine and feminine sports as a *status quo* necessary in order to obtain gender identity [4]. The hegemony of men in sport is the reason for the "rules of war" that are so frequently present in it. Therefore, women are required to adjust to conditions that are often at variance with their system of values [5]. Women participating in a traditionally masculine sport frequently have androgynous or masculine gender

identities [6, 7], and as Matteo argues [8], they tend to practice masculinized sports far more often (baseball, basketball, boxing, football). Mroczkowska [9] obtained slightly different results in competitors who trained a sport appropriate (i.e., neutral) to both genders (fencing) indicating the prevalence of androgynous (44.4%) and feminine (27.8%) over masculine and undifferentiated gender identity, while women who trained in disciplines that are inadequate in terms of their gender ("masculine" weight lifting), androgynous (53%) and masculine (23%) gender identity predominated.

For three years, Guillet et al. [10] observed the withdrawal of young (aged 13–15 years) women handball players from active sport. The highest percentage of female players that remained in sports belonged to the following types of gender identity: androgynous (76%), masculine (69%) and a lower percentage of those referred to feminine (56%) and undifferentiated (50%) identity. It is worth noting that participation in a feminine sport may depend on early behaviors, such as a girl's preference of "masculine" rather than "feminine" toys (*guns vs. Barbie dolls*) and games (*football vs. jump rope*), enhanced through the clear encouragement by their family, peers and coaches [11]. It seems quite possible that women who represented increased "masculinity" as girls were considered as so-called "*tomboys*", who were more glad to participate in more masculine activities than in feminine ones. Bailey et al. [12] reported that girls (aged 4–9 years) from a *tomboy* group were generally more masculine (playing, interests, *gender*) than their sisters, but not more than their brothers. It appears that retaining the childhood inclinations of girls may predispose them towards a certain sport in the future and account for them taking up activities in areas that belong to "masculine" culture.

One of the masculinized reservoirs of sport is football, and it was only not that long ago that women were allowed to enter this exclusive environment. Although football is becoming an increasingly popular discipline among women, there are a number of negative opinions on this form of emancipation. This is evidenced by recent results of a Polish study on the factorial structure of male and female professional stereotypes, which indicate that being a footballer is a job reserved exclusively for men [13]. According to Starosta [14], based on a sampling of students' opinions, the sports that have adverse influence on a woman's body (identified as being concerned on the aesthetics of a woman's body or about achieving motherhood) are: bodybuilding, weight lifting and football (ranked in this order). This is why it seems vital to determine the identity of women who undertake to break the limits outlined by the stereotypes of sex and sexist bias, and above all, to answer the question: "What are the costs of doing so?"

In tests performed on female football players ($N = 31$), Pacut [15] obtained a prevalence of androgynous (65%) and masculine (16%) gender identities. Chalabaev et al. indirectly explained the reason for such a distribution of gender identities based on an example of young female football players (M age = 13.5 years), showing that masculinity ensures a positive perceived ability in soccer [16]. In research done by Szmajke and Adamczuk [17], all of the tested female football players ($N = 17$) displayed typically masculine gender identity, a high aggression factor and low self-esteem, through which the authors then formulated a presumption that women playing football are socially "rejected" and that is what induces them to fulfill themselves within the enclave of women's football. On the other hand, the results obtained by Mroczkowska [9] indicate that this could be instead an adaptation to a typically masculine sport by means of an androgynous gender identity. However, the research in question did not take into consideration the specific nature of the sports discipline (it was not performed on women football players).

Thus it seems necessary to broaden the presented subject of research with a view towards focusing on the seniority of woman football players, the represented level of sport participation, their aggressiveness, which by simplification is the essence of the stereotype of masculinity (in being predominating, competing, success-oriented, pushing oneself forward, combative, brusque, or arrogant) and depressiveness, which, also being further simplified, appears to be connected with the stereotype of femininity, where sensitivity, mildness, reflectiveness, thoughtfulness, gentleness, and bashfulness are emphasized [18]. In some cases football is ranked among the more brutal team disciplines [19], with it being a sports environment where regulations or a referee's decisions are at times considered to be unjust and therefore hinder one's success in sport. Such decisions could be therefore perceived as consenting to a "justified" use of violence [20]. However, contrary to these findings, empirical research does not confirm a higher level of aggression in female football players than in women who do not practice any sport whatsoever [21], and it even points to a smaller amount of antisocial behavior on the field than in players [22]. This is despite the fact that the environment of football appears to create possibilities for higher social elevation and a substantial improvement in the quality of life [23], and the use of aggression might be seen as a good means at achieving them. "Pumping up" and promoting an attitude of optimal outward aggression among athletes gives them the physiological mobilization of enabling them to be more fully involved in competition [24], rather than a more destructive attitude of outright hostility, irritation and anger, which, when accompanied with sports aggression, makes it rather ineffective and useless [25].

Depression, as a mental illness, also plays a role in regard to sex stereotypes; in women it pertains to problems connected with the fulfillment of a social role (portraying the classic symptoms: low mood, an inabil-

ity to feel pleasure, anxiety). Whereas in men it pertains to the denial and threat to one's "masculinity" (e.g., a decreased feeling in control over one's life, the inability to work, which is sometimes concealed in self-destructive behaviors such as with the use of certain stimulants or gambling, but still attempting at salvaging one's masculinity), of who appears to fulfill the stereotype of the "strong man" that dominates in our culture [26]. Therefore, it seems worthwhile to determine the situation of female football players, whose model of experiencing this disorder may be closer to the masculine one and thus imperceptible in their own consciousness. In addition, previous research also points to the fact that women practicing sports and sustaining an injury may be more susceptible to depression than male athletes [27]. A counterpart to the characteristics of female football players' gender identity is one of their body image, as it is a personality component that undergoes unceasing social evaluation in terms of sex stereotypes and one not taken into consideration in any of the tools designed to measure psychological gender. According to Franzoi's theory, we can approach our body in two ways: by understanding the body as a collection of static elements evaluated separately (face, hands, feet) or the body as a functional whole (attractiveness, endurance, strength). Perception, in terms of *body-as-object* and *body-as-process*, is connected with sex stereotypes. Both genders assess their bodies in a more positive manner through the body-as-process approach rather than the body-as-object, and a high level of femininity induces a negative evaluation of the body as an object in women and positive evaluation in men, whereas a high level of masculinity induces a positive evaluation of body-as-object in women. The satisfaction received from perceiving one's body-as-process is interlinked with masculinity [28, 29]. This relationship consists of the fact that the more a woman is feminine the less favorably her body is evaluated by her as an object, while far more positively is such an evaluation received when a subject represents a high level of masculinity, which indicates that auto-identification with a masculine gender stereotype, when a masculine discipline is practiced, appears to be a favorable adaptational phenomenon. On the other hand, the specific character of typical masculine sport disciplines itself (football, boxing) induces the use of a masculine dimension connected with the functional evaluation of the body as a whole (body-as-process) that scores or loses goals or gives or receives blows in objective terms. Typical feminine sport disciplines (synchronized swimming, skating) give priority to femininity, which pertains to treating the body as an object undergoing on-going aesthetization and immeasurable evaluation, thus contributing to low self-esteem in women [30].

In such a context, women football players may undergo adaptive changes in their gender identity, in how they perceive their bodies or experience depressiveness and, as such, come to resemble men in terms of aggressive behavior that follow in the footsteps of having certain male characteristics. The analysis found above revolves around the dilemma of: "Does sport change the identity of a female player?" *vs*. "Does sport attract individuals having a special identity?"

In order to solve this problem, this study focused on determining the level of gender, the perception of one's body, depressiveness, the aggression of female football players across different skill levels as well as seniority, and a search for a relationship between these aspects. In order to operationalize the issue set forth in this paper, the following research questions were formulated:

Does the intensity level of femininity and masculinity in all subjects differ from each other significantly?

Does the intensity level of femininity and masculinity in female football players differ significantly from each other depending on the level of competition in which they play in (premier league *vs*. second league)?

Does the intensity level of femininity and masculinity in female football players and non-training women differ from each other significantly?

Is there any relationship between the gender identity variants and type of physical activity of women (women playing football *vs*. non-training women)?

Is there any relationship between the gender identity variants and level of competition played by female football players (premier league vs. second league)?

Do the following issues correlate with each other: the represented level of competition (women's premier league *vs*. second league), the seniority in playing football as well as the seniority one holds in their current division, masculinity and femininity, depressiveness, general aggression and its elements and perception of one's body as-process and as-object?

Does the level of general aggression in female football players significantly differ from the level of general aggression in non-training women?

Does the intensity level of perception of one's body as-object and as-process significantly differ from each other in women playing football?

Does the intensity level of perception of one's body as-object and as-process significantly differ from each other, depending on the represented level of competition in women playing football (premier league *vs*. second league)?

Material and methods

Research was carried out between January and April 2010 among randomly selected football clubs in Poland, selecting football players who train in the premier league (N = 49) and second league (N = 45) and were aged 16–31 years (mean age 20.77 years). The measurement tools for dependent variables were as follows: the Body Image Evaluation Questionnaire by

Mandal [30], which was developed on the basis of the concept of body image according to Franzoi, that focused on the satisfaction with one's own body and how it is perceived in a body-as-object (separate parts of the body) and body-as-process manner (body functioning); the *Bem Sex Role Inventory* (BSRI), adapted by Kuczyńska in her Inventory for Psychological Gender Evaluation (IPP) [3, 18], diversifying individuals in terms of their gender identity according to the Schema Theory by Bem; the Beck Depression Inventory, translated by Lewicka in Czapiński's work [31] as the level of depressiveness of an individual (it measures the components of depression seen as one of psychopathological dimensions manifesting itself in various disorders and is not used for diagnosing depression as a nosological unit); and the Buss-Durkee Inventory [32], which determines: the level of an aggression factor *en bloc* (understood as an unpleasant stimulus directed at another person), consisting of physical, indirect, verbal aggression and irritation, and the hostility factor (which was not analyzed in the present paper, however). The obtained results were then analyzed statistically.

Results

Repeated measures of ANOVA in a 2 × 2 design (level of competition: premier league *vs*. second league *vs*. femininity *vs*. masculinity) showed that all of the tested subjects obtained statistically significant higher results on the femininity scale (x = 56.84) than on the masculinity scale (x = 54.25); $F(1.\ 92) = 10.32$, $p < 0.002$, (partial) $\eta^2 = 0.10$ (Fig. 1), and did not indicate any dependence on the level of competition (premier league *vs*. second league) : $F(1.92) = 0.04$, $p > 0.84$.

The femininity of female football players did not differ in a statistically significant manner from the mean values obtained among non-training women (56.84 *vs*. 56.60); $|t(93)| = 0.36$, $p > 0.05$ (two-sided test).

The masculinity in female football players was significantly statistically higher than the mean value obtained among non-training women (54.25 *vs*. 46.71); $t(93) = 10.21$; $p < 0.0005$ (right-sided test). The figures pertaining to the mean femininity and masculinity in non-training women were taken from a study on female students ($N = 327$) carried out by Korzeń [33].

Statistical analysis conducted using the χ^2 test revealed a significant relationship between the type of gender identity and practiced sport (in this case female football players *vs*. students). Among female football players a clear deficiency of female and undifferentiated gender identities occurred with a simultaneous overrepresentation of androgynous types. Within the population of female students the tendency was reversed, namely, the androgynous type was underrepresented, whereas female and undifferentiated gender identities were found to be excessive, where $\chi^2(3) = 62.23$; $p < 0.001$ (Tab. 1).

No relationship between the type of gender identity and the level of competition (premier league *vs*. second league) was found in the group of studied female football players for $\chi^2(3) = 1.76$; $p > 0.62$ (Tab. 2).

Along with the increase of masculinity in female football players, a positive perception of body-as-object increases (0.26) while indirect aggression (0.27), verbal aggression (0.30) as well as general aggression also rose (0.28). The increase of depressiveness in female football players was accompanied by a higher level of indirect aggression (0.29), irritation (0.42) and general aggression (0.25). Longer player seniority of a female football player was accompanied with lower general aggression (–0.28), physical aggression (–0.24) and indirect aggression (–0.30) levels. Female football players, who trained football for a longer period of time in their present league reveal lower general aggression (–0.24) and lower indirect aggression (–0.19) when they achieve a higher level of sports participation (Tab. 3). General aggression of female football players does not differ sig-

Table 1. Comparison of the number of gender identity types in female football players and students obtained by means of Kuczyńska's IPP

Type of gender identity	Number of gender identity types in female football players	Number of gender identity types in female students*	Σ	χ^2
MW (masculine women)	10 (12.06)	44 (41.95)	54	62.23
FW (feminine women)	15 (32.60)	131 (113.41)	146	
A (androgynous)	64 (32.60)	82 (113.41)	146	
U (undifferentiated)	5 (16.75)	70 (58.26)	75	
Σ	94	327	421	

* Data concerning the gender identity of female students was obtained from Korzeń [33].
The values in brackets signify the expected number, the actual number can be seen above them

Table 2. Interrelationship of gender identity types obtained by means of Kuczyńska's IPP in female football players in the premiere and second leagues

Type of gender identity	Number of types of gender identity in premier league female football players	Number of types of gender identity in second league female football players	Σ	χ^2
MW (masculine women)	7 (5.21)	3 (4.78)	10	1.76
FW (feminine women)	7 (7.81)	8 (7.18)	15	
A (androgynous)	33 (33.36)	31 (30.63)	64	
U (undifferentiated)	2 (2.6)	3 (2.39)	5	
Σ	49	45	94	

The values in brackets signify the expected number, the actual number is above them

Table 3. Interrelationship of correlations for $N = 72$ (valid cases) in which variables marked with an asterisk (*) are statistically significant at $p < 0.05$

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. Lev	–	0.60*	0.41*	–0.00	0.04	–0.02	–0.00	–0.01	–0.14	–0.19*	0.01	–0.05	–0.09
2. Sen	–	–	0.73*	–0.03	0.08	0.12	0.15	–0.05	–0.24*	–0.30	–0.17	–0.14	–0.28*
3. Sen2	–	–	–	0.01	0.14	0.14	0.09	–0.14	–0.18	–0.23	–0.22	–0.12	–0.24*
4. Proc	–	–	–	–	0.47*	0.08	0.09	–0.20	–0.07	0.12	–0.13	0.06	–0.01
5. Objec	–	–	–	–	–	0.19	0.26*	–0.21	–0.09	0.10	–0.18	–0.17	–0.12
6. F	–	–	–	–	–	–	0.26*	0.18	–0.20	–0.08	–0.08	–0.06	–0.14
7. M	–	–	–	–	–	–	–	0.04	0.19	0.27*	0.07	0.30*	0.28*
8. Dep	–	–	–	–	–	–	–	–	–0.03	0.29*	0.42*	0.16	0.25*
9. Pa	–	–	–	–	–	–	–	–	–	0.33*	0.32*	0.57*	0.75*
10. Ia	–	–	–	–	–	–	–	–	–	–	0.49*	0.48*	0.73*
11. Ir	–	–	–	–	–	–	–	–	–	–	–	0.39*	0.70*
12. Va	–	–	–	–	–	–	–	–	–	–	–	–	0.84*
13. Ga	–	–	–	–	–	–	–	–	–	–	–	–	–

Lev – level of competition, Sen – total seniority as player, Sen2 – seniority in the present league, Proc – perception of body-as process, Objec – perception of body-as-object, F – femininity, M – masculinity, Dep – depressiveness, Pa – physical aggression, Ia – indirect aggression, Ir – irritation, Va – verbal aggression, Ga – general aggression (Sum of Pa, Ia, Ir, Va). Due to the manner of coding the level of competition (0 – premier league and 2 – second league) the correlations with it were calculated using Kendall's tau coefficient, and in the obtained values, the ± signs have been changed into their opposites

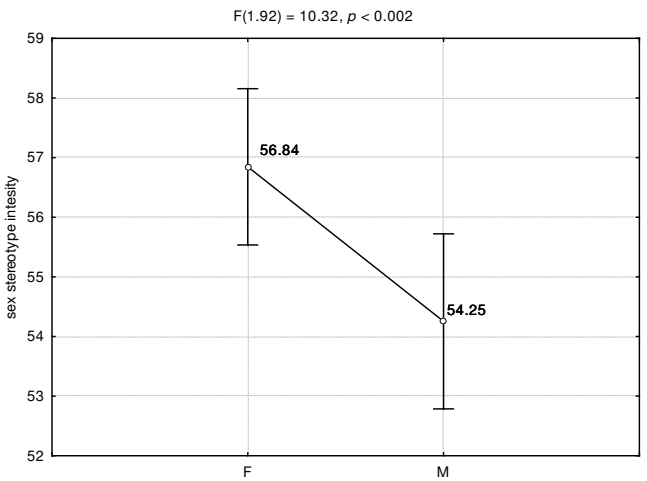

Figure 1. Mean femininity (F) and masculinity (M) measured by means of Kuczyńska's IPP in female football players

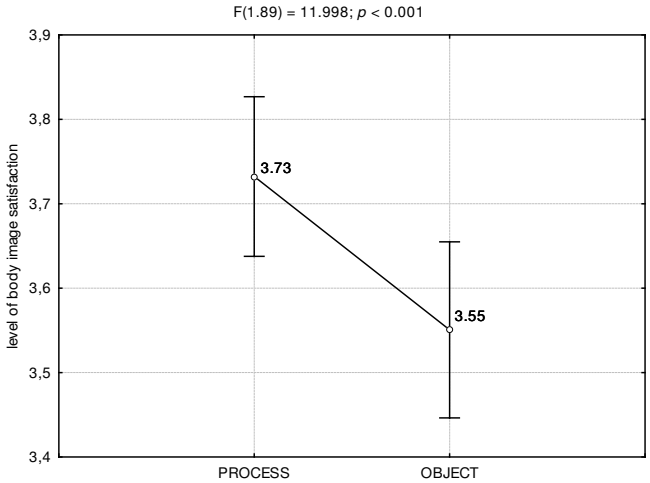

Figure 2. The perception of body image as an object and as a process by female football players

nificantly from aggression in the general population (the results used in the comparison by Stanik et al. [32]); (40 *vs*. 37.43) $|t(90)| = 1.77$, $p > 0.05$.

Repeated measures ANOVA in a 2 × 2 design (level of competition: premier league *vs*. second league *vs*. body image satisfaction: body-as-process *vs*. body-as-object, respectively) found that all of the female football players perceive the image of their body-as-process (strength, stamina) in a more favorable manner than in terms of body-as-object (face, figure); $F(1.89) = 11.998$, $p < 0.001$; (partial) $\eta^2 = 0.12$, and did not indicate any dependence on the level of competition (premier league *vs*. second league) : $F(1.89) = 0.18$, $p > 0.67$ (Fig. 2).

Discussion

Football, as a sports discipline that is stereotypically connected with the world of masculine values, prefers an androgynous type of gender identity among female football players. As the results of this study indicated, this was not linked to the level of competition and thereby strengthens the hypothesis of sport attracting and selecting more androgynous individuals. More importantly, the high intensity of masculinity (higher than in non-training women), which in combination with a simultaneously high level of femininity (similar to female players and a control group not practicing any sport), seems to fulfill an adjustment function to the conditions in which predominantly fitness categories prevail and therefore there is a risk of incurring high psychological costs. Mroczkowska [34], obtained similar results in her study, namely, that women fencers and women judoka, having higher intensity of masculinity, represent lower levels of fear and neuroticism and have better emotional balance. Gilenstam et al. [35], in their qualitative study, put emphasis on the socially constructed non-availability of typical masculine sports, based on the example of difficulties in the development of women's ice hockey in Sweden – a country famous for its egalitarianism.

Therefore, androgyny may be the type of gender identity that allows females to retain their femininity and effectively function in a stereotypically masculinized environment. Such a way of thinking is supported by research conducted outside of sports, indicating that women of an androgynous identity more easily force through their ideas, they accept their negative feelings, respect themselves, satisfy their need for safety, trust themselves better, more easily adjust to changing conditions and are convinced of the possibility of realizing their intended goals, which as a whole, establishes a high level of their self-actualization [36]. According to Terelak and Kluczyńska [37], androgynous women who were the victims of violence on the part of their partners cope much better with a traumatizing situation than individuals of different gender identities. Research on the relationship between temperament and gender also shows that male and androgenic women are characterized by a lower level of fear and a higher level of anger, activity and sociability than women with female and undifferentiated gender identity [38]. Breaking from the rigid perception of the simplified categories of the world, namely masculinity *vs*. femininity, where having a high limit of both masculinity and femininity appears to be a strategy enabling the regulation of one's behavior and to perceive oneself irrespective of a situation (women practicing football despite the lack of approval from their environment). Possessing masculine attributes by androgynous female football players may be connected with their higher self-esteem, which has found to be common as proved in the theoretical analysis by Lachowicz-Tabaczek [39] predominantly in the case of men. It is, however, partially inconsistent with the results obtained by Szmajke and Adamczuk [17], pointing to the possibility of an occurrence of high masculinity with low femininity (masculine women) and low self-esteem in female football players. It is also worth mentioning that androgyny constitutes a psychological quality *per se*, releasing thought from rigid generalizations and increasing the level of tolerance and openness, and, what is more, enabling the use of a broader range of behaviors that can flexibly adjust in a given situation. Claiming that female football players, however, may belong to a group of individuals who do not pay attention to sexuality (who do not follow the gender schema) has not been confirmed in the results of this study, where an undifferentiated type of gender identity was clearly underrepresented.

In this study, the obtained results proved that the higher level of female players, the lower the level of indirect aggression, and the longer the total seniority of one being a player, the lower general aggression (in addition, it was also found to be lower when player seniority was also longer in the current league they played in) and its primary components were physical and indirect aggression. Such consoling results that signify the role of sport as one of mitigating aggression, at the higher level, have been confirmed in a study carried out by Turosz and Storto [40] among female football players (playing in the national team *vs*. premier league) and by Szmajke and Gorajczyk [41], who tested women basketball players. A high level of masculinity in female football players correlates positively with indirect, verbal and general aggression, but in spite of this fact, female football players participating in the present study were not more aggressive (general aggression) than women who do not practice any sport.

The variables that pertain to depressiveness in female football players increased with indirect aggression (stamping one's feet, throwing objects, gossip, malicious jokes), irritation (irritability, touchiness, grumpiness, boorishness) and general aggression, which supposedly may confirm the use of the gentlest (stereotypically proper for women) variant of a masculine strategy to

cope with a difficult situation. "Putting on" such behavioral masks may protect the image of a fit female player who was put at risk at a time of crisis in a typically masculine sport.

The results comply with Franzoi's theory [28], namely that all female football players perceive their body image as-process (strength, agility, stamina) in a more favorable manner than as-object (face, figure, lips), and the increase of masculinity in gender identity is accompanied by a more positive perception of the body-as-object seems to be especially interesting. Participation in a masculine sport discipline and the possession of gender identity with elevated masculinity (as androgynous or masculine woman) may incline one to perceive one's body as a well-functioning whole orientated towards goal achievement in a sports reality which objectively evaluates fitness competence [30] and guarantees more contentment with the body undergoing very severe social evaluation. In this case, one may refer to the therapeutic function of masculinity in women who successfully fulfill themselves by taking advantage of it in a stereotypically masculine domain and, at the same time, protect themselves from the negative effects of self-objectification [42].

Conclusion

The application of the masculinity dimension by female football players with androgynous gender identity is probably an effective strategy for survival in harsh social conditions and in gender-inappropriate, typical masculine sports. The concurrence of the content that constitutes the stereotype of masculinity with fitness competence may be responsible for being effective in various activities and a reduction of its psychological costs. High masculinity conditions favorable perception of individual body parts (body-as-object) in female football players thus contributing to their increase in self-esteem. A professional sport (football in this case) does not trigger an intensification of aggression in females. On the contrary, just the opposite was found, where some of its signs are in fact curbed.

Female football does not deprive players of their femininity, but it does protect a high level of femininity with masculinity. It seems possible that androgynous female football players are predisposed towards playing the roles which are assigned to women both by society (maternity) as well as men (playing sport professionally), and the ability to eliminate the conflict that occurs between these two roles would thus account for their overrepresentation in one of the most masculinized sports.

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THE INFLUENCE OF THE WAY OF PLANNING TEACHING CONTENT ON THE EFFECTIVENESS OF MASTERING SELF-DEFENCE TECHNIQUES

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ABSTRACT
Introduction. The improvement of a learning process through transferring a skill already acquired to another one which is being learnt is one of the factors contributing to increasing the effectiveness of teaching. The aim of this study was to compare the effectiveness of teaching performed on the basis of two plans, i.e. a traditional (intuitive) one and a network one. **Methods.** A pedagogical experiment covering 13 weekly sessions of self-defence elements were taught. The control group was taught according to an algorithm developed in a traditional (intuitive) way, whereas the experimental group was taught according to a algorithm developed on the network model. After the sessions had been completed, five experts evaluated the acquisition level of three randomly selected elements. The results obtained by 32 men (average age 21.29 ± 0.76 years) from the experimental group and 32 men from the control group (average age 21.18 ± 0.87 years) were analysed statistically with the Student's *t*-test, two-way analysis of variance (ANOVA) and the Fisher post-hoc test. **Results.** The experts did not differ in evaluating both groups ($p < 0.05$). Moreover, no interactions were revealed ($p < 0.05$) between the method of planning the teaching programme and the experts who evaluated the acquisition level of the taught elements. The only significant difference between the experimental group and the control group was observed in the method of planning the teaching programme, according to which self-defence elements were taught ($p < 0.01$). **Conclusions.** The acquisition level of the taught self-defence elements according to the algorithm developed by basing it on the network model turned out to be significantly higher than in the case of those elements taught in the traditional (intuitive) planning process.

Key words: teaching programme, pedagogical experiment, traditional (intuitive) planning, network planning, acquisition of self-defence

Introduction

Progress, within the process of learning, depends on a number of factors which determine the speed, quality, durability and flexibility of acquiring motor skills. These determinants may be divided into two groups. The first one includes external conditionings which cover everything that exerts influence on a student. The other one consists of the individual, physical and mental capacities of every learner [1]. As far as external conditionings are concerned, one of the determinants is the planning of a teaching programme. To bring about the expected results in the form of acquiring new skills in the best possible way, the manner and scope of this activity ought to take into consideration, inter alia, the existing similarities between them. This makes it possible to use positive transfer, which occurs when material mastered in one context positively influences the course and the final result of learning other material in the same or different context [2, 3].

So far, research on transfer was concerned with various aspects of motor functioning of a human being [4, 5], including learning motor activities from different sports [6, 7] as well as within the same one [8]. The practical meaning of this research makes it possible to assume that implementing transfer into teaching will facilitate and improve the process of learning multi-element and complex activities such as self-defence. Most often, while conducting such sessions there occur time limitations and learners' expectations of fast progress. It may seem plausible to improve this process through making use of positive transfer. However, knowledge of the connections between the taught elements is indispensable. It is a hard and intricate task indeed. What is more, a traditional way of planning which draws upon the knowledge, intuition and experience of coaches is not very effective. Therefore, researchers are looking for better methods of optimising this process [9]. One of them is the critical path method (CPM) [10], which makes it possible to reflect the connections that occur between taught elements. The use of this method makes it possible to point out which activities, having been acquired in the teaching process, may be followed by the other ones as well as which activities may be taught simultaneously [11].

As such, the aim of the study was to compare the effectiveness of teaching self-defence elements according to two methods of planning a teaching programme, i.e. traditional (intuitive) planning and network planning. Experimental research was used to test whether the optimisation of a plan at introducing particular elements of self-defence, in the course of teaching, facilitated

better acquisition. This would be confirmed by an evaluation of the elements taught to the subjects in the experimental group (using a teaching process based on the network method), which was expected to be marked higher than in the evaluation of the subjects from the control group (using a teaching process based on the traditional method). This hypothesis is based on the assumption that network planning, already tested in other areas including teaching, will contribute to an increase in the effectiveness of teaching self-defence elements.

Material and methods

Random male subjects were divided into two groups, i.e. a control one and an experimental one. Each of the groups consisted of four teams in which the training sessions were carried out. The selection methodology of the experiment and the selection criteria are presented in Figure 1.

In the pedagogical experiment, which lasted for 13 weeks, the subjects had to participate in 45-minute weekly taekwondo sessions during which, apart from traditional techniques, elements of self-defence were

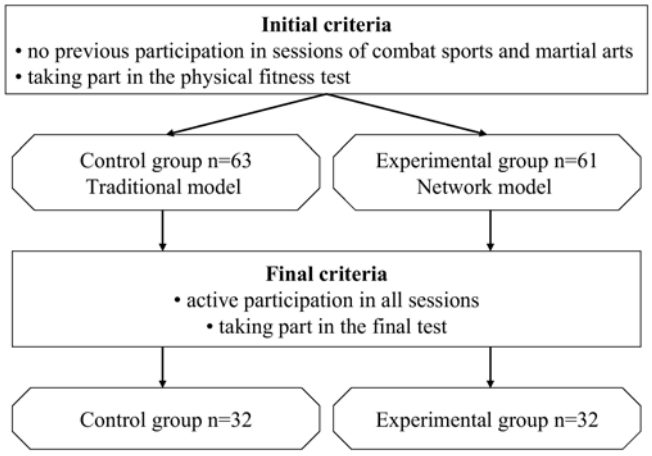


Figure 1. Methodology of subject selection

Table 1. List of taught self-defence elements

Element number	Element name
1	Defence against a grab by one hand 1
2	Defence against one-hand grab by clothes 1
3	Defence against two-hand grab by clothes 1
4	Defence against hair grab
5	Defence against two-hand rear choke
6	Defence against a front grab by both hands 1
7	Defence against a rear grab by both hands
8	Head release from a side grab
9	Defence against a grab by one hand 2
10	Defence against two-hand grab by clothes 2
11	Defence against a front grab by both hands 2
12	Defence against a front grab by both hands 3
13	Defence against one-hand grab by clothes 2

taught (Tab. 1). The amount of time devoted to mastering self-defence techniques during one session was between 5 and 10 minutes and depended on the number of elements taught as well as on circumstances that resulted from the teaching process, i.e. teacher-learner interactions.

The control groups' self-defence elements (Tab. 1) were taught according to an algorithm developed prior to the experiment which was based on observing taekwondo sessions (Tab. 2). The planning method used here may be called a traditional (intuitive) one because it mainly draws upon the skills and experience of coaches as well as on general programmes including requirements for particular degrees of advancement (gup, dan).

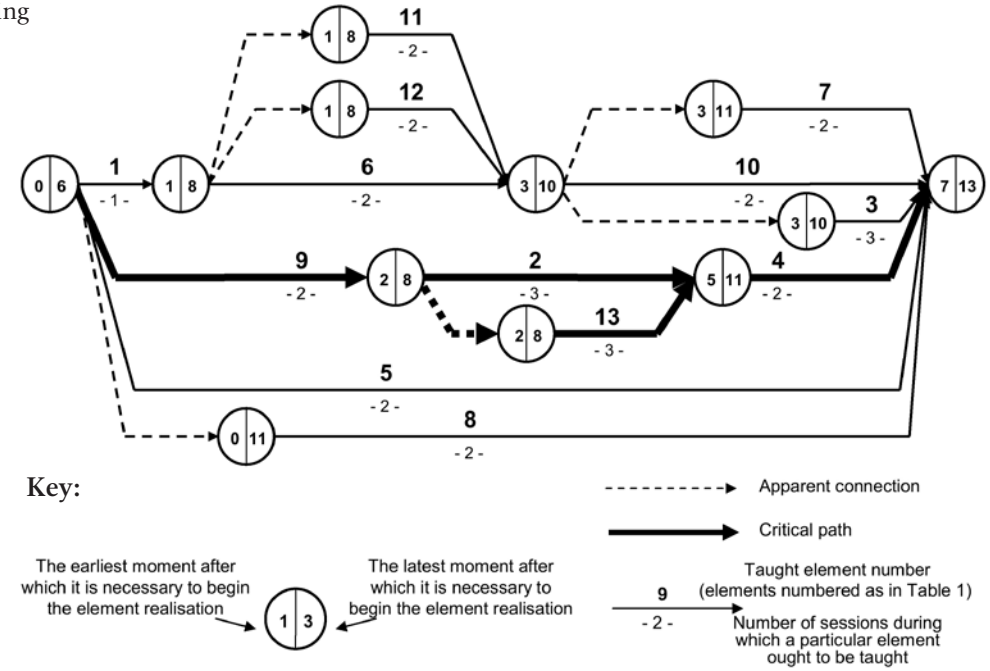
The first stage of developing the algorithm of methodological conduct for the experimental group was to find out the connections between the taught elements (Tab. 1). It consisted in defining which element or elements might be taught directly after acquiring a particular element or in parallel with it. The criterion applied for determining the order was the structure of techniques and their level of difficulty. Then those

Table 2. Algorithm of teaching self-defence elements* in the control groups

Session number	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
Elements taught during particular sessions*	1 3 6 9 10 11 12	2 4 7 13	5 8	–	3 10 13	4 9 11	2 3 6 12	–	2 5 13	7	8	–	–
Number of elements taught during sessions	7	4	2	–	3	3	4	–	3	1	1	–	–

* elements are numbered consecutively as in Table 1.

Figure 2. Network model of teaching the self-defence elements



connections were projected with the use of the critical path method. The model constructed in this way was completed with the number of sessions necessary, according to experts, to master the particular elements by the examined group. This number was determined through consultations with three coaches with the 6th dan and over 20 years of coaching experience. With the use of arrows, the created network determined the process of teaching particular elements and pointed to their order, i.e. those which may be taught simultaneously and those that can be implemented only after acquiring other elements. The arrows only point to a consequence; their length, shape and structure do not represent any kind of magnitude. Every activity (in this case the process of teaching a given element) is always determined by two occurrences (areas) indicating the beginning and the end of teaching. In order to embark upon teaching any element, it is indispensable to finish teaching all the preceding elements (Fig. 2). Based on this model the algorithm of teaching self-defence elements in the experimental group was developed (Tab. 3).

The algorithm was elaborated upon according to boundary conditions which are set by (1) the order of teaching elements, (2) the possible number of elements taught during the particular training sessions and (3) the time necessary to learn the elements. Within these criteria the elements of the programme were grouped so that their number at each session did not exceed five. The implementation of more elements in particular sessions (aimed at shortening the teaching time) would require, as the pilot studies revealed, more time devoted to their teaching at each training session.

The final stage of the study was to evaluate the level of the acquisition of the self-defence elements (i.e. the dependent variable) by the students. It was conducted by five experts with the 1st dan in taekwondo. Three randomly selected self-defence elements were evaluated on a scale from 0 (not mastered) to 10 (mastered very well).

After the experiment the results of those who had met the required criteria were analysed. The average age of those subjects from the experimental group was

Table 3. Algorithm of teaching self-defence elements in the experimental groups

Session number	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
Elements taught during particular sessions*	1 5 8 9	 5 8 9	2 6 11 12 13	2 6 11 12 13	2 3 10 13	 3 4 10	 3 4	7	7	–	–	–	–
Number of elements taught during sessions	4	3	5	5	4	3	2	1	1	–	–	–	–

* elements numbered as in Table 1.

found to be 21.29 years (SD ± 0.76) (N = 32), while that of the control group was 21.18 years (SD ± 0.87) (N = 32). The Student t-test was applied to find out if there were any differences between the groups in body mass, body height and the results of Pilicz general fitness test [12]. As far as the effectiveness of teaching is concerned, two-way analysis of variance (ANOVA) and the Fisher post-hoc test were used to evaluate it.

Results

The experimental and control groups did not differ significantly ($p < 0.05$) in body weight, body height and the results of the general fitness test which consisted of three parts: the standing long jump, 3 kg medicine ball throw and a zigzag run (Tab. 4).

The results of analysis of variance (ANOVA) revealed significant differences (effect Method; $F_{1;310} = 19.02$, $p < 0.001$) between the average values of the evaluation variable depending on which method was used to plan the sequence of the taught elements. It means that the subjects learning with the use of the network method mastered the elements better than their counterparts from the control group. Furthermore, there occurred significant differences (effect Expert; $F_{4;310} = 4.78$, $p < 0.001$) between the experts in evaluating the elements taught. In addition, the influence of the method of planning the teaching programme on how well the self-defence elements were mastered turned out to be dependent on the expert (effect Method*Expert; $F_{4;310} = 2.88$, $p < 0.05$).

Revealing the differentiation between the average of the experts' evaluations required in-depth analysis in order to find out which of them differed from one another and if it was possible to indicate a homogeneous group. The results of the Fisher post-hoc test revealed significant differences between the average of evaluations by expert no. 1 and the other experts (Tab. 5). In this way a uniform group of experts was selected (N = 4) and their evaluations were once again analysed statistically.

Table 4. Characteristics of the examined groups

Parameter	Group*	$\bar{x}$ ± SD	t	p**
Body height (cm)	E	179.81 ± 6.59	0.766	0.447
	C	180.97 ± 5.43		
Body weight (kg)	E	76.31 ± 7.87	0.692	0.492
	C	74.81 ± 9.41		
Standing long jump (cm)	E	221.81 ± 23.25	0.836	0.406
	C	216.97 ± 23.10		
3 kg medicine ball throw (m)	E	10.72 ± 1.10	1.478	0.144
	C	10.23 ± 1.52		
Zigzag run (s)	E	22.62 ± 1.75	0.220	0.827
	C	22.73 ± 2.10		

* E – Experimental groups (N = 32); C – Control groups (N = 32); **p = level of statistical significance

Table 5. Unanimity of experts' evaluations. Probabilities for the Fisher post-hoc test

Expert	1	2	3	4	5
1		0.000	0.019	0.000	0.005
2			0.240	0.674	0.502
3				0.111	0.614
4					0.275
5					

Table 6. Two-way analysis of variance of the level of mastering the self-defence elements evaluated by the four experts

Source	SS	MS	F (df)	p*
Method	7.91	7.91	7.46 (1, 248)	0.007
Expert	3.32	1.11	1.05 (3, 248)	0.373
Method/Expert	4.45	1.48	1.40 (3, 248)	0.244

SS – sum of squares, MS – mean square
* p – level of statistical significance

No significant differences ($p < 0.05$) were revealed between the average of the experts' evaluations. There was also no interaction ($p < 0.05$) between the Method and Expert factors. Moreover, the results of the first analysis, in which the evaluations of all five experts were taken into consideration and where significant differences were observed between the groups as far as the method of planning the teaching programme was concerned ($p < 0.01$), were confirmed (Tab. 6). The subjects taught according to the network plan mastered self-defence elements better ($\bar{x}$ = 7.71; N = 4) than the men from the control group ($\bar{x}$ = 7.20; N = 4), who were taught according to the traditional plan.

Discussion

All teaching plans ought to serve as a guide due to the fact that some events are unpredictable and cannot be planned [13]. As such, it is important to be able to make decisions interactively [14, 15]. It is for this reason that network planning focuses only on systematising the main elements (techniques, actions) and does not interfere in the way sessions are conducted, leaving such issues up to the teacher. It is the teacher who, upon seeing their specific learners and the motor abilities they have, ought to select the proper auxiliary exercises [16]. The development of plans that combine the teaching content in both combat sports and martial arts with an application of the critical path method was the subject of modelling in a theoretical dimension [17, 18]. However, no experimental research comparing the effectiveness of teaching in accordance with network and traditional planning has yet to be done. Only

a few practical studies comparing the effectiveness of teaching based on various plans were carried out in swimming [19] and windsurfing [20]. The authors of those works stated that teaching according to the network plan was more effective than according to the traditional plan. This is confirmed by the results of this study. Male subjects who were learning self-defence techniques through network planning mastered them better than those who followed traditional planning ($p < 0.01$). Thus, the hypothesis stating that a teaching process based on the network plan is more effective than one conducted in a traditional way was confirmed. Despite being split, the teaching method presented in this study is based on a linear sequence set of similar movements taught in a linear set. They are combined with the use of the same element of the performed motor task, e.g. with a lever (in the model presented in Figure 2 these elements were marked with the following numbers: 2, 9, 4). A positive transfer of those elements was predictable since they represent the same type of movement structure. In addition, another factor affecting the level of mastering various motor tasks is the teaching algorithm itself [21].

The main factors distinguishing both methods were the order of implementing the new elements (actions, techniques) and their interval placement. In the network model, the order of taught techniques that made up the whole teaching programme were dependent on such assumed criteria as the structure of movements and their level of difficulty. Using this analogy as a basis makes it possible to transfer a part of the representation of one skill to another [22]. This is opposite to the traditional model, where knowledge, skills, intuition and the experience of coaches were the decisive factors. An important thing is that coaches pay less attention to long-term planning instead concentrate on current session preparation [23]. In comparison to the traditional method, the application of the network planning method was restricted by a complex structure of the model. This structure requires the use of a specialist to carry out an assessment that would make it possible to find out what connections occur between each of the taught elements according to assumed criteria. It is essential to be aware that a plan developed in this way is not an end-all solution. It is only an optimised solution based on the available information and it ought to be modified and improved during the course of its development.

The point of the majority of studies on transfer is, as Hoffman indicates [24], to confirm the elaborated assumptions of a number of theories on teaching and learning conducted by means of examinations carried out in laboratory conditions that are far from the realistic conditions in which these phenomena occur. The teaching approach suggested in this study goes beyond laboratory settings and shows a way in which, in natural conditions, it is possible to increase the effectiveness of instruction along with lowering the time and effort applied in the teaching process. It is worth highlighting that the optimisation of the sets of motor activities put forward in this study does not interfere with the teaching method used in each of the particular elements. A teacher can exert some influence both in the way of communicating [25] and teaching the elements [26]. The study shows that hitherto, the selectively analysed concepts of transfer [27], interference [28], reminiscence [29] and the strategy of teaching [30] can occur simultaneously in the process of teaching and learning.

Conclusions

1. The level of mastering self-defence elements taught according to an algorithm developed on the basis of the network model was significantly higher than in the case of elements taught according to the traditional (intuitive) plan.
2. Teaching based on the network model, which takes into consideration the structure of the taught elements and their level of difficulty, makes it possible to improve the learning process providing a positive transfer from elements previously mastered to those which are being learnt.
3. The development of teaching algorithms exempts coaches from having to analyse when to embark upon teaching a particular element and allows them to concentrate more effectively on how to teach it.

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THE EDUCATION LEVEL AND SOCIO-DEMOGRAPHIC DETERMINANTS OF PHYSICAL ACTIVITY IN CZECH ADULTS

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ABSTRACT
Purpose. Previous research has shown that physical activity (PA) is determined by several variables, such as gender, social economic condition (SES) and place of residence. The main purpose of this study was to study the association between education and PA of the Czech adult population as well as discovering any other socio-demographic factors that may influence PA. **Methods.** A population-based survey conducted in 2008 resulted in 6,989 International Physical Activity Questionnaires (short version) from Czech adults aged 26–69 years. This survey included all regions in the Czech Republic. The data were analysed using frequencies and binomial logistic regression separately for gender and education level. The dependent variables were classified as either the "healthy minimum" and "health promotion" according to the amount of PA criteria the individuals met. **Results.** People with a university education had less PA than other groups of different education levels. The "health promotion" category was met by 9.9% of women and 6.5% of men with elementary education, 67.4% of women and 71.3% of men with a secondary education, and 22.7% of women and 22.2% of men with a university education. The "health promotion" category is also more likely to be met by males (OR 1.33, CI 1.20–1.48, $p < 0.001$), people with elementary (OR 1.67, CI 1.36–2.06, $p < 0.001$) and secondary education (OR 1.60, CI 1.42–1.80, $p < 0.001$), those living with a family with children (OR 1.49, CI 1.07–1.53, $p < 0.001$), living in villages (OR 1.35, CI 1.14–1.60, $p < 0.001$) or small towns (OR 1.27, CI 1.10–1.61, $p < 0.001$), those who have a dog (OR 1.15, CI 1.04–1.27, $p < 0.05$), and those who participate in organized PA (OR 1.30, CI 1.17–1.44, $p < 0.001$). **Conclusions.** There was a surprising low amount of PA among those who studied at a university. Programs that promote PA among university students and future graduates should be considered.

Key words: IPAQ, knowledge, gender, lifestyle, education, leisure time

Introduction

The amount of physical activity (PA) that adults perform usually decreases with age [1]. Other factors that play a role in the decline of PA include socioeconomic status, financial conditions, health, psychological and behavioural variables [2] and educational attainment. The positive effect of education on health comes from the fact that higher educated people usually have better job opportunities, higher annual income, improved housing, better access to nutritious foods and more health insurance. In addition, "higher levels of education could also have direct effects on health through greater health knowledge acquired during schooling and greater personal empowerment and self-efficacy" [3, p. 1503].

The association between the education level and the level of PA in an adult population has been reported by Sallis and Owen [4] and Trost et al. [5], where the relationship between education and PA has found to be positive; the higher education an adult obtains the higher level of PA he/she performs [6]. A general interest in PA, through the use of pedometers, was found in educated people as part of a multi-strategic community-based intervention [7]. This can be explained by possessing better knowledge and understanding of the effect PA has on a healthy lifestyle. As research showed, higher education attainment is related to an improvement in overall health which may increase the probability of performing PA [8]. However, Bergman et al. [9] discovered that having a university or college degree was negatively associated with higher PA according to the IPAQ scoring protocol they used in Sweden. It was postulated that those with higher education levels may participate in more leisure-time exercise, but due to their less physically demanding professions the total amount of PA was in fact lower.

Therefore, the aim of this study was to define what factors influence an individual's PA level, with emphasis placed on the level of education from a sample population of Czech adults. Regarding this study, the societal, economic and political situation of the Czech Republic before 1989 and after the "Velvet Revolution" is an important factor that needs to be taken into consideration. These changes significantly influenced various spheres of life for Czech citizens as they did for many post-communist countries. Most Central European countries tended to generally copy the societal development

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of western countries in various economic, health and sociological indicators with 10 to 20 years of delay. And, except for technological development, there is even a repetition of the undesirable trends found in Western society such as the rise of obesity, time spent watching television or on the computer, a general decline in PA and unhealthy eating habits. Contemporary trends from Western Europe lead to more time spent at work, higher income, and more possibilities in ways to spend leisure time. For example, in 1984, only 27% of adults (20 to 69 year-olds) practiced PA, however, in 2007 this number increased to 45% [10]. Nonetheless, the problem of balancing time between work, family life, and leisure occurred in many post-communist countries.

In the Czech Republic, a study was conducted [11] on PA with university students. This population segment was found to be sufficiently active with more than 85% meeting their PA recommendation, yet most university students do not have a family or work responsibilities. In a study on Icelandic youth [12], researchers found that lower BMI, overall PA and good dietary habits were associated with higher academic achievement. However, the possibility of a mutual association between PA and education was not considered. Similar results were obtained in a Texas study [13], where students who were physically active were more likely to do well academically, have better attendance and to have fewer disciplinary actions.

In contrast to students, adults who work and have families lead busy lives. In addition, someone with a university education may have more responsibility and may spend more time at work. Such time is often spent sitting at a desk and participating in more sedentary activities such as writing, planning, and consulting. The free time that such individuals may have could conflict with family responsibilities, individual wishes and personal chores, and the PA necessary for a healthy life does not factor as a priority. The potentially stressed lifestyle of those with a university education is justifiably a matter of concern and must be addressed. Roberson and Babic [14] described how adults in central Europe (Croatia) have problems with finding time for PA. Their research also showed the effect urban areas can have on health. The level of physical activity of Czech adults was previously found to be significantly influenced by the size of the locality where one lived – the larger the size of the city the lower total PA [15].

Therefore, the purpose of this study was to find which factors, such as the attained education level, have an effect on the level of PA of Czech adults. We assumed that with an increasing level of education, the amount of actual PA in leisure-time would also increase [16]. In addition, we wanted to know whether adults with different education levels (elementary, secondary and university education) adhere to their PA recommendations (judged by how many of the PA criterion they met) in the Czech Republic. We were also interested in other socio-demographic variables that may influence individuals of different education in meeting their PA recommendations.

Material and methods

A survey was conducted in the Czech Republic during the spring of 2008. The participants were randomly chosen based on their residence and represented all Czech regions. A computer program randomly selected 400 participants from an address database from the Ministry of the Interior of the Czech Republic; after the data was updated a representative sample of 250 remained. Trained coordinators visited those living at those addresses and handed out envelopes with the International Physical Activity Questionnaires – Short Version (IPAQ-SV). If they failed to meet the selected individual, they were advised to visit the nearest neighbour. The coordinators explained the meaning of the survey, how to complete the questionnaire as well as the deadline for handing back the completed questionnaires. Participation in the study was voluntary. The coordinators did not compel the questioned individuals to complete all the information and did not check for correctness and completeness.

The questionnaire used was the official Czech short version of the IPAQ [17], used to determine the frequency, type and duration of physical activity of Czech citizens and considered reliable and standardised [18]. It was translated by professional translators and followed the "Guide to Cultural Adaptation and Translation of the IPAQ Instruments". The collected physical activity data is self-reported and considered suitable for monitoring a population [19]. The sample characteristics are presented in Table 1.

The information collected included the length (in minutes) and frequency (days) of PA (walking, moderate PA and vigorous PA) in different domains (as part of their occupation, transportation, leisure-time, domestic chores and gardening). They also stated the amount of time spent sitting per day, however, this data was not subject to analysis in this study. People also listed personal information (see Appendix), such as gender, age, height and weight, years of education, whether they smoked, place of residence (location), living status, type of living arrangement, whether they owned a dog, car, bike or cottage and the level of participation in organized PA (whether yes or no and if yes how many times per week).

From 10,571 completed questionnaires (IPAQ-SV), we only analysed adult participants who were 26 to 69 years old. In addition, all participants with missing information were excluded from the analyses. After an adjustment of the obtained data according to the Guidelines for Data Processing and Analysis of the IPAQ, a total of 6,989 completed data sets remained. For data analysis we decided not to use the study's original classification of PA based on three levels of physical activity (IPAQ scoring protocol), because it does

not meet the requirement for countries with a higher level of PA in its citizens. For more details see Bauman et al. [20], where 62.9% of adults in the Czech Republic are classified as belonging to a highly active population. Therefore, we oriented our findings on the physical activity recommendations on the analysis done in Healthy People 2010 [21]. A similar study on PA recommendations was published by Bergman et al. [9].

Following this example, we classified three criteria for individuals meeting their PA recommendations according to the results from the questionnaire: 3 × 20 minutes of vigorous PA per week, 5 × 30 minutes of moderate PA per week, and 5 × 30 minutes of walking per week. Then we established one category as a "healthy minimum" for those adults who met only one PA criterion (no matter which one), and one category as "health promotion" for those who met two or three of the PA criteria. These categories were the dependent variables.

We categorized our sample according to gender and the self-reported length of education according to Czech education system – elementary (≤ 9 years of education), secondary (10–13 years of education) or university educated (≥ 14 years of education). We also categorized the sample according to four age groups (26–34, 35–44, 45–54, and 55–69 years old); BMI (less than 25 kg/m^2 and ≥ 25 kg/m^2), and smokers and non-smokers. We classified the sample as those living in a metropolis (more than 100 thousand inhabitants), city (30,000 to 100,000 residents), town (1,000 to 29,999 residents), or village (less than 1,000 inhabitants). In addition, other factors included if one lives alone or with a partner or with a family with children, if they have a dog, and whether he/she participates in organised PA. Data from the questionnaires were analysed using SPSS Statistics statistical software, version 18.0 (IBM, USA). We analysed the frequencies and percentage separately for gender (Tab. 2). We also incorporated binomial logistic regression for data analysis; the dependent variables were the criteria for PA and the independent criteria were the socio-demographic characteristics.

Results

The results of our surveys are presented in four tables. The mean characteristics of the men were: age 43.5 ± 10.6 years, height 179.7 ± 7.3 cm, weight 85.2 ± 11.6 kg and BMI 26.4 ± 3.2 kg/m^2, and in women: age 43.4 ± 10.6 years, height 166.5 ± 6.2 cm, height 66.6 ± 10.8 kg and BMI 24.0 ± 3.9 kg/m^2. As shown in Table 1, there were more male participants who were overweight and

Table 1. Sample characteristics of the short version IPAQ

Participant characteristics	Females (*N* = 3540)		Males (*N* = 3449)	
	N	%	*N*	%
Age: 26–34 years	933	26.36	918	26.62
Age: 35–44 years	1144	32.32	1053	30.53
Age: 45–54 years	968	27.34	970	28.12
Age: 55–69 years	495	13.98	508	14.73
BMI < 25	2346	34.82	1201	66.27
BMI ≥ 25	1194	65.18	2248	33.73
Smokers	843	29.78	1027	23.81
Education – elementary	324	6.49	224	9.15
Education – secondary	2329	63.09	2176	65.79
Education – university	887	30.42	1049	25.06
Large city (> 100,000 residents)	744	21.25	733	21.02
Bigger town (30–100,000 residents)	816	23.80	821	23.05
Small town (1000–29,999 thousand residents)	1396	38.59	1331	39.44
Small village (< 1,000 residents)	584	16.35	564	16.49
House	1687	48.59	1676	47.66
Apartment bloc (Flat)	1853	51.41	1773	52.34
Live alone	240	8.96	309	6.78
Live with a partner	1420	40.59	1400	40.11
Live as family with children	1880	50.45	1740	53.11
Have a dog	1478	40.88	1410	41.75
Participation in organized PA	1227	34.53	1191	34.66
Meeting 1 PA criterion	1550	37.81	1304	43.79
Meeting 2 PA criteria	1000	27.86	961	28.25
Meeting 3 PA criteria	183	9.94	343	5.17

PA – physical activity, *N* – number of participants

Table 2. Meeting physical activity recommendations by gender and level of education

Level of education	Women (*N* = 3540)						Men (*N* = 3449)					
	none		healthy minimum		health promotion		none		healthy minimum		health promotion	
	N	%*	*N*	%*	*N*	%*	*N*	%*	*N*	%*	*N*	%*
Elementary education	70	21.6	137	42.3	117	36.1	50	22.3	90	40.2	84	37.5
Secondary education	532	22.9	1000	42.9	797	34.2	461	21.2	785	36.1	930	42.7
University education	205	23.1	413	46.6	269	30.3	330	31.5	429	40.9	290	27.6
Total	807	22.8	1550	43.8	1183	33.4	841	24.4	1304	37.8	1304	37.8

Healthy minimum – meeting one PA criterion; health promotion – meeting two or three PA criteria;
%* – percentage within gender and the level of education

Table 3. Unadjusted odds ratio (OR) and 95% confidence intervals (95% CI) for the "Healthy minimum" and "Health promotion" associated with the socio-demographic determinants

Factors	"Healthy minimum" category				"Health promotion" category			
	N	%+	OR	95% CI	*N*	%+	OR	95% CI
Gender								
Females	2733	77.2	ref.		1183	33.4	ref.	
Males	2608	75.6	1.05	0.94–1.19	1304	37.8	1.33***	1.20–1.48
BMI (kg/m^2)								
≥ 25	2535	73.6	ref.		1207	35.1	ref.	
< 25	2806	79.1	1.38***	1.22–1.55	1280	36.1	1.15**	1.03–1.28
Smoke								
No	3940	77.0	ref.		1837	35.9	ref.	
Yes	1401	74.9	.88	0.78–1.0	650	34.8	0.91	0.82–1.02
Education								
Elementary	428	78.1	1.61***	1.27–2.03	201	36.7	1.67***	1.36–2.06
Secondary	3512	78.0	1.42***	1.26–1.62	1727	38.3	1.60***	1.42–1.80
University	1401	72.4	ref.		559	28.9	ref.	
N. of residents								
> 100.000	1109	75.1	ref.		454	30.7	ref.	
30.000–100.000	1239	75.7	1.01	0.85–1.19	561	34.3	1.13	0.97–1.31
1.000–29.999	2106	77.2	1.08	0.93–1.26	1020	37.4	1.27***	1.10–1.46
< 1.000	887	77.3	1.09	0.90–1.31	452	39.4	1.35***	1.14–1.60
Living status								
Alone	403	73.4	ref.		157	28.6	ref.	
With a partner	2121	75.2	1.11	0.90–1.37	973	34.5	1.30*	1.06–1.61
Family with children	2817	77.8	1.27*	1.03–1.57	1357	37.5	1.49***	1.21–1.83
Dog								
Don't have	3120	76.1	ref.		1390	33.9	ref.	
Have	2221	76.9	1.04	0.93–1.16	1097	38.0	1.15**	1.04–1.27
Participation in organized PA								
No	3442	75.3	ref.		1552	34.0	ref.	
Yes	1899	78.5	1.20**	1.06–1.36	935	38.7	1.30***	1.17–1.44

PA – physical activity, *N* – number of participants, OR – unadjusted odds ratio, 95% CI – 95% confidence intervals,
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$
%+ – Unadjusted percentage

Table 4. Unadjusted odds ratio (OR) and 95% confidence intervals (95% CI) for "health promotion" in relationship socio-demographic determinants

Factors		Women EE (*N* = 324)			Men EE (*N* = 224)			Women SE (*N* = 2329)			Men SE (*N* = 2176)			Women UE (*N* = 887)			Men UE (*N* = 1049)		
		%⁺	OR	CI	%⁺	OR	CI	%⁺	OR	CI	%⁺	OR	CI	%⁺	OR	CI	%⁺	OR	CI
Age (years)	26–34	49.0	ref.		31.4	ref.		30.7	ref.		45.0	ref.		29.7	ref.		28.1	ref.	
	35–44	31.0	0.41*	0.18–0.94	39.0	1.13	0.45–2.80	36.3	1.23	0.98–1.54	43.4	0.93	0.74–1.18	33.3	1.01	0.68–1.50	28.4	0.99	0.66–1.50
	45–54	41.3	0.70	0.32–1.55	42.6	1.37	0.60–3.13	35.5	1.29*	1.00–1.66	44.0	1.00	0.78–1.28	29.6	0.91	0.61–1.34	27.4	1.10	0.74–1.65
	55–69	30.7	0.53	0.24–1.17	35.9	0.92	0.39–2.19	33.5	1.33	0.95–1.85	34.9	0.72*	0.54–0.97	24.3	0.77	0.41–1.45	25.6	1.20	0.72–2.02
BMI (kg/m^2)	< 25	41.0	ref.		35.0	ref.		34.4	ref.		48.4	ref.		29.5	ref.		30.4	ref.	
	≥ 25	32.4	0.75	0.44–1.27	38.4	1.24	0.64–2.42	33.8	0.95	0.78–1.15	40.0	0.71***	0.59–0.86	32.8	1.31	0.92–1.85	25.8	0.81	0.61–1.09
Smoke	no	37.9	ref.		42.9	ref.		35.0	ref.		43.6	ref.		30.3	ref.		28.0	ref.	
	yes	32.0	0.71	0.40–1.25	31.4	0.56	0.30–1.03	31.7	0.91	0.74–1.12	41.1	0.93	0.77–1.11	30.4	1.08	0.71–1.65	26.4	1.00	0.71–1.40
Number. of residents (thousands)	> 100	28.3	ref.		33.3	ref.		26.9	ref.		41.9	ref.		26.8	ref.		24.7	ref.	
	30–100	36.6	1.55	0.71–3.38	41.3	1.18	0.50–2.82	34.8	1.44**	1.10–1.90	37.1	0.81	0.62–1.06	27.7	1.01	0.65–1.55	30.9	1.29	0.88–1.88
	1–29,999	39.3	1.67	0.81–3.47	34.9	0.98	0.45–2.14	36.9	1.51**	1.17–1.94	42.9	1.01	0.79–1.30	35.9	1.36	0.93–1.99	27.8	1.11	0.77–1.59
	< 1	37.0	1.62	0.70–3.74	43.2	1.32	0.50–3.45	35.5	1.37	0.99–1.88	50.2	1.30	0.96–1.75	24.3	0.75	0.42–1.33	26.9	1.06	0.62–1.81
Living status	alone	24.0	ref.		18.5	ref.		18.2	ref.		39.3	ref.		18.9	ref.		33.0	ref.	
	with a partner	33.3	1.50	0.69–3.24	38.5	2.17	0.71–6.65	34.3	2.09**	1.32–3.32	41.2	1.11	0.79–1.56	29.8	1.73	0.82–3.68	24.0	0.61	0.36–1.02
	family with children	44.9	2.32**	1.02–5.23	42.0	2.57	0.84–7.83	35.9	2.27***	1.42–3.60	44.5	1.23	0.88–1.72	31.8	1.87	0.89–3.96	29.6	0.81	0.48–1.37
Home	house	36.0	ref.		40.7	ref.		36.7	ref.		45.5	ref.		33.4	ref.		28.8	ref.	
	flat	36.3	1.49	0.85–2.62	37.5	0.96	0.49–1.86	32.0	0.93	0.76–1.13	40.1	0.91	0.75–1.11	27.6	0.75	0.54–1.03	26.6	0.90	0.67–1.23
Dog	don't have	31.1	ref.		35.2	ref.		32.5	ref.		41.5	ref.		30.3	ref.		26.6	ref.	
	have	42.4	1.73*	1.05–2.84	40.2	1.12	0.62–2.04	36.6	1.16	0.97–1.39	44.8	1.10	0.92–1.32	30.4	0.88	0.64–1.20	29.5	1.19	0.88–1.61
Participation in organized PA	no	36.3	ref.		38.0	ref.		32.1	ref.		42.0	ref.		25.7	ref.		23.5	ref.	
	yes	35.3	0.86	0.43–1.72	35.0	0.82	0.39–1.73	38.6	1.39***	1.15–1.68	44.2	1.05	0.86–1.27	35.5	1.57**	1.17–2.11	33.5	1.65***	1.24–2.19

PA – physical activity
N – number of participants
OR – unadjusted odds ratio
95% CI – 95% confidence intervals
* $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$
%⁺ – unadjusted percentage

obese than normal weight and more in the 35–44 years old age category. There were more non-smokers and more with a secondary education. In addition, a larger population sample lived in small towns (1 – 29,999 inhabitants), in flats rather than single dwellings, in families with children, and without a dog. Participants aged 35–44 years had the highest total PA score (73.9 MET-hours/week), followed by participants aged 26 to 34 years (72.1 MET-hours/week) and those aged 45 to 54 years (71.1 MET-hours/week). The lowest level of total PA was found in the older age group, 55 to 69 years old (67.6 MET-hours/week). These values are overall higher, except for the older age group, when compared to a Croatian study [22] which used the long version of IPAQ.

Table 2 presents information on the level of PA by one's gender and level of education. Women, regardless of their level of education were more likely to meet their "healthy minimum". Meeting the "health promotion" for women was found to be true for those with elementary education. However, more men with secondary education met the "health promotion" level rather than the "healthy minimum". Men and women with university education were the ones who indicated no PA. According to the IPAQ, 33.4% of women met three PA criteria compared to 37.8% of men. One third of respondents met all the PA criteria. In addition, 22.8% of women and 24.4% of men are considered to be sedentary (not meeting any of their PA recommendations).

Table 3 shows the results of binomial logistic regression on both PA categories. A significant greater number of males met the "health promotion" category than females. Overweight participants are less likely to meet the "healthy minimum" or "health promotion" category; smokers are also less likely to meet the healthy minimum category. Surprisingly, those with a university degree are less likely to meet the "healthy minimum" as well as "health promotion" category. Those who live in smaller cities, such as 30,000 inhabitants or less, are more likely to meet the "health promotion" category. People living with a family with children are more likely to meet both categories; those who live with a partner are more likely to meet "health promotion" as well as people having a dog. Lastly, the sample showed that those who participated in organized physical activity were more likely to meet both categories.

The "healthy minimum" category is more likely to be met by those whose BMI is below 25 kg/m^2, who do not smoke, have elementary or secondary education, live in a family with children and participate regularly in organized PA (Tab. 3). The "health promotion" category is more likely met by men, people with a BMI below 25 kg/m^2, do not have an university education, do not live alone, have a dog and participate regularly in organised PA.

We investigated if the category of "health promotion" (adjusted for gender and education) is associated with the various independent variables obtained from the IPAQ. As presented in Table 4, we separated the men and women according to their education level. Binomial regression analysis showed that in those who have an elementary education, the "health promotion" category is met only by women living with families with children as well as having a dog. Women with secondary education most commonly meet the "health promotion" category if they reside in a town of 100,000 or less as well as live with a partner or family with children. Secondary educated men who have a high BMI did not meet the "health promotion" category at all. Concerning women and men with a university education, only those who participated in some organized physical activity met the health promotion.

In addition, elementary educated women are more likely to meet the "health promotion" category if they live with a family with children and have a dog. Elementary educated men were not influenced by any of the examined variables when meeting the "health promotion" category. Meeting the "health promotion" category in secondary educated men is mainly a mutual interaction of body-mass index (the ideal being below 25 kg/m^2). Obese or overweight men are less likely to meet the "health promotion" category. In secondary educated women, more variables influenced them meeting their PA recommendations for the "health promotion" category such as place of residence, not living alone and participation in organized PA. With university educated women and men, we found only one independent variable that influenced meeting the "health promotion" category, and this was participating in organized PA. University educated women met the "health promotion" category more likely whether they lived with other adults or with a family with children. Although this result was not statistically significant, it may help persuade people to increase PA in their families or friends.

Discussion

Studying the various determinants of physical activity was the goal of many studies [23] as well as books [4]. To the best of our knowledge, a study on the level of physical activity with adults considering education level and other socio-demographic determinants has not been previously conducted in the Czech Republic. In the previous studies, evidence on the positive influence of specific determinants has been found, but some of the results from these scientific studies are weak or have mixed conclusions. The determinants that were found to have a positive association on overall physical activity from demographic and biological studies are: gender (male), genetic factors, socioeconomic status (income), and education [4, p. 115–116]. The study also mentioned psychological, cognitive and emotional factors, behavioural attributes and skills, social and

cultural factors (e.g. social support from a partner or family), physical environment factors [24] and physical activity characteristics that may have positive or negative influence on PA. In some of the determinants of PA, there is a lack of evidence (e.g. size of community, parents' education) or the results were found to be inconsistent. Although a number of demographic determinants were obtained from this study's questionnaire, based on the Czech version of the IPAQ-SV, we mainly focused on the education level of the Czech adult population.

Comparable to our study, Špaček [25] studied exercising and non-exercising adults (N = 1,124) by noting their gender (male or female), age (young or old), size of location (city, town or village), education and father's education (elementary, apprentice, secondary with state exam or university education). Yet, in contrast to our findings, he found that people with a university education are 4.5 times more likely to exercise than those with elementary education. Špaček's study [25] included university students, whereas the sample from our study contained working adults with a university degree. In his study, exercising adults were more likely to be males, those living in cities, of a younger age, and whose father had a university degree. These factors (in a regression model) explained only 40% of the variance, while the rest of the influences (60%) were unknown or not studied. This positive relationship between more years of education and increased physical activities was reported in other studies as well [2, 26–30]. Bertrais et al. [31] found this positive relationship between education level and meeting PA recommendations, but only in women. In one Croatian study [22], the level of education showed an inverse association with total PA but a positive association with leisure-time PA. We did not study each domain of the PA practised, but the lower total PA in people with a higher education level is probably connected with their sedentary jobs, resulting in more sitting time [29]. Thus, leisure-time PA cannot substitute for the time spent at work even though university graduates might have more leisure-time PA. This could stem from that fact that they have less physically demanding jobs, and as a result their overall PA is less than those with lower education levels.

On the other hand, Mitáš et al. [15] studied the influence of socio-economic status (SES) on PA and included the number of years of finished education as one criterion of SES (others were way of living, material conditions and income). This is congruent with our findings, where Czech adults with a very high SES, both women and men, performed the least amount of PA (in MET-min/week). However, in a study by Al-Hazzaa [32], using the short version of the IPAQ in Riyadh in Saudi Arabia, found that activity levels did not show significant relationships with education level or job hours per week.

According to Bernstein et al. [28], Swiss urban adults (in Geneva) with secondary education are the most sedentary group of men and women (57% of men and 60% of women). Whereas in our research, Czech men with a university degree could be labelled as the sedentary group (31.6%), while sedentary Czech women were those with secondary and university degree (23.2%). Regardless of the education level, PA is evidently less than in Switzerland. Similar to our study, the most active Swiss citizens were those with secondary education (56% of men and 54% of women). The difference between our studies may be explained by the different methods used to collect data. The Geneva study obtained data from persons aged 35–74 years who generally have a higher sedentary lifestyle. In addition, the country of birth may reflect behaviours, genetic factors, cultural habits and social factors.

The "higher physical active" category level of PA in the Bergman et al. study [9] can be compared with our "health promotion" category. The Bergman et al. study found similar results, where people in the more active category are more likely to be male and those with high school education, which is comparable to the Czech secondary education level. Also, people living in villages or small towns are more likely to be physically active. This may be due to the small distances easily reached by walking or cycling, while people living in cities rely on their own car for transportation. Similar results were found in other studies [22, 29, 33], where people living in large towns were less likely to be sufficiently active than those living in small towns. In a French study [31], only women not living in urban areas were more likely to meet their PA recommendations.

Living alone has been shown to be negatively associated with the "health promotion" category. This is congruent with the study by Ståhl et al. [34], where people who perceived low social support from their personal environment (family, friends etc.) were more likely to be sedentary. Interpersonal relationships may influence physical activity and establish new social networks and help individuals learn about physical activity and its benefits [8]. Family or peer influences have been found to have positive association with PA and exercise in other research [23, 35] especially in spontaneous PA programs during leisure time. But, interestingly, in some studies [5, 9] authors also found that having a family or living with a partner may negatively influence the level of PA. Our finding that smokers and obese people are less likely to meet their PA recommendations, regardless of gender, is in accordance with many other studies [9, 23, 26, 28, 31].

There are several limitations of this study that should be taken into consideration. One limitation stems from the fact that the IPAQ questionnaire is a self-reported instrument, yet it appears to have acceptable measurement properties [36]. In addition, it is used in many countries for international comparison

[29, 37]. Although our survey incorporated all regions of the Czech Republic, there was not a consistent amount of returned surveys from each region. For example, Ostrava had a 16.3% participation rate while the Karlovy Vary region only 1.2%.

Conclusion

Our results surprisingly found that adults from the Czech Republic with a university education, regardless of gender, had a lower PA level than those with lower education levels. Those with a university education may have more time constraints, especially those with children. This can be alleviated with more in-depth physical education at schools and sports clubs that stress the lifelong importance of PA. Furthermore, university sports clubs and physical education classes should offer courses in time management as this would help those with time constraints to budget time for PA. Community health and PA programs that can include children would be an added benefit.

Overall, the physical activity and leisure-time PA of adults is an important topic. We would like to include several suggestions as based on the result of this study.

First, since the research shows that more PA is practised by those who live in small towns; future urban planners ought to consider restructuring our cities to appear like a small town. Reliable roads, lighting, and sidewalks all contribute to the feeling of having a safe atmosphere for outdoor activity. Furthermore, parks can help to contribute to the amount of green space as well as offering a convenient place for exercise. Parks and walking areas could also have an education program with information on walking. Tax incentives, carsharing as well as advocating public transportation could all promote walking. Placing parking facilities half of a kilometre away from one's residence could promote a natural way to meet daily PA.

Second, a certain amount of restructuring of the physical education system needs to occur in school systems. Physical education needs to focus its curriculum on lifetime health and wellness. The sport preferences of students must coincide with the needs for PA [38].

Third, universities should encourage some type of wellness or fitness class as a requirement for all students. These classes should demonstrate and encourage fitness and sports, such as walking, Nordic walking and overall physical health for one's entire lifetime.

Lastly, businesses and corporations should take an active role to encourage more PA with their employees. Rewarding employees or offering some kind of motivation for those who maintain PA can be encouraged with vacations or days off. The work of physical education teachers should also be found in the workplace. Weekly classes on general health and PA geared for adults can be offered at work, as well as showing how parents can exercise with their children at home. Goal-oriented individuals may be motivated to use pedometers as way to lose weight and to begin to be physically active. The role of physical education is not to entertain children; physical education should be a viable part of everyone's life and continue throughout one's adult life.

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Appendix

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

   _____ **days per week**

   ☐ No vigorous physical activities → ***Skip to question 3***

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

   _____ **hours per day**
   _____ **minutes per day**

   ☐ Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

   _____ **days per week**

   ☐ No moderate physical activities → ***Skip to question 5***

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

   _____ **hours per day**
   _____ **minutes per day**

   ☐ Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

   _____ **days per week**

   ☐ No walking → ***Skip to question 7***

6. How much time did you usually spend **walking** on one of those days?

   _____ **hours per day**
   _____ **minutes per day**

   ☐ Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

_____ hours per day

_____ minutes per day

☐ Don't know/Not sure

DEMOGRAPHIC QUESTIONS

1. Gender ___ Man
___ Woman

2. How old were you on your most recent birthday?
___ Number of Years
___ I don't know /I am not sure
___ I refuse to answer

3. How many years of education have you completed?
___ Number of Years
___ I don't know /I am not sure
___ I refuse to answer

4. Do you have a paid job at the present time?
___ Yes
___ No → *Go to Question 6*
___ I don't know /I am not sure. → *Go to Question 6.*
___ I refuse to answer → *Go to Question 6.*

5. If your answer was yes, how many hours weekly do you work at your job?
___ Number of hours per week
___ I don't know /I am not sure
___ I refuse to answer

6. How would you classify the place where you live?
___ A large city (100 000 inhabitants or more)
___ A medium-sized town (30 000 –100 000 inhabitants)
___ A small town (1,000 – 29,999 inhabitants)
___ A small community or village (less than 1,000 inhabitants)
___ I don't know/ I am not sure
___ I refuse to answer

Additional information

Height (cm): ☐ **Weight** (kg): ☐

Place where you live: Town ☐ Postcode ☐ **Nationality**: ☐

Housing (house-H, block of flats-F): ☐ **Smoker** (yes-Y, no-N): ☐

Household (live alone-A, family-O, family with children under 18-F): ☐ **Do you own a dog** (yes-Y, no-N): ☐

Do you have access to any of the following (yes-Y, no-N) Bike ☐ Car ☐ Holiday/weekend home ☐

Organized participation in physical activity: (Please indicate whether you participate in any organized physical activity. If so, how many times a week: Never-N, Once a week-1, 2times a week-2, More than twice a week--) ☐

Which physical activity

do you participate in most regularly? ☐

would you like to participate in? ☐

I don't participate in physical activity! ☐

Thank you for taking the time to complete this questionnaire.

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WEALTH AND THE QUALITY OF LIFE FOR PHYSICAL EDUCATION TEACHERS

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ABSTRACT
Purpose. The purpose of the study was to assess the perceived quality of life of physical education teachers depending on their standard of living. **Methods.** The study included 287 graduates of the University Schools of Physical Education in Poznań and Wrocław, of whom 165 were men and 122 were women aged 40 to 60 years. The perceived quality of life was assessed on the basis of Kowalik's Quality of Life Questionnaire. The relationship between the perceived quality of life and the standard of living was then established, with statistical analysis performed using two stratum weights (*k*), the Mann-Whitney *U*-test and Spearman's rank correlation (*r*). **Results.** The majority of the studied participants positively assessed their lives, with no significant differentiation found between genders in their satisfaction in various spheres of life. However, only half of the respondents were satisfied by their level of income. A higher standard of life was found to be linked to higher life satisfaction, where the level of wealth significantly differentiated only in the perceived quality of life in the studied women. **Conclusions.** The surveyed graduates were found to be a very homogenous group of professionals in terms of their quality of life level. Only financial status was found to significantly differentiate in the level of satisfaction of the surveyed women.

Key words: quality of life, wealth, the physical education teachers

Introduction

A sense of the quality of life is a complex measure of the subjective psychological well-being of an individual. There can be no doubt that every person wants to feel fulfilled, happy and experience only happy moments in life. However, this satisfaction can be derived from various parts of life. Hence, more is being written and said about the aspect of the quality of life, but difficulties arise when one attempts to define this concept in relation to a specific individual or social group. Generally, the World Health Organization [1] outlines the quality of life as an individual's perception of their life situation in terms of their culture and adopted value system, which influences their life objectives, expectations, standards and interests.

According to Włodarczak [2], the quality of life is made up of such aspects as self-esteem, education, financial standing, having a life partner, good people relationships, coping with life, the ability to set and carry out goals, personal development, a good physical and psychological condition. Kiebert [3], on the other hand, feels that the quality of life is made up by one's physical health, mental health, social relationships, physical fitness, financial standing, spirituality, sexuality and self-esteem. In this study, the concept of the quality of life and personal happiness decided to also take into account the subjective perception of one's own prosperity, the welfare of their life, a feeling of overall happiness, satisfaction and mental well-being [2].

Physical education graduates feel a discrepancy between their level of education, the large amount of responsibility and difficulty they have at work and their financial compensation. According to Cieśliński [4], low wages and difficult working conditions are the main reasons that nearly one in three physical education teachers consider leaving their jobs. It has been found that physical education teachers feel that their professional specialization is considerably undervalued in comparison to other educated individuals in other occupations. The reasons for this have not changed over the years: physical culture's low standing in society, low wages, difficult working conditions and physical education's overall low standing in both schools and in society [4]. Therefore, it seems interesting to know if physical education teachers feel a sense of inferiority in relation to other professionals and, if so, whether this affects their perceived quality of life.

As such, the aim of this study was to determine the relationship between the financial standing of physical education teachers and their quality of life, with the following research question posed: In a group of surveyed respondents, does the perceived quality of life differ based on one's gender and financial status?

Material and methods

Research was conducted on 287 graduates from the University of Physical Education in Poznań and Wrocław, of which 165 were men and 122 women. The age of the subjects ranged from 40 to 60 years old, with

the largest group being those aged 50 to 60 years old (over 50% of the sample). 86% of subjects worked as physical education teachers. Their perceived quality of life was based on Kowalik's Quality of Life Questionnaire [5], which, as a measurement tool, assumed that an individual is able to experience their life in two ways – to live and to learn. In other words, the quality of life is treated as a reflection of one's own life and the experience of different mental states (as a subjective quality) over the course of one's life [5, 6].

Financial standing was determined by an individual's average monthly income split per person in their household; each of the respondents self-evaluated their own financial standing and family size. Based on the above, the homogeneity of the sample was divided into two socio-economic groups. Individuals who rated their financial standing as "high" were those whose average monthly income per person in a household exceeded 2780 PLN gross (2780 PLN gross was the average salary of teachers in 2010 [7]), and therefore, treated as those with a high standard of living. Similarly, based on the above classification, the respondents who rated their financial standing as good or average, with their monthly average income per person in a household not exceeding 2780 PLN gross were classified as a having an average standard of living. The sample size, split by their standard of living, is presented in Table 1. The majority of the respondents ranked themselves as having an average standard of living, even though one-third of the respondents were classified with having a high financial standing.

As was mentioned, research on the perceived quality of life was assessed by the "Perceived Quality of Life Scale" developed by Kowalik [5], which is based on Campbell's "Quality of Life Scale" [8]. The questionnaire was made up of two parts [6]. The first was a reflective evaluation of one's life that consisted of 15 spheres (i.e., marriage, family life, health, neighbors, friends and acquaintances, house chores, job, life in Poland, leisure, education level, earnings and savings, domicile, place of residence, standard of living, and "Me"). The respondents rated their satisfaction with these spheres using the five-point Likert scale, from strongly satisfied (4 points) to strongly dissatisfied (0 points). The total score of the 15 spheres allowed for an overall assessment of an individual's quality of life.

The second part of the survey was experiential, it assessed a person's perceived well-being over a period of time. Similarly, a five-point scale was used to assess the occurrence of nine positive emotional states and thirteen negative emotional states, where positive emotions were given positive points while negative emotions negative points. The total score represented the emotional state that a respondent recently felt.

All of the collected data were subjected to comprehensive analysis using the following statistical methods: stratum weights (*k*) for the ranked variables, the Mann-Whitney *U*-test and Spearman's rank correlation (*r*).

Table 1. The sample size of the respondents, divided by their rated standard of living

Standard of living	Men	Women	Total
Average	105	58	163
High	59	35	94

Results

The respondents all belonged to a professional group of individuals with a relatively high level of education but one that has a relatively low income [4]. In this study, the surveyed graduates were found to be considerably satisfied with their education (97%) and professional career (over 89%). This applied to both men and women (Tab. 2). This, however, did not reflect into a feeling of satisfaction with earnings. Only half of the surveyed women and slightly more than 60% of the men felt satisfied with their income. The respondents felt the largest amount of satisfaction with their family life, friends, their domicile and place of residence. Over 80% of the respondents were also satisfied with their health and themselves. Although men were found to be more satisfied than women in the surveyed spheres of life, most of these cases were not statistically significant.

Further analysis on the respondent's rating of positive and negative emotions was summarized by comparing the frequency of these emotions (Tab. 3 and 4). Both groups were found with similar results when eval-

Table 2. The perceived quality of life – a comparison of percentages

Perceived quality of life	Men (%)	Women (%)	Two stratum weights of the tested variables (k)
Marriage	81	78	0.49
Family life	92	91	0.30
Health	84	84	1.31
Neighbors	64	77	2.36*
Friends	85	96	3.11*
House chores	76	72	0.84
Job career	89	94	1.37
Life in Poland	59	66	1.13
Leisure	77	77	0.04
Education	97	97	0.28
Earnings	65	50	2.63*
Domicile	88	91	0.93
Place of residence	86	90	1.15
Standard of life	79	74	0.97
"Me"	80	83	0.67

* where the difference was found to be significant at 0.05

Table 3. Percentage of individuals who often feel negative emotions

Emotional state	Men (%)	Women (%)	Two stratum weights of the tested variables (*k*)
Anger	20	21	0.15
Sadness	36	50	2.34*
Dissatisfaction	34	30	0.66
Irritability	34	36	0.35
Hopelessness	23	19	0.78
Guilt	24	22	0.33
Burnout	38	39	0.09
Powerlessness	28	31	0.61
Unnecessary	16	15	0.16
Alone	23	25	0.24
Exhausted	33	36	0.53
Hurt	14	13	0.16
Tense	30	38	1.31

* where the difference was found to be significant at 0.05

Table 4. Percentage of individuals who often feel positive emotions

Emotional state	Men (%)	Women (%)	Two stratum weights of the tested variables (*k*)
Satisfaction	97	92	1.76
Cheerfulness	91	89	0.41
Happiness	87	89	0.27
Successful	83	72	2.14*
Joy	90	93	0.78
Safe, secure	89	85	1.02
Achieved success	83	66	3.37*
Relaxed	87	81	1.24
Freedom, carelessness	60	61	0.28

* where the difference was found to be significant at 0.05

uating their feelings, only the feelings of success and sadness differed significantly. Women were less likely than men to feel they were successful in life and felt sadness more often.

A comparative summary of the women's and men's total score on the quality of life in both the cognitive and experiential aspects is presented in Table 5. These totals find that the differences between genders do not differ significantly, which allows this group be treated as a very homogenous professional group of individuals.

Based on the above data, the following question was posed: Is there a relationship between respondents' subjective quality of life and their financial stating? In order to find this relationship, the level of quality of life was traced with their financial standing (Tab. 6). As was found, women and men who were less wealthy had a lower quality of life, while those who had a higher financial standing were more satisfied with their quality of life. Only in the surveyed women was the level of wealth found to be significantly different to their perceived quality of life.

Table 5. The perceived quality of life for the surveyed male and female graduates – numerical characteristics

Perceived quality of life	Men	Women	Mann-Whitney *U*-test
Cognitive aspect	43.49	43.66	0.15
Experiential aspect	2.56	1.79	0.68

Table 6. Financial standing and the quality of life

Standard of living	Average		High		Mann-Whitney *U*-test
	Mean	Standard deviation	Mean	Standard deviation	
Men	41.51	7.70	45.73	5.80	1.19
Women	44.62	9.34	42.58	7.03	2.80*

* where the difference was found to be significant at 0.05

Discussion

Polish research on graduates of physical education universities has been on-going for nearly 80 years. However, most of these studies focused on a number of issues connected to being a physical education teacher, such as what kind of teacher one should be (in seeking a normative standpoint) or how does today's physical education teacher work. A comprehensive review of the research conducted on physical education teachers can be found in Krawczyk [9], Żukowska [10], Mańkowski [11], Cieśliński [4] or Kosiby [12]. Whereas studies carried out by Dziedzic [13], Borzyszkowa [14] and Biniakiewicz [15] concentrate on graduates who studied physical rehabilitation. The results of these studies may be helpful in determining the professional profile of physical education graduates. The normative model of a physical education teacher, as described by Żukowska [10], provides a good frame of reference for the planning, organization and verification of these various empirical studies. Most of the studies indicated a conflict in the socio-economic roles of professional physical education teachers, especially with the functions, responsibilities and expectations that they face [4, 11, 16–19]. This could point to the fact that graduates of physical education universities, especially those who are teachers, feel burdened by numerous societal aspects.

Some of these studies indicated that a higher level of social stratification, defined as, above all, an individual's level of education, predisposes them to being more satisfied in life. However, in a study by Wiłkomirska it was stated that "[…] low wages lead to lower self-

esteem, where the employee feels less valued […], it is one of the most important factors that affect their sense of satisfaction" [20, p. 23]. On the whole, most of the studies found a relationship between one's social position and their attitude and psychological state; individuals with higher class values and who were better educated had greater satisfaction in life than those less educated [21]. One's level of income is considered as a measure of the quality of life only in the poorest countries (e.g., India, Bangladesh) and is found to have a weak correlation with the level of happiness in individuals living in industrialized countries [22–24].

On the other hand, there are data supporting a highly direct correlation between income levels and an individual's perceived quality of life [25, 26]. Pinquart and Sörensen [27] even stated that good financial standing correlates stronger to a better quality of life than education. This could be a factor in the result obtained in this study, such as the respondents' highly stressful socio-economic situation, which affected both sexes in a similar way, as evidenced by the low scoring of one's earnings (only 50% of the respondents were satisfied with their income). It is also worth mentioning that this economic aspect was found only in the surveyed women. There were no significant differences among the group of men representing different standards of living.

Nonetheless, the results obtained in this study found that over 80% of women and men were satisfied with their lives. Although male graduates were found to feel more happy than the group of female graduates, in most cases these differences were not statistically significant. The results of this study are also somewhat consistent with the results of test conducted by Czapiński and Panek in 2009 on the general population of Poland [28]. According to their Social Diagnosis test, which has been in effect since 1991, the mental well-being of Poles has significantly risen in recent years; currently 43% of the population stated they consider their life to be at least somewhat successful, while 76% considered themselves to be happy [28].

In summary, it is worth nothing that the surveyed graduates, most of whom were physical education teachers, composed a very homogenous group of professionals in their self-assessment of their quality of life. There were no dimorphic differences in most of the examined spheres of life, where the most significant differences in the perceived quality of life were found in the group of females. On the whole, teachers in general are found to be considerably satisfied with their lives, as found in a study by Day [29, p. 8–23]. This may point to the fact that teachers belongs to a group of "individuals with a passion". It is felt, by this author, that "teachers with a passion" are both hard-working and practical individuals who know their jobs and as such, store an incredibly amount of intellect and emotional energy that is reflected on their perceived happiness.

Conclusions

1. The majority of the respondents evaluated their life positively, with no differences between genders among the surveyed spheres of life. However, only half of the group was found to be satisfied with their income level.

2. Both men and women who were less wealthy had a lower perceived quality of life, while those who had better financial standing were found to be more happy. Only in the surveyed women was the level of wealth found to significantly differentiate in their perception of the quality of life.

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MY OWN BODY AS A FORM OF OTHERNESS IN PAUL RICOEUR'S PHILOSOPHY

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ABSTRACT
The philosophical rehabilitation of the body and corporeality, as undertaken by Paul Ricoeur, may be inscribed as a critique of the model of modern subjectivity as prefigured in the Cartesian *Cogito* of self-consciousness, self-awareness and substantial identity. This dominating paradigm of thinking cannot be preserved any longer in the face of Nietzsche and Freud, as well as of contemporary linguistics. This model reduced corporeality as a residuum of what is other than I to a handy object of scientific and technological exploration. Whereas, according to Ricoeur, otherness is not something that only accidentally happens to *ego*. It is not an unessential element and a negative aspect of a subject's and person's identity. Becoming oneself and understanding oneself take place in the medium of the Other. Otherness is for the identity of human ego something internal and originary, reaching us in a sphere of what is truly our own. The hermeneutics of being oneself, rejecting an appearance and the temptation of direct cognition, consists in the analysis of three figures of Otherness, which seem to be consecutively: my own body, the Other and Conscience.
Under the influence of the Husserlian distinction of "my own body" and "a body among other bodies", as well as the Heideggerian existentials describing "being-in-the-world", Ricoeur postulates, in a way similarly to Marcel and Merleau-Ponty, a reinterpretation of traditional understanding of both subjectivity and objectivity, as well as the very cognitive act of doing so. Its pre-reflexive foundation was uncovered by existential hermeneutics. The phenomena of being a body and having it appear to be problematic to the utmost, thus opening access to originary relationships between a man and the world as a correlation of bodily intentionality.

Key words: Paul Ricoeur, hermeneutics, phenomenology, body, subject, understanding

Wounded Cogito (*Cogito blessé*)

Begun by Descartes, the modern model of recognition, of self-awareness, self-knowledge and individual identity grounded in an act of indirect reflection, has been criticized and deconstructed by philosophy over the last two centuries. Paul Ricoeur (1913–2005), a French philosopher who joined both the hermeneutic and phenomenological traditions of his time named this a "wounded cogito" (*Cogito blessé*); wounded because under the influence of criticism one is obliged to revise his own ontological and epistemological claims.

The discovery of unconsciousness, according to Ricoeur, questioned the thought of subjectivity as totally transparent and accessible to itself. The discovery of intersubjectivity overstrained the idea of an immanent, self-sufficient and entirely autonomous self (*ego*). The constitutive role of tradition and pre-understanding, as raised by hermeneutics in their interpretation, including the interpretation of oneself, has struck Cartesian belief with the possibility of achieving an absolute, devoid of any prejudice, origin of knowledge. The discovery of a figurative and not transparent character of language has taken away the certainty of indirect reflection as a discursive event. As Ricoeur writes: "This obliteration of the sign as a thing is never complete, however" [1, p. 41].

This inner experience turned out to be no more less than the outer-mediated one, which through the form of articulation and language, in where a self-realizing subject understands what he is not. If corporeality has not become a synonym of experiencing oneself, it has surely become its unavoidable element, a kind of borderline case, opening a new horizon, at first in front of the French disciples of Husserl as well as the careful readers of Heidegger's *Sein und Zeit*: G. Marcel, J.-P. Sartre, M. Henry, M. Merleau-Ponty, and J.-L. Marion.

It is necessary to be aware that the crisis of modern subjectivity was initiated by discoveries, which at the beginning of 19th and 20th centuries, first helped to emancipate the humanities, and then gave them the impetus to go forward in their multidirectional development. A model of Cartesian subjectivity, as a philosophical project created to ground the mathematical philosophy of nature, proved to be too narrow and incomplete according to Paul Ricoeur. It could not cover the complex and problematic character of human experience and the nature of the world. The Cartesian model had an impact on conceiving the body and corporeality, reducing it to the function of being a correlation of a thinking ego, to having only a quantitative characteristics as a handy object of scientific and technical exploration. Thus it constituted a continuation of long standing thought, beginning in the Plato tra-

dition of metaphysics, which considered corporeality as a specific *residuum* of what is secondary, accidental, nonessential and negative.

Among the symbols that "allow one to ponder", Ricoeur also finds one deposited in the Orphic myth on the exiled soul and about the body as a foreign, unknown and hostile place, being literally the covering of "two opposite vectors of human existence" [2, p. 272]. In the assumed vision of Plato, where a body is a prison in which "a soul becomes a trivial criminal" [2, p. 268] and the "punishing function of a body" is the means of penance and of catharsis, which appear to be a "degrading sanction", a place of corruption and a secondary origin of evil. As Ricoeur writes: "[…] the scheme of exile, amplified by the scheme of repetition, has the tendency to transform a body into a symbol of misfortune of existence" [2, p. 271]. In the background of the radical dualism of both soul and body there is an opposition of identity and of otherness: "[…] a man is according to himself *the same* as his soul and *the other* than his body" [2, p. 264]. The Orphic myth tells us the story about the wandering of a soul which through consecutive incarnation redeems its guilt, but the real subject of that narration and its significant understatement is, according to Ricoeur, the "misfortune of existence", the return of the body into a place, at the same time, of punishment and of guilt, the struggle of the body with its own transparency, otherness and strangeness, retaining the deepest truths about human existence. It is a dramatic process of becoming oneself through experience and even through exposure to otherness. Philosophical tradition has tried to exorcise that truth and to cover it by the concept of pure subjectivity, which should be critically reconsidered once again.

Man is never what he considers himself to be. Paul Ricoeur accepted the arguments of the "masters of suspicion", especially those of Nietzsche and Freud, and completed them with his own understanding of the hermeneutical tradition and from the discoveries of contemporary linguistics. He does not announce, as Derrida, Lyotard or Foucault, "the death of man" or "the death of a subject". He seems not to consider a subject as a redundant category in an epistemological search. It is true that "I", as a principle of inner unity, affirmed by both modern philosophy and by a commonsensical approach of "egology", which stands for both the transcendental "ego" as well as the empirical "ego", appears to be a mystic and pragmatic illusion. However, the illusion is irremovable, one that we cannot escape from. It seems to be certain that a human being will speak about himself using the first person singular, whereas other people are treated by him as his other "ego". That is why Ricoeur writes about a *Cogito wounded, broken, humiliated*, especially through Nietzsche, and he does not expound, for example, on the annihilated ego [3, p. X]. He postulates on narrative identity as opposed to its substantial identity. That means that instead of being the same, one tries to be, in a narrative way, "oneself". The "Ego" appears to be a game which is played by man with himself. With himself, but really, with whom?

The Cartesian Ego, *res cogitans*, as a thinking subject, is only a heuristic abbreviation, a figure constructed for reasons of criticism. Ricoeur also writes on the different *cogitoes*: the Socratic, Platonic, Kantian and Husserlian, each time meaning that it is something inherent at the basis of the epistemological act, lasting in time as "the same" despite the plurality and variety of representations it holds due to the substantial status ascribed to it. *Cogito* is a thinking being, but a thinking being that metaphysics describes as the original form of being and, at the minimum, its most perfect representation. It is exactly this thing which Ricoeur opposes through the use of identity, which he expresses as being an *ipse* type, "Being oneself" (*Ipséité*, *Selbst*), a "narrative" identity that cannot be reduced to the simple feature of having an identical character. Categories such as promise, obligation or testimony all constitute "being oneself". Reflection is indeed to some extent a return to oneself, but as it has nothing of what indirect intuition has, it becomes mediation, becoming only a long and indirect way. The identity of the self (*ego*) is a task. It is a response to the presence of the other and one's own incomplete transparency of one's own being in the world. There is no other subject's identity besides the one to be recognized when somebody promises and then keeps that promise, being throughout this time the same person [4, p. 48–49]. Being oneself, as fidelity to oneself, is the credibility of one who accepts obligation, thus possessing a dialogical and ethical character and refers to the certainty which does not possess the character of representation. It comes close to the Heideggerian existentials which found the sort of being-in-the-world: "being decided" (*Entschlossenheit*) and "permanence of oneself" (*Selbst-ständigkeit*), as well as the "responsibility taken for another" by Emmanuel Lévinas. Ricoeur also frequently and in a vast extent refers to the Aristotelian conception of ethical activity, presented in his *Nicomachean Ethics* as well as through his concept of *fronesis* – practical wisdom and prudence which join the striving for "good life" with moral duty. It is conceived as a capability of regenerating each moment anew in a concrete situation while pondering on the subjective conditions and consequences of activity.

Towards the hermeneutics of existence

The attempt to elaborate a theory capable of justifying the techniques of exegesis and the interpretation of cultural texts is not the exclusive aim of Ricoeur's hermeneutics. Since our language speaks about man as the effect of one's work, this aim consists of understanding the sense of human existence. Between her-

meneutics as methodology (Schleiermacher, Dilthey) and hermeneutics as ontology (Heidegger) [5, p. 8], Ricoeur tries to recover what for the rationalist tradition was a baseless claim, what was superstition or nonsense, and which in the light of circular, or even elliptical, hermeneutical experience appears to be but a silent challenge. Understanding is not a constitution of meaning, thanks to which a subject consolidates its power over an object, but rather a kind of existence in which its capability to be open is tested. The subject is to be open to an object's revealing attestation. The goal of interpreting something is not just in understanding something, but rather understanding oneself in the face of something, let us add, never fully realized.

An objective moment has, through Ricoeur's hermeneutics perspective, a secondary character when compared with "participation", "belonging" and "including", as a primary form of a objective–subjective relationship, being nothing more than an existential situation. The ontological premises of understanding, the discovery of which Ricoeur is indebted to Heidegger, as well as the notion of "self-understanding", as the process open to Otherness, conceived analogously to Heidegger's "projecting" (*Entwerfen*), motivated Ricoeur to accept a thesis about the primacy of existence over reflection. Hermeneutics, confronted with the task of understanding what is understanding, appears to be a kind of search for the pre-reflexive meaning of reality [6, p. 3]. However, this ontology is rather peculiar: trying not so much to conceive being, but rather an effort of being, or even an effort of coming close to being through the regaining and wasting of that which/whom one is, through the process of appropriating and expropriating oneself, in which "*ego*, *ego cogito*, is to be grasped in the mirror of the testimonies of your own life" [7, p. 39].

Ricoeur's view that all cognition is preceded by pre-understanding allows for a critical understanding of the conception of "pure consciousness", elaborated on the basis of Husserl's phenomenology. Consciousness always runs to something else than itself; the notion of intentionality, opposite of Husserl, Ricoeur ties to the notion of otherness (*altérité*). Intentionality signifies the directing of consciousness towards a meaning before that meaning becomes a part of it as well as before the moment consciousness becomes an instance of measuring itself. The identity of a subject is not given directly, "[…] the meaning of consciousness lies beyond itself" [8, p. 112].

Existential hermeneutics, grasping "being oneself (yourself)" as a project, creates a distance between Ricoeur's language and Husserl's phenomenology with its directness, lack of assumptions and its immanence. Instead of an analysis of pure consciousness, Ricouer's program prefers "a roundabout way", where the dialectics of analysis and of reflection, the interpretation of interpretation in a hermeneutic circle, create a situation where a subject not only initiates the process of understanding. An object of interpretation is problematic from its own nature of being, even and perhaps especially when it appears to be its subject, where any interpretation is then neither unquestionable nor ultimate. The gift of speaking and of understanding consists in not having the last word. Language is rooted in what is accidental, distracted and ambiguous, any attempts at its idealization or formalization tend to falsify it. That which changes the course of human existence is, in the same way as existence itself, unimportant. A correlation of this unessentiality is its inconclusive character. Understanding is a way through which a subject comes back to itself by means of vanishing, falling away and becoming alienated. As we can read: "The shortest way that leads from me to me is the thought of the other" [9, p. 195–196]. The lack of obviousness, the lack of transparency of human existence, equips existence with a characteristic feature of ethical nature. Thus existential hermeneutics is also ethics, "[…] its aim is to grasp *ego* in its effort to exist and in its desire to be [10, p. 46]".

Otherness does not come from outside, it is not something that happens only accidentally to a subject such as *ego* (*Soi*). Otherness is also a heterogenic element in the face of an identity of a subject and a person, an element that may be removed beyond reflexive synthesis, it can be be overcome and made neutral. Otherness is something inner, original and constitutive for human identity. It reaches us in a dimension of something which belongs to what is our own in the strongest sense. *Soi-même comme un autre – Oneself as Another* – is the title of one of the most important books by Paul Ricoeur. There we can read that: "[…] the selfhood of oneself implies otherness to such an intimate degree that one cannot be thought without the other" [1, p. 3]. What is the place of the body in this philosophical turn? It seems that the hermeneutics of Ego, Ego open to Otherness or rather, one should say, open by means of Otherness, consists at first in hermeneutical-phenomenological analysis of three basic figures – the "figures of Otherness", of which "my own body" is the first one.

My own body – between being and possessing

It is for Ricoeur a peculiar paradox that we owe the creation of the problem of "my own body" to Edmund Husserl and not to Heidegger. When striving to elaborate on "an ontology of my own body" we must follow Husserl's "the most promising sketch of ontology" [1, p. 322]. If we follow Husserl's *Cartesian meditation* [11, p. 135–154], in the context of the question how to get to know the other man as "an analogue of myself", we would then choose to put aside everything that is given to us as not ours, as foreign, from all the senses "present to everybody", which means both from the

objective world as from the world of culture, and "concrete totality", where the experience of my own body will still remain irremovable. In this perspective the world is given to us in a different way. In the medium of a body as a sphere of what is our own to the utmost (*Eigenheitssphäre*), this is the difference between "me" and "not-me", between a subject and an object. In this earlier than intersubjective phase my own body and the world that forms a correlation to it are not yet an effect of creating the sense of intentional consciousness. All that is left is My own body, embodied as Ego, the worldly Ego. "I can" (*je peux*) is a formula expressing the fact that, despite radical intimacy and belonging, it should still be assimilated only as my own.

That, which for Husserl was only an episode of research, attempting to cross a bridge between the data of pure consciousness and the world of living experience (*Lebenswelt*), was an attempt that ultimately did not end successfully, which for his followers became a critical moment and a turning point [12, p. 97–106].

It formed the proper discovery of what in a phenomenological perspective is irreducible, at being a correlation of a pre-predicative, pre-objective, pre-discursive phase of cognition. As Ricoeur notices: "In a sharp-edged dialectic between *prâxis* and *páthos* one's own body becomes an emblematic title of a vast inquiry" [1, p. 320]. According to Ricoeur, besides the simple *Jemeinigkeit* of my own body, it exposes the whole sphere of inner passivity that is of otherness. At the same time it is the very body that constitutes the centre of attracting that otherness.

For Gabriel Marcel, "my own body" was already a particular case of what we have and what we, at the same time, are, opening a field of thought on the nature of possessing and being. As we can read: "Embodiment – a central datum of metaphysics. Embodiment, a situation of a being who finds himself to be connected to a body. Datum not transparent to itself: an opposition to *cogito*. I can say about that body neither that it is me, nor that it is not, nor an object to me. Immediately we find ourselves beyond the opposition of a subject and an object" [13, p. 9]. What connects me with my body is a model and pre-figuration of possession of which the body is "the most secret, the most deepest shelter" [13, p. 140], and at the same time I am my body, although I am not identical with my body. That much can be said of Marcel, to whom "Ricoeur owes a theme of his philosophy" [5, p. 11].

The phenomenon of "my own body" also becomes a point of departure of Merleau-Ponty's analyses, where he says: "Thus it is an object that never leaves me. Is it in such case still an object?" [14, p. 109]. Not at all. Its presence is not a factual necessity but a "metaphysical one". It is a condition of everything else that I meet. And because of that, it becomes something, in a sense, absent to me. The duality of experiencing my own body, namely that it is at the same time perceived and perceiving, is accompanied by its ontic double meaning: being something nearest to us and transcending over the limits of my own identity. Each time it is something more and something less than an object. Closer to us than us ourselves, and at the same time never given to us directly and, as such, transcending the sphere of what we are able to authorize.

The problem of my own body is possible when we accept the phenomenological research perspective while at the same time, realize the advanced revision it has taken on. Not only things are given to me but also the experience of them. Besides, as Merleau-Ponty writes: "The world is not what I think it is, but what I experience as the world" [14, p. 14]. To the Cartesian *Ego cogito* – "I think" – juxtaposes Merleau-Ponty's "I perceive", to pure thinking – perception. It is its analysis that allows one to reveal, as the French philosopher claims, the pre-predicative, pre-discursive phase of cognition. The body endows the character of "dwelling" to being in time and space. As an extension of my own body as a perceiving subject, things lose their objective character, their status as something represented, whereas the thinking I loses its substantial identity: "When I come back to myself, escaping the dogmatism of common sense or dogmatism of science, I discover not the focus of inner truth but a subject exposed into the world" [14, p. 8–9].

Perception, similarly to Ricoeurian pre-understanding, does not constitute an object of cognition, but is an intention of our being, its existence, "the modality of pre-objective view". Merleau-Ponty writes, "A body is a vehicle of my being in the world. To have a body means for a living creature to be related to a certain environment, to be identified with one's projects and constantly be involved with them" [14, p. 100]. The phenomenal body testifies to the fact of the pre-objective view of the world. Through my own body do I enter into the most intimate relations with the world, but always as an already "embodied subject" (*le sujet incarné*), not so much imprisoned in the body as rather being together with the body transgressing oneself in an ecstatic, expressive way.

Thus, the phenomenology of Merleau-Ponty, similar to Ricoeur's hermeneutics, seems to be an attempt at recovering the body, emancipating it from the dictation of an idea, a form and a thinking soul. But it is also an attempt at describing the world according to the body; a description of the world as the correlation of bodily, motor intentionality. The individualized, concrete, involved in the world, entangled with a subject, perception of Merleau-Ponty or the Ricoeurian subject of acting and experiencing are located between consciousness and things, as irreducible neither to it nor to them. What is this idea of subjectivity, tied to the world and open to it? At first nothing more than the experience of our corporeality. Corporeality, as a principle of experience, generally means that there is corporeal "know-

ledge" about the world, that a being is always grasped by us through a previous physically determined perspective. The perspectival character is an expression of "I can" and at the same time an order of power and possessing. As V. Descombes comments: "Immersed in existence a subject is pervaded by the inner difference, which Merleau-Ponty names consecutively: disagreement with oneself, not-possessing oneself, and the lack of transparency" [15, p. 84]. That which is connected, especially in the rationalistic tradition, with the phenomenon of appearance, i.e. a lack, similitude, incompleteness and dissonance, is the only resonance in which a body is reworked as a subject of perception, according to Merleau-Ponty, and as a subject of self-recognition according to Ricouer's concept.

The phenomenology of perception, which Ricoeur engages in a fruitful controversy [16, p. 25–31], as a return to the experienced world, is an attempt to describe the discourse of what precedes every discourse, that what is "mute" and "silent", which nonetheless seems to be an original source of the experience. Every discourse assumes that original character, but neither of them can rule over it, neither possess it, neither can they express it in a thematic way. It was explained that "the whole world of science is to build on the experienced world. If we want to reflect on science in rigorous way, to evaluate precisely its sense and extent, we have to arouse first the experience of the world of which science seems to be a sort of secondary expression" [14, p. 6]. This original sense, which belongs to "existential mimicry rather than conceptual statement" [14, p. 203], may be merely approximated, and a way to its explication is, by Merleau-Ponty, determined in advance as infinite. As Ricouer comments in his *Semiological challenge: the problem of a subject*, "[…] consciousness with its acquired skills and verbal tools remains always a debtor of instructive spontaneity of my body" [9, p. 257–258]. In a traditional discourse, the body as a thing, as an object, as virtually a supplement, is not allowed to speak. But it is the same with the body, as an uncovered subject of sense, it also is "mute" and "silent". How should one present something that is neither represented nor representing? How is discourse of a body possible, if a body is "neither signifying nor signified" [17, p. 24]?

Merleau-Ponty's phenomenology of perception is perhaps the most significant attempt at the philosophical restitution of corporeality. Paul Ricoeur shares neither its scope nor the radicalness of its scale. However, he does, unquestionably, similarly interpret Husserl's distinction between *Leib* (my own, alive body) and *Körper* (a body among other bodies), considering the very distinction (*le corps* – objective body, *la chair* – alive body) as the announcement of the "ontology of my own body", which he wants to develop in a shape of his own existential hermeneutics. He writes: "[…] possessing bodies is precisely what persons do, or rather what they actually are" [1, p. 33]. The discovery of my own body as a limit case should induce us to reinterpret the traditional understanding of both subjectivity and objectivity, as well as the very act of cognition, that also opens a new perspective about the relationship between identity and existence, which, after Heidegger, is thought as an understanding reference to itself, realised at first in a medium of the inauthentic forms of inner-worldly being [1, p. 327]. Although the Heideggerian analytics of *Dasein* seems to abort a body abort a body, Ricoeur notices significant reference to it in the concept of "Project-being thrown" [1, p. 327].

That act of possessing the body is something that we do and that we are, so is it therefore an act of possession at all? At least we can ask such a question, that is what the grammar of a natural language offers to us. The analysis of the phenomenon of the human body uncovers its universal character, ambiguous and vague, as belonging to the world. A body, a combination of what is particular and anonymous, located in a place so far predestined to the thinking conscious of itself, seems to be the essence of discourse, a reservoir of both a narrative and reflexive character. We never leave our own body, we neither completely possess it nor are we identical to it, and as Ricoeur writes, it is adequate to the "polisemic nature" of the sphere of human activity that never constitutes nor creates the whole. That is why it demands using a language that is not possessive. "Only a discourse other than itself […] is suited to the meta-category of otherness" [1, p. 356].

Being me as the process of signifying and preserving myself

My own body, something that Heidegger did not elaborate on as one of the existentials, seems to cosound with *Geworfenheit* and facticity, and expresses, according to Ricoeur, an alien character of being in the world as a paradox of human existence. It is a condition of a human belonging to the world: activity creates the happening of the world and at the same time signifies, in a self-referential way, its originator: "One's own body is the very place – in the strong sense of the term – of this belonging, thanks to which the self can place its mark on those events that are actions" [1, p. 319]. But this stigma can only be marked by the one who carries and bears it, who himself is marked by it, who is given first to its arbitrariness as sensing it. Who is something that remains in a question of "who?", even when there is a lack of answer. Who transgresses the limits of one's finitude, but before he has to experience them. That is why, it is exactly here, Ricoeur claims, "[…] in this strange and extraordinary relation to my body, and through it to the world, one should seek the essence of experience of finitude" [18, p. 304].

"Being oneself", as that identity postulated by Ri-

coeur, is not a primary fact, as much as a subject of understanding is not a condition of understanding or a reason, but rather, an effect. Man does not possess, at least in the common sense, his body, as he similarly does not possess, in a cognitive dimension, direct access to himself. The objective understanding of oneself, as problematic to the utmost degree as it is, is a response to the objectivity of self-understanding as a dialectical combination of what is universal and of what is particular. Self-understanding has to slide neither into solipsism, nor into naive realism, although it has support neither from the inside nor from outside. And it is exactly in "[…] this pre-linguistic relation between my flesh localized by the self and a world accessible or inaccessible to the «I can» that a semantics of action should be built" [1, p. 325].

As mentioned above, the "semantics of action" is an answer to that which is impossible to be held due to the "pre-linguistic" discourse of a body. Its "building" is there to stabilize the dialogic character of sense, within the space of a linguistic practice that is condemned to only offer exchange. The practice mentioned here is practice in the precise sense of a word, that is why Ricoeur especially prefers those interpretations of language which tie language is to an action, that all linguistic statements are performances, that the difference between the descriptive and performative character of statements is, to some extent, apparent (J. Austin, J. Searle) [9, p. 229–231]. The concept of speaking as the act of performing something finds its completion in the concept of action as speaking, acting is a gesture, it is articulation and expression, it tells about itself and about its creator whose personal unity appears to be "a narrative unity of life" (A. MacIntyre, Ch. Taylor). All these, as Ricoeur writes, active syntheses are built over the primary passive syntheses, which is a carrier of the subject and body.

To "be oneself", one should be able, as Ricoeur writes, "to signify oneself". Signifying oneself is mediated in the potency of action. It does not just consist in being a signatory to acts previously authorised and constituted by an acting subject, which through its potency is able to act and express itself by means of a body. The very act of acting is understood by Ricoeur not as an unhindered expression of a subject, but as an indication of being in the world. In this entanglement, as found in the world, which precedes every activity, there is no activity without sensing, no activity without passivity, no trespassing borders without experiencing the resistance that they exert. No form of activity, whether from speaking to perception, from traveling to producing something, is free from sensing otherness; it never is entirely liberated from it. But it is due to that action, according to Ricoeur, which possesses a reflective and self-reflexive character.

"Mutual interrelation between activity and suffering", as the deepest form of sensing (*páthos*), was discovered, according to Ricoeur, by Maine de Biran, a French philosopher of the 19th century. He analysed different degrees and layers of the passivity of the body and "[…] is therefore the first philosopher to have introduced one's own body into the region of non-representative certainty" [1, p. 321]. Both effort and resistance, similar to a dancing body, creates indivisible unity. Also touch, whose object becomes a part of the scheme of corporeality, is at the same time the nearest to what is internal and to what is outside, it offers the greatest certainty of the existence of "not-me", pointing to the fact that a body is a mediator between the internal character of a subject and the external nature of the world; thus it becomes a primary witness to its mutual, original belonging to each other [12, p. 106].

Being somebody in contrast to being something can be neither found nor identified. Rather, it is a state of character – the primary "I can", in which the "I" can hardly be heard, does not signify a subject-substratum, acquiring a form, as Ricoeur expresses it, of "preserving oneself". It is exactly this concept of "preserving oneself" that is a measure of the subjective duration of time and not the constant recurrence of type and character. Being somebody consists in the capability of preserving what we are only becoming. Action is the very process of becoming, as well as its first interpretation. Corporeality is a reflexive moment of activity. At first, thanks to it, lies the operation of a certain feature in activity, a readiness to being recognised by somebody as his own.

According to Paul Ricoeur – a body – my own, but not possessed, owned, but not transferable, is a mediator between the ego and the world, between internal and external experience. Nevertheless, it is apparent that a body is "[…] the only object that I rule over directly and in agreement with my will" [11, p. 141]. The embodied ego is a subject, where its distance towards an object becomes annihilated, where annihilated is understood in the sense that it becomes internalized. The experience of my own body is an experience of passivity. The fact that, by means of a body, I have the power over anything, and it makes room for something more elementary and primary: to the acts of sensing, submitting and being exposed. My own body, as a *residuum* of what is my own, appears as a carrier of Otherness, as something that I do not possess, do not choose, do not establish. It reveals its double meaning: on one hand it exerts resistance, on the other it is a means of overcoming. The intentionality of the body corresponds to a world that is not a represented world. The "I can" that is thrown into this world does not derive from "I want", but, on the contrary, it forms (constitutes) its condition. Somebody who remains himself, who reveals himself in activity, but who remains within the everlasting question of "who"?

Thus, my own body would be a certain function, as Merleau-Ponty once said: a "pendulum movement

of existence" [14, p. 106], or as Marcel wrote: a "[…] border sphere between being and possessing" [13, p. 70], which evokes the relative, temporal, unsteady relation between a subject and the world.

Their synthesis is, according to Ricoeur, the competent structure of affective intentionality, which lead the reader to two other figures of Otherness: the experience of the Other as well as Conscience. All of these figures, all the forms of Otherness, reveal the way of self-understanding, a way back to oneself as a dialectic of possessing as well as losing of property. The unity of subjective life aspires to authenticity, it may be even be the truth when confronted with the Other. It testifies to otherness and is testified by otherness. The way of being of the *ipse* type "[…] remains in a permanent effort of transcending oneself, opening oneself to otherness – without possibility of reaching it and without possibility of remaining oneself, of satisfaction, stabilization, of balance and rest" [4, p. 225].

The way of understanding does not so much solve the problem, but rather makes its solutions more problematic, where an order "[…] may be only the abstract phase of self-understanding by oneself; an order in itself is a thought external to itself" [19, p. 171]. While expressing ourselves, we produce a kind of difference between us and ourselves and we strive for the verisimilitude of being somebody, a verisimilitude which is perhaps the deepest form of truth of existence. As we continue reading, the "[…] consideration of truth, one would like to begin from paen to unity: truth does not deny itself, whereas there is a multitude of lies; truth brings people together, whereas a lie separates them. It is impossible, however to begin like that: unity before it becomes a source of satisfaction, appears to be a perverse temptation" [18, p. 57].

Paul Ricoeur's thoughts on the body, developed within the context of understanding the problem of subjective identity, contains a proposal more radical than just something as banal as once again writing about the historical controversy between idealism and materialism, between sensualism and rationalism. What is important is it is not just an appreciation of the body and corporeality as being more important than human nature that was conceived throughout the course of European thought. The problem remains not in the fact that man has also a body, but in the fact that it cannot be possessed. What is more, the idea of non-possessing should be, in a sense a paternal model for thinking about identity and non-identity of a concrete human cognitive subject of this world. Another me, whom I meet in myself and outside myself, is "always" Other than me.

It is not accidental that the rhetoric of corporeality, in comparing something to a body or pointing to a body of something, has in contemporary humanities a rather negative tone. It may be said that there is something that defies understanding, and even though it does escape us, it requires us to consider it, to agree with its inconclusiveness of epistemic conceptions. The body remains as a figure of Otherness, and our living and discursive practices, in relation to the body, is a measure of openness to Otherness, Strangeness and Difference in all of its social and cultural manifestations. This openness is, at the same time, an openness of our own body. Ricoeur writes that "[…] instead of having the feature of confinement characteristic of an oyster shell, about which Plato speaks or, even more, instead of the Orphic Tomb, it is an openness. What is more, it is openness of many different kinds: openness of a need, a need of the world I miss, openness of the very suffering, by which I am left at the mercy of the outside world, vulnerable to its threats, open as the uncovered flank, openness of perception, due to which something other reaches me" [18, p. 305]. This *topos* of the body validates and exposes our aspirations as unreliable in keeping another human being and the world around us in relationships that are only instrumental.

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THE NOTION OF THE BODY AND SEX IN SIMONE DE BEAUVOIR'S PHILOSOPHY

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ABSTRACT
In her masterpiece *The Second Sex*, Simone de Beauvoir depicts the atrocities of a typical patriarchal society. The author assumes that every human being should have the opportunity to experience feelings of a conquest and of being conquered to fully appreciate freedom. The body, the essential condition of human existence, is equally an object and a subject. Unfortunately, as Beauvoir reveals, this ontological rule is not respected in a society dominated by men. Patriarchy juxtaposes a male body, the subject, with a female body, the object. The main purpose of the present article is to answer the question, which many interpreters of Beauvoir's text have posed themselves: does Beauvoir really blame only patriarchy for such an injustice or is she rather willing to admit that female biology also contributes to such a biased situation. Researchers have never been unanimous on this issue. However, deeper analysis of *The Second Sex* as presented in this article finds that Beauvoir does not explain the social situation of women as a result of their biology at any point. According to Beauvoir, the discrimination of women in society is totally undeserved. This article also illustrates the originality of Beauvoir's thoughts in relations to Jean-Paul Sartre's philosophy. In her times, Beauvoir was mainly known as a novelist and the publication of *The Second Sex* was, misleadingly, not regarded by critics as a philosophical work. In *The Second Sex*, Beauvoir presents her own theory of interpersonal relationship, different from the one created in Sartre's *Being and Nothingness*.

Key words: existentialism, human body, sex, patriarchy

Western culture has shown its mistrust towards the body from almost as far back as antiquity. The metaphysical dualist characteristic of the philosophical thought developed in this part of the world held carnal desires in contempt and regarded them with suspicion.

Platonic axiological dualism, inspired by Orphic beliefs, evidently raised the status of spiritual reality and simultaneously isolated it from the bodily dimension [cf. 1, p. 94]. In his dialogue *Phaedo*, Plato gave the human soul the task of freeing itself from the "bonds" by which the body constrained it. The human being is perceived here as a soul, i.e. as Good and Existence, while the qualities of Evil and Non-Existence are attributed to the body. "And does purification not turn out to be what we mentioned in our argument some time ago, namely, to separate the soul as far as possible from the body and accustom it to gather itself and collect itself out of every part of the body and to dwell by itself as far as it can both now and in the future, freed, as it were, from the bonds of the body?" [2, p. 58].

The problem of the soul and body is conceived quite differently in methodological dualism, whose most distinguished representative is René Descartes [cf. 1, p. 97]. In *Discourse on Method*, he argues that thinking is a characteristic of spiritual reality, while the bodily dimension is best characterised by extension. *Res extensa* is conceived here as a machine at the service of *res cogitans*, which for its part always remains independent from the needs of the body.

Dualist solutions thus depict the body as either a non-existence or as an ordinary material object, like, for example, a table, a chair or a book, whose presence is an inseparable element of a being-in-the-world human being. Phenomenology departs from the tradition of a dualist mind-body division.

The experience of two world wars left their mark on the lives of intellectuals active in the first half of the 20th century, their way of perceiving the world was affected and redefined their relations to their surroundings. In France during this period a new current of thought arose, known as existential phenomenology, whose main creators were Maurice Merleau-Ponty, Jean-Paul Sartre and Simone de Beauvoir. In this philosophy, the notion of experience underscoring the separateness of subject and object was replaced by the notion of situation expressing their interaction. Reality, which empiricism and rationalism had tried, each in their own way, to split from each other, now gained a new image, one of an indivisible whole representing a process of continual intermingling and interaction between subjective and objective elements. Both the external world and consciousness were regarded as real and, most fundamentally, neither of these held a superior role over the other [cf. 3, p. 24].

The recognition that the subjective and objective spheres were interdependent changed the negative attitude towards the human body. In 1945, in her review of M. Merleau-Ponty's *Phenomenology of Perception*,

Simone de Beauvoir claimed that phenomenology returned to humans their property in the form of their own bodies [cf. 3, p. 25].

One of the fundamental theses of phenomenological deliberations on the human body is the assumption that it entails an element of subjectivity and objectivity. Full human embodiment is an essential condition for existence and is simultaneously an object and a subject. So human beings have the right to feelings of possession and being possessed.

Referring to the phenomenological conception of embodiment, Simone de Beauvoir in her work *The Second Sex* regarded the asymmetry of relations between the sexes as a breaking of an ontological principle. In a patriarchal society the objectification of a women's body, *la chair*, is in opposition to the activity of the male body, the living body, *le corps*. The body of a man is a subject, while a woman's body is an object.

When analysing *The Second Sex*'s content, the reader is faced with the following questions: In Beauvoir's view, is the object role which society ascribes to a women's body a consequence of adopting the patriarchal perspective? Or maybe she leans more toward the view that a woman's own bodily condition has condemned her to passivity and caused man's predominance in society? The opinions of academics researching Beauvoir's thought are divided. Some accuse her of misogynism and of criticising female biology, while others think that in her view blame for the objectification of the female body is carried out by society alone.

Therefore, the purpose of this article is an attempt to take up a polemic with certain interpretations of *The Second Sex*. What mechanisms govern a patriarchy? What is the relation between society and the female body? How is its sexuality perceived? These are the issues, which must be raised before the fundamental problem can be resolved of whether Beauvoir is condemning female biology or society alone.

Man made woman the "Other"[1], i.e. an exact negation of what he himself would desire to become. Beauvoir argues that in the patriarchal myths of Mother Earth, Mother Nature, as well as in the alliance between Woman and Death, the ontological unity of body-for-oneself and body-for-the-other is broken up. Myths identify the body of woman with matter, passivity and immanence, while ascribing transcendence and activeness to the male body. Patriarchy thus makes it possible for a man to ignore the fact that his own body is an object, as well as a subject. Thanks to this, he believes that his body, *le corps*, is completely free of any of those aspects of the physical human condition which would attest to its passivity.

Simone de Beauvoir thinks that the stereotypes laid down in myths have an overwhelming influence on the relations between the sexes. It is believed of a woman growing up in a patriarchal society that her destiny is neither to take an active stance towards the world nor engage in activity through which she would be able to realise her individuality. In consequence, her own body becomes an object of conflict between the desires she fosters as an independent individual and the interests of the human species. Ultimately, in the aftermath of intensifying processes of socialisation, a woman is reduced to a purely biological role. Her *corps* is transformed into flesh, *chair.* Yet is it really de Beauvoir's view that social conditions bear the sole responsibility for this situation so harmful to women? Or does she perceive biological data as an integrated contribution to the phenomenon of the "feminine"? A reading of *The Second Sex* induces some academics to claim that, according to the author, biology also condemns woman to the fate of an objectified *chair.*

In the article *Un rapport ambigu au corps et à la conscience des femmes* Laurence Aphéceix argues that the disdain with which Beauvoir describes the female body proves that she was seeking the cause of discrimination against women in biology [cf. 4, p. 44].

"[…] The feminine sex organ is mysterious even to the woman herself, concealed, mucous, and humid, as it is; it bleeds each month, it is often sullied with body fluids, it has a secret and perilous life of its own. Woman does not recognize herself in it, and this explains in large part why she does not recognize its desires as hers. These manifest themselves in an embarrassing manner. Man «gets stiff», but woman «gets wet»; […] to eject a fluid, urine or semen, does not humiliate: it is an active operation; but it is humiliating if the liquid flows out passively, for then the body is no longer an organism with muscles, nerves, sphincters, under control of the brain and expressive of a conscious subject, but is rather a vessel, a container, composed of inert matter and but the plaything of capricious forces. If the body leaks – as an ancient wall or a dead body may leak – it seems to liquefy rather than to eject fluid: a horrid decomposition" [5, p. 386].

Beauvoir emphasises the asymmetry between the body of a man and a woman. He, privileged by nature, possesses physical strength, thanks to which he can open himself to the world. She, endowed with a capricious body, is stuck in a state of immanence. Ultimately, asks Aphéceix, is it not these physical differences that lead to men-women relations not being dialectic in character? [cf. 4, p. 44].

In the part entitled *Destiny*, Simone de Beauvoir remarks that the body is a kind of instrument through

[1] In *The Second Sex*, the word "Other"– written with a capital letter refers exclusively to a woman. She is always the Other (the Absolute Other) in relation to man. However, in the text, we also come across the word "other" – written with a small letter. It can be only applied to a person who acquired this status in a dialectic, and not in an absolute, way. This distinction is crucial to fully understand Beauvoir's philosophy.

which a human being receives and acquaints him/herself with the world. In her view, biological construction has an overwhelming significance for the way in which the world is perceived, and the manner of being-in-the-world as well. Aphéceix maintains that, since Beauvoir devalues the female body, by the same token she employs biological data to explain woman's inferiority to man. In other words: the passivity of the female body is not only a product of society, but also of biology. And following on from this, patriarchal society is not just something inflicted on woman as something co-created by her biological circumstances.

A similar interpretation of *The Second Sex* is presented by Eve Gothlin in her book *Sexe et existence. La philosophie de Simone de Beauvoir.* She remarks that Beauvoir's thinking is marked by a certain vacillation. On the one hand, the author of *The Second Sex* presents the feminine as a product of society, while on the other she is not able to rid herself of the conviction that to a certain extent woman's fate is dependent on her biology [cf. 6, p. 254].

Beauvoir postulates that woman should possess her own living body – the *corps*, protest against her objectification, take action and open herself out "to the world", but at the same time her own vision of the female body makes it difficult to realise these plans. In Gothlin's opinion, although the philosophy of sex created by Beauvoir is a polemic against the sexist thought of Sartre and Hegel, it still remains under the overwhelming influence of this philosophical tradition. The desiring subject (*sujet désirant*) is in Beauvoir's text of the male sex, as in Sartre's being-for-oneself and Hegel's master and slave [cf. 6, p. 263]. According to Gothlin, there is no case in which the causes of this qualification should be sought out in the social situation alone.

The accusation of biologism levelled at Beauvoir is refuted by Fredricka Scarth in her book *The Other Within. Ethics, Politics, and the Body in Simone de Beauvoir.* She claims that the description of female corporeality contained in *The Second Sex* really is full of contempt, but it does not express Beauvoir's own attitude to the female body. This repugnant image should be interpreted within the context of patriarchal society. The author of *The Second Sex* is showing the male point of view and not identifying herself with it [cf. 7, pp. 117–118].

Scarth very clearly emphasises that Beauvoir is purposefully using phallocentric language, as she wants to unmask its atrocity. The dramatic nature of her description of the female body and the glorification of masculinity reveal how unjust patriarchal mythology really is.

In an interview given in 1982, Beauvoir, on refuting the accusation of biologism, sought justification in language. She explained that the brutality of the description of the female sex organs presented in *The Second Sex* is the result of her employing the language of men. This is hardly surprising, however, since phallocentric discourse has dominated phallocentric society and become completely binding. "[...] we all speak in the language of men. It is they [men] who have given us our verbs and pronouns, and we [women] who must do the best we can with them" [8, p. 384].

Beauvoir was aware that the language of *The Second Sex* presented the sphere of female sexual experiences in a harmful manner. Despite this, she made no attempt to create a language free of sexist influence. No words of criticism are spared by Martha Noel Evans in her article entitled "Murdering L'Invitée: Gender and Fictional Narrative", which takes Beauvoir to task for not using her own language in her literature. Evan claims that, by adopting a "male style" of writing, Beauvoir is reproducing the stereotypes of a patriarchal culture. In consequence, *The Second Sex* enters a tradition dominated by men and does not break away from it, as its author seems to have intended [cf. 9, pp. 50–51]. However, Evans does not take the pains to find the reason for which Beauvoir could not definitively reject a male way of thinking.

Phallocentric language founded on the dichotomous divisions of patriarchal society renders the character of the social situations of the "feminine" and the "masculine". By employing it, Beauvoir can present both man and woman "in their generalities". If the author of *The Second Sex* had decided to reject "masculine" language and create her own, allowing her to describe the typical situation of men and women, she would have had to appeal to extra-societal traits common to each of the sexes. By doing this, she would be adopting essentialism which would be in opposition to the assumptions of existentialist philosophy.

We ought not therefore to succumb to this illusion and accuse Beauvoir of biologism on the basis of her descriptions of the female body. Fredricka Scarth would appear to be right when she maintains that the author of *The Second Sex* is not expressing her own attitude on the female body through these descriptions. But do they in fact impart the male point of view? Is ascribing such ruthless traits to men not a manifestation of sexism? Discrimination against women in a patriarchal society, discrimination relying on the prevention of their gaining an education or work in profession, is a historical fact which cannot be challenged. Yet is difficult to accept that a man looking at a woman's body saw it as a "container composed of inert matter" from which effluence "leaks – as a dead body leaks" [5, p. 386].

It would appear that Beauvoir employed such a shocking description of female corporeality to focus the attention of public opinion on the scale of the problem of discrimination. By shocking her audience, the author of *The Second Sex* brought about popular discourse on the subject and this was undoubtedly her intention. If it weren't for its naturalistic descriptions of the body and female sexuality, her work would certainly not have had such far-reaching repercussions.

Moreover, Beauvoir defends herself successfully from the charge of biologism in *The Second Sex*. She underlies repeatedly the rebellion aroused in a woman against her status in patriarchal society. In the text, it is clearly stressed that women demand power of recognition and freedom for the subjective dimension of their body, *le corps*. It is a fundamental issue, to which interpreters of Beauvoir's thinking appear to have not attached the appropriate weight to.

"But at puberty the species reasserts its claim. […] Not without resistance does the body of woman permit the species to take over; and this struggle is weakening and dangerous" [5, pp. 26–27]. "[…] woman is of all mammalian females at once the one who is most profoundly alienated (her individuality the prey of outside forces), and the one who most violently resists this alienation; in no other is enslavement of the organism to reproduction more imperious or more unwillingly accepted. It would seem that her lot is heavier than just of other females in just about the same degree that she goes beyond other females in the assertion of her individuality" [5, p. 32].

When growing up, a girl is made to believe that her biology condemns her to the immanence of repetitions, and simultaneously deprives her of creative transcendence. As a result, a young woman begins to understand that motherhood will be the only role which she is supposed to play in society. In Beauvoir's opinion, this arouses principled opposition in her. A woman does not want to become a submissive tool in the hands of society as this does not accord with her destiny as a free human being.

Let's take note: if Beauvoir had really ascribed the reasons for woman's bodily passivity to female biology, then she would not have categorised society's imposition of a reproductive role on her as rape of the woman-individual. She would have regarded it as something naturally flowing from female nature.

In any case, would a woman rebel against the *chair*, if her body were in fact only a body-for-the-other? A woman wages war because society degrades her body to the role of a mere object and she wants to retain its subjectivity.

The *chair* is not the body imposed on her by biology. It is a socialised body which a woman accepts as a member of a patriarchy. Why? Paradoxically, in the ensuing social situation the yoke of the passive body she has come to hate represents the only opportunity for her to demonstrate her independence. "[…] a woman assures her most delicious triumphs by first falling into the depths of abjection; […]" [5, p. 291]. It is thanks to the *chair* that a woman can please a man and therefore take possession of him.

The stance of the author of *The Second Sex* appears to be clear: the tragic situation of women relies on society's interference with her body. The forces exerted by social mechanisms cause female corporeality to be wrested from one of its ontological dimensions, body-for-oneself, and become passive flesh, *chair*. This passivity is not, however, something natural to her, i.e. something flowing from female physical conditions. "I deny that biological facts establish for [a woman] a fixed and inevitable destiny. They are insufficient for setting up a hierarchy of the sexes; they fail to explain why woman is the Other; they do not condemn her to remain in this subordinate role forever" [5, pp. 32–33].

Is there a way of liberating the female body from socially imposed immanence? Can a woman's body become an expression of her humanity? Suggestions appear among those who study Simone de Beauvoir's philosophy that in her view the path to humanity has already been staked out by men. Issue is taken with this judgment on the author of *The Second Sex* by, for example, Dorothy Kaufmann in her essay entitled *Simone de Beauvoir, The Second Sex and Jean-Paul Sartre*. In her opinion, Beauvoir, by identifying the masculine ability to bear risks as a trait characteristic of humans while identifying the giving of life with animality, perceives in the imitation of man a way of liberating the female body [cf. 9, p. 55].

Géneviève Lloyd interprets *The Second Sex* in a similar spirit in her study entitled *The Man of Reason: "Male" and "Female" in Western Philosophy* [cf. 10, p. 251]. She thinks that Beauvoir adopted male transcendence as an ideal for which women should strive. The existential alternative, to look and act or be looked at and acted upon, became a trap for Beauvoir. For if woman does not want to be the "Other" any longer, she must become the "Self", i.e. man.

"His [boy's – AT] apprenticeship for life consists in free movement toward the outside world; he contends in hardihood and independence with other boys, he scorns girls. Climbing trees, fighting with his companions, facing them in rough games, he feels his body as a means for dominating nature and as a weapon for fighting; he takes pride in his muscles as in his sex; in games, spots, fights, challenges, trials of strength, he finds a balanced exercise of his powers; at the same time he absorbs the severe lessons of violence; he learns from the early age to take blows, to scorn pain, to keep back the tears. He undertakes, he invents, he dares. […] In woman, on the contrary, there is from the beginning a conflict between her autonomous experience and her objective self, her «being-the-other»; […]. She is treated like a doll and is refused liberty. Thus a vicious circle is formed; for the less she exercises her freedom to understand, to grasp and discover the world about her, the less resources will she find within herself, the less will she dare to affirm herself as subject. If she were encouraged in it, she could display the same lively exuberance, the same curiosity, the same initiative, the same hardihood, as a boy. This does happen occasionally, when the girl is given a boyish bringing up; in this case she is spared many problems" [5, p. 280].

The above passages, quoted from *The Second Sex*, when removed from their context, might lend support to Kaufmann and Lloyd's viewpoint. Nevertheless, their own interpretations do not appear to harmonise with Simone de Beauvoir's mode of thought. The anthropology of sex she proposed has, in this case, been oversimplified and twisted. "Woman, like a man, *is* her body; but her body is something other than herself" [5, p. 29, distinction made by SdB]. That is how the situation of men and women living in a patriarchal society is presented. If a woman casts aside the submissiveness, softness and physical weakness of her body, making it into a kind of tool that boldly and freely expresses her desires, she will then cross over to the "male side". But according to Beauvoir, the male *corps* is an artificial construct of society as well!

Men try to free their corporeality from its passive and finite aspects, but at the same time the *chair* becomes the object of their desires. Women's corporeality attracts them and at the same time fills them with awe. "[…]; man dives upon his prey like the eagle and the hawk; woman lies in wait like the carnivorous plant, the bog, in which insects and children are swallowed up. She is absorption, suction, humus, pitch and glue, a passive influx, insinuating and viscous; […]" [5, p. 386]. In "immersing himself" in woman, man senses his own flesh. He then understands that his subjectivity is a common illusion through which the patriarchy has him in its hold.

"Thus what man cherishes and detests first of all in woman, whether a loved one or mother, is the fixed image of his animal destiny; it is the life that is necessary for his existence but which condemns him to the finite and to death. From the day of his birth man begins to die: this is the truth incarnated in the Mother. In procreation he speaks for the species against himself: he learns this in his wife's embrace; in excitement and pleasure, even before he has engendered, he forgets his unique ego. Although he endeavours to distinguish mother and wife, he gets from both a witness to one thing only: his moral state. He wishes to venerate his mother and love his mistress; at the same time he rebels against them in disgust and fear" [5, pp. 165–166].

Simone de Beauvoir does not distinguish between the "dark" and "light" sides of social dichotomous divisions. It is not true that she complains about the passivity of the female body while simultaneously glorifying male physical activeness. The division of corporeality into two ontological dimensions: body-for-oneself, *corps*, and body-for-the-other, *chair*, is for her a symptom of "bad faith"[2]. It is, in particular, this "bad faith" that defies a human being's destiny as a free individual and tries to locate the essence of this destiny in either "consciousness" or "body", in "subjectivity" or "objectivity", or in "transcendence" or "immanence". So within the framework of Beauvoir's anthropology man cannot be identified with a liberated human, because being a pure Subject is, in her view, being imprisoned by conventions [cf. 9, p. 58].

The accusation that Beauvoir urged women towards the complete rejection of the "feminine" of their bodies in favour of the adoption of the traits characteristic of "masculine" would appear to be off the mark. In the text of *The Second Sex*, it would be difficult to find a supporting passage in which the author explains in what manner a transformation of this kind might be completed.

"Let her swim, climb mountain peaks, pilot an airplane, battle against the elements, take risks, go out for adventure, [...]" [5, p. 333]. In Beauvoir's view, a woman is a free human being who has the right to demonstrate the subjectivity of her body. Of course in a patriarchal society only man could indulge in such activities and in this sense we can acknowledge that woman is copying him. She is not doing this, however, in order to become a person modelled on him, but because she is a human being and has the right to. This is a fundamental distinction that Lloyd happens not to notice.

Beauvoir postulates that each of the sexes should be able to express the subjectivity of their bodies in their own chosen and convenient manner. Objective differences resulting from the physical construction of man and woman cannot become the basis for the introduction of a hierarchy of the sexes beneficial to men. Woman is weaker but this does not make her inferior. Biology does not explain *gender*.

"These biological considerations are extremely important. In the history of woman they play a part of the first rank and constitute an essential element in her situation. [But] They are insufficient for setting up a hierarchy of the sexes; they fail to explain why woman is the Other; they do not condemn her to remain in this subordinate role forever" [5, pp. 32–33].

A situation in which a portion of society is deprived of the right to freedom is morally reprehensible. The case of discrimination against women is so particular, however, that the oppressor himself has here become the oppressed. A free individual does not only have the obligation to establish him/herself as transcendental; he/she must also allow others to realise their freedom [cf. 11, p. 139].

For the author of *The Second Sex* an authentic human being is an independent individual expressing both the subjective and objective elements of his/her body. Let us take note that in Sartre's philosophy, the human body is also examined both in subjective and objective categories, although the accent falls here on the division of these two dimensions. Furthermore, the shame which, according to Sartre, a feeling of being objectified arouses

[2] In *The Second Sex*, the term "bad faith" has two different meanings. As in Sartre's *Being and Nothingness*, it describes a state of fear, which makes humans abandon their freedom and look for cancellation in deterministic solutions. Secondly, it refers to an unjust division of qualities between the sexes.

in humans, suggests the introduction of a hierarchisation of these two dimensions. Similarly to Hegel, Sartre clearly asserts that a human being wants to be a subject and does not consent to the objectification of his/her body. Beauvoir, on the contrary, thinks that human beings are able to derive satisfaction from the subjective activeness and objective passiveness of their bodies.

"It is possible to rise above this conflict if each individual freely recognize the other, each regarding himself and the other simultaneously as object and as subject in a reciprocal manner. But friendship and generosity, which alone permit in actuality this recognition of free beings, are not facile virtues; they are assuredly man's highest achievement, and through that achievement he is to be found in his true nature" [5, p. 140, distinction made by AT].

Human beings sense the autonomy of their egos. Freedom and subjectivity serve as proof of their isolation in the world. Becoming an object in the eyes of the "other"[3] can conquer the fear which accompanies a feeling of loneliness. The glance of the other can give someone a sense of the permanence of being and confirms him/her as a being. As opposed to Jean-Paul, Beauvoir thinks that relations with "others" need not assume the character of a conflict, but can be based on feelings of friendship and love.

Sartre gives the term "Mitsein" to a multitude of subjects commonly describing themselves by the pronoun "we". The appearance of the "third party" (*le tiers*) makes an object of my "self – the other" relation. The "third party" by his/her glance simultaneously arouses in me and in the "other" a feeling of shame and alienation, allowing us to mutually sense the "we-object" phenomenon. Nevertheless, as Sartre notes, the surrounding world also allows us to both feel pleasure at the "we-subject" psychological experience [cf. 9, p. 42]. My "self" becomes a transcendence, which does not stand out from the "others", because I confirm its subjectivity by realising aims fixed by the interests of a community and not my own personal ones.

Notice that the "we-subject" in Sartre does not have an primordial character, but is simply grounded in the "self-other" relation. For the author of *Being and Nothingness*, "Mitsein" is just an illusion. In his view all human relations are affected by conflict.

The recognition that the subjective and objective sides of corporeality are equal led the author of *The Second Sex* to create her own theory of interpersonal relations. On the basis of her anthropology, it is possible for two individuals who are not entangled in *gender* to meet and "[…] establish the reign of liberty in the midst of the world of the given" [5, p. 732]. According to Beauvoir, the confirmation of one's subjectivity is not tied to the objectification of the "other", if it proceeds on the principle of mutual recognition of the right to freedom. On the basis of the anthropology presented in *The Second Sex*, a human being can become a participant in a "Mitsein" which will not only be a psychological experience but also an ontologically grounded relationship.

Simone de Beauvoir believes in relationships between men and women based on freedom and equality. An individual of male sex and an individual of female sex are capable of living together, while simultaneously, as individuals, realising their humanity to the fullest. According to the author of *The Second Sex*, a meeting of two subjects who recognise the relativity of their existence with regard to each other can be fulfilled in the most perfect fashion during sexual intimacy. Desire and respect for the biological differences of one's partner and his/her sexuality become the basis of a happy relationship. You are an "other" to me, but you are not inferior as a result. On the contrary: I love you and myself in your and my "otherness".

"The dissimilarity that exists between the eroticism of the male and that of the female creates insoluble problems as long as there is a «battle of the sexes»; they can easily be solved when woman finds in the male both desire and respect; if he lusts after her flesh while recognizing her freedom, she feels herself to be the essential, her integrity remains free in the submission to which she consents. Under such conditions the lovers can enjoy a common pleasure, in the fashion suitable for each, the partners each feeling the pleasure as being his or her own but as having its source in the other. […] Under a concrete and carnal form there is mutual recognition of the ego and of the other in the keenest awareness of the other and of the ego. […], the relation of the *other* still exists; but the fact is that alterity has longer a hostile implication, and indeed this sense of the union of really separate bodies is what gives its emotional character to the sexual act; and it is the more overwhelming as the two beings, who together in passion deny and assert their boundaries, are similar and yet unlike. This unlikeness, which too often isolates them, becomes the source of their enchantment when they do unite" [5, pp. 401–402, distinction made by SdB].

Simone Beauvoir names this utopian vision of a relationship between a male subject and a female subject as "authentic love". In opposition to Sartre, who regarded love as an impossible feeling, she claims that two people who love each other will manage to recognise the subjectivity in each other, without erasing their own boundaries or "otherness". Unfortunately, in Simone de Beauvoir's opinion, patriarchy degrades the female body to the status of flesh, *chair*, which as a consequence leads to the meeting of the "Absolute Subject" – man, and the "Other" – woman.

In *The Second Sex* two kinds of oppression which appear in interpersonal relations were detailed: the

[3] The change of orthography is not hazardous here. We are referring to a dialectic relationship.

first of these has its source in the master-slave conflict and can only be felt by one man in confrontation with another man, while the second exclusively involves woman oppressed by man. It should be stressed very clearly at this juncture that Beauvoir, when invoking the Hegelian conflict between master and slave, did not ascribe the role of slave to woman. On the contrary, by grounding her argument in this conflict, she wanted to reveal the specificity and uniqueness of the oppression experienced by woman. Although for woman, man is a master, an independent consciousness, woman is not his slave, because the relations between them are fashioned in an absolute, rather than dialectic, manner [cf. 6, p. 54].

The law of dialectics removed from Hegel's slave the burden of dependent self-consciousness and imposed it on the master, who was only allowed to enjoy the certainty of being-for-oneself for a short time. This way the conflict between them, although it appeared to have been obviated, flared up again and at the same time there was a reversion to the originally established roles. The conception of human nature presented by Hegel, by emphasising the hostility of one consciousness to an "other", explained by all manner of actions dictated by dislike of the "other", such as in the phenomenon of social injustice, class division or war. Nevertheless, the pressure felt by the weaker and defeated parties as a result of these circumstances is different in character to that which is experienced by woman.

According to Simone de Beauvoir, none of those participating in the master–slave conflict are of the female sex. In a patriarchal society, woman is not someone possessed with self-knowledge who might seek the recognition of someone else possessed with self-knowledge. It is unethically assumed that only men desire this. By creating a dialectic tension among themselves, they mutually ascribe to each other the role of master, or slave. The presence of woman gives man the confidence to "being-for-oneself" without struggle and is all the more comfortable for him, because it does not require his reciprocation.

Looking, defining and acting are activities which the Absolute Subject ascribes to himself in relation with the "Other", a party he observes and defines and who remains in a state of eternal expectation. "Being watched" is the role which society assigns to woman. Woman has never gained the opportunity to describe man and as a result, she has never created a myth reflecting male "nature".

The concepts of "the masculine" and "the feminine" in Beauvoir's anthropology do not allude to ontological structures which determine human beings in a top-down fashion. They are merely descriptions of social constructs under whose carapace are hidden individuals desiring to demonstrate the fullness of their humanity.

"Now, what peculiarity signalizes the situation of woman is that she – a free and autonomous being like all human creatures – nevertheless finds herself living in a world where men compel her to assume the status of the Other. They propose to stabilize her as object and to doom her to immanence since her transcendence is to be overshadowed and forever transcended by another ego (conscience) which is essential and sovereign. The drama of woman lies in this conflict between the fundamental aspirations of every subject (ego) – who always regards the self as the essential – and the compulsions of a situation in which she is the inessential" [5, p. XXXV].

It should be clearly emphasised that the answer formulated by Beauvoir to the question "what is a woman?" [5, p. xix] is not a duplication of the myth of "the eternal feminine", which she firmly rejected. The term "feminine", as employed by Beauvoir, refers to a set of experiences common to all women and not to the archetype determining women's fate. The "feminine" describes the state of affairs that arose in patriarchal society, where the general situation of men is still markedly more privileged than that of women.

The view that Simone de Beauvoir formulated her own existentialist theory [cf. 12, pp. 130–138] would appear to be accurate. It is true that in her reflections, an echo sounds of Sartre's assertion that "existence precedes essence." However, in contrast to the author of *Being and Nothingness*, Beauvoir very clearly emphasises the influence of the general social situation in which the individual is entangled due to his/her sex. Beauvoir broke away from Sartre's naïve conviction about human beings' absolute freedom, while at the same time steering clear of essentialist statements. She managed to reconcile that which is common to the experiences of individual women with the uniqueness of these experiences. The female condition does not rule out either the diversity of women's experiences or the individuality of each of these. These two perspectives in her account are not in competition with regard to each other but are locked in a dialectic tension [cf. 12, pp. 130–138]. Experiences continue to be unique, even when similarities appear between them. On the basis of Beauvoir's philosophy, the constant features of experiences do not create essence. They simply provide a kind of structural framework which confers form and coherence on variable qualities. A bi-lateral relation appears among the unique moments in a given experience and its permanent components. Through this particular bond, they mutually determine and define each other. There is no mention here of any absolutely independent elements which would indicate the existence of a meta-structure homogenising all the experiences [cf. 12, pp. 130–138].

If a certain situation moulds me, it must also have a similar impact on the other individuals involved in it. A clear example of a situation of this kind is "the femi-

nine." Every woman possesses her own life experiences, but the schemata of oppression, exclusion and "Otherness" which affect all women in society also appear in her own personal situation. This state need not however – as Beauvoir underlines – continue to endure.

The main idea in *The Second Sex* is an abrupt departure from the vision of woman as a simple object grounded in the patriarchal myth of the "eternal feminine." The recognition of the "feminine" as a social construct rather than a derivative of female "nature" opened up for Beauvoir a vista of potential changes. A "liberated woman" is not a phantom, a chimera or a wish timidly emerging from certain imaginary hopes, but an authentic human being.

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PUBLISHING GUIDELINES – REGULAMIN PUBLIKOWANIA PRAC

The Editorial Office of *Human Movement* accepts original empirical as well as comparative research papers on human movement science from varying scientific fields (including sports medicine, exercise physiology, biomechanics, kinesiology, sociology, psychology, pedagogy) covering education in health, physical education, recreation and tourism, rehabilitation and physiotherapy. The Journal also invites such contributions as letters to the Editor, reports from scientific conferences and book reviews. The publication of submitted contributions to *Human Movement* is free of charge.

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The introduction prefaces the reader on the article's subject, describes its purpose, states a hypothesis, and mentions any existing research (literature review)

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This section is to clearly describe the research material (if human subjects took part in the experiment, include their number, age, gender and other necessary information), discuss the conditions, time and methods of the research as well identifying any equipment used (providing the manufacturer's name and address). Measurements and procedures need to be provided in sufficient detail in order to allow for their reproducibility. If a method is being used for the first time, it needs to be described in detail to show its validity and reliability (reproducibility). If modifying existing methods, describe what was changed as well as justify the need for the modifications. All experiments using human subjects must obtain the approval of an appropriate ethnical committee by the author in any undertaken research (the manuscript must include a copy of the approval document). Statistical methods should be described in such a way that they can be easily determined if they are correct. Authors of comparative research articles should also include their methods for finding materials, selection methods, etc.

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The results should be presented both logically and consistently, as well as be closely tied with the data found in tables and figures.

Discussion

Here the author should create a discussion of the obtained results, referring to the results found in other literature (besides those mentioned in the introduction), as well as emphasizing new and important aspects of their work.

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In presenting any conclusions, it is important to remember the original purpose of the research and the stated hypotheses,

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We wstępie należy wprowadzić czytelnika w tematykę artykułu, opisać cel pracy oraz podać hipotezy, stan badań (przegląd literatury).

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and avoid any vague statements or those not based on the results of their research. If new hypotheses are put forward, they must be clearly stated.

Acknowledgements

The author may mention any people or institutions that helped the author in preparing the manuscript, or that provided support through financial or technical means.

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The bibliography should be composed of the article's citations and be arranged and numbered in the order in which they appear in the text, not alphabetically. Referenced sources from literature should indicate the page number and enclose it in square brackets, e.g., Bouchard et al. [23].

The total number of bibliographic references (those found only in research databases such as SPORTDiscus, Medline) should not exceed 30 for empirical research papers (citing a maximum of two books); there is no limit for comparative research papers. There are no restrictions in referencing unpublished work.

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