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PREFACE

Monographs “Science in Swimming” have been issued periodically since 2007. From the beginning the intention of the authors was to create a forum for the exchange of up to date research results and their transfer into teaching and coaching practice. Science in Swimming passes the message that swimming as an element of physical culture is developed thanks to the involvement of teachers, trainers, and passionate research scientists.

The monograph included works devoted to the issues of learning and teaching swimming, swimming training, recreational swimming and swimming for the disabled. Both the broad spectrum of issues presented in the monograph, and the interpretation obtained by the authors of the research results have a well-established base in the fields of the humanities, teaching physical education, pedagogy, psychology, biology, physiology and biomechanics. The tangible result of research activities is to obtain objective feedback from the research subject, i.e. the people who learn to swim, or train swimming, or simply people who treat swimming as recreational activity.

The concept of “Science and Swimming” and the level of research published in subsequent editions of the monograph gave it a permanent place in world specialist publications, which is confirmed by the positive reviews of the opinion leaders in the International Journal of Aquatic Research and Education [2012, 6 (4), 366–367 and 2013, (7), 407–408]. According to the reviews, “Science in Swimming” is a source of unique knowledge, exchange of ideas and a place for establishing cooperation creating new quality in the science of swimming.

We therefore offer our sincere thanks to the authors of published works and their reviewers: Professors Tadeusz Bober, Robert Keig Stallman and dr Jaroslaw Domaradzki (Associate Professor of University School of Physical Education, Wroclaw) whose work hard contributed significantly to the Science in Swimming V.

Editors
CHAPTER I

DIDACTICS IN SWIMMING
Sport as a utopian competition of equal opportunities

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ABSTRACT

The paper discusses a causal model of pursuance of a sport utopia. By way of a regressive analysis, reaching back to the primary metaphysical premises, it explains the key reasons for achieving the sport utopia. The recent cases of breaking the sport ontic order by sprinters and swimmers, who violated the rules of proper conduct in their personal lives, show how easily the state of sport anti-utopia can be reached. The applied regressive analysis model reveals that the success of sport utopia, being a variety of social utopia, is determined by authoritative judges managing the common good of the sport family. There is a reason why the sport community is referred to as the sport family. Maintaining familial relationships is a utopia itself, i.e. a daunting but feasible task. And although the hope of each family, also of the “sport family”, are its children, only the adult family members – capable of assuming the responsibility for the common good – can maintain order in the family and render all its activities sensible. Similarly, the successful organization of competitions in a sport family aimed at perfection according to the family’s ideals is only possible, if the order of competitions is preserved by: a) judges-categorizers responsible for maintaining sexual-somatic equality; b) judges-classifiers responsible for ontic equality (extra-sexual physicality) of the gymansion ascetics; c) judges-exposers responsible for revealing ontic inequalities of doping abusers; and d) judges-moderators responsible for the moral equality between competitors. If it had not been for these judges’ authoritative enforcement of moral and ontic equality among athletes, then – without diminishing the athletes’ contribution to the creation of fair competition – it could be assumed that the liberally, relativistically and individualistically disposed athletes would not have been able to tackle their humanistic tasks by themselves.

Key words: sport, fairness, fair play, morality, moral relativism

INTRODUCTION

The recent cases of violation of the ontic order by sprinters – who deceived themselves, their competitors and the stadium community – and by swimmers, who are allegedly members of the Olympic family, but play nice children from good families in daylight, and then at night, show their true face attending houses of ill repute seeking filthy entertainment, show how easily one can destroy the sport order. Those who are unfair in their personal life will not seek decency in their sport life, even if there was some

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1 This article is the english version of the article Sport jako utopia konkursu równych szans first reported in the “Rozprawy Naukowe AWF we Wrocławiu”, 2014, 44, p. 3–20. The paper is an enlarged and revised version of a chapter from the volume Kultura fizyczna a różnice i nierówności społeczne (eds. Z. Dziubiński, M. Lenartowicz), SALOS, AWF, Warszawa 2013, p. 249–269.
authorized code of fair conduct laying out the passageway through the gate of agonistic competition, and threatening exclusion from the stadium community for misconduct.

These and many other cases of athletes’ violation of the norm of self-respect that are, in fact, more numerous than evidenced in official reports of anti-doping bodies and law enforcement agencies, raise a serious question about the moral validity of sport competition and about the prospects of sport as a utopia of social justice. Sport theorists, who seek sociological explanations for the achievement of the common good by the stadium community, must look into the nature of these developments. It is highly probable that athletes themselves, who had experienced the liberal vulgarity of social (dis)order in childhood, and succumbed to the temptation of breaking the norms of law and mocking ideals and authorities, have no interest in such misconduct. In any case, their sport achievements, i.e. achieving the status of the first among equals, does not depend directly on athletes themselves. Who else stands behind this success? One may ask naively, how it is possible that these “mature children”, audacious in their liberal usurpations and betraying moral values, are granted the honor to take part in the feast of the fair ones. No child is ever an emanation of moral evil. Evil are the deeds a child sees in adults. The expectation that joining the sport community would change the fixed moral habits of “children of liberal freedom” in pursuance of some rigor of sports law, finds no confirmation in the psychological laws of internalization of values and norms.

The sport community has always been highly conservative. It has been known from the various fields of confrontation between ideologues and ethicists that the most formidable enemy of the conservative social orders are liberals who praise the superiority of individualized life without obligations or moral aspirations. The ideologues of liberal-democratic social systems do not have to encroach upon sport. All they can do is to arrange a space of unconstrained cavorting outside the stadium, and ensure that participants in “autonomic” life will reach eternal happiness without any responsibility for others.

In confronting the ideology of unconstrained celebration of differences and diversity, the conservative utopia of sport competition assuming rigorous moral equality for everyone may not persist. Who wishes to comply with the sports law of passage through the narrow gate of constraints of actions, when with the consent of managers of marketed fun one may pass through a much wider gate to an easy life (cf. Mathew 7: 13–14).

How can sport become a utopia of the fair ones, when the liberals in the stadium, who are unable even to control themselves intellectually in the sense of their sport destiny, may not contribute to sport autopoiesis following the principle of joint responsibility for the common good. The social system of sport culture is self-reproductive. It replicates norms, patterns and ideals, and it sustains itself through responsible moderators of cultural self-determination such as intellectual and spiritual leaders of sport, scholars and scientists, experts and moralizers, activists and judges, trainers and tutors and finally sport educators and their students. All of them assume their designated roles and positions: competitors, organizers, volunteers and fans. In their roles and positions they fulfill their tasks properly by animating the social system of the stadium for themselves, realizing the stadium’s inherent good and experiencing their self-fulfillment. By contributing to the system, they contribute to the order inscribed in their collective memory as a thought about themselves, i.e. the culture of the stadium community. The autopoietic existence of the
social system of sport culture is undoubtedly its metaphysical peculiarity or even a mystery. One may ask how the self-reconstruction of this social being is possible at all, following its inherent sense experienced by the system's participants as the attainment of the highest good measured with humanistic ideals. This question is a valid one since athletes, being the authors of their deeds, are unable (not all of them) to achieve the personal potential of humanity while developing their physical being, i.e. the simplest way of training their natural potential. An individualist who is willing to elevate oneself above others is not able, due to his selfishness, to attain the common good. Thus he or she may not take part in the mysteries of sport autopoiesis, following the rules of participation in the stadium culture.

Is it then possible at all for the sport stadium community to persist in conviction about the sport competition becoming a social utopia of the fair, if athletes who usurp their participation in this community are not able to meet the requirements of fair conduct? This is especially the case of those who adhere more to moral relativism than to the conservatism of good customs.

**HYPOTHESIS**

In the confrontation with the ideology of unconstrained celebration of diversity, the conservative utopia of sport competition, rigorously assuming moral equality of all, guards its good with the aid of judges-guardians of the ontic order (categorizers, classifiers, exposers) and of the moral order (moderators). Without judges a sport competition is never a utopia of equal opportunities.

**REGRESSIVE DEDUCTION: KNOWING THE CAUSES OF SPORT COMPETITION UTOPIA**

I intend to discuss the causes of sport competition utopia by way of regressive deduction. The assumed causal model of becoming a sport utopia is the explanation of the original metaphysical premises, i.e. the key reasons (X) for a utopia. What are these premises whose outcome is an observable phenomenon called the utopia of sport competition (Y)? The reasons for this phenomenon constitute its hypothetical explanation.

**SEXUAL DUALITY**

The first premise is that natural heterosexuality is a determinant of hetero-culturality of sport manifested by the independence of women’s sport of men’s sport. According to this premise the reason for a sport situation is a substantive, physical and sexual, difference between men and women. It is essential and imperturbable. In agonistic practice this difference determines the organization of two independent social orders, which despite their ontic variability, remain axiologically identical, i.e. are substantiated by the same ideal. Although men and women possess the same nature, i.e. they are essentially identical as similes, and the same dignity, they possess different sex traits (chromosomal, genetic, gonadal, hormonal and somatic) and are quantitatively unequal. Due to these sexual-physical differences, men and women create sport situations independently of each other, ensuring
equal access to primacy in sport. The fair selection of male and female top athletes requires physical equality and thus sexual equality. Sport culture must divide the world of sport into the feminine and masculine categories, each radically homogenous. Physical and sexual hybrids within each category render the sport agon unequal.

When sexuality is recognized somatically, but is altered through an arbitrary re-definition, a deception occurs in the world of sport. Sport as a contest between two unequal sex categories loses its humanistic value. Thus, if sport is to be fair, it must be conditioned by athletes’ heterosexuality in both sex categories.

**JUDGES-CATEGORIZERS: THE GUARDIAN OF EQUALITY OF THE SEXES**

The guardian of sexual equality is the judge-categorizer, who describes the somatic sex by establishing its qualitative denomination. The judge-categorizer uses the qualitative variable: man – woman. The judge-categorizer does not describe the genetic, gonadal, hormonal or psychical sex. The difference in somatic sex is the metaphysical reason for the duality of sport community. Sport does not take place when its metaphysical reason is rejected. Without the categorizer, there is no sport.

**EXTRA-SEXUAL DUALITY**

Thus the categorical duality of sexes is an ontic reason for the sport competition. The duality also goes beyond sexual physicality, in which the *substantia corporea* is manifested differently in men and women.

The second premise is that the social system of physical culture of sport with its bipolarity of categorical differences between male and female ascetics, makes both groups of gymnasion participants ontically equal before they enter their roles of sport performers. All gymnasion participants are equal in terms of their physical characteristics, as all of them – pursuant to sex category – are assigned procedures of bodily refinement, accounting for their ontogenetic age. The ontologically equal male and female ascetics of the gymnasion acquire the same chances of access to the highest good of sport, i.e. victory, thanks to the mentioned bipolarization. Ontic equality creates sport equality. Ontic equality signals sport fairness as it ensures everyone equal access to the most coveted sport good: the experience of reaching the top. When all participants leave the gymnasion, convinced of their ontic equality (by category), to enter the sports competition, the judge-moderator – as the highest guardian of stadium fairness – is entitled to announce that sport fairness has been potentially complied with, even though the sport agon has not begun yet.

Judges-categorizers established the foundations of people’s professions, before the sport competition. They gave each participant an equal right to win. Before athletes were set at variance they had taken part in a parade of ontic equality. They were divided into categories and classes, to make themselves equal sexually and substantively. They were also divided into categories of personal and performance development as well as into classes and subclasses of somatic deficits and motor dysfunctions. Knowingly or unknowingly, they took part in the creation of the order of sport fair-
ness before they entered the competition. As ontically equals in competition, they can attain all goods being their natural properties: spirituality, reason and physicality, and bring out all they had acquired and perfected in order to tower over this equality in possessing the exceptional status of top athlete, i.e. the first among equals.

Thanks to the categorizers, also the extra-somatic bodies of ascetics become ontically equal, which means that all athletes have enjoyed equal chances of victory. The ontic equality generates sport equality and is a manifestation of sport fairness. Thanks to the judges-categorizers the requirement of fairness in sport is potentially satisfied.

These two premises precede the discussion of causes of sport as a utopian competition of equal opportunities. It is a utopia which is paradoxically a platform for celebration of diversity as well as redressing social inequalities, and in some other cases, for their reproduction and preservation. Although the sport competition is a mixture of highly explosive components, quite unexpectedly, the entire energy of agonistic relations is utilized in a self-developing system of a humanistic ideal being fulfilled. When it appears that the conflict in sport is inevitable and when the different and the unequal come to meet one another, there is peace. Sport as a system of living for the moment reaches its ideal: the different ones discover they are at least equal in their humanity, or rather assume they are those who respect their own moral dignity.

Both metaphysical premises enable regressive deduction. The first one assuming the indispensability of the heterosexual order in sport praxis leads to the postulate of (self) elimination of intra-sport homosexuality (of homosexual women in women’s sport and homosexual men in men’s sport) and of inter-sport homosexuality (of women in men’s sport and men in women’s sport). If a sport situation is to be fair there must be the heterosexuality of athletes in both categories. I should add here I am not aiming at any segregation or discrimination.

In its metaphysical nature sport is a relational, one-sided, unequal being. When subjects in a sport relationship are not equal to each other, for example, in their level of fitness, a less fit or disabled person will be deprived of chances of victory. When one loses, one either relinquishes their participation in the agon, or decides to seek opportunities to win among equals. This is how sports for physically and intellectually disabled were developed parallel to sports for the able-bodied, i.e. in the metaphysical sense, athletes compete in their existence and function.

2 This appears to be the hidden reason (explained only metaphysically) why homo-sexual athletes organize independent sports games and competitions within their own sex category. Is this not the reason why men who declare themselves homosexual take part in these competitions because only within their category can they find themselves among equals? In the radically masculine sport of heterosexual men, homosexual athletes might be unequal, or even worse in sport. This can be illustrated by a football tournament of homosexual players I witnessed during the Second World Congress of the International Sociology of Sport Association that took place on June 18-21, 2003 in Cologne, Germany. Other examples only seemingly refute this supposition. For instance, a homosexual man (in a gay relationship) wins a sport event against heterosexual competitors. In his relationship, however, he assumes the male sex. He is therefore a man type in a relationship with a man as a “woman”. He possesses all recognized gonadal, hormonal and genetic properties of the male sex. Thus he meets the condition of heterosexuality in men’s sport, although he defines his gender differently. His partner, i.e. the female type in the gay relationship, would not stand a chance in access to primacy in men’s sport. Women do not compete against men, even when they primary sex traits may suggest they represent the male type.
Why is this differentiation so important? It must be maintained to ensure the fairest selection of the best top athletes in their heterosexual category. Agonists must be physically and thus sexually equal to one another in the somatic, genetic, gonadal and hormonal sense. Female athletes must be sexually feminine, while male athletes must be sexually masculine. To do justice in sport, the culture of sport must involve the division of the world into radically homogenous feminine and masculine categories.

Hetero-sexual women’s sport must be organized in a homogenous way – within its own category – as the “world of women’s sport”. In the same way men’s sport must be organized in such a way that it affirms homogenous masculinity. Sexual hybrids within each of these categories, or permeating, by subterfuge or due to ignorance, into the world of the opposite sex, make the sport agon unequal (in terms of opportunities of victory) or even absurd. Themselves they become exposed to moral stigmatization. One may not know that one may be a man or a woman (gonadally, genetically and hormonally) since the sex may not be manifested by somatic appendages recognized by the brain and the senses. However, when sexuality is recognized somatically, but is still falsified as it becomes re-defined, and a deception in the world of sport occurs, e.g. the case of Stanisława Walasiewicz. Sport as a competition of unequal agonists (within the same hetero-sexual category) loses its humanistic significance3. Sexual hybrids destroy the axio-normative order of the world of sport in the way physically disabled athletes, who are wrongly categorized by judges or who put themselves into a category they do not belong to, stake out their claim to primacy, often in a raging and arrogant manner (e.g. Oscar Pistorius)4.

By assuming that a human being can be of female or male nature due to physical differences I would like to point to a certain fact, even though sounding like a platitude. Without a society, created by men and women, with its dual system of physical culture legitimizing the bodily values of men and women separately, there are no sociologists (of physical culture). Similarly, without carbon there are no physicists. 5 Thanks to sociologists who reveal the existence of the system of physical culture we can accept this assumption. We know at the same time that sociologists themselves are unable to explain the origins of this system but must seek the assistance of metaphysicians. A sociologist would have never discovered sport (men’s and women’s) without a sport community as a relational entity preserved for generations thanks to parents of different sex and permanent socialization: primary (family) and secondary (school, stadium).

Why is this platitude so important? According to Heller, in 1961 Robert Dicke observed in his article in Nature that carbon, as we know it today, is formed inside stars as a result of multiple burning of the nuclear fuel. When stars die, a human being, i.e. a Homo sapiens, emerges in a cycle of changes from carbon (and from other elements heavier than hydrogen and helium). Physicists and astrophysicists have

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4 The classifiers in the sports for the disabled do everything to ensure equal participation of individuals with all kinds of disabilities in the sport agon. When the creation of classes of physically equal athletes is not possible, than they take part in non-competitive contests in which each participant becomes the winner. This can be illustrated by the shot put event during the London Paralympics in 2012, when 17 gold medals were awarded to all the participants. One may say that each competitor at Paralympic Games wins, the ideal of sport family is fully accomplished in sports for the disabled.
5 Analogy after M. Heller.
discovered that carbon may have been formed $10^{40}$ natural time units ago. Before that time we could not have existed since our building material had not been there yet”\(^6\).

As for sociologists a similar “platitude” can be stated: sociologists cannot be formed without a society that is “born” from humans of two sexes: men and women. Without the death of stars there is no carbon, and without carbon there are no humans. There is no offspring then without individuals with their “assigned” sexuality, i.e. without parental relations. And human offspring is always born from man and woman (mother and father), who are equal to each other in the origin of their physicality, but differ in their sexuality. Without generations of human beings, there is no society, i.e. a relational entity, self-conscious of its destiny and displaying the ability of cultural self-reproduction (\textit{autopoesis}). Without this self-determination due to hetero-sexual relations between man and woman, there is no society in which its heterogeneous members can experience cultural replications of patterns, norms and ideals being the sources of their personal and communal identity. Without the sexual differentiation of humans, society and culture – as self-aware entities – would have never been formed, and no self-conscious being would have acquired its identity. Without human sexual differentiation, humanity or society would not have developed in the universe. Each society starts from man and woman, and each society ceases to exist, if in an inter-generational perspective, for some reason, there is no father or mother or both.

Hetero-sexuality of the human body is a metaphysical principle of social reality. If it is morally and legally protected – as a determinant of creation of the common good thanks to which the society can transfer its cultural values and content onto future generations – it is recognized by society as the highest fundamental good; while physicality and its inherent hetero-sexuality are substantive conditions of social life. The hetero-sexual human being – who is responsible for this common good and who respects the natural order and emphasizes its ontic significance in the logos of natural law – casts a cognitive anchor to secure their attachment to their cultural ideal. The self-control of the heterosexual being is on all accounts conservative as it involves the responsibility for the good of others, from which a society, understood as a network of personal relations, can emerge. Thanks to this commitment to the common good heterosexual persons can transfer their being onto others and ensure their presence in cultural heritage. They can also assert that their successors will be safely anchored in this ideal. Moreover, the benefits of this self-controlled freedom (for the community) is momentous as thanks to it human beings can become good persons thanks to the opening to the existential good of others. Those who live for the benefit of others become persons and, by contributing to the common good, co-create society, i.e. a relational entity, which is sexually and thus physically polarized.

\textbf{MEN’S AND WOMEN’S GYMNASIONS}

Human beings are not only male or female, as manifested by their biological traits. They also affirm their sexuality in their reproductive fitness to enhance their vitality, health and reproductive purity. In this way human beings establish a diverse pattern

of physical culture accounting for the nature of male and female sex, and thus, for male and female physicality. They establish two different norms for the same, biotic, vital (health-providing) pattern of physicality accounting for physical differences between men and women. In the gymnasion of biotic-vital fitness they establish male and female physical culture programs, which are inspired and developed at school in co-educational or, more often, single-sex classes. In the practice of biotic fitness men and women take part in the educational programs independently of each other, which does not yet lead to a special spatial identification of gymnasia for males and females. Although men and women are equal in their human nature, because of their natural differences they must master their biotic and vital fitness in different ways in order to develop their vitality and health. This differentiation leads to a division of many social roles into “feminine” and “masculine” and, in particular, to a division of agonistic roles in which different physical competences determine the sport victory. When the agonist’s physical competences are recognized (somatically, gonadally, genetically and hormonally) and categorized into male and female, the ontic requirement of differentiation of training and competitive sport into masculine and feminine is fulfilled.

Certainly, the very fact of being a man or a woman does not impose the necessity of having two categories of hetero-sexual sport. Sport is a product of culture, not nature. The sexual nature of agonists is the ontic determinant of the cultural existence of sport, but never its cause. Thus when sport emerges as a) a ludic event, i.e. recreation for the working community; or b) redeeming event, i.e. as the Olympic movement of the global community against evil and for the good of peace and love, it must be split into two hetero-sexual categories. In fact, two worlds of sport must emerge: women’s sport and men’s sport. And, even if we only had had sport for men – as desired by Pierre de Coubertin – emancipated women demanding equal rights and defying the world of male tyranny would have led to the development of sport for women. They could not break into men’s sport in the past, not only because the gates of the stadium were shut to them (in ancient Greece with its male homosexual tyranny, and in England and France with their haughty, patriarchal aristocrats being the sole “owners” of social order). Even if they had managed to crash the gates open they would have been in a lost position in any competition against men. The agon, in which physicality determines the result of the social relation between the two sides, demands categorical equality from both sides. And since men and women are not equal to each other within the same category as physical beings, they cannot enter the sport agon in a bilateral, mutual relation because they cannot meet the demand successfully. No goodwill act will ever change the ontic status of agonists representing different categories. While in the chess agon, non-physical qualities of the competitors decide about victory and this bilateral relation may be possible, in the gymnic agon (to use a more appropriate ancient Greek term) this is unacceptable. Women do not challenge men to compete with them in sport, while men should not express their hubris to demand satisfaction in a competition with women. A man should know that physical competition against a person of a different sex category, one may say weaker category, will never prove his primacy among others. When others do not count as they do not equal with the top one (as well as represent another category), and provided the top one does not suffer from delusions about his greatness, he will not find respect in his self-perception. An agonist of sound mind
will seek confirmation of his aspirations to primacy by entering an equal relation with others within his category: men among men, and women among women. When a *sport* relationship takes place between a man and a woman, e.g. the famous tennis Battle of the Sexes between Billie Jean King and Bobby Riggs won by the woman, it is for non-sport reasons. That tennis match was a scene of symbolic humiliation of the arrogant male part of the human race, when in front of the stadium audience – enlarged with the use of television broadcast – a desperate defense of woman’s dignity took place in a non-lethal duel. By its nature, sport cannot stand a *sex mix*. This should not be confused with the tennis mixed doubles competition in which sexuality – as a media variable of the causal model of the agon – becomes ontically neutralized. When sport becomes a relation between two unequal subjects, i.e. a man and a woman unequal in their natural physical fitness, it is made through some extra-sport force which makes both sides first confront each other and then leads to the victory of the weak one over the stronger one.

**MANIPULATION OF THE SEXES: A SPORTS DECEPTION**

A different case are homosexual or transsexual individuals, who have experienced a deficit of reproductive fitness for some reason, and who profess themselves to be men, women, or both. When due to the cultural “bewitchment” of one’s sexuality or due to its bio-technical inversion, a homosexual human being entering a heterosexual sport circle in his or her category (a woman entering a women’s sport, a man entering a men’s sport) or the category of the opposite sex (a woman entering a men’s sport, a man entering a women’s sport), makes himself/herself ontically unequal to a heterosexual agonist and, therefore, violates the principle of equality of opportunities – fundamental for the causal model of sport agon. It is not really important whether a homosexual female agonist – who fights for predominance in the world of women’s sport – starts competing from a losing position at her own request; while a man who impersonates femininity and “sneaks into” women’s heterosexual sport can proclaim his victory at the very start of the competition. In both cases the moral order of sport competition is violated, i.e. the axiological situation of sport becomes destroyed. When there is deception, i.e. sex manipulation, sport is no longer fair. Sport is, in fact, a simple normative system in which morally equal agonists – equalized earlier by judges-classifiers in their respective sex and age categories compete against one another for victory in a game for primacy among equals. Individuals who cause sex inequality, spoil the fun of the game. Disillusioned spectators would condemn them for their deception, while judges-classifiers – being the guardians of equal access to the common good of sport – would *arbitrarily* exclude the deceivers from the community of fair agonists.

**EXTRA-SEXUAL PHYSICALITY IN SPORT**

The *geneonomic* purity of femininity and masculinity is an ontic condition of the competition, in the world of men’s and women’s sports, independently. It is not, however, the only condition “directed” by the logos of the causal model of sport

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towards the physicality of male and female agonists. This condition also applies to extra-sexual physicality, in which the *substantia corporea* is manifested differently in men and women by its substantive qualities (osteoarticular, muscular, cardio-pulmonary systems) and functional qualities (biochemical and physiological states and processes, and motor fitness). The corporeal masculinity and femininity are manifested fully by primary sexual traits, but they are mostly visible and recognized dimorphically in internal states (different habituses) and actions (operational habi-tutes). The extra-sexual physicality of both categories differs naturally and is equally susceptible to external changes resulting from intentionally repeated self-actions aimed at the development of capabilities of the mind and the body. Certainly, I mean here sport training, i.e. constant perfecting of agonists in their existence and performance, and optimally loaded exercises leading to the transformations of muscles, bones, and joints and to the perfection of tissues, cells and functions of all body systems, in particular, its cardiovascular and respiratory capacities. All this leads to the extreme masculinization (often pathological degeneration) of the male agonist’s body and, in some sports, to a pathological decomposition of the female agonist’s body, e.g. in male and female body builders. Despite these deformations observable in both sex categories, there is no “equalizing” or sexual homogenization between the sport masculinity and sport femininity. Thus in circumstances in which sport training culture features an enormous strength of body transformations at the genetic, cellular, tissue, organic, morphological and motor levels, it is nature that decides about the indispensability of both categories in sport. It also turns out that when scientific technologies of sport training are confined to the transformation of natural physicality, then despite the existence of the enormous loads of the man’s and woman’s body, they will not lead to the development of a new, refined agonist. There is no force in the culture of sport training that can transform (essentially) a man or a woman into their ontic opposites, or – as some usurpers of technological power over humankind think – into the “new athlete”. If this were to happen, for example, by way of technological manipulation of the male or female genome (or both at the same time), the monstrous creation of such new athletes would lead to the establishment of ahumanistic post-sport as an alternative social movement to the bi-categorical humanistic world of men’s and women’s sports. Those who dared to activate such biotechnological production of post-athletes, would also have to establish a constant scheme of control over those fake agonists in order to comply with the principle of fair selection of *in vitro* bred agonists. Otherwise, the race of biotechnologists to attain the superiority of their methods in the post-sport praxis would have no sense, and post-athletes – eager for victory themselves, regardless of any costs or damages – would lose their humanity. Sport, or a sport body, is always male and female separately, being a cultural affirmation and concurrent preservation of the dual human nature. By sealing the hetero-sexuality of human nature sport culture also derives ontic persistence from human nature to be, despite its sexual duality, axiologically uniform. Sport as a manifestation of social life would have never existed, if it had not been for its sexually bipolar nature. Also society as an inter-generational, relational entity would have not been there, if individuals of two different sexes had not pass their sexuality onto their offspring, assuming the respon-sibility for the common good.
JUDGES-CLASSIFIERS: GUARDIANS OF ONTIC EQUALITY

Pursuant to the principle of equal access to the sport community, more complex criteria of categorization of agonists had to be developed that would account for individual, physical and intellectual shortcomings. To comply with the mentioned rule of equality in both sex categories, male and female agonists had to be divided by judges-classifiers into at least six classes of physical disability with a number of subclasses of deficits and defects. The sport organizers established in this way a division into various categories and classes of sport. The agonists were divided into men and women, boys and girls, juniors and seniors, or able-bodied and disabled. The realization of sport as a utopian competition of equal opportunities is only possible within these categories and classes. They consist of members with comparable intra-category and intra-class developmental abilities, conventionally indicated by their calendar age. Once this ontic differentiation is respected and rigorous rules of access to membership in these classes and categories are followed, the common efforts among different sport “subfamilies” towards the same axiological ideal become possible. Each participant is different, yet all of them in their respective sport classes and categories are similar to one another. Because of these rules individuals become similar to one another, but never identical. There are simply no ontically identical individuals. Even identical twins are not identical in their physicality. Some may accuse the classifiers of maintaining an ontic fiction. Some may add that it is not enough to attain complete ontic equality, and that the resulting classifications and categorizations are merely approximate, especially when considering human qualitative genetic traits, which calls up associations of racial discrimination.

THE FICTION OF EQUALITY IN SPORT: BETWEEN ONTIC INDIVIDUALIZATION AND GENERALIZATION

Since the achievement of an ideal state of ontic equality is impossible among participants in sport competitions, the competitions become fiction themselves, since they fail to meet the requirement of equal access to victory. A white sprinter would say I don’t stand a fair chance of victory because I differ genetically from my black opponent. I have trained myself the same way as others, but I have not become ontically equal to my competitors. Similarly, a European long-distance runner may compare himself with his East African counterpart; or a disabled runner who realized he lost a race because his opponent with shorter thigh stumps had used longer artificial limbs (Oliveira vs. Pistorius).

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8 Age categories in sport are separated by 12-month intervals. This may lead to the violation of the rule of equal access in sport, especially in sport for children. In the Canadian junior hockey league boys who were born later in a calendar year have smaller chances of advancing to the youth category (at the age of 9) than their counterparts born in the early months of a year. The rule of equality was violated for many years in the case of those boys born later, while boys born in the first quarter of the calendar year were promoted. Trainers could not understand why boys born in the same year differed biologically, i.e. did not attain the same performance level in sport as their peers they trained together. The younger boys were recognized by trainers as “untalented” and were eliminated, while their older peers – who were allegedly more talented – advanced to further stages of hockey training. Scientists pointed to the trainers that their procedures were routine and unreflective. See more in M. Gladwell, Poza schematem. Sekrety ludzi sukcesu, Kraków 2009, Znak, pp. 29–45.
Can judges-classifiers meet this challenge to equality of opportunities, when they know that individual athletes classified into cohorts and clusters still differ qualitatively or quantitatively? They differ until the procedure of equalizing opportunities is completed, i.e. until the moment when there are only two athletes in the same sport. And then it would turn out that the strict adherence to the logic of maintaining equal opportunities in sport makes the classifiers invalidate the established two-athlete clusters since they would differ, for example, in eyesight acuity (in shooting), hair length (in sprinting) or foot length (in swimming). The ultimate solution would lead to the individualization of each male and female athlete in every sport. Each athlete would compete against himself or herself only. In result, everybody would be satisfied with the possibility of equal access to victory over oneself, but no one would claim any primacy. The first ones in the competition would become the last ones. A sport victory would be simultaneously a failure. Justice would be done, but it would be justice with a bitter victory tasting like a failure. It would not be a sport victory since it can only be attained as a result of an established social relation. Sport is a game for primacy. When there are two or more individuals, sport becomes a social fact, i.e. an intergenerational relational entity.

On the other hand, an excessive ontic generalization that even ultimately blurs sex differences in the sport community would lead to the invalidation of the rule of equal access to victory. In this case injustice would be done. If all take part in the same competition, regardless of sex (men with women), age (juniors with seniors), physical abilities (disabled with able-bodied) and of any other physical, somatic and fitness differences – the top athlete (a man, I assume) would have to nevertheless compare against a more or less ontically equal opponent to be able to gloat over the identity of the first among equals. Still, even in an “ontically generalized” marathon race, for example, it is the judges-classifiers – rendering the competition humanistically sensible by respecting the principle of equal access to the sport good – who divide the competitors into heterosexual categories, classes and subclasses in which all are considered ontically equal. In result, everyone wins in his or her category, class or subclass.

Both aforementioned situations involve a degree of absurd. The former leads to the annihilation of sport as a social relational entity; in the latter – which does make sport a social phenomenon – the classifier destroys its human sense by ignoring the principle of equal access to the same good. It is a logical challenge. We know that sport has never been ontically individualized or generalized in order to destroy itself as an interplay of ontically and morally equal competitors.

**ONTIC MEDIUM OF EQUAL OPPORTUNITIES: MALE TRAINERS FOR MEN, FEMALE TRAINERS FOR WOMEN**

As mentioned earlier the second assumption of regressive analysis refers to the dispensability of independent development of physical and sexual fitness of male and female athletes. Both sex categories in sport must develop physically in two independent systems of physical culture through their own actions since the constituent traits in each sport category: youth, junior, senior – different in their sexual and extra-sexual physicality – force modern trainers to adopt two types of projective and normative rationality: “only for women” and “only for men”. In consequence, a split of **paidotribes** and **gimmastes** into male and female social roles.
takes place. Modern sport trainers have faced this division in the social gymnasium practice, but they did not necessarily have to divide themselves in their own community (of the same social roles of trainers) into sex categories of trainers of female physicality and trainers of male physicality, i.e. male trainers for men and female trainers for women. In gymnasium practice, the model of a male trainer of women has been well established, but not the model of a female trainer for men. It is not only a conscious departure from the principle of equal opportunities but an arbitrary and involuntary infringement of the model of trainer for all. It was embedded into the social mentality of the gymansion, in its pre-emancipation stage, by its dominant male part as a sort of relict of the habitus of sport trainer for men and women alike. However, the rigorous rule of equal opportunities in the sport agon, the respecting of which makes male and female athletes equal ontically in their respective categories, imposes on the logos of gymnasium the division of gymnastes into male trainers for men and female trainers for women. A male trainer in a women’s sport does not aid potential top athletes more than a female trainer in a women’s sport. A male trainer does not create more opportunities for victory for female athletes than a female trainer. The question remains whether the hypothesis about the “superiority” of male trainers over female trainers has ever been examined. Without a doubt, the infiltration of the world of women’s sport by trainers from the other sex category brings about unequal access to the sport good, i.e. to the potential distinction of being first among equals. Potential top female athletes do not become equal to one another in terms of their physical, but also mental and emotional, characteristics when a man (and only occasionally a woman) becomes the trainer in their gymnasium. It does not matter what sport results would be attained by female athletes trained by women. The most important is the rigorous application of the rule of equal opportunities, i.e. that primacy could be potentially gained by every female athlete.

It is also significant that the guardians of the ontic equality of female athletes become men, similar, by way of “heritage of tradition”, to men becoming gynecologists more often than women. Should there be female classifiers for female gymnasium ascetics, and male classifiers for male gymnasium ascetics? Although there are no empirical arguments justifying the indispensability of this division, by way of regressive deduction used here, this division is logical.

**X-FACTOR AS A SELF-MODERATOR OF MORAL EQUALITY HIDING IN SPORT CONSCIENCE**

Thus, only after acknowledging sport categories, classes and subclasses can one refer to sport as a utopian competition of equal opportunities. Certainly, in each ontic variety of sport the ideal is realized independently. But there is always a question why – despite the fulfillment of the condition of “ontic equality” sport praxis fails to attain the ideal or even defies it. Why is the axiological ideal of sport of equal competitors so arduously attained? Why is its humanistic content destroyed long after the ideal has been reached (see the cases of the famous cyclist or sprinters who had abused doping substances)?

Can now the logic of regressive thinking lead to the finding of some non-ontic reasons explaining the validity of sport as a competitive utopia and causes of sport
failure? Should we perhaps focus on ascetics as participants in the gymnasion, and then on their transformed characters as participants in the stadium? In both roles the same social persons may add much to their ontic characteristics and states (not only in terms of their physicality, but also spirituality, intellect, prudence, volition or emotionality), and to their sport activity as a transgressive expression of agonistic force – subject or not to normative conscientious regulation, i.e. moral assessment of one’s actions.

Thus the two premises of the regressive analysis are: 1) indispensability of the division of sport into men’s and women’s; and 2) division of gymnasion ascetics into categories, classes and subclasses ensuring the ontic equality of future agonists. Using both premises we can now briefly consider the subjectivity of sport as a reason explaining the final result of competition, and realization of competition as a utopia of fairness. We should consider it briefly because the science about reasons for sport results, commonly known as sport theory, has already contributed much to the causal model in question.

Therefore we must accept a simple anthropological assumption (we cannot do anything else in the light of irrefutable metaphysics) that a sport person is rational, internally free, and capable of perfecting each level of its being: material, physical, fitness but also spiritual, intellectual and psychical. We must assume that a sport person is a dynamic case of a person of free will, who is able to increase his or her ontic resources of physicality and constantly improve oneself. Athletes are, first of all, persons, i.e. they consciously contribute ontically to their individuality. They simply acknowledge that becoming first among equals (as recognized initially by the judge–classifier) depends on one’s ontic primacy in the gymnasion over the opponent, before the competition.

GAINING PRIMACY IN THE GYMNASION

When the ontically equal gymnasion ascetics start their training aimed at their natural and physical development, they abandon the equality imposed on them by the judge-classifier. They enter a race for diversity – metaphorically compared to an “arms race” (by arming themselves with agonic competences) – or even apply some political ideology to their physicality, e.g. in gymnasions of authoritarian states, and wage a “technological war” among the boards of designers, advisors and experts. Depending on the degree and scope of rationalization of training methods, especially on their scientific optimization, the gymnasion ascetics engage in the race by default with an earnest of victory in the future stadium race. They have their workers’ right to perfect their physicality, provided they abide by the logos of natural law. Since they work discretely, unknown to their competitors, no one knows (neither the judge-classifier nor even the trainer) in what ways: natural (i.e. complying with natural laws) or artificial (i.e. defying natural laws) they would acquire their ontic prominence. When actions of ascetics do not infringe their natural physicality, they are actions maintaining one’s personal dignity; they are praiseworthy (workers can praise themselves) as training in the gymnasion allows ascetics to enjoy their personal dignity. This is how the workers of the gymnasion respect their physicality and, by training, ennoble it with new additions. In no way do they transgress its nature; but rather they affirm it and admire it. Ascetics are therefore
worthy of themselves as they are fair to themselves. As being part of their own personal dignity, fair ascetics have the right to expect their stadium competitors to act in the same way. Their intensive work and training would have no sense, if their competitors would perfect their ontic characteristics by violating human natural traits and ignoring natural laws. When the ontic equality imposed by the judge-classifier – which is a guarantee of equal access to the ultimate agonistic good – is perfected by breaching the natural law, sport competition becomes absurd. It does not matter whether the violator of one’s physicality loses or wins. He or she may declare: No problem, I haven’t won, I haven’s taken anything from anyone, I haven’t deprived anyone of chances of gaining primacy. It really does not matter at all. One’s personal dignity, regardless of one’s role: actor, athlete, doctor, mother, is one’s ability to obey the natural law: the athlete does not even consider transformations of the genome, the doctor does not consider euthanasia, and the mother does not consider abortion. The rogue athlete would consider ways to refuse to obey the natural law.

**JUDGES-EXPOSERS**

Athletes who alter their natural physicality do moral evil since they transgress their personal dignity, and deny their opponents potential and real self-realization in their sport dignity. They do evil to themselves and others, although no one apart from the originator of moral indignity, realizes this disobedience. They do not know, but they can learn about this deception resulting in an infringement of the rule of equal opportunities in the process of gaining primacy. They can learn about it from the judge-exposer (an anti-doping law enforcer), an ally to the judge-classifier, who makes sure by using all means available to him that the development of one’s ontic resources does not violate one’s natural physicality. In fact, the judge-exposer, who signals a breach of the natural order, i.e. the existence of unacceptable ontic inequality between competitors, declares an infringement of the moral order. Although he usually files secret reports on “doping in sport”, in fact, his narrative encompasses a hidden message about the deception, i.e. about an insidious acquisition of the ontic good and diminishing the opponent’s chances of gaining primacy. The deceiver will be disqualified and excluded from the sport community. The judge-exposer will inform the stadium community that there is no place for violators of the established order of ontic equality among fair competitors. Thus the judge-exposer announces a breach of the natural order, i.e. the existence of ontic inequality and therefore, a breach of the moral order.

The common good of the stadium is then determined by the fair conduct of gymnasion ascetics at the precompetitive training stage. Before they enter the sport competition, we will know whether they fulfill the requirement of moral equality of competitors and thus equal access to victory. Fair and morally equal gymnasion ascetics enter the competition being worthy of one another, despite the fact that they differ ontically. This is another factor of the discussed causal model of sport, which can be found in the sport conscience of ascetics. It is the pure conscience, i.e. obeying the natural law, which defines the phenomenon of utopian sport competition. This phenomenon takes place when gymnasion ascetics respect their personal dignity in all their activities, maximizing the potential of their physicality, before they enter the competition.
Finally, I would like to mention one more reason explaining the phenomenon of utopian competition. It can also be found in one’s conscience and it can be called – in the language of methodology – the moderator of social change towards the fulfillment in sport utopia. This moderator is a competitor, who in his role as an actor craving for victory, benefits from his own personal properties and allows his competitors to externalize all their competences.

**JUDGES-MODERATORS: GUARDIANS OF MORAL EQUALITY**

The judge-moderator is not merely a referee, who makes sure the relations between competitors are fair, but – first and foremost – it is an athlete himself/herself that respects the opponent, i.e. realizes the premise of moral purity. The morally equal and fair ascetics who leave the gymnasion for the stadium still act fairly (respect each other's dignity) and allow their competitors to be fair as well. When, for some reason, they cannot conform to the norm of fair acts and make it difficult for others, they must succumb to the regulative power of the external moderator. Judges-moderators make sure the competitors are morally identical through their equality in fairness. Thus they greatly contribute to the realization of the sport utopia. They somewhat enforce equality from athletes and order them into a formation of polite agonists bowing down to the vanquished. This contribution is significant regarding the fact that the stadium is also attended by anomic athletes gloating about the habitus of their lawless promiscuity (like those Olympic swimmers of double morality who attended houses of ill repute after the competition). The judge-moderator becomes an X-factor – a reason explaining the competition as a utopia. It may happen that athletes are found to be dissimilar, qualitatively and quantitatively non-identical and unequal during the competition. In such cases the judge-moderator substitutes for the judge-classifier, and at the same time, exposes the deceptions of those violators of ontic inequality who fall into pride and vanity. Thus moderating is calling to order by “muckrakers” who explain the essence of the sport competition.

The moderators are often external judges who call athletes to moral order from the position of critics, publicists, authors, poets or public opinion. Moreover, a judge-moderator is also a scholar-humanist, who deduces operative propositions constituting some kind of athlete’s code based on the natural law or universal ethics, and justifies the moral sense of the athlete’s action as the highest good. Thanks to the judge-moderator the stadium community can learn via educational channels that the internal good of the sports act is justified by the external good of the highest axiological rank.

**CONCLUSIONS**

The sport act realized in the ambitious postulate of utopia of fair redistribution of access to the good of victory can be explained by a number of reasons. It may seem that the sociological theory of sport supported by many auxiliary sciences has explained this phenomenon sufficiently. I have also thought I trusted the moral empowerment of athletes would determine their real – not just potential or normative – attainment of this ideal. I thought that polite and decent athletes would be
entering the competition, respecting others and their own dignity, and that the sport utopia would be fulfilled in its own secret *autopoiesis* – as supposed by experts in theories of social systems – despite external adversities from centers of political power, or internal hardships associated with corrupted sport managers. I never thought that each subsequent generation of *children of sport*, participating in the gymnasion life, would manifest itself by a different understanding of freedom. This understanding would be characteristic of adults, and would be associated with their time they could not choose themselves. Sport assumes some ascetic work and moral rigor. It therefore assumes a double limitation of freedom as well as a physical constraint imposed by training loads and programmes. By this assumption sport involves little fun and even less freedom, but much sacrifice, unlike in extra-sport life when everybody is promised an easy, obligation-free way to happiness.

In the discussed causal model I did not see initially that a “new child” had entered the social system of sport – a child born in the world of liberal usurpations, with whom the establishment of a familial relation regarding freedom, morality, ideals and authority would be very difficult. I did not think about this reason, which is key to understand the cause of the humanistic failure of sport competition, i.e. the cause of deconstruction of the sport utopia.

The applied regressive analysis model reveals that the success of sport utopia, being a variety of social utopia, is determined by authoritative judges managing the common good of the sport family. There is a reason why the sport community is referred to as the sport family. Maintaining familial relationships is a utopia itself, i.e. a daunting but feasible task. And although the hope of each family, also of the “sport family”, are its children, only the adult family members – capable of assuming the responsibility for the common good – can maintain order in the family and render all its activities sensible. Similarly, the successful organization of competitions in a sport family aimed at perfection according to the family’s ideals is only possible, if the order of competitions is preserved by: a) judges-categorizers responsible for maintaining sexual-somatic equality; b) judges-classifiers responsible for ontic equality (extra-sexual physicality) of the gymansion ascetics; c) judges-exposers responsible for revealing ontic inequalities of doping abusers; and d) judges-moderators responsible for the moral equality between competitors.

Therefore, sport as a utopian competition of equal opportunities can be achieved if athletes are: 1) categorized – which does not exclude their discrete self-categorization that would ensure the equality of sexes; 2) classified – which does not exclude their discrete self-classification that would ensure their extra-sexual physical equality; 3) moderated – which does not exclude their discreet self-moderation ensuring their moral equality; and 4) exposed – which does not assume their self-exposition. The actions of judges provide sport competitors (ontically, quantitatively and qualitatively, and morally equal) with a possibility of gaining primacy. Their opportunities are equal, which is fair, since all those equal to one another gain access to the good of dignity of the top athletes. Gaining primacy among the unequal ones (quantitatively) and dissimilar ones (qualitatively) is unjust.

If it had not been for these judges’ authoritative enforcement of moral and ontic equality among athletes, then – without diminishing the athletes’ contribution to the creation of fair competition – it could be assumed that the liberally, relativistically and individualistically disposed athletes would not have been able to tackle their humanistic tasks by themselves. Athletes cannot judges in their own cause. Without judges they will never survive their first sport competition.
The use of visual information in teaching swimming to people of various age

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ABSTRACT

Due to great sensitivity of visual receptors, visual information plays an important role in the teaching and learning process of motor skills. There is a theory that visual communication is more efficient with young children and its role diminishes with the age of learners. The aim of the study was to find out if visual communication is less used to teach adult learners than children. Three age groups of swimming learners: 9 and 10-year-old children, university students and adults took part in the study. In order to collect the data on the amount of visual information provided by the teacher, an observation method was used. All the data on visual communication, its duration and type, was recorded on the observation sheet of each group during 5 consecutive lessons. Analysis showed that visual communication took 8% of the total sum of lessons with children, 12% in the case of students, and 6.5% in the case of adults. Whereas the range of visual communication techniques was limited to two: on-land demonstration and in-water demonstration. The former was used during all the lessons in all the age groups. The latter was used only in the group of students and it took about 1% of the total time. The amount of visual information provided during a lesson differed in the age groups, but only the difference between the children group and the student group was statistically significant. The type of visual communication is not age-related. Teachers still prefer traditional visual communication – on-land demonstration.

Key words: swimming, visual information, observation, communication

INTRODUCTION

In our culture it is a common practice that whatever we see we try to describe by putting it into words. However, if we go back to the world where the use of language was not known and people communicated using a set of signs accepted in their culture, visual information was decisive in the social communication.

In the era of information technology, we observe new social behaviors emerging. They are based on communication in a new cyberspatial dimension or “telepresence”, which seems to depreciate the role of words, thus creating a new entity called a “screen generation” (Dziedzic, 2006, p. 44). Coining this new term to define a new generation, Goban-Klas shows that youth makes use of senses only to perceive the world and the reality through images, or models based on the images. Comprehension and transformation of a spoken text is diminishing (Goban-Klas, 2005).
An undesirable effect of the communication through mere images is its lower interactivity – there is no role change between the sender and the receiver. This means that their communication is asymmetrical; the roles of a sender and receiver are not of equal importance, because the visual technique in itself does not include the answer channel. Thus the level of reception, interpretation and conclusion of the learner in the learning and teaching process is lower. Results of the diagnostic tests taken at the end of each education stage confirm this tendency. Nevertheless, media devices were introduced to the school program so as to meet the needs of modern technology. This gave rise to fast-developing media education whose motto is “a journey between the registers of speech, writing and image” standing on the border between cultures and their interrelationships, on the border between individualism and community action, and finally creating common ideas or criticizing them displaying the peculiar opposition between the culture of image and the culture of word (Szkudlarek, 1999).

Media education is interdisciplinary as it combines thesis of humanistic, technical, social and other sciences. In the dimension of the reality of life its area of operation comprise both daily life and science. Besides, it is the effects of development of advanced information and communication technologies.

The process of motor learning – which includes the ability of swimming – involves permanent changes in the learner’s behavior. The skill program can be recorded in the learner’s motor memory due to the reception of various information from the environment and other people, or through multiple repetitions of the motor skill. However, the process will last shorter if the motor skill is demonstrated by an experienced teacher. The way the teacher transmits the information of the skill that is to be learned has a direct effect on its acquisition, therefore the efficiency and purposefulness of communication has a significant impact on the final outcome. During physical activities the teacher mostly speaks and demonstrates the correct performance of a skill, while learners either learn or improve their abilities, so there is a process of verbal and non-verbal communication. Information is received by the visual, auditory and kinesthetic analyzers (Czabański, 2000). The teacher should choose the right amount of information provided to learners during the classes so that they could achieve a desired goal as quickly and efficiently as possible. The good teacher selects teaching methods, forms and contents to make the learning process as short as possible (Zatoń, 2008). Due to high capacities of visual receptors to receive information, visual information plays an important role in learning and teaching motor skills. In the learning process visual information is used to demonstrate the correct performance of a movement. Presentations and demonstrations are the most common visual communication techniques used by PE teachers. However they may have different forms, such as film presentation, video recording, computer-assisted demonstration, cinamagram, photograph, diagram, drawing. Modern visual devices provide a wide range of possibilities of affecting the learner’s intellectual sphere. Due to scientists’ concentration on verbal communication, there is a gap in the research area that concerns visual communication in the learning and teaching process of motor skills, which needs studying. Wiesner (2009) was one of the first researchers to deal with the problem. He published his PhD thesis on the effectiveness of a didactic film. Other forerunners were Nowak and Posmyk who promoted implementation of information technology into physical
education, and Dybińska who studied optimization of visual information in teaching and learning motor skills. The problem was that, according to the research procedures, the independent variable was not supposed to include a modified verbal communication accompanied by some visual information prepared in detail beforehand. Wiesner’s study showed that a well-conceived didactic film, its length, the way and number of times the film is seen and the fact that it is accompanied by verbal comments have an impact on efficiency of learning motor skills by 7-year-old children. However the outcome depends on the possibility of translating the knowledge acquired during the film into practice while swimming in water. Better results were achieved in the group that watched the film after a few practical lessons of learning a given technique in water compared to the group that watched it on the first lesson. This leads to the conclusion that there is a relationship between the knowledge and image of a given technique and the ability to execute it in the water. In addition, visual information forms have to be varied (video excerpts seem to be obsolete in the era of computer technology) and accompanied by well-conceived and previously prepared verbal information. Dybińska focused on the optimization of visual information as a significant factor in improving the teaching and learning process of swimming skills by 10-year-old children. She used an instructional film, educational posters and traditional demonstrations to modify the visual communication during the lesson. According to her, “these techniques of information transmission, particularly visual ones, had a significant impact on the effectiveness of acquiring new motor skills” (Dybińska, 2004, p. 115).

The advantage of the image over the word is the most evident in the case of preschool and young school-based children. The older is the learner, the less important becomes the visual communication. Włodarski writes: “for a child visual presentations are more comprehensible and clear than verbal ones, though with age the latter become more important” (Włodarski, 1979). Analysis of the duration of a visual presentation during learning a given skill found that usually it took 4–6% of the lesson. Basing on her studies, Chrobot came to the conclusion that the highest efficiency in learning and teaching the freestyle was observed when an enhanced visual communication was introduced (Chrobot, 2010). Teaching swimming skills is a process that is disturbed by noise, unfavorable environmental conditions (e.g. water environment), and consequently the verbal contact is hindered. In this situation, hand gestures are the best communication technique (Pyżow, 1969), and the information transmitted in this way has an effect on development of a correct performance of motor skills.

Młodkowski (2000, p. 47) defines the term of visualization as “controlling the process of imaging in the visual code by selecting contents and transformation operations in order to embed the vision content into the current or future action plan”. Analyzing this term and trying to fit it into motor skill teaching, Kuprel defines visualization as “a process of activation of sensory (perceptive) and emotional experiences in order to use the accumulated psychical resources in the future plans of their implementation” (Kuprel, 2007, p. 37). However, in this paper explanation of the term of visual information is the most important. Dybińska defines it in this way: “transmission of the learning content through its impact on learners’ visual analyzers” (Dybińska, 2004, p. 124).

Presentation and demonstration play two different functions: motivational and instructive. The motivational function shows “a comprehensive picture” which
affects the learner’s emotional sphere. It is very important because it motivates the learner to act, increases his or her will to learn and increases the likelihood of success. An efficient demonstration, or another interesting way of demonstrating a given skill, is the best method of incentivizing and encouraging the learner to take up learning. The instructive function is applied to create the idea of the skill, that is why it involves “observing the elements” of a complex motor skill and affecting the learner’s cognitive sphere. Everybody knows that our sight is not meant to perceive quick and short-lasting actions, therefore we cannot record consciously fast-moving fragments of the movement that constitute the entire motor skill. Visual information has to meet basic requirements of the information theory in order to perform the instructive function:

Movement presented as a whole with its detailed structural analysis included
- The teaching goal and the way to achieve it. It may require using slow-motion demonstration of some video excerpts
- Simplification, i.e. recognizing individual sensory-motor sequences in the complex structure and focusing on them by pointing out to the most important reference points
- Coherence, i.e. eliminating any superfluous information, thus reducing information to the key sequences
- Inclusion of spatio-temporal elements of the skill, i.e. movement coordination and rhythm
- Adaptation of the presentation to the learner’s perceptive abilities including individual visual perception
- Direct presentation before performing the motor skill; the short time gap between watching and performing the task ensures a better storage of the movement sequence in the motor memory
- Interaction of visual communication techniques with other teaching methods
- Use of various demonstration techniques
- Consideration of the learner’s emotional state which has an effect on the selection of incoming and processed information (Kaca and Dybińska, 2009).

The larger amount of visual information provided during teaching motor skills guarantees a highly efficient learning process. Dybińska claims that in the case of young school-based children information transmission techniques, especially visual ones, have a significant effect on acquiring new motor skills, while traditional demonstration techniques have little effect on developing motor image (Dybińska, 2004). The use of educational posters and films is the effective teaching approach to develop a conscious, precise and correct image of a new motor skill. Similar conclusions were drawn by Chrobot who found the highest efficiency in the groups where both verbal and visual communication was used, however with a dominating visual one (Chrobot and Zatoń, 2010). Nawrocka reports that the most efficient teaching technique is a presentation, however she adds that the ratio between the word and the image during the lesson of physical education depends to a great extent on the learners’ age, level of proficiency in the sport and knowledge accumulation (Nawrocka, 1962). The importance of a presentation diminishes with the age of learners and an increase in their intellectual level (Włodarski, 1985). Taking into consideration general developmental regularities, it is recommended to dedicate more time to demonstration in the case of younger children and with age complementing it,
and partly replacing, with verbal communication. In younger school children the dominant perception of the transmitted content is through visual analyzer and with age the role of verbal analyzer increases (Chrobot, 2009). Nevertheless, it does not mean that while growing, children make use of less visual information, as the amount of their experience is constantly increasing, and consequently quality of perception of visual information is higher. Although the hypothesis of efficiency of enhanced visual information transmission has been proved to be true, Weisner highlights high verbal activity of physical education teachers. It takes 25% of all activity taken by the teacher during the lesson. He thinks that this is due to the teacher’s poor competence. Verbalization should denote an increase in the verbal communication efficiency, and not verbosity (Wiesner, 2005). According to Orawiec, as many as 83% of all the communicative signals received by humans are perceived by the sense of vision, 11% by the sense of hearing; thus the use of audiovisual devices in the teaching process increases its efficiency by 20–40% (Orawiec, 1986). Although visual information is so important during lessons of physical education, it takes only 5–10% of the total time, while the verbal communication plays a decisive role.

On-land and in-water demonstrations are the most common observational method used to teach swimming. Teaching swimming requires demonstrating the elements of movements which are performed under the water. Demonstrations can be performed on land or in the water, while learners can watch it being on land, in or under the water. Visual information is provided by means of a demonstrator, usually a teacher or a good learner, and by means of teaching devices such as films, posters, multimedia presentations.

In-water demonstrations observed from the land provide learners mostly with general information of the executed motor skill. Learners can see what is the correct body position of a swimmer in the water, observe the coordination of limb movements, learn what is the rate and rhythm of performing these movements and their range. In-water demonstrations observed form under the water are the most efficient in terms of locomotion as swimmer’s movements are performed under the water surface. Another demonstration is the one on land. It is a very common method used to teach swimming as it allows demonstrating elements of a given motor skill. When observed from the land it has some advantages as the teacher has a full control over the group of learners and can accompany the demonstration with verbal information. The main disadvantage is that learners are detached from the water environment. It is possible to overcome this drawback by allowing the observation from the water where learners can immediately try to emulate the movement. Due to modern technology, it is possible to arrange a demonstration with the use of visual devices, which can increase the efficiency of teaching swimming motor skills. Films and graphic representations are undoubtedly constant elements of contemporary culture. The use of visual information in teaching allows the participation of mental operations such as analogical reasoning, metaphorizing, making associations, abstracting and transforming in the creative process (Sie-mieniecka and Siemińska-Łosko, 2007). Fleming and Jacoby found in their study that the use of audiovisual devices can increase the learning effectiveness by 10–40% (Fleming and Jacoby, 1969). Whereas Wiesner showed in his study that a didactic film is a valuable material to be used in teaching swimming, as it helps learners to grasp the idea what the motor skill looks like (Wiesner, 1988). Filming is another
audiovisual method. It allows learners to analyze their movements, which results in a higher awareness of errors made, and consequently it encourages learners to correct them. This type of demonstration is very attractive to learners, but it has a great disadvantage – difficult to use at the swimming pool due to specific conditions. Therefore most of the teachers make use of traditional methods of visual communication, mostly a demonstration performed by them (Czabański et al., 2003; Dybińska, 2009).

Authors such as: Włodarski, Dybińska, Wiesner, Chrobot focused in their research on the importance of visual communication in the teaching process and explained its effect on the efficiency of the teaching process. They studied how much time it took during the lesson and calculated the ratio between the visual and verbal communications. In their experiments they showed that the highest efficiency is achieved when varied visual communication techniques are accompanied by some verbal explanations. The outcomes of these experiments may suggest a reflection on the ratio between visual and verbal communications during lesson of motor skills.

In the literature of the subject, there are not many papers that report studies of the adaptation of information communication to the age of learners. Nowadays, it is noticeable that not only children learn new motor skills, but also people of various ages. Wlodarski reports that the role of image becomes less important with age. This statement implies an interesting research problem: do a group of adult learners really perceive less amount of visual information than younger school age learners.

In order to find the answer to this research problem, the following questions were posed:

1. How much visual information does the teacher communicate to 10-year-old children, university students, and adult learners during swimming lessons?
2. Does the amount of the transmitted visual information vary in respect to the learners’ age?
3. What kind of visual information is used during swimming lessons?
4. Does the kind of transmitted visual information depend on the learners’ age?

MATERIAL AND METHODS

Three age groups participated in the experiment:
- 9- and 10-year-old children attending swimming lessons which were part of their school curriculum,
- First-year students of the University School of Physical Education in Wrocław,
- Adults attending a swimming course for beginners.

Each experimental group did not differ significantly in terms of their swimming level. No feeling of fear was observed, which is usually an important inhibitor hampering implementation of the teaching process. Each of the groups included male and female learners.

An observational method was used to determine the amount of visual information transmitted by the teacher during swimming lessons. The method is defined in literature as “planned and regular data collecting through sensory perception
of a researcher who studies teaching and educational activities of teachers and learners as well as the outcomes of these activities”. The research tool was an observation record sheet where time of visual communication was recorded in each lesson unit, and in each age group. Observation was conducted in two ways: passive (the observer did not influence the course of the observed activity) being outside the examined group and directly (the observer recorded in person the analyzed teaching activities) (Janowski, 1985). The analyzed activities were recorded at ten-second intervals. This type of observation is called time sampling (Łobocki, 1999). The sheet contains a table with a list of various activities such as: on-land demonstration, in-water demonstration, film, drawing and others. Each column indicated a ten-second segment of time where the observer ticked how long the activity lasted. Data collected in this way became the material to analyze.

The study was conducted from March to May 2012 at some swimming pools in Wrocław. The pools were adapted to the swimming lesson requirements. Observations were carried out with the consent of the teachers and instructors conducting swimming lessons. Each age group was observed during 5 consecutive lessons of a standard swimming technique. In each age group the 5 lessons were conducted by another teacher and the lessons lasted 45 minutes. The subject and goal of each lesson was formulated by the teacher who runs the lessons. During each lesson unit the teacher’s pedagogical activities were observed and each minute of visual information provided was recorded on the sheet, including what kind of visual information was used.

RESULTS

Due to the observation of the swimming lessons with the use of observation record sheet, it was possible to determine the length of time dedicated by the teacher to visual communication during lesson units in all three age categories. Table 1 shows the obtained results both in seconds and in percentage of the total lesson unit.

<table>
<thead>
<tr>
<th>Lesson number</th>
<th>Children</th>
<th>Students</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time [s]</td>
<td>%</td>
<td>Time [s]</td>
</tr>
<tr>
<td>1</td>
<td>250</td>
<td>9.3</td>
<td>470</td>
</tr>
<tr>
<td>2</td>
<td>210</td>
<td>7.8</td>
<td>340</td>
</tr>
<tr>
<td>3</td>
<td>210</td>
<td>7.8</td>
<td>210</td>
</tr>
<tr>
<td>4</td>
<td>230</td>
<td>8.5</td>
<td>310</td>
</tr>
<tr>
<td>5</td>
<td>220</td>
<td>8.1</td>
<td>260</td>
</tr>
<tr>
<td>Total</td>
<td>1120</td>
<td></td>
<td>1590</td>
</tr>
<tr>
<td>Mean</td>
<td>224</td>
<td>8.3</td>
<td>318</td>
</tr>
<tr>
<td>Maximum</td>
<td>250</td>
<td>9.3</td>
<td>470</td>
</tr>
<tr>
<td>Minimum</td>
<td>210</td>
<td>7.8</td>
<td>210</td>
</tr>
</tbody>
</table>

TABLE 1. Time of the teacher’s visual communication and its percentage share in each lesson unit.
time of the lesson unit; in the group of students it was 5'25”, equal to almost 12% share; in the group of adults it was about 3’, equal to nearly 6.5%. It means that the teacher dedicated most time to transmit visual information in the group of students and the least in the group of adults. The value of maximum time of visual communication during one out of five lessons was in the group of students and it exceeded 17% of the total time. In the group of children it was more than 9%, a in the group of adults nearly 7.5%. Whereas the smallest difference between the values of maximum and minimum time of visual communication taking into account all 5 lessons was found in the group of children and it was 40 seconds. The largest difference was found in the group of students and it amounted up to 4'20”. In adults the difference was 50 s, very close to the difference in children. This means that the teacher used the most even distribution of visual information working with children.

Figure 1 shows that the teacher provided the most visual information in each of the lessons in the group of students. The differences are clearly visible, with the largest (10 percentage points) being the one between the groups of students and adults. The amount of visual information in the group of children was relatively stable and located midway between the other two groups. It is evident that the least amount of visual information was transmitted in the group of adults.

Figure 2 shows the mean amount of visual information transmitted by the teacher during 5 consecutive swimming lessons. It was found that the difference between students and adults expressed as percentage amounted to 5.4 percentage points, which means that students were given nearly twice as much information in this way. The difference between the lessons with children and students is less evident, as it amounts to only 3.5 percentage points.

Student’s t-test was used to find the answer to the posed research question about the relationship between the time dedicated to visual communication and
the participants’ age (Tab. 2, 3, 4). Statistically significant differences were found only between the groups of children and students.

In order to find out what kind of visual information technique was used during the lessons, the data was recorded on the observation record sheet, where the following techniques were listed: on-land demonstration, in-water demonstration, film presentation, drawing or other techniques that could possibly be used during lessons. It is interesting to note that during the lessons the teacher limited the range of possible techniques to the first two. Analysis of the obtained results is shown in Tables 5 and 6.

TABLE 2. Comparison of the visual communication times during lessons with children and students determined by student’s t-test.

<table>
<thead>
<tr>
<th>Variable</th>
<th>T-tests</th>
<th>Group 1: children</th>
<th>Group 2: students</th>
<th>T</th>
<th>df</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time [s]</td>
<td>Mean/children</td>
<td>224.0000</td>
<td>Mean/students</td>
<td>318.0000</td>
<td>8</td>
<td>0.068172</td>
</tr>
</tbody>
</table>

FIGURE 2. Mean amount of visual information transmitted during swimming lessons

TABLE 3. Comparison of the visual communication times during lessons with children and adults determined by student’s t-test.

<table>
<thead>
<tr>
<th>Variable</th>
<th>T-tests</th>
<th>Group 1: children</th>
<th>Group 2: adults</th>
<th>T</th>
<th>df</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time [s]</td>
<td>Mean/children</td>
<td>224.0000</td>
<td>Mean/adults</td>
<td>174.0000</td>
<td>8</td>
<td>0.003013</td>
</tr>
</tbody>
</table>

TABLE 4. Comparison of the visual communication times during lessons with students and adults determined by student’s t-test.

<table>
<thead>
<tr>
<th>Variable</th>
<th>T-tests</th>
<th>Group 1: students</th>
<th>Group 2: adults</th>
<th>T</th>
<th>df</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time [s]</td>
<td>Mean/students</td>
<td>318.0000</td>
<td>Mean/adults</td>
<td>174.0000</td>
<td>8</td>
<td>0.012538</td>
</tr>
</tbody>
</table>
TABLE 5. On-land demonstration and its duration during lessons

<table>
<thead>
<tr>
<th>Lesson number</th>
<th>Children</th>
<th></th>
<th>Students</th>
<th></th>
<th>Adults</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time [s]</td>
<td>%</td>
<td>Time [s]</td>
<td>%</td>
<td>Time [s]</td>
<td>%</td>
</tr>
<tr>
<td>1</td>
<td>250</td>
<td>9.3</td>
<td>470</td>
<td>17.4</td>
<td>190</td>
<td>7.0</td>
</tr>
<tr>
<td>2</td>
<td>210</td>
<td>7.8</td>
<td>310</td>
<td>11.5</td>
<td>150</td>
<td>5.6</td>
</tr>
<tr>
<td>3</td>
<td>210</td>
<td>7.8</td>
<td>180</td>
<td>6.7</td>
<td>170</td>
<td>6.3</td>
</tr>
<tr>
<td>4</td>
<td>230</td>
<td>8.5</td>
<td>290</td>
<td>10.7</td>
<td>160</td>
<td>5.9</td>
</tr>
<tr>
<td>5</td>
<td>220</td>
<td>8.1</td>
<td>210</td>
<td>7.8</td>
<td>200</td>
<td>7.4</td>
</tr>
<tr>
<td>total</td>
<td>1120</td>
<td></td>
<td>1460</td>
<td></td>
<td>870</td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>224</td>
<td>8.3</td>
<td>292</td>
<td>10.8</td>
<td>174</td>
<td>6.4</td>
</tr>
</tbody>
</table>

TABLE 6. In-water demonstration and its duration during lessons

<table>
<thead>
<tr>
<th>Lesson number</th>
<th>Children</th>
<th></th>
<th>Students</th>
<th></th>
<th>Adults</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time [s]</td>
<td>%</td>
<td>Time [s]</td>
<td>%</td>
<td>Time [s]</td>
<td>%</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
<td>30</td>
<td>1.1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>30</td>
<td>1.1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>20</td>
<td>0.7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0</td>
<td>40</td>
<td>1.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>total</td>
<td>0</td>
<td></td>
<td>120</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>0</td>
<td></td>
<td>40</td>
<td>0.9</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Analysis of the types of demonstration used during the lessons showed clearly that the teacher made use of only two types of visual communication: on-land demonstration and in-water demonstration. On-land demonstration was used during all the analyzed lessons and in all age categories. It was used most during lesson with students – on average nearly 11% of the total lesson unit, followed by the group of children – over 8%. In the group of adults visual communication took nearly 6.5% of the total time.

It is interesting to note that in-water demonstration was used only during lessons with students and its mean duration was nearly 1% of the total time. This type of demonstration was used during four lessons out of five. Among the four lessons with in-water demonstration, the least time was dedicated to it on the fourth lesson and the most on the fifth lesson, 0.75% and 1.5% respectively. Film presentation or other graphic techniques were not applied during the analyzed lessons.

**DISCUSSION**

Analysis of the results obtained during this experiment is the basis for reflection on the duration of visual communication during swimming lessons of people of different age and the way it is performed. Despite numerous research publications where authors state how important is to use varied and intense visual communication, swimming lessons have not been evolving in this direction. The amount of
time dedicated to visual communication now does not differ from the one measured and analyzed a few years ago, and it usually ranges from 6% to 12%. Teachers conduct their classes in a traditional way without using modern methods which could increase the teaching effectiveness and make lessons more interesting. The aim of the teaching process is to achieve the goal as quickly as possible irrespective of the learners’ age. An implementation of innovative teaching methods helps to achieve the goal and increase the learners’ motivation level, and consequently their involvement in the learning process and their eagerness to participate in lessons. That is why teachers should do their best to encourage people of different age to take up swimming lessons so that the largest possible share of the population could be taught swimming by highly qualified teachers and instructor and adopt proper attitudes and beliefs. Here the question arises: why isn’t it like this? We can speculate whether the reason lies in insufficient amount of communicative competence, lack of proper technical devices or just for the sake of convenience as teachers are used to conducting lessons in a traditional way. There is no one answer, but it seems that teachers do not appreciate the use of various, goal-oriented visual aids which affect visual receptors reinforcing an exact and conscious image of a motor skill, including swimming, particularly in young school-based children, who are in the psychomotor stage where motor imagery plays an important role in thought processes.

Taking into consideration the amount of visual information and comparing it to the learners’ age, it seems that teachers employ it intuitively. According to the aforementioned theory it should be applied more to teach children and less to teach adults. Nevertheless, this study showed that students were provided the most visual information, which can result from their teacher’s higher competence. In addition, the group of students was the only one where apart from on-land demonstration they were provided with in-water demonstration with one of the learners as a demonstrator. Adult learners received the least visual information, and the difference between the two extreme groups was about 6 percentage points which is equal to 3 minutes. The authors of this paper think that the optimal employment of visual information during lessons may have an effect on an increase in effectiveness of the teaching process through regular evaluation of the teaching methods and devices used by swimming teachers – gradual departure from the traditional approach and adoption of innovative visual communication techniques.

CONCLUSIONS

Due to the analysis of the experiment the following regularities were found:
The amount of visual information provided by the teacher is the largest among students, and the smallest among adults, about 6% and 12% respectively. Among children it is 8%.
The share of visual information used during the lesson varies and it depends on the learners’ age. The difference in visual communication between children and students is statistically significant.
During swimming lessons traditional types of visual information (on-land demonstration) are employed.
Types of information communication does not depend on the learners’ age, because the predominant type, i.e. on-land demonstration was used during all the lessons in all the age categories.

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Swimming talent, level of aspirations and kinesthetic efficiency

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ABSTRACT

Functionality of kinesthetic sense is a determinant of motor control of our body. According to scientific literature definition of kinesthesia says that it is an ability to feel body positioning. This Basic skill also called spatial orientation remains constant and invariable during whole life. That is why we assumed that there is relation between individual level of kinesthetic efficiency and aspirations level. The main goal was to verify this hypothesis among swimmers. The Research was performed in 2009 in Human Movement Laboratory In University of Physical Education In Wrocław with valid PN-EN ISO-9001-2001 certificate. The entity included 20 swimmers between 17 and 26 years old with highly developed swimming skills (First and Master Sport Class). The level of kinesthetic differentiations was established for every individual by using device called kinesthesiometer. There is a significant correlation between the level of kinesthetic efficiency and aspiration quality, Kinesthetic abilities do not show significant correlation with the anthropometric features of the respondents. Although our observations confirmed the hypothesis they still need more research and empirical studies.

Keywords: talent, swimming, kinesthesia, kinesthetic differentiations

INTRODUCTION

Swimming is one of a sport disciplines performed in a specific environment. Contemporary training is very time-consuming. It requires a lot of self-subordination, physical immunity and highly developed coordination, skills and endurance. The effect of sport training is a phenomenon, which in most cases is a subject to measurable and comparable evaluation process. To maximize it, we need to optimize body functions, and develop specific adaptation to exercise. The latest research proves, that success is highly influenced by heredity, exceptionally favorable upbringing conditions, and early education, that put together creates an optimal condition of evolution. Success in sport is a resultant of many factors, which are being controlled, judged and directed during sport training. Modern training should be considered as a pedagogical process, in which we acquire special technical and tactical skills, as much as volitional and personal characteristics enriched with knowledge of selected sport discipline. However the most important thing about achieving sport goals is to keep improving motor and coordination skills of our proteges. Ongoing research on planning and organizing sport classes suggest the
change in swimming training, to make it more up-to-date. Present-day training would not exist without influence of human factor. It’s the contestants that form a sports event, enduring the pain and fatigue induced by physical exercise.

Where is the difference between good sportsman and great ones? What makes some swimmers impress us with their easiness or technique during start of competition, while others can be even better trained and they never win? The highest class sportsman, located on top of the competitive sport pyramid, have endurance, coordination, great technique, flexibility, but what makes them standing out is talent, the spark of god. It is a value, equally vague to, for example, sense of humor. Rawls claims that sport talent is at some level of meaning the matter of luck. Effort, dedication and involvement during exercises are not calculated in luck categories. We can assume, that present form of competitive sport reflects an effort put into the training in the past, and the level of expenditures shows us, in some sense, luck (Rawls, 1971).

Most of researchers looked for sport abilities conditions basically in physical predispositions from two different assumptions:

- nativism – where abilities are equal to genetic heredity
- sociopsychological reasons – where we allow possibilities of unlimited development due to external input (Mroczkowska, 2010). According to Mroczkowska „sport talent is a set of different kind of features, properties and predispositions which change in time and determine each other”. It is important to acknowledge, that given predispositions can be one of many criteria determining success in sport.

Nowadays the process of talent development is extended to an interdisciplinary knowledge. Hereafter, we can assume that „sport talent is connected to other dimensions of psychological and intellectual human performance.” (Mroczkowska, 2010). It is presumed, that in spite of inherited abilities most of youth can build up and perfect their skills throughout the process of maturation, and the process of learning. „Maturation process indicates speed and rhythm of individual progress. Learning process stimulates and regulates speed and rhythm of the evolution to the point where the individual is ready to do more, better, with a different angle...” (Mroczkowska, 2010). People should have opportunity to extend their talents, even if they were not born or brought up in the same conditions. The task of education, is to create possibilities for everyone no matter their origin. It means that we need to provide high level of education to everyone, and recognize strength of every child boosting their potential (Bailey, 2007)

Philosophy of the social justice and equality implies, that the commitment should be equally rewarded. The matter is that effort and commitment can be objectively measured, and talent is something fleeting and indescribable. Regarding talent it is impossible to reward it. It is known that in sport groups there are people who do not put the same amount of work and effort into their success, and victory in given competition or discipline, as others. Very often they do half or even less work compared to their colleagues during trainings, and after competitions they stand on the first place of the podium. In our human perception it is not connected in any way to justice. The special thing about talent is that you cannot describe it or put it into solid frames of work and commitment. You have it in given field of life or you do not, and then even the hardest work is not enough. Everyone is different and have different kind of skills, the only way for us is to find a domain of life where we can be the best. It is not always sport and swimming.
Talent is a value, a value which unfortunately is unmeasurable. It is a compilation of many physical, genetic, psychological, personality, technical, and tactical factors. Many researchers claim, that appropriately selected tests are all that is needed to examine any ability. They conduct surveys showing the level of endurance and speed. Unfortunately talent cannot be measured in such tests. It is a set of different factors which are essential in success. While searching for talent in swimming, we draw attention to physical attributes (height, body weight and length of limbs) or motor skills (speed, strength, endurance, coordination). It is also advisable to check parents, and not only their physical appearance, which should be inherited by their child, but also their point of view on swimming and support that they are giving their offspring in reaching his goal. Because swimming is a sport that requires intelligence, it is important to pay attention to the ability of quick learning. Needed psychological and personality feats are: commitment, passion, devotion, stress carrying capacity and confidence in their own skills, as well as the subjective evaluation of their talent by competitors made on the basis of determining their level of sporting aspiration.

On the other hand, “talent, predispositions or makings, however we understand them – are necessary but not sufficient to achieve mastery – without extensive development of these predispositions they will remain only the “inner potential” (Mroczkowska, 2010).

Swimming is one of the few sports occurring in different, for a human, surroundings, namely water environment. Because of its specificity and a high degree of coordination complexity the role of kinesthetic differentiation level may be considered a priority by creating a measurable aspect of individual abilities.

Aspiration is a term commonly associated with ambitions, a striving that in the human consciousness has occurred since ancient times, however, in scientific research, mainly in the Social Sciences, where it has featured during the 1920s. Today it is defined as “plans, striving, desires, wishes concerning the results of one’s own actions or the achievement via one’s own mediation of the desired condition, which is deemed satisfactory and rewarding to the individual” (Lukaszewski, 2006). It is worth noting the differences in psychological understanding of the meaning of the concepts of expectations and aspirations. According to many psychologists (Lukaszewski and Skin, etc. 2006) aspirations are desired states, i.e. those which man wishes to achieve and in this sense are part of the “ideal self”, while the expectations concern the results anticipated on the basis of past experience, tests and account for the component of the “real self”. Research on aspirations have proven that the question, “what result you want to achieve?” and “what result you expect to accomplish?” get different answers. This demonstrates a higher level of aspirations than expectations. At the same time it should be noted that there are at least two types of aspiration, namely wishful aspirations (ideal self) and practical aspirations (real self), which, when combined with the individuals expectations allow them to prepare for the expected effects of their own actions and to take the risk of exceeding their current capabilities based on previous experience. Risk is inherent in combat sports, so it can be expected that in this group there will be a sizable percentage of people presenting the level of high or overestimated aspiration. Psychologists dealing with the aspirations of such people see them as risk-takers and as proven by research, athletes are a group of people that often attempt to carry out tasks which
are potentially unattainable. However, this is a risk well calculated, supported by multiple repetitions of tests, sparing/training, measurements, etc. (cf. Gracz, 1980; Hošek, 1966; Karolczak-Biernacka, 1977; Wasilewski, 1967; Wlazło, 1977).

The subject of the research is to determine the repetition level of the muscle force momentum in the aquatic environment as a manifestation of kinesthetic differentiation level, which may be one component of sporting prowess, as well as an assessment of the general level of wishful aspirations as a manifestation of long-term planning in the context of continuing their sports careers.

Kinesthesia is a term referring to the sense that detects body positioning, movement of the limbs, and human torso (Proske, 2009). This basic kinesthetic ability also called spatial orientation implies the possibility of resolving individual motor tasks. Studies on the kinesthetic sensitivity comprise of two main strands. The first is about explaining regulation mechanisms of kinesthetic “sense”, second determining its performance.

During the work on the mechanisms regulating the spatial orientation of the human body the breakthrough was made in the 70’s past century, describing the role of muscle spindle (Goodwin et al., 1972) in creating an impression of movement, speed and position of the limbs. Not without meaning are the stretch receptors of the skin, tendon proprioceptors and joints, it is considered that the most common information generated from them complements muscle sensation (Allen, 2007). Role of the skin stretch receptors is highly increased in the arm area. Because the muscles responsible for movement in the joints of the fingers are in the hand and forearm, impressions created by them are not very precise, but are being refined under influence of information provided by skin receptors (Collins et al., 2005).

Studies on the regulation of the positioning of upper limbs in human body have shown that some receptors indicate the position and the other control the movement of the limb. There is also a group of receptors capable of producing both information simultaneously (Brown et al., 2003).

Efficiency of the body control system is the second stream of research problems in kinesthesia. Particular attention is paid to determine the accuracy of the repetition of muscle force momentum, repeatability of the joint range of motion or maintenance of body balance. At the same time the influence of additional variables on kinesthetic sensitivity is examined. This problem already occupied scientists in the XIX and XX century (Bastian, 1898; Žekulin, 1935; Puni, 1955; Rudnik, 1958; Krestownikow, 1954; Zimkin, 1952; Farfel, 1960), conducted research tried to explain the relationship between accuracy of movement repetition and effectiveness of its implementation in an indirect way. The indirect explanation of the problem was to determine the level of a certain characteristic (kinesthetic differentiation) and its influence on the level of other features i.e. movement techniques, sports result. The exact causes of this phenomenon are not explained to this day. Modern technologies of physiological and medical research led to the gradual discovery of the motor control mechanisms, and set a new direction of kinesthetic research (Zatoń et al., 2009).

Due to the nature of the aquatic environment kinesthesia receives additional importance because it enables not only precise execution of movement, but also the human body to adapt to new conditions. In water many human senses like spatial orientation, muscle tension, visual control and even the sense of direction (only in first phase of adaptation) is disturbed. The human body receives the physical characteristics of the aquatic environment such as the buoyant force, increased den-
sity of water, pressure, or changes in thermal conditions. The appearance of body offload phenomenon additionally activates nerve system.

It was confirmed by Lackner’s research (1996) who was exploring motor behavior in body offload conditions. Reduction of gravitational force (weightlessness) causes immediate changes in muscle tension accompanied by increase of movement precision. In aquatic environment we observe the similar phenomenon, body offload occurs with changes in coordination behaviors of human movements. It is very important to look for individuals whom the change of the environment (water) does not impair, but even aid their coordination abilities.

**RESEARCH PURPOSE**

The main purpose of this research is to define the correlation between measurable manifestations of human talents such as anthropometric characteristics and kinesthesia, as well as the subjective evaluation of their talent by competitors made on the basis of determining their level of sporting aspiration. The following hypothesis has been set:

1. There is a correlation between individual level of conscious kinesthetic differentiation in water environment and sporting aspiration
2. Individual level of conscious kinesthetic differentiation in water environment is uninfluenced by anthropometric characteristics of human body.

**MATERIALS AND METHODS**

There were 20 people between 17 and 26 years old (4 females, 16 males) who participated in research. They are athletes who currently train swimming in sport clubs such as AZS AWF, WKS “Śląsk” Wrocław and Juvenia Wrocław with similar competitive internship. The average length of competitive internship is 10 years. Athletes attend weekly to 11 training sessions in the swimming pool (twice a day and also during Saturdays) and 3 sessions on land (gym exercising or cross-running). The average overload during research was 55 kilometers weekly (depending on preparatory period regulated by established macrocycle). All athletes represented master level in sport compatible with FINA classifications. Some participants were finalists and medalists of Junior and Senior Polish Championships, 2 people took part in Junior European Championships and 1 person participated in 2008 Beijing Olympic Games.

**THE METHOD OF DETERMINING THE LEVEL OF CONSCIOUS DIFFERENTIATION CAPACITY OF KINESTHETIC SENSATIONS IN THE WATER**

The method used for the research was the laboratory experiment method, where the aim was to assess the level of differentiation of kinaesthetic sensations in the aquatic environment.

Research was carried out directly in the shallow end of the pool using a device called a ‘kinesthesiometer’. This device was created in the workshop of movement...
research in the University of Physical Education in Wroclaw. It was constructed and designed according to the original idea which complies with the standard PN-EN ISO-9001-2001. The apparatus allows for the registration of conscious motor actions in the water, as measured by changes in the amount of force per time unit and the spatial structure movement.

Study participants had to perform 10 repetitions of force differentiation of their upper limb adduction movements, under the influence of water resistance felt on the surface of the palm of their hands in such a way that the feeling of water resistance was maintained at the same level. During the arm movements pull force changes were recorded by sensors. Those changes were a direct result of a conscious behaviour in water environment. The algorithm measures used during the performance of the study procedure are shown in the figure 1.

Before the measurements were determined, all the respondents were informed exactly how to perform the task (Figure 1).

The force of deliberate muscle strength production activates the upper limbs in the shoulder, which begin to move in a plane transverse to the long axis of the

![FIGURE 1. Illustration of the study procedure](Image)
body. The resulting difference in pressure between the surface of the inner and outer arms and the moving mass of water, cause a force which consequently presses the body of the participant to the force plate (Bobrowski 2004). It can therefore be assumed that the force recorded by the sensor platforms is the result of the deliberate action of the test subject.

The experimental apparatus includes:
- seat to act as a force plate. The resistor sensors placed inside record changes in the size of the elastic stress components. These sensors are widely used in industrial metrology (The participants’ stable sitting position ensured breathing comfort).
- metal handle with a tool for regulating the depth of the platform’s immersion in water to the nearest 1 cm.
- PC, which allowed the registration of signals from the sensors.
- mounting straps 2 pieces (stabilize the position of the subject).

In order to indicate the level of conscious differentiation capacity of kinaesthetic sensations in the aquatic environment, the method of mathematical analysis was adopted. The maximum force value was distinguished in each repetition, thereby indicating the individual courses of force distribution over time and its maximum value.

Based on the acquired data, an index was established which indicates the level of conscious differentiation capacity of kinaesthetic sensations in the water environment. This index is indicated with the letters WD. The numerical value ratio is expressed by the formula:

\[ WD = \sqrt{\frac{\sum (X_i - X_r)^2}{n - 1}} \]

Where:
- WD – average mathematical error
- Xi – force average value of the distribution
- Xr – force value of the actual distribution
- n – number of repetitions

WD index values are given in arbitrary units.

METHOD OF EVALUATING ANTHROPOMETRIC FEATURES

The measurements were made with measuring tape and medical scale. Using unitary measuring system we measured height, hand length, feet length, arm range and weight of all research participants. We chose previously described characteristics because of the idea existing in the literature that says that the size of this feats correlates with sport results. Height and weight was measured by using measuring tools of medical scale. The length of the hand, feet and arm range was measured respectively: from the line connecting endings of processus styloideus to the end of the third phalanx of the middle finger, from tuber calcanei to the end of the tuberositas phalangis distalis of the first or the second toe, depending on which
one is longer, and from the middle finger of the left hand to the middle finger of the right hand. These lengths were measured in straight line and expressed in [cm] (Roslawski et al., 2000).

METHOD OF ASSESSMENT OF SPORTS ASPIRATIONS

To measure the level of aspiration a questionnaire survey was used, which includes questions about the respondents anticipated sporting career. Obtained responses were converted into numerical values, where levels of low aspiration corresponds to results in the range of 0 to 2 points, for medium-level results from 3 to 5 and for high level results in the range of 6 to 10 points.

RESULTS

RESULTS OF ANTHROPOMETRIC PARAMETERS

The results of the measurements are presented in diagram forms to clearly illustrate differences in the distribution of tested anthropometric parameters. During the training stage on masterful level athletes reach maximalist not just of their results, but also of their personal development capabilities. Because of that measurement results show in most cases final size of examined anthropometric features. Swimmer’s weight is a factor which is treated in nowadays sport as an element of sport condition. During competition preparations we endeavor to reduce it while maintaining the same level of relative strength. Figure 2 shows the size of individual body weight obtained during research.

It is a highly varied feature, connected with both subject’s gender and type of bodily composition (Malinowski, 1989). The lightest person weighted 47 kg and the heaviest 91 kg.

Figure 3 shows data obtained from body height and arm span measurements. These qualities are strongly correlated with each other (Malinowski, 1989). Both height and arm span are considered as factors predisposing people to take up swimming or other disciplines of sport. In the study group body height varies between 194 cm and 161 cm. However, people with height around 182 cm are dominant.

Many researchers claim that hand and feet length make reaching high propulsion easier whilst moving in water (Rejman, 2003). Results of the studies illustrated in figure 4 show differences of hand and feet length in subjects.

Feet length and hand length is determined genetically, in the study group we clearly see no connection between these parameters. Descriptive statistics of measured features are included in table 1.

Analysis of swimmer’s height showed that average value amongst subjects is 181,05 cm whereas $V_x = 5,01\%$ allows us to state that variability of height is statistically irrelevant. 25% of swimmers measure not more than 174,75 cm, 50% of swimmers measure not more than 184 cm, and 75% of swimmers measure not more 187,5 cm. Moreover height is characterized by moderate left-side asymmetry, because $A_x = –0,75$. It follows that we note higher concentration of height value above average 181,05 cm. Of course we can run similar type of analysis against other anthropometric features.
FIGURE 2. Size of individual body weight of subjects [kg].
Weight (in kg) of the tested swimmers

FIGURE 3. Height and arm span in study group.
Height (in cm) and arm span (in cm) of tested swimmers

FIGURE 4. The length of hand and feet in study group.
(Hand length (in cm) and foot length (in cm) of tested swimmers)
For special attention deserves the fact that only one parameter, swimmer’s weight was a feature statistically differentiated because of $V_x = 16.35\%$. Whilst this differentiation is moderate (we note that completely similar conclusion was set during a review of the analysis based only on the column chart). However in our sample feet length, hand length and arm span are features of the volatility statistically irrelevant. Furthermore all of the anthropometric traits are characterized by left-side asymmetry (higher concentration of values occur above average), although weight and arm span can be considered as features with small symmetry derogations because of the coefficient skewness’s value close to zero.

Next step of statistical analysis was identification of observation of outliers such as the ones who stand out from the rest so much that they should be removed for the greater efficiency of further comparisons. It is assumed that if some value in a study is smaller than $Q_1 - 3Q$ and higher than $Q_3 + 3Q$, it is found as atypical and usually thrown out of the case. The following table shows values for all anthropometric characteristics.

**TABLE 2. The values of mathematical series for anthropometric characteristics**

<table>
<thead>
<tr>
<th>Height (Q1 - 3Q)</th>
<th>Weight (Q1 - 3Q)</th>
<th>Palm Length (Q1 - 3Q)</th>
<th>Feet Length (Q1 - 3Q)</th>
<th>Arm Span (Q1 - 3Q)</th>
</tr>
</thead>
<tbody>
<tr>
<td>739.25</td>
<td>300.75</td>
<td>80.5</td>
<td>110.5</td>
<td>747.5</td>
</tr>
<tr>
<td>739.25</td>
<td>300.75</td>
<td>80.5</td>
<td>110.5</td>
<td>747.5</td>
</tr>
</tbody>
</table>

It is easy to notice, that every value of investigated characteristics is within the ranges determined by values such as $Q_1 - 3Q$ and $Q_3 + 3Q$. Thus, in those cases there are no standing off or atypical observations. Moreover, it is a common sense to determine the lower limit at 0 for every anthropological feat in the Chart 2, because we are dealing with measurements, whose value must be greater than 0.

**THE VALUE OF WD INDICATOR (ACCURACY INDICATOR)**

Most crucial part of the research was to determine the level of kinesthetic differentiation capacity in water. WD indicator was designated to every surveyed athlete (Figure 5).
This feature has a very large diversity among the surveyed athletes; variation factor $V_x = 58.66\%$ indicates that there is a significant statistical volatility. In addition, very high value of skewness factor suggests that there is an asymmetry right-sided here (greater concentration of values below the average). In addition, we can see that the swimmer x10 clearly stands out from the other athletes because of his $ WD = 0.537$. However, the value $Q_3 + 3Q = 0.633$ for this characteristic cannot let us recognize said WD observation for unusual.

**THE RESULTS OF THE ASSESSMENT OF ASPIRATION LEVELS**

Aspiration level determined on the basis of the survey points to the existence of the high aspirations in athletes. More than half of the athletes wish to achieve the title of Olympic champion or world champion (8–9 points), others seek to the title
of European Champion (6–7 points), only two people would be satisfied by a national title (5 points) (Figure 6).

VALUE COMPARISON OF KINESTHETIC DIFFERENTIATION IN THE WATER TO ASPIRATIONS RANKS OF RESPONDENTS

In order to verify the hypothesis about the dependence of WD indicator amount to value of respondents aspirations, correlation matrices were used with the help of Statistica program.

TABLE 3. Correlations of the measured parameters (WD and aspirations)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlations</th>
<th>Labeled index correlations are important with p &lt; .050000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>WD</td>
<td>0.172</td>
<td>0.103</td>
</tr>
<tr>
<td>Value of aspirations</td>
<td>6.95</td>
<td>2.089</td>
</tr>
</tbody>
</table>

Based on the 20-member research we estimated the correlation ratio $r = –0.871$. This value seems to be surprising, because it shows a negative linear relationship between the measured trait.

However, it should be remembered, that the WD indicator defines the highest level of kinesthetic differentiation at the smallest numerical value. So the hypothesis is confirmed. It additionally shows graphical analysis of the span of measured parameters (Figure 7), supplemented by schedules of aspirations ranks and WD indicator.

FIGURE 7. Dispersion of WD indicator and the value of aspirations in the study group
Similarly, as in previous analysis, correlation matrix of the program Statistica was used for those studies. Verification of significance of chosen dependence measurements were based on the assumption of the materiality level \( \alpha = 0.05 \). The effects of the calculations are presented by Table 4.

The correlation coefficients show relatively low values. This indicates a slight dependence between the rate of kinesthetic differentiation, and a specific feature of anthropometric swimmers.

Correlation tests confirmed the second hypothesis adopted in the work of the independence of anthropometric characteristics, and the level of kinesthetic differentiation. On the other hand, those tests clearly indicate a positive correlation of body weight \( (r = 0.92) \), hand length \( (r = 0.71) \), foot length \( (r = 0.78) \) and arm span \( (r = 0.90) \).

### TABLE 4. Correlation matrix of various anthropometric characteristics and the rate of WD

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlations for ( p &lt; 0.05 )</th>
<th>average</th>
<th>standard deviation</th>
<th>Body height</th>
<th>Body weight</th>
<th>Hand length</th>
<th>Foot length</th>
<th>Arm span</th>
<th>WD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body height</td>
<td></td>
<td>181.05</td>
<td>9.31029</td>
<td>1.000</td>
<td>0.9274</td>
<td>0.716</td>
<td>0.787</td>
<td>0.905</td>
<td>0.322</td>
</tr>
<tr>
<td>Body weight</td>
<td></td>
<td>72.000</td>
<td>12.074</td>
<td>1.000</td>
<td>0.927</td>
<td>0.711</td>
<td>0.852</td>
<td>0.908</td>
<td>0.049</td>
</tr>
<tr>
<td>Hand length</td>
<td></td>
<td>19.735</td>
<td>1.123</td>
<td>0.716</td>
<td>0.711</td>
<td>1.000</td>
<td>0.669</td>
<td>0.726</td>
<td>0.094</td>
</tr>
<tr>
<td>Foot length</td>
<td></td>
<td>26.900</td>
<td>2.083</td>
<td>0.787</td>
<td>0.852</td>
<td>0.669</td>
<td>1.000</td>
<td>0.713</td>
<td>0.056</td>
</tr>
<tr>
<td>Arm span</td>
<td></td>
<td>185.335</td>
<td>10.838</td>
<td>0.905</td>
<td>0.908</td>
<td>0.726</td>
<td>0.713</td>
<td>1.000</td>
<td>0.023</td>
</tr>
<tr>
<td>WD</td>
<td></td>
<td>0.149</td>
<td>0.109</td>
<td>0.0322</td>
<td>0.049</td>
<td>0.094</td>
<td>0.056</td>
<td>0.023</td>
<td>1.000</td>
</tr>
</tbody>
</table>

**THE EFFECT OF THE INTERACTION BETWEEN VALUES OF WD INDICATOR AND MEASURED ANTHROPOMETRIC PARAMETERS**

Results of the research confirmed assumed study hypothesis. However, question if kinesthetic differentiation ability is an element of swimming talent remains. In literature we distinguish two concepts: talent and ability. Abilities are broader concept concerning many aspects of creative work of man such as science subjects, languages, sport, vividness or music. Commonly abilities are grouped together in certain thematic blocks (Lewis 1998). Ability is, shortly speaking, the easiness of receiving and processing information about world around us. However, talent is a narrower concept which relates only to chosen area of activity (we do not talk about talent to sport in general but to swimming or to pole vault). The concept of talent in most of the studies on kinesthesia has a symbolic meaning. Because this problem is identified as individual skill of repeating muscle force momentum or motion range in single joint in isolated conditions (Zatoń et al., 2009). Authors found a confirmation of the thesis that height level of this ability correlates with sport result (Starosta and Botwina, 2002) or athlete’s physiological capabilities (Zatoń et al., 2009). Generally, abilities of controlling and regulating body movements are described as coorditional predispositions (Ljach and Witkowsk, 2004). According to experts (Brill, 1980; Zimmermann,
Swimming talent – aspiration and kinesthetic efficiency

Ljach, 1995) kinesthetic ability to differentiate the movements determinate high accuracy and economy of their performance. Typical assumption in defining individual ability to control body movements is an error of the difference between the effect of the current task and intended effect. The size of the error, according to some authors is constant and is not subject of adaptation (Opher, 2003), however other scientific reports proves that reducing the value of the errors is possible and it changes during motor learning (Wołk and Zatoń, 2002).

Research results didn’t indicate the correlation between swimmer’s anthropometric characteristics and their rate of WD. Noticeable regularity of reaching the best results in swimming by athletes with higher values of body measurements can be the result of acceleration and not predispositions indicator. The phenomenon observed for the last 100 years of accelerated biological development such as reaching higher values of final body measurements between next generations is defined as secular trend. These evolutions have become an important interest area of contemporary human biology (Rożnowski and Budzyńska, 1993). They are often documented with changing values of body height and weight. These are the features which genetic determination is weaker and because of that they are influenced by environment conditions (Jopkiewicz, 1997; Wolański, 1983). Body weight and height are feats that external factors can affect. In conducted research among studying youth reduction of body height and weight increment was noticed under the influence of stress and increased physical activity (like in sport) (Jodłowska et al., 2010). That studies suggest reversed situation in which rivalry and sport training can cause reduction of our body’s development possibilities by being highly stressogenic.

The authors of anthropological studies rarely take the problem of growth and shaping of the upper limb, especially hand. Very few works, considered at intervals of several years, dedicated to this issue describe the development of the basic parameters of the hand, such as length, width and strength dynamo-metric. As an excellent bio-machine hand is an invaluable part of our body. Complicated, yet very subtle design provides huge kinematic and dynamic possibilities. The combination of a wide range of movements with sensory sensitivity makes it the most perfect tool for handling, created by nature (Jasinski, 1992). With age, the hand becomes more thinner. Boys hands change from wide to average width, and girls from wide through average width and finally to thin (Sitek, 2005). Due to its uniqueness hand is considered in swimming as part of the body, which decides the sensation of “feeling water” for athletes. This is grounded in the functional structure of the human body. Hand has the largest representation in the central nervous system, acting at the same time the most effective element of the propulsion system in the water. In the presented study assessments were made for the length of arm in the group of people actively practicing swimming. Comparing hand size to the obtained values of the WD indicator (level of kinesthetic differentiation capacity) didn’t show any significant relationships. It is clear that not size but rather individual capacity to exploit opportunities of skin and depth of palm feeling, determines the accuracy of hand movements. Relationship between this trait and talent couldn’t been found either. Because the respondents represented the age group of athletes, who have ended a period of maturation, it can be assumed that this parameter is not likely to have any significant changes. Studying dynamics of hand metric traits development in postnatal period, it was agreed that the fastest pace of changes in the height is characterized primarily
with pubertal spurt period, which according to Tanner is between 12.5 and 15 years old for boys, and from 10.5 to 13 years for girls. Therefore the biggest gains occurs predominantly in the length characteristics of the hand.

Human foot performs three basic functions support, motion and cushioning. In swimming, feet are an additional speed source (about 30%) and on long distance it serves only motion function. As opposed to walking or running, the decisive factor of the successful propulsion in the water is the ankle joint flexibility. The foot length is also essential as it increases the paddling area (Rejman, 2006). Assessment of the correct feet shape is of great diagnostic importance in medical science. Ruling on the state of human feet should be based on proven, in terms of reliability and validity, assessment methods and strict classification criteria (Radło, 2005). Developed anthropometric measurements systems allow for accurate data collection and the comparison of their intra-specific populations. Results of the studies didn’t confirmed the association of the foot length with kinesthetic differentiation and the value of talent. Similarly to the other measured anthropometric parameters.

Comparison results of the kinesthetic differentiation capacity level in the water with the value of aspirations in the studied group confirmed the accepted hypothesis of work. A negative correlation was stated between the measured parameters ($r = -0.8178$). Negative dependence direction is related with the method of determining the WD indicator. Since the calculated indicator reflects the values of the errors committed in the course of the study, the lowest value of WD is the highest kinesthetic capacity. On this basis the co-existence of high aspirations with level of conscious differentiation capacity of kinesthetic sensations in the water, which confirms on the one hand, the already mentioned fact that a large proportion of risk-takers are athletes, and the other hand supports a well-justified belief about the high level of their abilities which in turn translates into a strongly motivated desire to achieve high sporting results.

Also, the second hypothesis was positively verified by results of the work. Kinesthetic abilities do not show significant correlation with the anthropometric features of the respondents. Presented proposals lead to the generalization that high levels of swimmers kinesthetic differentiation is individual, and is a result of specific adaptation to the perception and processing of kinesthetic sensations arising in the water. It can therefore be assumed that in the analyzed cases, this capacity is one of the predispositions needed for professional swimming. Despite the prevailing belief that the long feet and hands may predispose to swimming, it has nothing to do with the examined features. Established subjections do not entirely solve presented problem, however, they draw attention to certain ways of methodological solutions that could allow for more accurate interpretation of human talent.

**CONCLUSIONS**

Comparison results of the kinesthetic differentiation capacity level in the water with the value of aspirations in the studied group confirmed the accepted hypothesis of work. A negative correlation was stated between the measured parameters ($r = -0.8178$). Negative dependence direction is related with the method of determining the WD indicator. Since the calculated indicator reflects the values of the errors committed in
the course of the study, the lowest value of WD is the highest kinesthetic capacity. This authorizes the inference that swimmers characterized by a higher ability to differentiate kinesthetic sensations in the water received had higher level of aspirations.

Also the second hypothesis was positively verified by results of the work. Kinesthetic abilities do not show significant correlation with the anthropometric features of the respondents. Presented proposals lead to the generalization that high levels of swimmers kinesthetic differentiation is individual, and is a results of specific adaptation to the perception and processing of kinesthetic sensations arising in the water. It can therefore be assumed that in the analyzed cases, this capacity is one of the predispositions needed for professional swimming. Despite the prevailing belief that the long feet and hands may predispose to swimming, it has nothing to do with the examined features. Established subjection do not entirely solve presented problem, however, they draw attention to certain ways of methodological solutions that could allow for more accurate interpretation of human talent.

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The impact of preferred music on heart rate, subjective perception of exertion and swimming effectiveness

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ABSTRACT
Music is increasingly popular in athletic training or before competition. As technology develops, now it is possible to use music in swimming to motivate swimmers, make them relax or feel less exhausted. That is why the aim of this study was to ascertain differences in heart rate, swimming effectiveness (expressed in the number of 25-metre pool lengths) as well as subjective perception of exertion during a swimming Cooper test – after the introduction of individually selected music (independent variable). Ten participants were asked to swim a 12-minute Cooper test twice: first without music, then with music. The interval between the two tests was one week. The exertion level in the subjects was measured by the Borg Rating of Physical Exertion Scale. Their heart rate was measured before entering the pool, after a warm-up, and after 5, 10 minutes during the Cooper test and at the finish. A one-way ANOVA analysis revealed no statistically significant differences in heart rate. Similarly, no significant differences were observed when it came to effectiveness. Only in the case of the RPE score was a statistically significant difference observed. The results showed that individually selected music during exertion does not influence heart rate. Similarly, there is no increase in the effectiveness of the task performed. However, there is a significant impact of music on the subjective perception of exertion.

Key words: music, motivation, effectiveness, swimming

INTRODUCTION
Over the last few years people have become increasingly interested in physical fitness and activities promoting a healthy lifestyle. However, at some point specialists became aware that in order to make the often monotonous tasks more satisfying, we needed something to increase their attractiveness. Suggestions began to appear that music, as an important mood improving element, could help make training more enjoyable and effective (Tenenbaum et al., 2004; Simpson and Karageorghis, 2006), also in swimming (Szczepan and Kulmatycki, 2012). Swimming is a physical activity that can significantly improve the functioning of the entire human body and the quality of life (Haffor et al., 1991; Meyer and Bucking, 2004). However, it can be regarded as laborious and monotonous, owing to the cyclical nature of movements and invariability of the water environment. This is especially pertinent to com-
petitive swimming. When a decision is made to pursue this discipline on a competitive level, an athlete needs to be systematic and needs specific conditions to persevere. One of the ways to achieve that is to increase satisfaction with training. Using favourite music may be the main factor that makes swimming pleasant.

Technological developments have brought music very close to us, making it strongly present in our emotional and social life (DeNora, 2009). Music can bring back pleasant memories and thus block unpleasant feelings that disrupt physical activities (Gfeller, 1988).

Following in-depth studies, numerous authors increasingly point to various functions of music. These include, first of all, motivating function (Karageorghis, 1999), ergogenic function (Karageorghis and Jones 2000), relaxing function (Hewston et al., 2005), as well as the function of lowering exertion perception (Tenenbaum, 2005). These positive qualities of music have led to its being increasingly used in sport and leisure activities. Accompaniment, hitherto used primarily in physical therapy (Dotoit, 1980; Blair, 1983) or physical education (Olszewska, 1985; Kubinowska, 1996; Okoń, 2002), has been transferred, in the form of music, also to competitive sport and leisure activities (Szmedra and Bacharach, 1998, Karageorghis 2001). Music is increasingly used in various types of athletic training or to provide mental support before competition, and to make favourite leisure activities, e.g. jogging, more pleasant.

The interest in the effect of music on physical activity prompts researchers to undertake empirical studies in this respect. Karageorghis and Terry (2001) describe the main benefits for athletes of listening to music. They are: enhancement of a positive and limitation of a negative mood; arousal before physical activity or relaxation of the body; dissociation from unpleasant sensations (pain and fatigue); lower perception of exertion; enhanced work effectiveness through synchronisation of movement with music; better acquisition of motor skills when adjusting the rhythm to the required movement patterns; good mental state; enhanced performance thanks to all the above mechanisms. Beckett (1990) notes that the type of music listened to by students during treadmill walking has a significant impact on recovery heart rates. He conducted his experiment in three musical settings: without music, with continuous music and with intermittent music. Upal and Datta (1990) carried out an experiment among female high school students in order to verify whether music increased their heart rate during exercise. It was important for heart rate to increase during exertion in order to obtain maximum benefits. The results showed a significant heart rate increase during jogging with music. Smith (1987) carried out a study on students doing workouts and found that their heart rate was much higher if they listened to fast music, though it was much lower when they listened to slow music, in comparison to exercise without music and with fast music. Different results were obtained by Szmerda and Bacharach (1998). Their study was carried out among subjects aged 19–32 and showed that listening to music significantly lowered the subjects’ heart rates. This was also observed by Copeland and Frank (1991) in students doing treadmill exercises. In these studies music was chosen by the researcher conducting the experiment.

The numerous studies listed above and dealing with the effectiveness of music as well as its impact on motor behaviour have inspired the authors of the present study to take up the issue of the impact of music on the heart rate, performance and subjective perception of exertion during swimming.
OBJECTIVE OF THE STUDY, HYPOTHESES, RESEARCH QUESTIONS

The aim of the experiment was to establish differences in heart rate, swimming effectiveness (expressed in the number of 25-metre pool lengths swum) as well as subjective perception of exertion (measured using the Borg Scale – RPE) during a swimming Cooper test – after the introduction of individually selected music (independent variable).

The assumptions were as follows: there would be no statistically significant differences in heart rate between the two musical settings (with and without music); the number of 25-metre pool lengths would be greater in the test with music than without music; the Rating of Perceived Exertion (RPE) would be higher without music than with music.

The following research questions were asked to verify the hypotheses:

1. How does the heart rate change in the subjects under the impact of their preferred music during a swimming Cooper test?
2. How does the number of 25-metre pool lengths swum by the subjects change under the impact of their preferred music during a swimming Cooper test?
3. How does the Rating of Perceived Exertion of the subjects change under the impact of their preferred music during a swimming Cooper test?

MATERIAL AND METHODS

SELECTION OF RESEARCH SUBJECTS

The experiment comprised 10 healthy individuals: 5 females and 5 males aged between 23 and 55. The subjects had to declare that their level of swimming skill was good, though they did not have to be competitive swimmers. This was dictated by the fact that the study involved an endurance test (the Cooper test in water) which required swimming at a steady pace (without stopping).

All subjects were informed about their rights to anonymity and data confidentiality. In order to take part in the study, the subjects signed a consent form. The tests took place in 25-metre indoor swimming pool, in water at a uniform temperature of 27°C.

RESEARCH METHODS

Before the experiment, each subject was asked to fill in a questionnaire specifying their sex, age, swimming ability and preferred kind of music. Individually, selected music was transmitted to the subjects in the main test.

The subjects’ heart rate (HR) was measured by means of the Polar RS 400 heart rate monitor (Polar Electro, Finland). The heart rate was measured 5 times: before entering the pool, after a warm-up, and after 5, 10 minutes during the Cooper test and at the finish. The heart rate data were digitally recorded on a computer hard drive.

The number of 25-metre pool lengths swum by the subjects was noted in the questionnaire sheets after the tests were completed.
The subjects’ perceived exertion was assessed by means of the quantified Borg scale (RPE). It has 15 levels (6–20 points). It begins at level 6, which corresponds to a rest, i.e. heart rate of 60/min, and ends at level 20, which corresponds to maximum exertion, i.e. heart rate of 200/min. Test results showed that the instrument was reliable within the range of 0.80–0.90% (Borg, 1998). The subjects were asked to rate their perceived exertion after each test. All data obtained in this way were used in statistical analyses.

RESEARCH TOOL

Individually selected music was transmitted to the subjects by means of a waterproof MP3 player (Dolphin Touch, NU, Taiwan). The device makes it possible for a swimmer to listen to music in the water.

ORGANISATION OF THE EXPERIMENT

The experiment consisted of two trials during which the subjects performed the Cooper test. The Cooper test consists in swimming continuously as long a distance as possible within 12 minutes in steady waters. The total distance covered is measured within an accuracy of 25 metres (Kozar and Fuljanty, 1997).

In the first test the subjects swam without music. In the second test individually selected music, i.e. preferred by the subjects, was transmitted to the subjects. The tests were performed at an interval of one week. During that interval between the two tests, the subjects did not take part in any other form of physical activity, which might have affected the results of the tests.

Before each test the subjects did a warm-up (swimming 100 metres using a stroke of their choice).

PROCEDURE FOR PREPARING THE INDEPENDENT VARIABLE

Before the experiment the researchers made a list of musical pieces individually preferred by each subject. The music chosen by the subjects had a motivating function. This means that it was a factor prompting the subjects to act and behave in a specific manner. Motivation is a system of needs and values defining the direction and degree of an individual’s engagement in his or her aspirations and actions (Czajkowski, 1987).

The pieces indicated by the subjects were recorded onto a waterproof MP3 player in 10 lists – one per each subject. This enabled each subject to listen to their chosen music. The duration of each compilation was longer that the 12-minute Cooper test.

STATISTICAL ANALYSES

Statistical analyses were carried out using the Statistica 9.0 software (StatSoft, USA). The difference is statistically significant if the p < 0.05. To determine differences in the subjects’ heart rates, the number of 25-metre pool lengths swum as well as subjective rating of exertion with and without music, the researchers used a one-way ANOVA (analysis of variance).
The accuracy of subjective exertion rating was determined by dividing the heart rate in a given test by 10 and comparing the result to the RPE given by the subjects. The maximum heart rate was calculated as 220 minus age. Owing to a substantial standard deviation in the age of the subjects, they were divided into two groups: A aged 23–25 (8 persons), and B aged 52–55 (two persons). This made it possible to make the results more objective.

RESULTS

The average general heart rate in two tests – with and without music – was 138.09 beats/min. The average heart rate without music was 135.98 beats/min, whereas the average rate with music was 140.75 beats/min (Tab. 1).

A one-way ANOVA analysis revealed no statistically significant differences in the heart rate under the two conditions – without and with music ($\alpha = 0.05$: $p < 0.25 < 0.05$) (Tab. 2).

In addition, heart rates were calculated for two age groups: A 23–25 years and B 52–55 years. The results were used in an analysis of subjective perception of exertion. For group A the average heart rate without music was 137.09 beats/min, and with music – 140.75 beats/min. For group B the average heart rate without music was 131.50 beats/min, and with music – 138.00 beats/min (Tables 3–4).

<table>
<thead>
<tr>
<th>TABLE 1. Average heart rate during the Cooper test, standard deviation, minimum and maximum HR, variance for 10 subjects in two different musical settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Musical setting</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Without music</td>
</tr>
<tr>
<td>With music</td>
</tr>
<tr>
<td>Average</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 2. One-way ANOVA analysis of variance for 10 subjects in two different musical settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source of variance</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Inter group</td>
</tr>
<tr>
<td>Intra group</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 3. Heart rate in group A (aged 23–25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Musical setting</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Without music</td>
</tr>
<tr>
<td>With music</td>
</tr>
<tr>
<td>Average</td>
</tr>
</tbody>
</table>
The authors noted that the number of 25-metre pool lengths swum by the subjects was lower without music than with music. The average general result for the two settings was 18.10 pool lengths. The average result without music was 17.30 pool lengths, whereas the average result with music was 18.90 pool lengths (Tab. 5).

A one-way ANOVA analysis of variance revealed no statistically significant differences in effectiveness (number of 25-metre pool lengths swum) in the two musical settings ($\alpha = 0.05; p 0.12 \geq 0.05$) (Tab. 6).

The average general RPE for the two settings was 13.50 points. The average result without music was 14.50 points, and with music – 12.50 points (Tab. 7).

A one-way ANOVA analysis revealed a significant difference in the RPE score between the two musical settings ($\alpha = 0.05; p 0.04 \leq 0.05$) (Tab. 8).

### TABLE 4. Heart rate in group B (aged 52–55)

<table>
<thead>
<tr>
<th>Musical setting</th>
<th>Average HR (beats/min)</th>
<th>Standard deviation</th>
<th>Minimum HR (beats/min)</th>
<th>Maximum HR (beats/min)</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without music</td>
<td>131.50</td>
<td>1.50</td>
<td>130.00</td>
<td>133.00</td>
<td>2.25</td>
</tr>
<tr>
<td>With music</td>
<td>138.00</td>
<td>3.50</td>
<td>134.50</td>
<td>141.50</td>
<td>12.25</td>
</tr>
<tr>
<td>Average</td>
<td>134.75</td>
<td>2.5</td>
<td>132.25</td>
<td>137.25</td>
<td>7.25</td>
</tr>
</tbody>
</table>

### TABLE 5. Number of 25-metre pool lengths swum. Average, standard deviation, minimum result, maximum result, variance in two different musical settings

<table>
<thead>
<tr>
<th>Musical setting</th>
<th>Average (pool lengths)</th>
<th>Standard deviation</th>
<th>Minimum (pool lengths)</th>
<th>Maximum (pool lengths)</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without music</td>
<td>17.30</td>
<td>–6.17</td>
<td>12.00</td>
<td>20.00</td>
<td>4.90</td>
</tr>
<tr>
<td>With music</td>
<td>18.90</td>
<td>4.16</td>
<td>14.00</td>
<td>22.00</td>
<td>4.54</td>
</tr>
<tr>
<td>Average</td>
<td>18.10</td>
<td>2.16</td>
<td>13.00</td>
<td>21.00</td>
<td>4.72</td>
</tr>
</tbody>
</table>

### TABLE 6. One-way ANOVA in the number of 25-metre pool lengths swum for 10 subjects in two different musical settings.

<table>
<thead>
<tr>
<th>Source of variance</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Value-p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter group</td>
<td>12.8</td>
<td>1</td>
<td>12.8</td>
<td>2.71</td>
<td>0.12</td>
</tr>
<tr>
<td>Intra group</td>
<td>85</td>
<td>18</td>
<td>4.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>97.8</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 7. Subjective exertion rating (Borg scale), average rating, standard deviation, minimum and maximum rating, variance for 10 subjects in two different musical settings

<table>
<thead>
<tr>
<th>Musical setting</th>
<th>Average rating (pts)</th>
<th>Standard deviation</th>
<th>Minimum (pts)</th>
<th>Maximum (pts)</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without music</td>
<td>14.50</td>
<td>2.01</td>
<td>11.00</td>
<td>17.00</td>
<td>4.50</td>
</tr>
<tr>
<td>With music</td>
<td>12.50</td>
<td>1.75</td>
<td>10.00</td>
<td>16.00</td>
<td>3.39</td>
</tr>
<tr>
<td>Average</td>
<td>13.50</td>
<td>1.88</td>
<td>10.50</td>
<td>16.50</td>
<td>3.95</td>
</tr>
</tbody>
</table>
TABLE 8. One-way ANOVA analysis of variance in RPE for 10 subjects in two different musical settings.

<table>
<thead>
<tr>
<th>Source of variance</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Value-p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter group</td>
<td>20</td>
<td>1</td>
<td>20</td>
<td>5.07</td>
<td>0.04</td>
</tr>
<tr>
<td>Intra group</td>
<td>71</td>
<td>18</td>
<td>3.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>91</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DISCUSSION

What determines one’s involvement in regular physical training is how well an individual feels during physical exertion. Although music can enhance pleasant sensations during exercise, it is equally important to consider its specific impact on the human body. If studies reveal a significant difference between exercise with and without music, individuals should consider using it routinely.

The aim of the present study was to assess the effect of motivational music on heart rate, swimming effectiveness and perceived exertion during a swimming Cooper test. An overview of the literature shows that when subjects perform tests with their preferred music, it always has a positive impact on effectiveness or perceived exertion. However, many studies revealed no significant differences in heart rate when tests were performed with the subjects’ preferred music.

Szmedra and Bacharach (1998) demonstrated that listening to music lowered heart rate, lactate level and noradrenaline production when their subjects ran at 70% VO$_2$max. On the other hand, when studying the link between HR and musical tempo, Karageorghis et al. (2006) found that fast and moderate tempo influenced heart rate. A tempo eliciting over 120 bpm is preferred during physical activity.

However, in the present study there were no statistically significant differences in heart rate between tests with and without music (Tables 1–4). These results confirm the results of experiments carried out by e.g. Coutts (1965), Bouther and Trenske (1990), Patton (1991), Ferguson (1994), Abraham and Thomas (1999), Potteiger (2000) as well as Tenenbaum et al. (2004).

The researchers also expected that music, having a positive influence on the mental and emotional state during swimming, would indirectly enhance swimming performance. The assumption was that the number of 25-metre pool lengths swum would be greater in the test with music in comparison with the test without music. Indeed, the subjects swam more pool lengths with music, but the difference was not statistically significant (Tables 5–6). This is confirmed by the results of studies carried out by Nelson (1963), and Pujol and Langenfeld (1999), in which the researchers did not observe any effect of music on performance.

Many researchers highlight that the RPE scale is a very important instrument for measuring perceived exercise intensity (Borg, 1973, 1998). The subjects subjectively rated their exertion as being indeed lower when swimming with music than when swimming without it. In addition, without music the perception of exertion was slightly higher than the actual exertion compared by means of heart rates with reference to the RPE scale. In the case of tests carried out with music, the perception of exertion was much lower in comparison with the actual exertion measured by means of heart rates in both age groups (Tables 7–8).
This confirmed the position adopted by Borg (1973), according to whom environmental factors such as music, temperature and social interactions can divert a person’s attention away from exertion, and consequently the rating is too high or too low. In addition, the results of the present study conform to an opinion whereby, as Johnson and Siegel note (1992), performing exercises while focusing on music leads to a lower perception of exertion than in the case of persons focusing only on internal sources of information.

Szabo, Small and Leigh (1999) found that during the switch from slow to fast music during a cycle ergometer test, music and its tempo had an ergogenic effect. A similar position was presented by Koudinov (2004), who suspected swimmers listening to music before races of doping. Koudinov’s accusations were substantiated by Chou et al. in their studies (2003) in which asthma patients undergoing music therapy saw their oxyhaemoglobin – responsible for transporting oxygen from the lungs to the various tissues – returned to the standard level much faster. The regulations of the World Anti-Doping Agency, WADA, have banned methods improving the transport of oxygen or enhancing its intake or delivery (the WADA Code 2011). This is why Koudinov regarded music as an ergogenic factor.

In the present study, no statistically significant differences were observed in the analysed variables (heart rate, swimming effectiveness, except for subjective perception of exertion) between tests with and without music (Tables 1–8). Apparently the ergogenic effect mentioned by Chou et al. (2003) and Koudinov (2004) did not work in this case. Similar conclusions were drawn by Szczepan and Kulmatycki (2012). In their experiments. The authors provided subjects swimming over a distance of 50m at maximum velocity with motivational music. However, it had no impact on swimming effectiveness in terms of the time needed to cover the distance and did not increase the level of the swimmers’ motivation.

Very few studies have shown a beneficial effect of music on all analysed variables (Patton 1991). Additional experiments are necessary to demonstrate that music is a significant factor improving swimmers’ motor performance. Such future studies may demonstrate that music helps individuals turn their attention away from their inner sensations, exhaustion, physical pain or discomfort, and increases their mental and physical comfort, thus contributing to an improvement in their swimming motor skills.

Many things are still unclear when it comes to the mechanisms activated as music is perceived by the auditory system. Listening to music may disrupt polysensory perception, including signals reaching the body during swimming. However, research has shown that it is useful in recreational leisure activities in water and in competitive swimmers’ training. Despite the fact that it does not affect significantly swimming effectiveness, it does enhance positive emotional reactions, which affect satisfaction and lower exhaustion caused by a repetitive activity such as swimming. Music can play a significant role in distracting swimmers from thinking about pain and exhaustion which occur during training.

Generally speaking, the benefits of listening to music while swimming are noticeable, though this is an opinion from the point of view of motivation and emotions, and not physiology.
The experiments carried out as part of the present study allows the following conclusions to be drawn:

1. Music has no significant effect on the heart rate in swimmers.
2. Music does not improve effectiveness measured by the number of pool lengths swum.
3. Music has a significant impact on subjective perception of exertion as measured by the Borg scale. This means that when focusing on music persons performing exercise pay less attention to the exertion and discomfort which accompanies it.

REFERENCES


CHAPTER II

BIOLOGY IN SWIMMING
The effect of recreational breaststroke swimming on the posterior curves of the lower spine

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ABSTRACT

The most common cause of back pain is degenerative intervertebral disc disease. Pain that derives from a disc may have a mechanical origin. Structural distress syndrome (derangement) is the most common spinal disorder among the mechanical spinal syndromes. The clinical pattern in this syndrome is highly variable – pain can occur gradually or suddenly, be constant or irregular, moving from one side of the body to the other, as well as in a proximal or distal direction. In the practice of physiotherapy, it is quite common to hear that people with lower back pain are not recommended to swim the breaststroke. Therefore, the question arises: if in the vast majority of cases, hyperextension of the lower spine eliminates pain, how does the spine behave during swimming recreational breaststroke? And is it justified to restrict the activity in the water? The aim of the study was to determine the range of the lower spine motion during swimming the breaststroke. Fifteen participants, students of the University School of Physical Education in Wroclaw, took part in the study swimming the breaststroke at a recreation level. In order to determine the range of motion of the lower spine, the method of movement analysis, SIMI, was used. Measurements were carried out in water in the sagittal plane. The analysis of the motion range in individual sections of the spine indicated that recreational breaststroke swimming may be considered a pro-health physical activity.

Key words: breaststroke swimming, low back pain, posterior derangement

INTRODUCTION

The subject of modern clinical epidemiology is the distribution of a particular disease in the population and its natural and clinical course. With every disease entity there are related risk factors as well as health needs that enable physicians to determine the most effective methods of treatment and procedures (Streiner and Norman, 1996). In epidemiological research, it is believed that lower back pain (LBP) risk factors are connected to three aspects: individual factors associated with lifestyle, physical or biomechanical, and psychosocial factors (Ferguson and Marras, 1997).

The literature shows that the most accurate prediction of LBP is possible due to the combination of individual physical and psychosocial variables (Burton et al., 1989,
Thorbjornosson et al., 2000). Krause et al. (1998) established that physical and psychosocial factors are independent predictors of LBP (1998), however Adams et al. (1999) concluded that a distressed and shallower lumbar lordosis is constant predictors of each LBP attack.

Each innervated anatomical structure can start the nociceptive process; that is, the reception and transmission of information of the damaged tissue to the cerebral cortex. Possible sources of pain in the lumbar spine include: the joint capsule of the facet and sacroiliac joints, the outer segments of the intervertebral discs, cranial cruciate and longitudinal ligaments, vertebral steams, the dura mater, as well as connective tissue forming part of the nerves and blood vessels of the spinal canal (Bogduk, 1997; Bernard, 1997). A large number of nociceptors around the lumbar spine prevent the development of procedures that selectively test loads on the particular movement of segments of the spine (McKenzie, 2003).

An interesting study was conducted by Kuslich et al. (1991) with the participation of patients undergoing decompression due to a hernia of the nucleus pulposus or spinal stenosis. In the study, 193 people were examined, who were conscious or under the influence of sedatives, whereby they had every tissue in the region agitated prior to anesthesia and then slit, and the area into which the pain was inducted in this way was recorded. Kulisch et al. found that the most prominent source of pain in the lumbosacral area was a pinched nerve root and the outer layer of the intervertebral fibrocartilage. All other anatomical sources of pain were classified as less significant. Healthy nerve roots were rarely the cause of pain. The reproduction of pain occurred only when the nerve root was pinched, stretched or swollen. Schwarzer et al. (1994, 1995a, b) in their studies recognized the role of the intervertebral disc as a major cause of spinal pain, while other structures such as the facet and sacroiliac joints were qualified as etiologically less significant.

With aging of the organism, the intervertebral disc goes through natural morphological changes, increasing its susceptibility to the formation of lesions that cause signs and symptoms of pain (Kramer, 1990). Biochemical changes within the intervertebral disc appear earlier and last a lifetime. They consist of drying out of the disc, increased collagen content and a decreased amount of elastin, which ultimately results in a more fibrous disc. Thus, this blurs the distinction between the intervertebral fibrocartilage and the nucleus pulposus. The nucleus pulposus starts to fulfill its function less effectively, which consists of the steady distribution of radial pressure on the fibrous ring and via the ring it transfers an ever increasing vertical load (Bogduk, 1997). Within the layers of the fibrous rings distortion, damage and cracks appear (Osti at al., 1992):

- transverse tear or damage of the labrum with breaking of Sharpey fibers in the marginal layers of the ring at its base or its outer section
- circular tear extending/running between vertebral endplates
- radial slits intersecting layers of the anulus fibrosus.

Homogenous disc structure may be subject to disturbance during fibrosis, drying and nucleus disintegration, which may result in the appearance of separate, fibrous lumps being formed from fragments of the nucleus or anulus (Brinckmann and Porter, 1994). Degenerative changes are often visible in both parts of the disc – desiccation and disintegration of the nucleus pulposus often co-occur with radial slots and damage in the anulus fibrosus (Yu et al., 1989). Many of the described
morphological changes, including even enormous changes in the structure, are asymptomatic because two-thirds of the anulus fibrosus (from the inside of the disc) as well as the entire nucleus pulposus do not have any innervation. Ashton et al. (1994) found that in preparations obtained from patients undergoing surgery due to degenerative disc disease, the receptors were located in the outer half of the anulus or in the outer layer of a width of 3mm. In other studies it was noted that in degenerative and pain causing discs the innervation can be more developed (Coppes et al., 1997; Freemont et al., 1997). In eight out of ten painful discs with advanced degenerative changes the innervation network reached two-thirds of the inner anulus width, and in the other two discs, up to the marginal layers of the nucleus pulposus (Freemont et al. showed a high diversity of the degree in innervation of the tested discs, which derived from patients with chronic spinal pain. In almost 50% of the sample preparations nerves reached up to one-third of the inner anulus, and in about 25% of the preparations up to the nucleus pulposus.

To this day, no answer has been obtained as to why the disc becomes a source of pain. There are several models according to which the cause of the inner disc ailment is described. The difficulties in choosing one binding model are associated with the presence of morphological abnormalities in the group of patients who did not experience the pain ailment. Donelson et al. (1997) demonstrated the reliability of the patient’s pain reactions during mechanical clinical evaluation as a factor enabling the prediction of the presence of discogenic pain as well as the endurance of the anulus fibrosus wall. Donelson et al. also stated the advantage of a mechanical clinical evaluation process over the MRI examination in relation to the possibility of distinguishing between painful and painless discs.

An asymmetric disc load usually moves the nucleus pulposus towards the area with the lowest pressure (McKenzie, 2003; Kramer, 1990). This effect was confirmed by the results of experiments on corpses (Shepperd, 1995) and also on living individuals with the use of different imaging techniques (Brault et al., 1997, Edmondston et al., 2000). These studies demonstrated the reverse movement of the nucleus pulposus during flexion of the trunk and the forward movement during the hyperextension of the spine. Krämer (1990) on the basis of the conducted research described in detail the issue of disc movement. Nucleus pulposus displacement occurs most rapidly in the first three minutes of asymmetric loading, but continues to last at a slower rate for several hours in the case of the maintenance of asymmetric pressure. As a result of age-related progressive fibrosis of the nucleus pulposus in elderly people it is more difficult to induce its movement. A nucleus pulposus that is displaced under the impact of asymmetric loading returns to its original position when the pressure is released. If the disc load is maintained, the displaced nucleus tends to remain in an unusual position, but the return to its proper place can be facilitated by pressure in the other direction. However, it may be the case that the natural elasticity of the disc that allows for overcoming the effects of asymmetric loading will be lost by intradiscal morphological changes (Kramer, 1990). In the presence of radial slots the dislocated tissue may exert pressure on the outer, innervated part of the anulus. As long as it can withstand the pressure, the displacement can be eliminated, but if sufficiently weakened or broken, the dislocated tissue will create a hernia penetrating the outer part of the anulus. An unimpaired hydrostatic disc mechanism is therefore needed to cause any displacement of the tissue.
If the outer wall of the anulus has not suffered damage, the hydrostatic mechanism is also unimpaired and it is possible with an appropriate load to affect the displaced tissue. After the rupture of the outer layer of the wall or its weakening to the point that it causes its failure, the movements and positions of the body will no longer have a lasting impact on the displaced tissue of the disc.

On the basis of discographic tests it was shown that the intradiscal damage with an intact outer layer of the anulus boarder and without any abnormal masses outside of the disk may be a disease entity that is manifested through pain. The results of these tests indicate that the pain originating from the disc, without a nerve root in the clinical picture, may manifest itself as ailments in the lumbosacral spine and pain in the lower extremity.

The criteria for categorizing back pain into groups based on mechanical grounds (CSAF 1994) Clinical standards advisory group are as follows:

- age at onset in most cases is between 20–55 years,
- ailments in the lumbosacral area, buttocks and thighs,
- the “mechanical” pain which is changeable depending on physical activity and time,
- the general well-being of the patient is good.

McKenzie (1990) proposed a concept of three nonspecific mechanical syndromes: postural, dysfunctional and derangement. A syndrome is a characteristic group of symptoms and patterned events that are typical of a particular disorder. It describes the disease entity, recognized on the basis of the typical pattern of symptoms. Typical patterns of symptoms can also be used as a guide during treatment, because the syndrome also describes the distinguishable pattern of the reaction. The diagnosis of the syndrome is made during a mechanical assessment which involves a targeted medical history and physical examination.

Structural derangement syndrome is the most common syndrome among spinal disorders. The clinical pattern in the structural derangement syndromes is much more variable than in the other two syndromes. Pain in this syndrome may appear gradually or suddenly. It may be constant or irregular, can move from one side of the body to the other, in either the proximal and distal directions. Repetitive movement and static positions can quickly lead to a gradual increase or decrease in pain intensity and range. Derangement syndrome is also characterized by a mechanical clinical picture, which should normally reduce the range of motion, and sometimes even periodic deformation and deviation from the normal pattern of movement. Since the strategies of postural loading during daily activities affect both the symptomatic and mechanical clinical picture, the images can vary during the day and over the course of time.

In rear derangement syndrome the nucleus pulposus moves posteriorly. Diagnosis of the posterior syndrome allows for the introduction of the hyperextension pattern. The pattern of treatment includes procedures (performed by the patient and therapist) causing hyperextension of the lumbar spine. In the posterior derangement syndrome they are used in order to eliminate, reduce or centralize symptoms.

In the practice of physiotherapy people with LBP are very often recommended by doctors not to swim the breaststroke. Breaststroke, commonly called the “frog” stroke, is a natural, very popular way of human locomotion in water, used frequently during long-distance swimming, mainly by people with a low level of swim fitness.
The popular breaststroke has relatively little in common with the modern technique used at competitive level, which is characterized by a very complex structure of movements generating at a fast swimming speed a large hydrodynamic resistance, which may affect the motor system (Antoniak, 2001; Leblanc et al., 2009). Due to the high popularity of this movement in water among people who go swimming for physiotherapeutic or recreational purposes, the authors decided to take a closer look at the issue. Therefore, the aim of this work was to determine the actual range of spinal hyperextension during swimming the breaststroke. It was assumed that the excessive backward movement of the spine, executed while swimming the breaststroke, in the case of the posterior derangement syndrome, is not only not harmful, but may be beneficial, which is contrary to the general opinion of the medical community.

MATERIAL AND METHODS

The sample consisted of 15 people, 6 women and 9 men (Tab. 1), who swim the breaststroke at a recreational level. A criterion for selection into the experimental group was a lack of faulty posture.

TABLE 1. Characteristics of the experimental group

<table>
<thead>
<tr>
<th>Number of participants</th>
<th>Age (years)</th>
<th>Body Height [cm]</th>
<th>Body Mass [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 15</td>
<td>21.94 ± 3.47</td>
<td>165.63 ± 9.62</td>
<td>61.88 ± 8.25</td>
</tr>
</tbody>
</table>

The study was carried out in March 2013, in the indoor swimming pool at the University School of Physical Education in Wroclaw. To monitor the way that motor tasks were performed in water, camcorder and specialized computer software for motion analysis – SIMI Motion – were used. The system applied in the research allows for measurement and visualization of the conducted measurements and also enables the immediate use of the data, direct feedback as well as the further use in comparative studies.

The test method was based on filming the participant while swimming the breaststroke. A Sony DCR-HC30E Pal camcorder, positioned in a waterproof casing was placed underwater on a stand fixed to the side wall of the swimming pool at a distance of 3m from the subject. The optical axis of the lens was set perpendicular to the subject. The frequency of the recording was 50 frames/sec. In order to convert the distance between points of the image into the actual dimensions, a calibration system (size: 1x1x1m) was placed in the filming area. The image from under the water was continuously monitored on a screen located outside the pool (Fig. 1).


For the purpose of measurement, 6 markers with 10mm diameter were positioned on the subject’s body on the side which was closest to the camera. Markers indicated with letters H (hip), A, B, C, D, S (shoulder), formed a line connecting the hip axis with the axis of the shoulder joint (Fig. 2). The letter indication and placement of the markers ensured an optimal level of data recording. During the
experiment a record of the entire process was created. For each trial, information boards were filmed specifying the trial indication letter and the number of the person being tested. The task of the participant was to repeatedly swim the breast-stroke at a slow-to-moderate velocity over the distance of 25m. For the analysis of the filmed material only one full cycle of the motion was used, which was in a line perpendicular to the optical axis of the camcorder.

As no out-of-water measurements regarding the natural curves of the spine were taken on the participants, it has been assumed that the position adopted by the participant during the so-called “slide”, which is a part of the motion cycle (position with the upper extremity arms behind the head) is a zero (neutral) position for every participant within the observed points. Such procedure ensured that the measurements were individualised and highly reliable.
RESULTS

TABLE 2. The average values of angles on the lumbar section of the spine during one Swimming Cycle. Determined lumbar spinal angle HAB, with vertex A, lower thoracic angle ABC with vertex B, and upper thoracic spine BCD with vertex C

<table>
<thead>
<tr>
<th>N = 15</th>
<th>Max. $\alpha$ range [°]</th>
<th>Min. $\alpha$ range [°]</th>
<th>Max $\alpha$ value [°]</th>
<th>Min $\alpha$ value [°]</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAB angle</td>
<td>$(-38.59°; +11.96°)$</td>
<td>$(+0.27°; +0.85°)$</td>
<td>$50.55°$</td>
<td>$0.58°$</td>
</tr>
<tr>
<td>ABC angle</td>
<td>$(-9.28°; +32.69°)$</td>
<td>$(-0.48°; +0.07°)$</td>
<td>$41.97°$</td>
<td>$0.5°$</td>
</tr>
<tr>
<td>BCD angle</td>
<td>$(-23.12°; +26.85°)$</td>
<td>$(-0.89°; +0.49°)$</td>
<td>$49.97°$</td>
<td>$1.38°$</td>
</tr>
</tbody>
</table>

Values with (–) stand for the extension from the zero (neutral) position to the back, values with (+) – the flexion.

DISCUSSION

It is assumed that the physiological range of the lumbar spine is 60° for flexion, 25° for extension, 25° for lateral flexion and 30° for the movement of rotation. Magee (2006) on the basis of her research identified that the scope of the lumbar spine extension measured in the upright position with hands resting on the back side of the pelvis was 20°–35°. Troke et al. (1998) and Lantz et al. (1999) used a modified analyzer to examine the mobility of the spine – electrogoniometer CA-6000 (Orthopedic Systems Inc., Union City, California). With the help of this device, Troke (2005) measured a standard range of motion of the lumbar spine in 405 people aged between 16–90 years. The median range of the lumbar flexion movement was 73° in the youngest age group and 40° in the oldest. The range of motion of the spine extension was 29–26 with a 79% fall between the oldest and youngest group. The range of the side slope decreased from 28° to 16°, and the range of rotation remained constant at 7° in both age groups. Troke (2005) found no significant difference in the median range of motion of the lumbar section between women and men over such a broad age range. Ulucam et al. (2006) used the Zebris 3D Ultrasound-Based Motion Analysis System to determine the mobility of the lumbar spine. He differentiated the range of lumbar spine motions in the individual segments of movement and with regards to sex. While conducting research on a group of 100 people (50 women, 50 men) aged 18–22 years, Ulucam et al. measured the mobility of the lumbar spine. Among men it was $61.6 ± 8.1$ in flexion and $19.4 ± 8.3$ in extension, and among women $61.8 ± 7.8$ in flexion and $18.4 ± 6.3$ in extension.

The tests quoted above concern the out-of-water measurements, whereas the in-water measurements taken by us indicated that the maximum range of the spine motion in the sagittal plane in the group of participants amounted to $41.97°$ (ABC angle) – $50.55°$ (HAB angle). In respect of the out-of-water measurements, it may be assumed that the obtained angles remained within the physiological norms. While swimming the breaststroke, the maximum extension of $38.59°$ was registered in the HAB section of the spine (lumbar spinal angle) which may be interpreted as a hyper-extension which is rare in everyday activity (McKenzie 2003). Taking into consideration that the spine motion in this section is an activity repeated multiple times due to the cyclic nature of swimming movements, it is a desirable phenomenon from the point of view of therapy.
In contrast to measurement of the range of motion of the lumbar spine on land, where depending on the selected position in which the movement is performed we have a different degree of stabilization, in water we cannot talk about stabilizing the body position. Position stabilization is understood by the authors as the limitation of movement in the adjacent joints by abutting the body on the ground (stable surface) in order to obtain a greater range of the tested joint. During the extension movement of the spine in the prone position, stabilization is obtained by the pelvis and lower limbs resting on the ground (movement of the spine extension is achieved by straightening the upper limbs resting on the ground), and while standing it is obtained by the contact of the foot with the ground. Positioning hands on the back side of the pelvis during extension of the spine provides additional stabilization of the body. In this sense, stabilization of the position in the water environment while swimming the breaststroke is impossible. Therefore, the authors of the article consider the analysis of the “slide” position as the neutral position in our research, which constituted a basis for the calculation of angles, to be a correct assumption, in consideration of the fact that the literature on the subject lacks similar research. According to the authors, similar research should be conducted with the participation of persons suffering from back pain in order to eliminate the pain during recreational breaststroke swimming.

In structural derangement syndrome, most patients can successfully treat themselves. Nevertheless about 30% of them do not recover by doing exercises only, and they require additional techniques to be performed by a physiotherapist (McKenzie, 1992, 2003, 2006). According to the concept of McKenzie (2003) the basic requirement for the self-treatment of posterior derangement syndrome is the adoption and maintenance of a prone lying position because it is the starting point for other procedures and patterns of hyperextension self-mobilization. With reference to the above quoted McKenzie’s statement regarding the high efficiency of self-therapy of patients with structural derangement syndrome and on the basis of the results of the present research, it was found that swimming the breaststroke can be used in the treatment of posterior structural derangement syndrome.

CONCLUSION

1. Maximum values of the spine movement range while swimming the breaststroke registered during the research remain within the physiological norms.
2. Hyperextensions occurring while swimming the breaststroke, due to the cyclical nature of the movement, may be perceived as a phenomenon supporting the treatment of the rear derangement syndrome.
3. The conducted research should be repeated with the participation of persons who suffer from the structural derangement syndrome.

REFERENCES


The variability of the stroke index (SI) in swimming for people with disabilities

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ABSTRACT

In the swimming of people with disabilities, a particularly important factor, besides the physiological aspects, is the efficiency of the effort. This suggests that monitoring and the evaluation of the effectiveness of swimming should be a regular part of training for swimmers with disabilities. Therefore, it seems important to distinguish how changes occur in the parameters determining the effectiveness swimming. This is especially true about anaerobic lactic acidic exercise as the lactic acid concentration in the blood increases significantly. The aim of this work was to evaluate the usefulness of the velocity and the stroke index in swimming training of people with disabilities, along with the progressive fatigue of an high-intensity interval training workout. The sample consisted of 12 elite competitors with a disability. The experiment consisted of swimming at maximum intensity sequential distances of 48m, 50m, 52 m, and 54m. Competitors performed four sets of four repetitions with a 75 second interval between repetitions and 15 minutes of active resting between sets. All sets were recorded by five digital cameras with a frequency of 50 frames per second. The recorded material was analyzed with the use of special software for motion analysis and then the stroke index were calculated. There was no significant change in the average swimming velocity during each set and corresponding repetition, which means that the participants were able to tolerate the training intensity. Also, the stroke index did not change in a statistically significant way in both the subsequent sets as well as the subsequent repetitions ($p < 0.05$). An analysis of the value of the swimming stroke index for people with disabilities can be a diagnostic method for an assessment of the effectiveness of high-intensity interval training.

Key words: disability, swimming, stroke index, high-intensity interval training

INTRODUCTION

For many years, the aims and objectives of sport did not fit within its framework the concept of disability. Sports facilities are often not available to the disabled. This was due to ignorance about their needs and capabilities. However, the last decade of the twentieth century was a time for the professional development of sport for people with disabilities. Since then the research which defines the functional capabilities of disabled people and improves the training process has moved far beyond the original rehabilitative goals (McCann, 1996).

Similar trends can be observed in swimming sports for people with disabilities, both in Poland and all over the world. It is no longer possible to say that swimming
is only a form of rehabilitation for the disabled, but ever increasingly a professional activity. To equal the best, athletes with disabilities must train like the able-bodied. The continuous improvement in achievement results in the need to seek additional options, because very often tiny details are decisive for the best results (Fulton et al., 2010; Malone et al., 2001; Pelayo et al., 1999).

Changes in the model of competitive swimming for people with disabilities means that there is a need to seek new, more advanced training solutions that will increase the chance of achieving greater results. Success in swimming for people with disabilities increasingly depends on a precise, even model-like framework for determining the process of training, with a particular emphasis on the energy processes that occur along with the maintenance of optimal swimming techniques. Consequently, it will be possible to provide the knowledge needed to plan training loads while taking into account energy consumption in addition to the type and magnitude of the dysfunction, which impacts on the functional abilities of the competitor, and is directly correlated with the optimal swimming technique (McCann, 1996; Barbosa et al., 2010; Capelli et al., 1998; Fernandes, Vilas-Boas, 2006).

Speed in swimming is the ability to cover a certain distance in the shortest possible time. Speed levels are defined by three components: reaction time, execution time of basic movements and the frequency of the movements. In swimming, speed is one of the most important components when performing motor skills, where obtaining the best result is only possible when the swimmer is able to control the course of the movement, so that the movement is as effective as possible, despite the influence of progressive fatigue. Ineffective movements do not allow for the full liberation of energy, mental and intellectual potential of the swimmer and this potential is often squandered and wasted. Thus, studies on the physiology of swimmers with disabilities and studies related to the biomechanical aspects of swimming, present coaches and swimmers with new opportunities of finding hidden reserves. It seems reasonable, however, that aspects of the physiology of effort as well as the biomechanics of swimming were dealt with at the same time (Barbosa et al., 2010; Malone et al., 2001; Pelayo et al., 1995; Pelayo et al., 1999).

The analysis of swimming technique is based on the interpretation of the indexes resulting from the measurement of kinematic parameters, such as stroke length (SL), stroke repetition (SR), velocity (V) and the stroke index (SI). The stroke frequency (SR [the cycle/s]) is one complete motor cycle of one arm over a given unit of time or the quotient of the number of cycles divided by the time it took for their completion. The stroke length (SL [m]) is the distance that a swimmer covers during one swimming cycle. The velocity (V) is the distance covered per unit of time. The stroke index (SI [m²/s]) is the product of the velocity (V) and stroke length (SL) (Aujouannet et al., 2006; Chollet et al., 1997; Haljand, 1996; Huot-Marchand et al., 2005; Pelayo et al., 1999; Toussaint, Truijens, 2005; Toussaint et al., 2006) and indicates the effectiveness of the movement. The result of the stroke index analysis could be used by coaches to assess the swimmers’ progression regarding changes in swimming technique, as well as to verify the effectiveness of training methods in the context of the training cycle (Aujouannet et al., 2006; Haljand, 1996; Huot-Marchand et al., 2005; Pelayo et al., 1999; Toussaint et al., 2006).

The swimmers test results indicate that each competitor swims with a unique individual combination of frequency and stroke length, which varies depending
on the speed and the distance covered. It was noted that an increase in swimming speed is possible by increasing the number of performed cycles and shortening the distance swum in one cycle. The best swimmers are able to control and vary these parameters (Aujouannet et al., 2006; Huot-Marchand et al., 2005; Pelayo et al., 1995; Pelayo et al., 1999; Toussaint, Truijens, 2005).

The above considerations seem to be particularly important for people with disabilities, primarily due to their limited functional capabilities which consequently affect their ability to create a drive force. The key, therefore, seems to be to search for an optimal swimming technique in which swimmers are able select their stroke rate (SR) and stroke length (SL), which will allow for the optimal use of their functional capabilities (Fulton et al., 2010; Malone et al., 2001; Pelayo et al., 1999; Satkunskiene et al., 2005).

It is generally agreed that the threshold considered for aerobic transformation corresponds to the concentration of lactic acid in the amount of 2 mmol/l in the blood, and the anaerobic threshold at approximately 4 mmol/l. The value of lactic acid in the blood while resting is close to 1 mmol/l. It can be assumed that in addition to the physiological aspects, another important factor for swimmers with disabilities is the efficiency of their effort, which is directly linked to the swimming technique. This implies that fixing the anaerobic transformation threshold at the level of 4 mmol/l, it simply indicates the value at which the aerobic and anaerobic exercises are distinguished. However, this does not indicate the true possibilities of the proper technique when performing the movement, which is closely associated with the efficiency of the effort of each competitor. Hence, monitoring and evaluating the swimming stroke should be a regular element in the technical training of swimmers with various dysfunctions while taking into account variations in the level of their swimming ability. Therefore, it seems important to distinguish in what ways changes occur in the parameters determining the effectiveness of the performed movements. This is especially true about anaerobic lactic acidic exercise, during which the concentration of lactic acid in the blood increases significantly. It is desirable for swimmers to maintain the correct technique when performing subsequent repetitions over the distance at maximum intensity.

The result of such analysis will be possibility for the development of an individual swimming distance. In such a way, the competitor will be able to perform the effort several times at maximum intensity while preventing a decline in the stroke index. It is assumed that if the swimming distance is too long or the competitor is unable to withstand successive repetitions at the same speed, the stroke index will decrease.

The aim of this work was to evaluate the usefulness of the velocity (V) and the stroke index (SI) in swimming training of people with disabilities, along with the progressive fatigue of an high-intensity interval training workout. For this reason, the research hypothesis was that the analysis of the value of kinematic indicators (V and SI) can be a useful and diagnostic method for evaluating the effectiveness of training and provide insight into the development of high-intensity interval training programs.
MATERIALS AND METHODS

A group of research subjects consisted of 12 competitors with disabilities. The swimmers were characterized by functional capabilities (with swimming classes of S9-S10) and all were elite competitors – each was a medalist in the Polish Cup, the Polish Cup for juniors or even higher ranked competitions. The age of the swimmers was 16.3 ± 2.7 with a competitive swimming experience of 7 ± 2 years. Swimmers trained on a regular basis, taking part in 10 training sessions a week. Both swimmers and their parents were informed of all circumstances related to research. Each participant signed a research agreement to take part in the experiment.

The experiment was carried out after two days of rest. All swimmers were well nourished and hydrated. None of the participants claimed to be injured. Testing was conducted in a 25m swimming pool. Prior to the experiment, the swimmers performed a standard warm up (swimming the distance of 600–800m), after which each swimmer rested until reaching the subjective state of readiness for the implementation of effort at maximum intensity. The starts were carried out from the stationary lying position, and hence there was no push-off from the walls. The swimmers’ legs were held by the Assistant Trainer.

After the signal, without pushing-off from the wall, the competitors swam with crawl stroke at a maximum possible intensity over the following distances: 48m, 50m, 52m, 54m. This means that the volume of the training load during each of the series increased. Competitors performed four sets of four repetitions with a 75-second interval between repetitions with 15 minutes of active rest between sets. All sets were recorded by five digital movie cameras with a frequency of 50 frames per second. The cameras were positioned along the pool at five-meter intervals. Prior to the experiment, the middle of the lane was equipped with a 25-meter calibration line with plastic balls placed along the line at 1-meter intervals. The line was then recorded to be used as a reference point and the taken out from swimming track. Participants swam in swimming caps which had two circular calibration marks on both sides with a diameter of 7cm.

The recorded material was analyzed with the use of software for motion analysis. The analysis consisted of registering the head position of the swimmer at the beginning and the end of each swimming cycle. On these grounds the average velocity and the stroke index were calculated.

Empirical distributions of the average velocity and the stroke index did not substantially differ from the normal distribution, as proved by applying the Shapiro-Wilk test. The comparison between average velocity values and the stroke index in specific sets was conducted using the student’s t-test to obtain dependent samples.

RESULTS

The average velocity is assumed to be the quotient of the distance and its duration. In the first 3 training sets the participants covered distances from 48 to 54 meters at a similar velocity. However, in the final training set, the average velocity slightly decreased (Tab. 1). Nevertheless, the observed changes were small and statistically insignificant (p < 0.05).
Slightly larger variations were noticed in the case of the stroke index, which was assumed to be the quotient of the stroke length (SL) and the average velocity (V). Changes in the value of the stroke index are illustrated in Figure 1. The higher value of the stroke index indicates an increased effectiveness of swimming, which in turn suggests a more productive technique and a higher efficiency of effort.

In the first set of training the stroke index was the highest in the first and last repetition, whereas the lowest was recorded during the second repetition over a distance of 50 meters. In the second set the stroke index was rising as the distance increased, which indicates that the maximum efficiency of swimming occurred in the last repetition – over the 54 meter distance. In the third and fourth training sets the stroke index decreased quite significantly, however, its value grew in the subsequent repetitions of the aforementioned sets – with the increasing distance (Fig. 1). However, all changes in the value of the stroke index, both in subsequent repetitions and sets were not statistically significant (p < 0.05).

### Table 1. Average swimming velocity in each training set

<table>
<thead>
<tr>
<th>Set</th>
<th>Distances</th>
<th>Velocity (± 1SD)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set 1</td>
<td>48–50</td>
<td>1.305 (± 0.170) – 1.295 (± 0.163)</td>
<td>0.080</td>
</tr>
<tr>
<td></td>
<td>50–52</td>
<td>1.295 (± 0.163) – 1.262 (± 0.162)</td>
<td>0.619</td>
</tr>
<tr>
<td></td>
<td>52–54</td>
<td>1.262 (± 0.162) – 1.264 (± 0.165)</td>
<td>0.977</td>
</tr>
<tr>
<td>Set 2</td>
<td>48–50</td>
<td>1.269 (± 0.191) – 1.299 (± 0.193)</td>
<td>0.705</td>
</tr>
<tr>
<td></td>
<td>50–52</td>
<td>1.299 (± 0.193) – 1.259 (± 0.176)</td>
<td>0.601</td>
</tr>
<tr>
<td></td>
<td>52–54</td>
<td>1.259 (± 0.176) – 1.265 (± 0.176)</td>
<td>0.931</td>
</tr>
<tr>
<td>Set 3</td>
<td>48–50</td>
<td>1.266 (± 0.164) – 1.282 (± 0.180)</td>
<td>0.031</td>
</tr>
<tr>
<td></td>
<td>50–52</td>
<td>1.282 (± 0.180) – 1.241 (± 0.184)</td>
<td>0.574</td>
</tr>
<tr>
<td></td>
<td>52–54</td>
<td>1.241 (± 0.184) – 1.257 (± 0.190)</td>
<td>0.828</td>
</tr>
<tr>
<td>Set 4</td>
<td>48–50</td>
<td>1.166 (± 0.083) – 1.173 (± 0.094)</td>
<td>0.361</td>
</tr>
<tr>
<td></td>
<td>50–52</td>
<td>1.173 (± 0.094) – 1.163 (± 0.124)</td>
<td>0.841</td>
</tr>
<tr>
<td></td>
<td>52–54</td>
<td>1.163 (± 0.124) – 1.158 (± 0.109)</td>
<td>0.919</td>
</tr>
</tbody>
</table>

**FIGURE 1.** The swimming stroke index in each training set
DISCUSSION

In swimming of people with disabilities it is common practice to use training methods based on models designed for able-bodied swimmers. The level of the results achieved by swimmers with disabilities continues to increase. Due to increased competition and the desire to maximize results, swimmers with disabilities are treated as competitive athletes (McCann, 1996).

It is known that the intensity of the training load and the swimmers’ corresponding heart rate values during the workout must not exceed the threshold. In the case of able-bodied swimmers these values shall be determined on the basis of age, competitive experience, their sports ability and the period of the training cycle. Additionally, for people with disabilities, factors requiring further consideration are the nature and magnitude of the swimmer’s dysfunction (Daly, Vanlandewijck, 1999). In the study, certain values which seem to be optimal were assumed, however, the practical application of these values do not guarantee the desired effect. The coaches of swimmers with disabilities face a much more difficult and complex problem, regarding the planning and implementation process, than coaches of able-bodied swimmers. It is impossible to develop a universal training model for swimmers at a given point of their career, even if it were only for one type of dysfunction. An appropriate, and above all, efficient selection of the correct training load as well as the accurate identification of the required intensity for a given effort requires significant experience as well as relevant cyclical research in this field. In the selection of the load and training type it is necessary to specify (individually for each player) the intensity of the effort, at which the transition from the aerobic to anaerobic occurs (Cregan, 2007; Capelli et al., 1998; Dummer, Bare, 2001; Fulton et al., 2010; Pelayo et al., 1995; Zamparo et al., 2000).

The scientific literature on this issue confirms that there is a relationship between the selection of the training load and the condition of the swimmer. Therefore, there is a need to determine the condition level using a series of tests and to monitor the effects of training on swimmers with disabilities, in order to optimize workloads according to their individual functional ability. In this experiment, based on the recordings of the five digital video cameras set along the swimming pool, the swimming race and the number of completed cycles were indicated. On these grounds, the average velocity and the stroke index were calculated. It seems unlikely that the method used contains significant errors in measurement accuracy and the sampling frequency. However, there is a small possibility that inaccuracy could arise from swimmers pushing-off from the walls after preparing for the return swim. With the above in mind, the relative error was estimated to be around 3% (Haljand, 1999; Toussaint, Truijens, 2005).

The aim of this work was to search for new and more advanced training solutions that will increase the chances of competitors with disabilities to obtain better results. The research issue arose from the fact that in recent years the level of sport has increased significantly. One of the means for improving athletic performance and obtaining even higher results at competition level is to focus on the development of methods for managing and training competitors with disabilities. The above aimed at defining reliable methods for the support and design of technical training, while taking into account the intensity of the effort. It is assumed that an incor-
rectly selected distance in lactic acidic training could cause a significant decrease in velocity (as a result of the change in the energy), or inefficiency (wasteful) in swimming over a certain distance, which in turn, could mean that the competitors were not able to take full advantage of their potential speed and sometimes it was simply wasted. The research problem was resolved by establishing the mean velocity at which the competitors traversed the consecutive distances as well as through the calculation of the stroke index. On the basis of changes in the value of the average velocity, it was speculated as to whether the competitors were able to continue the exercise at maximum intensity. Whereas, on the basis of changes in the value of the stroke index it was speculated that the effort was performed in an effective manner. Indirectly, it is also proof of the efficient performance of effort and the correct swimming technique.

In the literature on the subject, scientific resources dedicated to this area of study were available, however, the research that could exactly clarify the above factors was not found. This issue is particularly important for swimmers with disabilities, where it is an important factor for improving individual swimming techniques and anaerobic capacity; especially since the research revealed that the effectiveness of swimming is affected by both the duration of the training and the distance swum (Cregan et al., 2010; Fulton et al., 2010; Pelayo et al., 1999). So, it seems reasonable to seek individual training methods, which would help in objectifying training loads, while taking into account the optimal swimming technique. Also in the case of swimmers with disabilities, the measurement of the stroke index could be easily introduced by coaches into the training program, as an active indicator for the purpose of monitoring the competitors’ progression during the season (Pelayo et al., 1999; Dummer, Bare, 2001).

The fact that there was no significant decline in the average swimming speed during each repetition indicates that the swimmers were able to tolerate the increasing concentration of lactic acid. This suggests that the distance covered by the competitors was too short to lead to a significant decrease in swimming velocity. However, the question arises as to whether, despite these new findings, there was a decrease in the effectiveness of the swimming, which in turn would signal greater energy expenditure. However, changes in the value of the stroke index in various repetitions and training sets were small and statistically insignificant (p < 0.05). It can be concluded that the quantity of sets, the number of repetitions in the set, as well as the length of the individual distances may be better established.

Controlling the level of the competitors’ condition should be an integral part of the effective management and programming of the training process. Despite the fact that invasive studies (e.g. the assessment of the concentration of lactic acid in the blood) allow for a precise assessment of the competitor’s condition, this is not a tool available for all trainers, nor is its use within the present capabilities of all trainers. In such cases, it is possible to use non-invasive methods, conducting swimming speed tests and an analysis of the basic kinematic parameters (Ajuouannet et al., 2006; Barbosa, 2010; Chollet et al., 1997; Toussaint, Truijens, 2005).

Recursive determination of the anaerobic transformation threshold is currently the primary means of determining the level of changes in the conditioning of swimmers, which can also be applied to swimmers with disabilities. It depends to a large extent on the impact of training, genetics, and for swimmers with disabilities, the
type and degree of their dysfunction. It can therefore be assumed that the above mentioned factors, although they concern only a selected area of the training evaluation, form an integral part of the training monitoring system. Moreover, the research conducted in this field contributes to the trainers’ expertise and can be used in developing a more accurate rationale for the process of training for swimmers with various disabilities and with different levels of sports experience.

CONCLUSIONS

1. An analysis of the value of the swimming stroke index for people with disabilities can be a diagnostic method for an assessment of the effectiveness of high-intensity interval training.

2. The evaluation of kinematic indicators for swimmers with disabilities can also be a clue for determining the distance, the number of training sets as well as the numbers of repetitions during high-intensity interval training program.

REFERENCES


Pressure differentials on swimmers’ hands and swimming direction

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ABSTRACT

This study aimed to determine the relationship between pressure differentials exerted on the right and left hands and swimming direction. Nine subjects participated in two tests. In the first they swam the breaststroke in a straight line, while in the second along a curved line when blindfolded and with ears plugged. Propulsion was generated by the upper limbs only. The pressure differentials exerted by the water on the palmar and dorsal sides of both hands were measured. Then, the differences between right hand and left hand propulsion were determined. The values obtained for linear and curvilinear motion were similar, but differed significantly from model performance. No correlation was found between the dominant propulsion generated by one side and the veering of the swimmer to the other side. It could be concluded that the asymmetry of pressure differentials between the swimmer’s hands do not depend on visual and auditory control. A greater propulsion generated by the right hand, during blindfolded arm breaststroke swimming, does not determine veering to the left, nor is the opposite true. Not only should the balance of propulsion be taken into account during straight line long-distance swimming in open water, or straight line diving in non-transparent water, but the forces of resistance as well.

Key words: veering, blindfolded locomotion, breaststroke, propulsion, symmetry

INTRODUCTION

It is very important to maintain a straightforward movement direction when performing locomotion. The act of turning while walking or skiing is triggered by an impulse from the leg when located outside its rotation axis (Orendurff et al., 2006; Vaverka and Vodickova, 2010). It is believed that a similar relationship can be observed in swimming. The greater propulsion forces produced by limbs on the right side cause a turning to the left. Contrary to locomotion on land, when swimming, the human body finds itself in a horizontal position. Moreover, both the upper and lower limbs generate propulsion. With the former playing the main role (Berger et al., 1999; Toussaint et al., 2002), the surface of the hand is the main propulsion surface of the upper limb (Takagi et al., 2004; Vorontsov and Rumyantsev, 2000a). Propulsion is determined by a pressure differential P(t) exerted by the water on the back of the hand and the palm (Takagi and Wilson, 2004; Toussaint et al., 2002). In breaststroke, according to the International Swimming Federation, “all movements of the
arms shall be simultaneous and in the same horizontal plane without alternating movement”. Simulations of breaststroke movements on land have revealed a lack of dynamic and kinematic asymmetries (Jaszczak, 2006a, b). Studies conducted during swimming in water have determined that the asymmetric errors of lower limb movement may increase the asymmetry of the upper limbs’ performance (Jaszczak, 2011b; Jaszczak and Zatoń, 2011). The upper limbs seem to play a steering role during swimming (Jaszczak, 2011a). The relationship between selected asymmetrical movements of the lower limbs and swimming direction, has not been determined (Koszczyc, 1974). It seems that the upper limbs, which are the more precise tool (Rutkowska-Kucharska, 1999), and at the same time the main source of propulsion, should play an important role in the execution of turns while swimming. Literature on this subject lacks information regarding the mechanism of turning in swimming. It is quite a mystery as to whether the differences observed between land and water environments, and different body positions during locomotion, reflect different turning mechanisms. Therefore, the aim of this research was to determine the relationship between the pressure differential exerted on the right and left hands and breaststroke swimming direction. The following questions were posed: i) are pressure differentials exerted on the right and left hand equal during straight line breaststroke? ii) does turning left or right place greater pressure differentials on the hands outside the turning axis?

**MATERIALS AND METHODS**

Nine participants volunteered to take part in the study. They included three females and six males. Each of them presented different swimming skills with their characteristics described in Table 1. All the subjects performed correct breaststroke swimming technique according to the International Swimming Federation rules. Four of the males had previous experience in training for competitive swimming. One of them is currently an active competitor. The level of swimming skills was determined on the basis of results obtained from swimming the breaststroke over a 25 m distance, after a push off start from the pool wall. All participants were informed about the research and provided written consent for involvement. The research was approved by the Senate Committee for Ethics in Scientific Research.

The research was conducted in a 25 m indoor swimming pool. The area selected to perform the experiment measured 25 m × 5.75 m. Two 26PCB type 5 (Honeywell, USA) differential pressure sensors were placed between the third and fourth finger of the right and left hands. They measured the difference in water pressure between the back and the palm of each hand, which resulted from hand

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<th>Participant</th>
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<tr>
<td>Age [years]</td>
<td>21,9</td>
<td>25,5</td>
<td>21,5</td>
<td>21,3</td>
<td>21,3</td>
<td>20,6</td>
<td>23,4</td>
<td>23,7</td>
<td>21,9</td>
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<tr>
<td>Body height [cm]</td>
<td>162</td>
<td>165</td>
<td>168</td>
<td>183</td>
<td>182</td>
<td>175</td>
<td>181</td>
<td>190</td>
<td>194</td>
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<tr>
<td>Body mass [kg]</td>
<td>48</td>
<td>60</td>
<td>56</td>
<td>77</td>
<td>70</td>
<td>75</td>
<td>71</td>
<td>80</td>
<td>97</td>
</tr>
<tr>
<td>Training period [years]</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>6</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Time of 25 m breaststroke [s]</td>
<td>27,1</td>
<td>26,8</td>
<td>24,1</td>
<td>22,7</td>
<td>22,5</td>
<td>20,2</td>
<td>19,8</td>
<td>19,4</td>
<td>16,9</td>
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TABLE 1. Characteristics of the participants (subjects ordered according to swimming skill from lowest to highest, the first three being the females).
movement only. The effect of hydrostatic pressure was eliminated. The sensors were connected to an analogue-digital converter and computer, by wires attached to the swimmer’s limbs and back, with the ends of the wires attached to a rod located above the water. While taking measurements, the rod moved at the same velocity as the swimmer. Hence, the resistance related to the pull from the wires was minimal. The course of movement was recorded by a video camera placed within the long axis of the research area. Nine swimmers took part in two tests. In the first trial, the swimmers were instructed to swim the breaststroke over a 20 m distance, at moderate speed, using only their upper limbs as propulsion. At that time, the lower limbs were immobilized and held a pull buoy placed between them. In the second test, in order to induce a curve in the swimming direction (Novak, 1983), the subjects wore opaque goggles and earplugs. The remaining conditions were as described in task one. The initial position taken by the subjects was identical in both tasks. The subjects lay prone and motionless. Their faces were immersed in the water with arms extended parallel to the head. The swimmers were placed within the symmetry axis of the research area and pushed forward. The test was started by a glide. Pressure differentials of the upper limbs were synchronized with the video recording in order to determine the propulsion phases (Fig. 1). First, mean values of differential pressure $P \cdot \Delta t$ for each propulsion phase of the limbs were calculated. Then, mean values $P \cdot \Delta t$ for each limb were determined. The results obtained from the right and left limbs were used to compute the difference ($D$) between them. Afterwards, the normal distribution of $D$ was verified by the Shapiro-Wilk test. This was followed by a test of the difference between the two means. The absolute values of the results of the differences obtained during straight line ($D_1$) and curved line swimming ($D_2$) were compared with the model value ($D_m = 0$) and between one another. Statistical analyses were made with Statistica Software (Statsoft, Inc., USA). The level of significance was set at $p < 0.05$.

RESULTS

During the first trial, the participants swam 20 m in a straight line trajectory (Fig. 2a and 2b). During the second test, conducted with limited visual and auditory control, eight out of the nine subjects swam along a curved trajectory. The ninth subject was able to swim straight. The results obtained by this swimmer will be discussed separately. During the second test, the participants first swim along
a symmetry axis of the selected area. After performing 1–4 cycles, they veered toward the side of the area. When a curve in swimming began, it was continued up to the point of reaching the edge of the determined field. The veering side did not change after initiation. The distance of curved line swimming did not exceed 14 m. A dominance of propulsion by a single-side, resulting in veering to the opposite side, was observed in only one subject (Fig. 2c and Tab. 2). The seven remaining participants revealed the opposite tendency, i.e. dominant right side propulsion reflecting a right side veering (Fig. 2d and Tab. 2)!

A statistically significant divergence ($p = 0.002$) was observed between the mean differences of absolute values $P \cdot \Delta t$ developed by the right and left upper limb, in the propulsion phase during straight line swimming and model performance ($D_m = 0$). Similar results ($p = 0.001$) were obtained for curved line swimming when compared with the model result. However, the mean differences of absolute values $P \cdot \Delta t$ for straight-line and curved-line swimming displayed no statistical differences ($p = 0.98$) (Fig. 3). In the second test, one of the nine subjects swam in a straight line despite visual and auditory limitations. At the time of testing, this subject was a nationally ranked competitor. In both tests, the subject swam in a straight line despite propulsion domination in the upper left limb (Fig. 4a and 4b). There was no change in the amount of movement cycles performed by this subject in either of the tests.

TABLE 2. Side of veering during limited visual and auditory control (subjects ordered according to swimming skill from lowest to highest, the first three being the females)

<table>
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<tbody>
<tr>
<td>Side of veering</td>
<td>L</td>
<td>L*</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>L</td>
<td>L</td>
<td>R</td>
<td>0</td>
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</table>

R – veering right; L – veering left; 0 – no veering
* domination of propulsion by a single-side is resulting in veering to the opposite side

FIGURE 2. Mean values $P \cdot \Delta t$ for successive propulsion phases for the right and left limb during straightforward (a, b) and curvilinear (c, d) swimming – example of two subjects

FIGURE 3. Mean values $P \cdot \Delta t$ for successive propulsion phases for the right and left limb during straight line swimming and model performance (Dm = 0).

FIGURE 4. a) Straightforward swimming – subject 2 b) Curved line swimming – subject 3 c) Veering left – subject 2 d) Veering right – subject 3
This research aimed to determine the relationship between pressure differentials exerted on the right and left hand and swimming direction. The values of pressure differentials obtained during the research were similar to those in freestyle and breaststroke swimming (Jaszczak and Zatoń, 2011; Toussaint et al., 2002). In the first trial, all the subjects swam in a straight line. However, differences were observed between right and left limb propulsion (pressure differentials), which significantly differed from the model result (no differences). This seems to reflect dynamic limb asymmetries in the participants. These asymmetries can be found in a majority of people (Olex-Mierzejewska and Raczek, 2001). Nevertheless, the participants were able to swim in a straight line. In the first trial, they had non-limited visual feedback. Using directional references, such as landmarks, they could compensate for differences in limb propulsion to continue straight-line swimming.

During the second test, conducted with limited visual and auditory control, eight out of nine subjects swam in a curved line. Swimmer trajectories differed from those observed during the first trial, however the differences between the propulsions generated on both body sides were similar in the two tests. Only in one case did a dominant propulsion on one side reflect a veering in swimming direction to the opposite side, as was expected. The remaining participants displayed an opposite tendency. The ninth subject swam straight ahead, in both tests, despite the propulsion differences observed between the sides of the body. These results suggest that
a one-sided domination of propulsion did not determine a deviation in swimming trajectory toward the opposite direction. After putting on opaque glasses, all the subjects tried to maintain a straight-line swimming trajectory while performing limb movements similar to those in the first test. Despite their efforts, they finished at different points than in the first test. There are two main forces which affect the body while swimming: propulsion and drag. The relationship between them determines swimming velocity. Straight-line swimming requires balance between resultant forces acting on the right and left sides of the body. The density of water is about 800 times greater than that of air, therefore the resistance forces created in water are disproportionately greater. This study revealed the differences between forces generated on the right and left sides of the body, which remained unchanged, no matter whether the trajectory of the swimmer was straight or curved. Therefore, drag can play the main role in performing turns while swimming. The observations and comparisons of the participants' performances over two different trials, would seem to confirm this thesis. In the first test, the initial position taken by each swimmer was prone and streamlined. Their faces were immersed in the water and their arms were extended parallel to the head. In the second test, while blindfolded and wearing earplugs, some subjects presented bent trunks in the frontal plane before start. Such a position was corrected by an assistant. However, such a correction was not possible during the performance of swimming itself. Limited visual and auditory control could lead to increased stimulation which subsequently led to performance errors (Wulf, 2007). The visible results of the decreased kinaesthesia (Enoka, 2008) observed in some subjects performing swimming with limited visual and auditory control, were in the form of: lateral trunk bend during glide phase or the upper limbs being placed laterally to the front and to the side, in recovery. It seems that the conditions of the second test (e.g. no visual and auditory control) may have disturbed previously developed movement patterns (Jansen et al., 2011). Movement asymmetries observed in the preparatory phase may have caused an asymmetry of drag (Popa et al., 2011; Zaidi et al., 2008) and resulted in veering from the straight-line trajectory. Symptoms of veering while swimming in the second test were observed surprising early. They occurred in cycles 1–4 and gradually intensified. However, no changes in the veering side were observed in consecutive cycles. This may indicate a systematic error made by the swimmer which accumulates in slight deviations throughout all cycles (Souman et al., 2009). The subject who was an active competitive swimmer at the time of testing, was the only one who maintained a straight swimming trajectory in both tests, despite the differences between propulsion impulses generated by both hands. In both tests he performed an equal number of cycles and swam at the same velocity. In addition, there were no visible asymmetrical trunk position or upper limb movements in his preparatory phase. His achievement seems to be the result of 11 years of swimming training and a well developed “feel for the water” – efficient stroke (Colyer, 2010). This brings about an increase in propulsive force and a reduction in drag (Pendergast et al., 2006; Toussaint et al., 1988). The fastest swimmers will typically optimize the ratio between thrust and drag (Taiah et al., 1999). But straight-line swimming is the result of a balance of the forces generated by both body sides. During the performance of this task, the interaction of the entire system (Seifert et al., 2005) seems to be more significant. A change in swimming direction can be obtained by the applica-
tion of three strategies: “propelling” – the act of turning is triggered by propulsive forces (which causes extra effort from already loaded muscles and may disturb movement coordination), “resisting” – based mainly on the action of resistance forces (involving other muscle groups) and “mixed” – a balanced influence of resistance and propulsive forces. In this study, there was no correlation between the domination of propulsion on one side of the body and veering to the opposite side. The differences between propulsion developed by the right and left upper limbs, observed in the two different tests, were similar. Therefore, veering would not appear to be caused by the first strategy. In eight out of nine cases veering was the result of the lack of visual feedback and a limited auditory one. This was completely accidental. In our opinion this is an example of the resisting strategy. There are two types of drag which can be determined on the basis of a movement type in water: passive (glide) and active (during propulsion) (Pendergast et al., 2006; Vorontsov and Rumyantsev, 2000b). Both of these were observed here. Finally, not only should the balance of propulsion be taken into account during straight line long-distance swimming in open water, or in straight line diving in non-transparent water, but the forces of resistance as well.

CONCLUSIONS

The research conducted, and the analysis of literature pertaining to it, enabled the following conclusions:
1. The asymmetry of pressure differentials between the swimmer’s hands do not depend on visual and auditory control.
2. A greater propulsion generated by the right hand, during blindfolded arm breaststroke swimming, does not determine a veering to the left; nor is the opposite true.
3. A symmetry in the propulsion generated by both sides of a swimmer are not a necessary condition for straight-line swimming.
4. The forces of drag seem to be a factor which causes veering during blindfolded arm breaststroke swimming. Further studies should be conducted to confirm this.

REFERENCES


Somatic construction of young swimmers

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ABSTRACT

The aim of this study was to determine age- and gender-related differences in body composition and anthropometric characteristics among swimmers. The study involved 317 swimmers aged between 11 and 15 years (175 girls and 142 boys) attending training sessions in the swimming clubs in the province of Silesia, Poland. The subjects underwent anthropometric measurements: body circumferences, body weight, body height and body fat, using: anthropometer, electronic scales, anthropometric caliper, measuring tape and skinfold caliper. The collected data were used to determine the components of somatotypes: endomorphy, mesomorphy and ectomorphy, according to the Heath and Carter method (1990). Statistical analysis included: cluster analysis which took into account three basic somatotypes for 6 clusters, and then for 3 clusters, two-way analysis of variance to determine the effects of age and gender on the development of somatotype, post hoc analysis – RIR Tukey test, analysis of variance for the standardized terms of gender and age. Somatic build of swimmers can be classified into three somatypes according to the quantification of three primary components of somatic build: endomorphy, ectomorphy and mesomorphy. The distinguished somatypes were: ectomorphic, meso-endomorphic and mixed type (average quantification of all three components). All somatotypes significantly differed in mesomorphy, endomorphy and ectomorphy. Endomorphy is a variable that significantly differentiates competitors both in terms of age and gender. Percentage shares of girls and boys within the three clusters were statistically significant. The cluster of high mesomorphy and endomorphy was clearly dominated by girls. Swimmers’ somatic profiles were significantly differentiated by gender. Gender did not differentiate only in such variables as: chest and lower leg skin folds.

Key words: swimming, somatotype, anthropometry, age

INTRODUCTION

It is easy to notice that the body build of high performance athletes differs according to the sport they practice. It is a result of two processes: selection and adaptive changes induced in response to specific types of training. These processes, alongside genetic, psychological and cultural factors, determine to a large extent which individuals persist in their sporting career. Their body type is decisive as it creates favorable conditions for achieving high sporting performance.

Swimming as an individual discipline requires special predisposition of an athlete. One of them is the body shape and composition. Nowadays, sport at the highest
level makes higher demands on athletes. At the outset of sporting career athletes with the appropriate body build are being looked for, because somatic features are to a greater extent genetically determined, thus less susceptible to the effects of swimming training. It is worth noting that the correct selection for competitive swimming is just a “starting point” for a further effective development of the swimmer and the identification of talent. Therefore, when the motor skills and potentials of young swimmers are at a similar level, it is necessary to look for the characteristics that may increase their advantage over competitors. These include the relative body length and the length of the other body segments (feet, hands, arms). They provide a “natural” advantage for the swimmer, due to the effect of mechanical advantage on development of propulsion (Geladas et al., 2005; Zampagni et al., 2008; Sortwell, 2011, Barghamadi et al., 2012).

Not always competitive swimming is taken up by those who are really meant for it. This depends on various factors, including: inadequate selection process, or even no selection. This paper presents the body build characteristics of young swimmers. It was interesting to examine if intense physical activity had a significant effect on formation of somatic features in young, still developing, organisms when many different factors act on them and their effects often overlap (Malina and Bouchard; 1991, Wieczorek, 2001).

The aim of this study was to assess the age- and gender-related anthropometric differences between the swimmers.

MATERIAL AND METHODS

The study involved 317 swimmers aged from 11 to 15 years (175 girls and 142 boys) attending training sessions in swimming clubs in the province of Silesia, Poland. All subjects and their guardians expressed their consent to participate in the study. The research was approved by the Bioethics Commission of the Jerzy Kukuczka Academy of Physical Education in Katowice (No. 4/2009). Anthropometric measurements were taken between 8.00 am and 10.30 am, in 2011. In order to determine the somatotype, i.e. body fat distribution, the following measurements were taken: body height and weight, as well as chest, abdominal, upper arm and forearm, subscapular, supraspinal, thigh and lower leg skinfolds. In addition, measurements of the upper arm, forearm, thigh and lower leg width, as well as upper arm girth (elbow flexed and tensed), thigh and lower leg girth, chest girth (at rest, during maximum inspiration and during maximum expiration), waist and hip circumferences. Body height was measured to the nearest 0.1 cm using anthropometer (Swiss Made GPM), and body weight was measured using an electronic weighing scale to the nearest 0.1 kg (Tanita TBF 401A, Japan). During measurements the subjects were wearing only swimsuits. Measurements of skinfolds were made to the nearest 0.2 mm using a skinfold caliper (GPM - CE, range 0–45 mm), the circumferences were measured to the nearest 0.1 cm with the use of a tape measure, and the widths were measured using an anthropometric caliper. The three components of the somatotypes: endomorphy, mesomorphy and ectomorphy, were determined using the Heath and Carter method (1990). Statistical analysis included cluster analysis which first took into account three basic somatotypes (endomorphy, mesomorphy, ectomorphy) within 6 clusters: un-
defined, ectomorphic, endomorphic, ecto-endomorphic, mesomorphic, meso-ectomorphic, meso-endo-ectomorphic. Cluster analysis was carried out using k-means. As a measure of the distance between the clusters used Euclidean distances. Out of these three clusters dominated and only they were analyzed in further study: ectomorphic; mesomorphic and mixed. In order to determine the effects of age and gender on the development of somatotype analysis of variance for the normalized values for sex and age were carried out, supplemented by post hoc analysis – RIR Tukey test. The level of statistical significance was set at $p < 0.05$ and it determined the somatotype classification according to each component rating (mesomorphy, ectomorphy, endomorphy) as well as gender and age-related differences. The data were analyzed using STATISTICA 9.0 (StatSoft Poland).

**RESULTS**

Somatic parameters are shown in tables 1 and 2. Older female and male swimmers were taller and heavier and their parameters of somatic components are higher. The somatic build of all the examined swimmers varied a lot (Fig. 1), that is why their somatotypes are scattered around on the somatograph.

Basing on the k-means cluster analysis participants were divided into three clusters according to the dominance of one of the three primary components of body type: endomorphy, ectomorphy and mesomorphy. The method used clearly showed that the average Euclidean distance between the clusters are larger than the average distance within the cluster (Table 3–5), and the results are statistically significant ($p \leq 0.016$). As a result of the method obtained three clusters. Cluster 1 consisted

| TABLE 1. The mean values of the girls’ somatic parameters |
|-------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Age (years) | Variable               | 11 | 12 | 13 | 14 | 15 |
| n = 43     | Body mass (kg)             | 39.47 | 47.39 | 47.32 | 53.26 | 55.11 |
| n = 33     | Body height (m)            | 148.92 | 155.64 | 159.05 | 163.77 | 164.92 |
| n = 34     | BMI (kg/m²)                | 17.68 | 19.50 | 18.58 | 19.86 | 20.28 |
| n = 33     | Endomorphy                | 3.40 | 3.97 | 2.96 | 3.47 | 3.72 |
| n = 32     | Mesomorphy                | 3.46 | 3.65 | 2.88 | 3.45 | 3.38 |
| n = 32     | Ectomorphy                | 3.59 | 3.09 | 3.82 | 3.38 | 3.17 |

| TABLE 2. The mean values of the boys’ somatic parameters |
|-------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Age (years) | Variable               | 11 | 12 | 13 | 14 | 15 |
| n = 24     | Body mass (kg)             | 40.12 | 41.46 | 49.90 | 56.02 | 61.87 |
| n = 23     | Body height (m)            | 149.37 | 152.99 | 161.48 | 168.33 | 174.36 |
| n = 34     | BMI (kg/m²)                | 17.95 | 17.62 | 18.94 | 19.66 | 20.30 |
| n = 38     | Endomorphy                | 3.19 | 2.61 | 2.46 | 2.50 | 2.98 |
| n = 23     | Mesomorphy                | 3.89 | 3.71 | 3.67 | 3.79 | 3.24 |
| n = 23     | Ectomorphy                | 3.50 | 3.93 | 3.75 | 3.65 | 3.78 |
of those participants whose body type was ectomorph, cluster 2 included the athletes with the type of meso-endomorph build, and cluster 3 – athletes whose body was of a mixed type – average rating of all three components.

The results indicate that the size of boys’ and girls’ samples did not differ significantly from one another in different age categories. Analysis found that the clusters differed significantly in terms of percentage shares of girls and boys (p ≤ 0.025)
There was also a statistically significant difference between the number of girls and boys within the meso-endomorphic cluster ($p \leq 0.000$).

ANOVA results indicate that endomorphy is a variable that differentiates athletes both in terms of gender and age. 12-year-old girls significantly differed in terms of endomorphy from boys aged 12, 13, 14 ($p \leq 0.007$; $p \leq 0.000$; $p \leq 0.000$, respectively) and girls at the age of 14–15 differed from boys aged 13–14 ($p \leq 0.000$). There were endomorphic differences between girls aged 12 and 13 ($p \leq 0.029$). Whereas in the case of the other two components: ectomorphy ($p \leq 0.027$) and mesomorphy ($p \leq 0.017$) the differences were only gender-related.

The analyzed somatic variables showed significant gender-related differences. Among the variables dependent on body weight (Fig. 3), the greatest diversity was...
found in: body weight (42.3%), WHR (32%) and BMI (15%). Analysis of the body circumference parameters (Fig. 4) showed a significant difference between the values of girls and boys ($p \leq 0.000$). The highest values were found in the measurement of the chest circumference – 45%, whereas the remaining variables ranged between 30–40%. The body length measurement parameters (Fig. 5) were also found to depend significantly on gender ($p \leq 0.000$). The largest differences were observed in the arm span (55.9%) and body height (54.5%), and the smallest in the arm length – 38%. Analysis found that the values of the body width parameters also showed significant differences ($p \leq 0.000$). Among the width parameters (Fig. 6) the greatest differences were noticed in shoulder widths (54.3%), hip widths (47%) and the base of lower leg (47%). The smallest differences were recorded in the base of the forearm. Measurements of adipose tissue indicate that only values of the chest and lower leg skinfolds ($p \leq 0.087$ and $p \leq 0.0275$, respectively) showed no significant gender-related differences (Fig. 7). Among other parameters where differences were statistically significant ($p \leq 0.000$), the largest difference was observed in the arm (21%), hip (12%), thigh and shoulder (both 11%) skinfolds.
The analyzed profiles indicate that the smallest values of the width parameters are characteristic of the boys at the age of 13, whilst the largest of the boys aged 15. It is interesting to note that 11-year-old girls are characterized by higher values of these parameters than the older girls.

Measurements of the body circumferences showed that 15-year-old boys have the largest dimensions, while 13-year-olds – the smallest (Fig. 4). Length profiles showed a linear character (Fig. 5). Like in previous profiles the oldest boys have the highest values of the parameters; while the girls and 11-year-old boys – the lowest. Profiles of the body weight parameters are non-linear (Fig. 3).

**DISCUSSION**

On the basis of the somatic parameter analysis, athletes of similar body builds were distinguished. The somatotype of swimmers aged between 11 and 15 fell into
three categories: ectomorphic, meso-endomorphic and mixed (average magnitude of: ectomorphy, mesomorphy and endomorphy). The most numerous group consisted of the athletes with the mixed body type (n = 139), followed by the ectomorphic type (n = 125) and the smallest group included the athletes with the meso-endomorphic body build (n = 65). Among the participants with a meso-endomorphic body type, girls (68.8%) outnumbered boys.

Study of Zuniga et al. (2011) showed that the girls’ body build significantly differed in endomorphy rating in relation to the boys. The authors carried out a study on a group of 69 swimmers (age 11.03 ± 2.29 and 10.45 ± 2.29) training in regional clubs which showed that gender significantly differentiated the percentage of body fat content and the value of endomorphy. The girls were characterized by higher endomorphy than boys. No differences were found in relation to the active tissue content (TA), weight and dimensions of widths. Research has shown that gender differentiated all tested width parameters and body mass.

Martínez et al. (2011) showed that Caucasian female swimmers (n = 14) belonging to semi-professional teams had higher values of arm muscles, supraspinale and abdominal skinfolds. As a result, somatotype was characterized by a higher value of endomorphy in girls than in boys (n = 22). Boys’ somatotype was characterized by higher values of mesomorphy and ectomorphy. Their outcomes coincide with the ones obtained in this study, because the boys and girls of meso-endomorphic body type were characterized by higher values of endomorphy and mesomorphy than swimmers with other types of somatic features.

These results were confirmed in a study carried out on Polish swimmers aged 15–18 years (Strzała and Krężałek, 2010). The tested athletes had ectomorphic (n = 11) and mesomorphic (n = 15) body types. The body build of younger athletes in the group (aged 16 and 14, n = 19) had similar somatotypes (Strzała, Tyka, 2007) as in the aforementioned study, with a slight advantage of a mesomorphic type. The authors (Strzała, Tyka, 2007) identified athletes with mesomorphic (n = 6, aged 16; n = 5, aged 14) and ectomorphic body type (n = 5, aged 16; n = 3, aged 14).

Body type determines the success in competitive sports. Athletes of different sports discipline are characterized by different somatic features. Often, the success and achievement of important results is determined by a combination of several sport-specific parameters. Knechtle et al. (2011) showed that lower body weight, lower body mass index and lower body fat were associated with both a better time in the Ironman race and a faster run. Reduced circumferences of the upper arm and thigh were also associated with faster times of the run. In practice, athletes having lean body, lower body height and low body fat gain an advantage over others, and consequently better performance in the Ironman race.

In open-water swimming in extremely tough conditions (Knechtle et al., 2011) body fat, height or lengths of the limbs do not affect the result, like it does in the swimming pool on shorter distances. Zampagni et al., (2008) studied effects of anthropometrical parameters: body weight, body height, lengths of the arm and forearm, circumferences of the arm and forearm muscles on swimming performance. They found that in a short distance of 50 m the important parameters were: age, the handgrip strength and body height. In medium and long distances these were: age and body height. In swimming events of 50m gender was not a determining factor, although it was in the 100, 200, 400, 800 m freestyle events as the measured parameters had statistically different values among male and female swimmers. Other
studies found that anthropometric parameters were important in sprint swimming. Those parameters included: body height, arm span and lean body mass (Jürimäe et al., 2007; Strzała and Tyka, 2009). Lätt et al. (2010) also found that anthropometric characteristics in 45% decide about the time in the 100 m freestyle event. A significant relationship between a swim time and body height was also proven by Gelledas et al. (2005) and Toussaint and Hollander (1994).

Influence of swimming on the somatic structure was confirmed by numerous other studies (Nowacka-Chiari, 2005; Ostrowska et al., 2005, 2006; Gołąb et al., 2009; Hazir, 2010; Gualdi-Russo and Zaccagni, 2001; Poliszczuk and Broda 2010; Orhan et al., 2010; Sterkowicz-Przybycień et al., 2011). Nowacka-Chiari (2005) showed that girls training swimming had higher values of body height and weight than their non-training peers. In addition, they differed in shoulder and hip widths and arm circumference.

Ostrowska et al. (2005) stated that swimming differentiated the body build. A higher degree of diversity in somatic features was observed among boys. The body circumferences (arm, thigh, leg, chest, waist), the parameters of length (length of the upper and lower limbs) and width of the pelvis had the highest differentiating value. These parameters indicate development of the body build typical of swimmers. The study showed much smaller differentiation among girls. The most important differentiating features were: thigh and lower leg circumferences, pelvis width and depth of chest. Differentiation in somatic build may be the result of selection for particular sports, whose aim is to choose children and young people with the specific body build parameters which in the future would determine the result.

Ostrowska et al. (2006) highlighted the important prerequisites for competitive swimming: weight, muscular trunk, muscular lower and upper limbs, height, and length of lower limbs. They should be considered when selecting athletes to competitive swimming, and successively monitored regularly to assess training-related changes in the swimmers’ body.

Research showed that in such a large group of athletes there were individuals with different somatic builds. Future studies should focus on high level athletes to assess the impact of somatic build on their performance taking into account the swimming stroke.

CONCLUSIONS

1. Swimmers belonging to different clusters significantly differed in mesomorphy, endomorphy and ectomorphy.
2. Endomorphy is the only variable that significantly differentiates competitors both in terms of age and gender.
3. Percentage shares of girls and boys between the three clusters differed significantly. The cluster of a high mesomorphy and endomorphy rating was dominated by girls.
4. Swimmers’ somatic profiles were significantly differentiated by gender.
   a) Gender did not differentiate only in such variables as: chest and lower leg skinfolds.
REFERENCES


The relationship between body composition and performance results in people engaged in recreational swimming

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ABSTRACT

In swimming, top sporting achievement is associated with low levels of body fat. Therefore, it seems important to provide detailed information about the values of each component of body composition and its relationship to maximum athletic performance. However, most studies focus on elite swimmers, excluding recreational swimmers. The aim of this study was to determine the relationship between selected components of body composition and maximum results obtained by men and women engaged in recreational swimming – in a single exercise test. The study included 38 swimmers (19 women and 19 men) who had never trained for swimming at an elite level. In this experiment, all participants swam the 25m front crawl twice, each time as fast as they could. The body composition was determined by non-invasive spectrophotometry using near-infrared technology. In order to determine the relationship between the time to traverse the distance and selected components of body composition (body fat mass, fat-free mass, BMI, body height and weight) Pearson’s correlation \( r \) was used. Statistical analysis did not find such correlation in women. In men, there was a negative correlation between the time and body fat mass \( (r = -0.36, p < 0.05) \). This means that among individuals practicing recreational swimming, results are not determined by the components of body composition – with the exception of fat-free mass in men.

Key words: swimming, body composition, body fat, fat-free mass

INTRODUCTION

Physical activity is beneficial to human physical and mental health (Williams and Wallace 1988, Biddle et al. 2000). Physical activity in the aquatic environment is considered to have numerous favorable properties (Haffor et al. 1991, Meyer and Bucking 2004) including preventive health behavior and rehabilitation (Prins and Cutner 1999), aesthetic value understood as a harmonious development of the body, social value manifested in development of interpersonal contacts (Zatoń and Kwaśna 2008), utilitarian value conceived as an ability to move in the aquatic environment for one’s own safety or to save others from drowning (Zatoń and Kwaśna 2007), recreational value understood in terms of leisure activities (Zatoń and Kwaśna 2011).
Possible effects arising from physical activity in the aquatic environment have been the subject of many studies. Research focuses on the areas associated with the use of the aquatic environment for different purposes, particularly health, recreation, development of motor capacity and competition. Competition is an inherent part of sport which aims at achieving maximum results. Recently competition become an inerent part of amateur sport.

To be successful in amateur sports competition one needs to achieve adequate motor capacity. The development of motor skills is determined primarily by body composition (Siders et al. 1993, Andrzejewska et al. 2012), including the percentage of body fat (Lukaski et al. 1985). Relatively higher body fat levels increase the buoyancy of the body, which can help in achieving high-speed in swimming (Avlonitou et al. 1997, Maglischo 2003).

The buoyancy of the human body is an important factor when determining the predisposition to practice swimming. This predisposition is determined by the nature of the exercise performed during training (Lukaski 1987, Bolonchuk et al. 1990, Andersen et al. 2002). Making long-term efforts can have a significant impact on the buoyancy of the body. The physiological response to exercise is a long-term increase in muscle mass and a reduction in body fat (American Dietetic Association 1987). However, reduced body fat does not improve buoyancy in swimming. Another factor determining buoyancy, standing in contrast to the previous statement, is the temperature of water. Prolonged and frequent exposures to cold leads to accumulation of extra body fat (Pugh and Edhold 1955, Keatinge 1966). This is due to the increased probability of survival in cold water (Nuckton et al. 2000, Brannigan et al. 2009). Increased body fat improves buoyancy, as the immersed body has a lower density than water.

Another important scientific problem is the effect of buoyancy on sporting success. Studies in elite swimmers showed that sprinters have a poorer buoyancy (lower body fat) than long-distance swimmers (Faulkner 1966). In contrast, studies conducted by Bloomfield and Sigerseth (1965) did not show differences between the buoyancy of short- and middle-distance swimmers. Another study showed that short-distance and long-distance runners have the same fat mass level (Stager et al. 1984). Siders et al. (1993) found that women who have achieved good times in swimming have low levels of body fat. Among men, there was no significant correlation. In turn, Nuckton and Kohn (2012) observed no differences in body fat between swimmers and the average population. Perhaps this is due to the process of adaptation to the aquatic environment which enables swimmers to obtain maximum results and sporting success.

Generally speaking, on the basis of the above considerations on elite swimmers, it is easy to draw the conclusion that top sports results are associated with low levels of body fat. However, contradicting reports imply that the dependence between the buoyancy of the body and the sports level has not been clearly defined, yet. In particular, this applies to people engaged in recreational swimming. Therefore, it seems important to provide information about the values of each component of body composition and its effect on maximum performance. Nevertheless, these studies mostly focus on elite swimmers and not recreational swimmers.

The aim of this paper was to determine the relationship between selected components of body composition and maximum results in single test, among male and female, amateur swimmers. The authors assumed that there is a relationship between selected components of body composition and the time needed to swim the test dis-
tance for both sexes. In order to verify the research hypothesis the following research question was established.

Q: What is the relationship between selected components of body composition and the time essential to traverse the distance in the swimming test for men and women who are non-trained swimmers?

**MATERIALS AND METHODS**

The participants in the experiment were 38 healthy subjects (19 women and 19 men). They were people who practiced swimming twice a week for one hour (recreational swimming). Prior to the experiment, they were informed of its nature. All participants gave written informed consent to participate in the test. Approval to conduct the experiment was obtained from the university’s school of physical education in Wroclaw ethical committee.

The participants were characterized by the following similarities: (1) Group (practicing recreational swimming). (2) Sex (a group of women and men), (3) Age (F: \(\bar{x} 20, \pm 1, \text{Min } 19, \text{Max } 21; \) M: \(\bar{x} 20, \pm 1, \text{Min } 19, \text{Max } 22\)). (4) The height of the body (F: \(\bar{x} 168, \pm 7, \text{Min } 158, \text{Max } 184; \) M: \(\bar{x} 181, \pm 6, \text{Min } 164, \text{Max } 192\)). Before the experiment to align the groups, the hypothesis was adopted that the standard deviation cannot be greater than 10% of the mean body height (F: 10% \(\pm 16.77, \) M: 10% \(\pm 18.07\)). (5) Weight (F: \(\bar{x} 60, \pm 7, \text{Min } 52, \text{Max } 80; \) M: \(\bar{x} 77, \pm 9, \text{Min } 62, \text{Max } 102\)). All those similarities were taken into account when choosing female \(n = 19\) persons) and male subjects \(n = 19\) persons).

The experiment took place in a 25-metre swimming pool. For the purpose of the test, all participants swam the length of the pool twice at maximum speed. In order to verify if it was their maximum swimming speed, it was assumed that the mean time to swim the distance of 25m in the first trial cannot exceed 10% of the mean time obtained in the second trial. The percentage of the mean value of the swim time obtained in the first trial in relation to the one recorded in the second trial was determined by the equation (1). The assumption guaranteed that the subjects swam at their maximum speed (Tables 2, 3). Participants who did not meet this requirement were excluded from the experiment.

\[
t_{3,4/1,2} = 100 - \frac{t_{3,4}}{t_{1,2}} \times 100.
\]

In all trials the subjects swam the front crawl stroke. They started each trial lying prone and motionless. In order to minimize the effects of fatigue, subjects performed all tests 5 minutes after a 10-minute warm-up. Subjects begun the test at resting heart rate value. Heart rate was measured by touching a carotid artery with index finger (Zatoń and Jastrzębska 2010).

Swim times were measured electronically using the Colorado timing system (Colorado Time System, USA) with timing resolution of 0.01 s.

Body composition was determined using non-invasive near-infrared spectrophotometry – the FUTREX-6100 analyzer (FUTREX, USA). This analyzer uses a method based on light absorption of the near-infrared spectrum light by the or-
ganic compounds contained in the body, e.g. fats. It uses the difference in absorption and transmittance of infrared radiation between tissues (Davies and Cole 1995, Nawarycz et al. 1996). An outgoing infrared light beam passes through the adipose tissue and lean body, and then reflected returns to the probe. The amount of energy absorbed is directly proportional to the concentration of the substance. This allows for easy and direct measurement of body fat percentage (%), fat mass (kg), fat-free mass (kg), total body water (l). The device is equipped with a shield that protects it against the interference of external radiation. The test was performed by positioning an optical probe on the anterior midline surface of the biceps brachii. This method is characterized by a low percentage error, which was estimated at 3% by the manufacturer. The analyzer also measured BMI (kg · m⁻²) (Quetelet II), which is a ratio of body weight to height.

Body weight was measured using an electronic analyser scale (Salter 9152 SV3R, U K) in increments of 0.1 (kg). Body height was measured using Martin’s method, from vertex to basis (v-b) while the participant was in an upright position and as straight as possible with the head in the Frankfurt Plane position. An anthropometer was positioned perpendicular to the base, the measurement was made in increments of 0.1 cm. The values of the measured parameters were used for the analysis of body composition.

TABLE 1. The women’s times of swimming trials with the implicit assumption of maximum speed

<table>
<thead>
<tr>
<th>No.</th>
<th>Times of Trial 1 (s)</th>
<th>Times of Trial 2 (s)</th>
<th>Mean times of trials 1 + 2 (s)</th>
<th>Condition of swimming with V max (%)</th>
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</table>

Verification of swimming with V max (%) – (values between –10 and 10 indicate fulfilment of the condition of maximum swimming speed).
RESULTS

The times obtained in both swimming trials by each swimmer with the implicit assumption of the maximum speed are shown in the following tables. Table 1 shows the women’s results. Table 2 shows the men’s results. Table 3 shows the raw data of the body composition components among women. Table 4 shows the raw data of the body composition among men.

The data was analysed using Statistica 9.0, with level of statistical significance alpha = 0.05 (if \( p < \alpha \), i.e. \( p < 0.05 \), there is a statistically significant difference). Pearson’s correlation coefficient \( r \) was used to determine the relationship between the time of traversing the distance and selected components of body composition: fat mass, fat-free mass (indicating the body mass of the active and skeletal tissues, excluding adipose tissue), BMI as well as body height and weight among women; Pearson’s correlation coefficient \( r \) did not show, at the statistical significance level \( (p < 0.05) \), any correlation between the time needed to traverse the distance and body fat mass, fat-free mass, BMI, body height and body mass (Table 5).

Among men, statistical analysis of Pearson’s correlation \( r \), at the assumed statistical level \( (p < 0.05) \), found a significant negative correlation only between the time needed to traverse the test distance and fat-free mass \( (r = -0.36, p < 0.05) \) (Tab. 6).

TABLE 2. The men’s times of swimming trials with the implicit assumption of maximum speed

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<th>Mean times of trials 1 + 2 (s)</th>
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</tr>
</tbody>
</table>

Veriﬁcation of swimming with \( V_{\text{max}} \) (%) – (values between –10 and 10 indicate fulﬁlment of the condition of maximum swimming speed).
TABLE 3. The components of body composition among women

<table>
<thead>
<tr>
<th>No.</th>
<th>Fat mass (%)</th>
<th>Fat mass (kg)</th>
<th>Fat-free mass (kg)</th>
<th>Total body water (%)</th>
<th>Total body water (l)</th>
<th>BMI (kg · m⁻²)</th>
</tr>
</thead>
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<tr>
<td>( \bar{\chi} )</td>
<td>24.77</td>
<td>14.97</td>
<td>44.87</td>
<td>56.87</td>
<td>34.97</td>
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<td>2.89</td>
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<td>4.35</td>
<td>1.85</td>
<td>5.22</td>
<td>1.61</td>
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<tr>
<td>Min</td>
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<td>53.20</td>
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<tr>
<td>Max</td>
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<td>21.80</td>
<td>58.20</td>
<td>60.10</td>
<td>51.50</td>
<td>24.60</td>
</tr>
</tbody>
</table>

This means that when fat-free mass (bone and muscle tissue) increases, the value of the time to traverse the test distance decreases.

**DISCUSSION**

In the present study it was assumed that there was a relationship between selected components of body composition (body fat mass, fat-free mass, BMI and body height and body mass) and the time taken to traverse the test distance by female and male recreational swimmers. The original hypothesis stating that there is a relationship between selected components of body composition and the swimming speed of both sexes has not been fully proven.

The hypothesis was based on the theoretical foundations of human anthropometry. It is known that adipose tissue has the lowest density (0.92–0.94 g · cm⁻³) of all the components of the body. Due to this characteristic, adipose tissue floats as water density is greater (0.9998 g · cm⁻³ at 0°C) (Sokołowska et al. 2005). This means that women have an advantage as they physiologically have more body fat than men (Lukaski et al. 1985). Probably, this may have an effect on the achievement of better results in swim time (through reaching higher speed) due to improved
TABLE 4. The components of body composition among men

<table>
<thead>
<tr>
<th>No.</th>
<th>Fat mass (%)</th>
<th>Fat mass (kg)</th>
<th>Fat-free mass (kg)</th>
<th>Total body water (%)</th>
<th>Total body water (l)</th>
<th>BMI (kg·m⁻²)</th>
</tr>
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<td>65.94</td>
<td>63.77</td>
<td>48.78</td>
<td>23.46</td>
</tr>
</tbody>
</table>

Min | 3.60        | 2.20         | 53.70             | 59.00                | 39.80               | 18.30       |
Max | 21.60       | 21.70        | 80.30             | 70.50                | 60.40               | 28.10       |

TABLE 5. Results of Pearson’s correlation analysis r between the time needed to traverse the test distance and selected components of body composition – among women

<table>
<thead>
<tr>
<th>Pearson’s correlation r</th>
<th>Fat mass</th>
<th>Fat-free mass</th>
<th>BMI</th>
<th>Body Mass</th>
<th>Body Height</th>
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</thead>
<tbody>
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<td>Swimming speed (s)</td>
<td>correlation</td>
<td>−0.12</td>
<td>−0.24</td>
<td>−0.30</td>
<td>−0.30</td>
</tr>
<tr>
<td></td>
<td>p</td>
<td>0.61</td>
<td>0.31</td>
<td>0.22</td>
<td>0.22</td>
</tr>
</tbody>
</table>

TABLE 6. Results of Pearson’s correlation r analysis between the time to traverse the test distance and selected components of composition – among men.

<table>
<thead>
<tr>
<th>Pearson’s correlation r</th>
<th>Fat mass</th>
<th>Fat-free mass</th>
<th>BMI</th>
<th>Body Mass</th>
<th>Body height</th>
<th>Body Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swimming speed (s)</td>
<td>correlation</td>
<td>−0.19</td>
<td>−0.36</td>
<td>−0.21</td>
<td>−0.32</td>
<td>−0.32</td>
</tr>
<tr>
<td></td>
<td>p</td>
<td>0.45</td>
<td>0.05</td>
<td>0.40</td>
<td>0.19</td>
<td>0.18</td>
</tr>
</tbody>
</table>

Statistical significance is indicated by bold font
Buoyancy. This is due to decreased frontal resistance force, which acts like a brake on the swimmer’s body (Toussaint, Truijens 2005). The magnitude of the total resistance depends mainly on cross section of the body and the square of velocity of the body submerged in the water (Toussaint and Beek 1992). An increase in buoyancy caused by greater fat mass may lead to a reduction of resistance, and consequently contribute to an increase in swimming speed. However, when limited only to the above considerations, one could draw an absurd conclusion that pathological obesity may have a positive impact on swimming speed.

However, when we look from a different perspective, such as the kinematics of movement, the increased amount of fat in the swimmer’s body causes limitations in joint mobility, disrupting their normal range (Beuther and Sutherland 2007). Excess body fat also significantly adversely affects the body loading, energy cost and fatigue (Vgontzas et al. 2006). Therefore, a large amount of body fat does not help in achieving better athletic performance in swimming.

Among swimmers, the accumulation of extra fat tissue is a common phenomenon (Pugh and Edhold 1955, Keatinge 1966). This is caused by the human body’s defence mechanisms that are activated during prolonged exposure to cold water (Nuckton et al. 2000, Brannigan et al. 2009). However, physical activity along with the development of muscle tissue prevents from pathological accumulation of body fat.

The competition is sport domain, mainly. However, a competition become important aspect of agonistic character in amateur sport as well (Zatoń and Kwaśna 2011). Knowledge of the percentages of the body components may occurs important in the diagnostics of sport and physical recreation as it gives information about the morphological characteristics of athletes. It also allows for assessing the somatic effects of the applied physical training. This may, in turn, provide information about the complementary nature of the aims and effects of training (Zatoń and Jastrzębska 2010). Measurement of body composition is easier now and measuring devices are increasingly cheap and objective. The obtained data about the composition of the body provides information which is very useful to better manage the development of swimmers so that they can achieve better results. Measurements of body composition have also become an indispensable element of effective work of physical education teachers and personal trainers (Saczuk et al. 2001). Body composition evaluation allows to the teacher to program optimum training program.

In this study the average body fat mass among women was $\bar{x}$ 14.97 kg (24.77%); $\pm$ 3.45 (2.89%). Among men, the result was lower and amounted to $\bar{x}$ 10.79 kg (13.74%); $\pm$ 4.43 (4.28%). The level of fat mass is high due to the nature of the sample which was composed of people who are not professional swimmers but treat swimming as a form of recreation.

Statistical analysis showed that adipose tissue did not have a significant impact on swimming results, and it certainly did not improve them. It follows, that greater amount of adipose tissue do not improve swimming results.

However, a study conducted by Zatoń et al. (2005) found a small but statistically significant correlation between swimming performance of 11-year-old children and their body density, and thus buoyancy. Nevertheless, in athletes aged 12 and 13 years no statistically significant relationships have been found.

For comparison, in a group of children aged 10–12 years old who attended swimming training classes, the average body fat mass was about 5.00 kg (Wierzbicka-Damska et al. 2006). In other studies carried out on 14-year-old swimmers,
the average body fat mass was 5.67 kg (Cholewa et al. 2006). However, in a study involving short distance runners, the average body fat mass was 6.90 kg (Čabrić et al. 2008). Moreover, junior rugby players had the average level of body fat of 14.03 kg (Bortnik et al. 2007).

Differences in body density also occur in athletes practicing various sports. Higher body density, due to a higher level of muscle tissue, was found in weightlifters than in swimmers. There was also a study of the distribution of subcutaneous fat in pentathlon athletes, swimmers, and people who don’t train any sport. No significant differences were found in the adipose tissue thickness on the shoulder, under the shoulder blade and above the iliac crest in swimmers and pentathlon athletes. The most significant differences in thickness of subcutaneous of adipose tissue between various groups were in the area of abdomen and the upper part of the thigh. It follows, that pentathlon athletes had lower levels of body fat than non-training participants in comparison with the swimmers had a higher level of body fat than non-training participants (Pacelt, Ilnicka 1992).

The assessment of body composition, including body fat is also taken into account in teaching the swimming technique. People who learn to swim should be aware of this phenomenon and its causes. First of all, measurement of adipose tissue can play an important role, since its amount directly affects the improvement of the body’s buoyancy. Besides adipose tissue, lungs volume influence on buoyancy. Teacher should use body composition measurements to make students aware of their adipose tissue level and of high fat level risk to the health. Human buoyancy, like other characteristics, such as general physical fitness, motor skills and proper body structure, is one of the most important factors determining the natural predispositions for swimming. Buoyancy determines whether persons who cannot swim, after being entirely immersed in water are able to automatically go up and float on the surface, or whether they immediately go down. There are people who possess excellent buoyancy, i.e. such that allows them to keep their head above water without making any additional moves. For such people it is much easier to overcome the fear of water, which often occurs when learning to swim. They can easily master the basic locomotor movements in water, and later, the technique of competitive swimming. More significant difficulties are encountered by people with low buoyancy who after immersing themselves in deep water will experience problems in keeping their heads above the surface. These learners will have to first learn to lie on the water surface, which can extend and greatly hinder the learning process.

**CONCLUSIONS**

Among women, the relationship between the time obtained to swim the test distance and body fat mass, fat-free mass, BMI, body height and body weight was not found. Among men, the relationship was observed only between the time obtained to swim the test distance and their fat-free mass. This means that when considering individual persons engaged in recreational swimming, their maximum performance is not determined by the composition of body components (with the exception of fat-free mass among men).
REFERENCES


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CHAPTER III

SWIMMING PERFORMANCE AND LIFESAVING
Analysis of swimming pacing patterns at the Polish Championship and the European Championship in 2012

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The Department of Swimming and Rescue
The Kukuczka Academy of Physical Education in Katowice, Poland
j.karpinski@awf.katowice.pl

ABSTRACT
The aim of this paper was to analyze the swimming pacing pattern adopted by the finalists of both European and Polish championships in 2012. The material is based on the results achieved by the competitors in 2012 at the Polish Major Senior and Junior Championship in Olsztyn and the European Championship in Debrecen, Hungary. The paper presents a detailed analysis of the results of the 200m freestyle winners, medalists and finalists. In the case of Polish swimmers it was noticed that despite their relatively lower level, compared to the world results, in many cases their pacing pattern was quite even. Slight differences from the optimal value of the coefficient of even pacing in some Polish freestyle swimmers show their insufficient endurance and speed-endurance preparation. However, the optimal pacing pattern in the case of some finalists of the Polish Championship gives well-founded hope for freestyle swimming in Poland.

Key words: swimming, training, pace distribution, men, women, freestyle

INTRODUCTION

While training elite swimmers it is important to take into consideration a number of key elements in achieving the highest level of performance. Recently, there have been many quality changes in swimming coaching, e.g., planning training loads, methods of training (both efficiency and technique), supportive actions and regeneration. Other important factors include the strategy of covering the distance, that is the pacing pattern and the optimum performance of other components of the race, such as: start, turns and final sprint (Ting Liao, 2008). The last World Swimming Championship confirmed that in many cases a hundredth of a second was decisive, no matter how long the distance was. Tempo is of great importance in the race, i.e. the rate of all movement cycles and their combinations as well as that of the movements of body parts marked by the time they take or their frequency (Erdmann, 2009; Kennedy et al., 1991). Tempo of movements in cyclical activities, in this case – swimming, can be measured by frequency of motor actions per unit of time. A pacing plan, i.e. the ability to distribute one’s effort during a race is the key element in coaching high performance level swimmers. It is an ability that can be
trained in the process of coaching and acquired after years of experience (Arellano et al., 1994; Chatard et al., 2003). While training, swimmers should learn to perceive the speed at which they move in the water. Therefore they should develop the so-called internal ‘speedometer’, thanks to which at any moment (at the beginning or the end of the race) they will be informed about their velocity. Thus they will be able to control their energy consumption and slow down or speed up at the right moment, which is an indispensable attribute to reach a maximum result in sport. In competitive swimming, maintenance of the right pacing pattern during the race will give optimal results, the more even is the pace over the whole distance, the better it is. Even pacing, i.e. optimum swimming tactics, can be observed in top world swimmers with a sustained high level of speed (Sweetenham and Atkinson, 2003; Colwin, 1992; Hannula, 2003). It is also worth mentioning that the tactical approach to the race depends on the swimming heat schedule, i.e. order of prelims and semi-finals, and it may be adjusted to achieve the goal (Chatard et al., 2003). This regards also freestyle finalists for whom participation in prelims and semi-finals causes a great deal of mental pressure.

**MATERIAL AND METHODS**

The aim of this study was to analyze the pacing patterns of freestyle finalists in both the 2012 European and Polish Swimming Championships. The study was also an attempt to verify the research hypothesis which assumed that the best European swimmers maintain their pacing pattern as even as possible, whereas top Polish swimmers do not use this tactical approach. The research material comprised the long-course times achieved by the finalists of the 2012 Polish Major Senior and Junior Championships in Olsztyń and the 2012 European Championships in Debrecen, Hungary. The present study included male and female finalists in the 200 m freestyle event. The paper presents a detailed analysis of the times of winners (1), medalists (M), and finalists (positions 1–8) (F) participating in the race. The split times achieved by Polish and top European swimmers were compared and analyzed. The range between the best and the worst split times achieved by male and female competitors (1.M.F.) as well as the coefficient of even pacing (W) were calculated. The coefficient W is the ratio of one split time to the successive split time multiplied by 100. The optimal value of the coefficient W is 100, and it happens when the successive split time is equal to the previous one. The values over 100 indicate that the successive segment was swum faster than the previous one, whereas the values under 100 indicate the opposite trend, the previous segment was swum faster. The more the coefficient W deviates from one hundred, the bigger is the difference between the speeds at which the two consecutive segments were swum. In order to determine the degree of even pacing of the analyzed distance, three pairs of consecutive segments were compared: 1st and 2nd (W 1–2), 2nd and 3rd (W 2–3), 3rd and 4th (W 3–4). In addition, mean values of the coefficient W were calculated for each group of male and female swimmers (1, M, F).
RESULTS

TABLE 1. Pacing patterns in the men’s 200m freestyle

<table>
<thead>
<tr>
<th>200m</th>
<th>Split times [s]</th>
<th>Range (s)</th>
<th>Coefficient of even pacing W</th>
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<td></td>
<td>150 2–50 3–50 4–50</td>
<td>1–2 2–3 3–4 mean</td>
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<td>I</td>
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<td>92.87 100.64 101.34 98.28</td>
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<tr>
<td></td>
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<td>93.78 99.30 99.41 97.50</td>
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<tr>
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<td>92.33 99.62 102.57 98.17</td>
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<tr>
<td></td>
<td>ME 25.00 27.14 27.34 27.75 2.75</td>
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Differences between MP and ME d (s)

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1 – winner, M – medalists, F – finalists

FIGURE 1. Pacing patterns in the men’s 200m freestyle – gold medalists

FIGURE 2. Pacing patterns in the men’s 200m freestyle – medalists
Analysis of the pacing patterns of the two best European and Polish freestyle swimmers showed a considerable difference. The European Championship gold medalist (P. Biedermann) swam the first 50m segment fastest of all four laps by one second better than the fastest swimmer at the Polish Championship. The other segments of the race Biedermann swam at slightly but progressively diminishing speed. The Polish Championship gold medalist (P. Korzeniowski) adopted a completely different pacing pattern to swim the same distance – he swam the last two segments progressively increasing his velocity. Nevertheless, it should be noted that the differences between the two swimmers were considerable, The European Championship winner swam the distance in 1:46.27 min. whereas the Polish best freestyle swimmer’s time was by 3.75 sec.slower. P. Korzeniowski’s slow-fast pacing pattern may indicate that he did not use all his potential (Tab. 1, Fig. 1).

Analysis of coefficient W in the men’s 200m freestyle showed disparities between two top Polish and European swimmers. Comparing the European champion and the Polish champion it was found that the value of W 1–2 was closer to a hundred in the case of the European champion, which indicates that he swam the first two laps more evenly. The last two segments (W 2–3 and W 3–4) both P. Korzeniowski and P. Biedermann covered at a more even pace. The Pole achieved the W values above 100 while the German swimmer slightly below 100. Analysis of the arithmetic means of the total sum of three coefficients W showed that the Polish Championship gold medalist, P. Korzeniowski, swam at a more even pace. However, it should be mentioned that the best Polish freestyle swimmer is a very experienced competitor and is one of the best world swimmers not only in the butterfly stroke but in freestyle as well.

A similar pacing pattern can be seen among the European Championship medalists and top three swimmers in the Polish Championship. The European Championship medalists, similarly to the winner, swam the segments at a slightly and progressively diminishing speed, except for the first 50m lap. The differences in the time achieved by them were relatively small. The tactical approach adopted by the Polish Championship medalists was different. Like all the analyzed swimmers, they swam the first lap fastest of all due to the start. The next part of the race (2nd and 3rd laps) they swam more slowly only to speed up considerably in the last lap. It

**DISCUSSION**

FIGURE 3. Pacing patterns in the men’s 200m freestyle – finalists
seems that such an acceleration in the final lap of the race was the result of a relatively slow speed for the first 150m. Most probably, top Polish swimmers subconsciously waited for the final strife for the best place over the last 50m. The values of W 1–2 were very similar (difference 0.23) in the case of the European Championship and Polish Championship medalists, and in line with the trend, i.e. their W 1–2’s were much below the value of 100. The next segments of the race, both in the case of the European and Polish medalists were close to the ideal value, however only the Poles were able to exceed the value 100 in W 3–4 where they achieved 102.67. The mean value of the total sum of all the coefficients W obtained by the Polish medalists was closer to the even pace pattern than the one achieved by the European medalists, which can indicate the Poles had a high endurance speed level (Tab. 1. Fig. 2). However, the times of the Polish medalists were clearly slower.

All the European Championship 200m freestyle finalists adopted the same pacing pattern as the winner and medalists in this event. It is obvious that their performance level was definitely lower, which is logical. As for the best eight swimmers participating in the same event at the Polish Championship, their tactics of covering the distance was slightly different from the one adopted by the medalists. The differences in the coefficient W in Polish competitors and European elite swimmers are not significant. Both Polish and European finalists covered the distance with even pace. In this case the Polish Championship finalists turned out to be better (Tab. 1. Fig. 3).

Pacing of the best European and Polish female freestyle swimmers varies. The European Championship winner (Italian – F. Pellegrini) swam the first 50m fastest and got a slight advantage over the Polish Championship winner K. Szczepaniak. The next segments of the distance Pellegrini covered in a very irregular way. The second and third segment she swam at a slightly diminishing speed when compared to the first 50m, however, on the last 50m she sped up again. In the case of the Polish swimmer, the pacing pattern was different from the European champion’s; each succeeding segment (excluding the first 50 m) was swum relatively faster. Irrespective of different pacing patterns, the differences between their performances were considerable, Pellegrini’s time was 1:56.76 min., while Szczepaniak’s result was 2:01.15 min., much slower than the Italian swimmer’s (Tab. 2. Fig. 4).

Coefficients W for the women’s 200m freestyle winners are also completely different. The comparison of the European champion and the Polish champion showed that the Italian swimmer’s W 1–2 was more even as it reached 96.41, and was much closer to the optimal value than the Polish swimmer’s – 92.64. Analysis of W 2–3 and W 3–4 showed Szczepaniak swam the third and fourth segments faster than the second segment. The arithmetic mean of the sum of coefficients W calculated for both swimmers showed that the Polish Championship gold medalist swam at a slightly more even pace. The European Championship medalists, like the winner in this event, apart from the first 50m, covered the rest of the segments at a slightly diminishing speed. The tactics of swimming in the case of three top swimmers taking part in the Polish Championship was different. The competitors swam the 2nd and 3rd segments more slowly than the first 50m and sped up in the final segment (Tab. 2, Fig. 5). Analysis of the mean values of the coefficient W obtained by the medalists in this event found that, like in the case of the winner, the more optimal pace was that of the best three freestyle swimmers at the Polish Championships.
TABLE 2. Estimation of pace distribution in women’s 200m freestyle

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Differences between MP and ME (s)

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<td>1.31</td>
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1 – winner, M – medalists, F – finalists

FIGURE 4. Pacing patterns in the women’s 200m freestyle – winners

FIGURE 5. Pacing pattern in the women’s 200m freestyle – medalists
The European Championship female finalists swam the 200m distance with the distribution of effort slightly different from the medalists in this event; they sped up in the final lap. The best eight female swimmers of the Polish Championship distributed the pace in an identical way as the winner and medalists in this event. The mean values of the coefficient $W$ for the finalists of the European and Polish Championships were similar, and they were 97.66 and 97.60, respectively. It proves that top European and Polish Championship finalists were well prepared in terms of endurance and speed (Tab. 2, Fig. 6).

### CONCLUSIONS

Tactics in competitive swimming is beginning to play a greater role in training elite competitors. Although it is not of such great importance as in many other sports disciplines (e.g. team games), yet in the strife for the best positions in the most important competitions, tactics is a key to achieving maximum results. It is especially important in the current system of swimming competitions, the Olympic Games included, where – participation in one event means that top competitors must swim with a maximum of effort as many as three times. In many cases a pacing strategy in swimming a given distance turns out to be one of the fundamental elements of the elite swimmers’ training programs. Analysis of the split-times over the men’s and women’s 200m freestyle event found that the best European swimmers cover the distance in a regular, even way slightly but progressively diminishing their velocity in each successive segment of the distance. Women, in most cases, speed up in the final 50 meters. It was noticed that Polish swimmers, despite their relatively lower level of swimming performance as compared to the world’s top swimmers, in many cases adopted even pacing, especially freestyle swimmers, both men and women, whose sporting performance is relatively high. In each analyzed group there was an increase in velocity in the final segment. It was interesting to note that in the most of the analyzed groups of Polish swimmers the mean values of coefficient $W$ were closer to the optimal value of 100 than those of their European counterparts, which presage optimism. The fact that such a large group of swimmers, among whom...
there are also very young competitors, adopted a mature tactic of swimming and versatile training programs may have great impact on the progress of freestyle in Poland. The above presented data confirm the general tendency in record-seeking sports that the higher level competitive swimmers have, a more efficient and rational way of distributing effort (Arellano et al., 1994; Ting Liao, 2008; Chatard et al., 2003). The efficient effort distribution over a 200m freestyle race is often determined by the aim, i.e. to achieve a good position, not swim for time. It is a common practice particularly in the high-level competitions and during qualification meets for them. It regards not only the competitors who strive for medal positions but also those who strive to qualify for the finals, and for whom the participation in those races causes great mental pressure and serious fatigue processes. The above analysis did not confirm the research hypothesis about shortcomings in the optimum swimming strategy of the top male and female freestyle swimmers in Poland as compared to the best swimmers in Europe. It seems that the tactical preparation of the top Polish swimmers is adequate but not backed by equally good motor preparation, which was observed due to the strength reserves they maintained in the final part of the race.

REFERENCES

The evolution of performance in the 50, 100 and 200 m freestyle events in the Polish Championships and the European Championships between 1922 and 2012

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ABSTRACT

The main aim of this study was to present how, over 90 years (1922–2012), the results of the men’s and women’s 50, 100 and 200 meter freestyle events recorded at the Polish Swimming Championship finals changed in comparison to the results at the European Swimming Championships. The primary research method was a critical analysis of available sources and materials containing the results achieved in these swimming competitions from 1922 to 2012. The swimming results recorded in this time span in the 50, 100 and 200 m freestyle finals at the Polish Championship were analyzed in detail, separately for men and women. The progression of swimming results of the Polish Championships in all analyzed distances proved to be more evident among female than male swimmers. The results of Polish gold medalists were significantly worse for both genders than the European Championships results.

Keywords: sport result, freestyle, Polish Championships, 90-year period

INTRODUCTION

Each competitive swimmer should strive to achieve the highest possible level of sport performance. Proper use of the young athlete’s innate potential is the key to success in sport. Success is the result of long-term training, a complex process which requires a rational approach and planning.

Sports result is defined as: “...manifestation of special skills in a sportsperson, executed in conscious activities, aimed at solving a motor task which is restricted by the regulations of a given sports discipline” (Prus, 2005). A sport result is the expression of an athlete’s aggregated capacities, developed during a long-term, conscious training process. This is the objective of training, but at the same time it is a process aimed at developing a competitive athlete” (Prus, 2005).

Achieving high results in swimming requires long-term systematic and intense training. Outstanding swimmers have at least 10–12 years of such experience. Women need fewer years to achieve success (by 2–4 years). World class male swimmers usually take up swimming when they are 8–12 years old, while 99% of female swimmers start at the age between 3 and 10 years (Maglischo, 1993; Płatonow, 1997; Dybińska and Haljand, 2005; Bompa, 1994). At the beginning of this paper,
it may well be justified to ask what factors determine emergence of a swimming talent and what characteristics are essential to identify while selecting a prospective outstanding swimmer from among many candidates. Success in childhood does not guarantee achievement of senior elite level.

A sports result is determined by a set of individual characteristics of a competitor: morphological, functional and personality traits (e.g. temperament, motivation, volitional features, knowledge, etc.). Determinants of achieving optimal performance may include: the level of somatic factors, the range of technical parameters, the scope of personality factors, the level of fitness parameters as well as the scope of tactical parameters (Maglischo, 1993; Platonow, 1997; Dybińska and Haljand, 2005; Bompa, 1994). The special motor skills typical of a given sports discipline are one of the factors which play an important role. The level of their perfection or deficiency is manifested in the form of so-called sports technique (Król 2003).

The observation of the evolution of sports results over several dozen years has inspired the authors to tackle the subject matter at hand. The basic objective of the paper was to present changes occurring over a period of 90 years (from 1922 to 2012) in sports results obtained by the female and male finalists of the Polish Swimming Championships in 50, 100 and 200 m freestyle in comparison to the results obtained in the same year at the European Championships.

The following study questions were asked:

How have the results of Polish swimmers evolved in the 50, 100 and 200 m freestyle events over a period of 90 years (from 1922 to 2012).

What were the differences (or similarities) in the results obtained by finalists of the Polish Swimming Championships in the 50, 100, 200 m freestyle in the years from 1922 to 2012 compared to the results achieved in the same events (and years) at the European Championships?

Was there a difference in the evolution of performance between men and women in these events?

MATERIALS AND METHODS

The basic research method was critical analysis of the results obtained in competitive swimming over 90 years, from 1922 to 2012. The detailed analysis and interpretation covered the results from this period obtained in the women’s and men’s freestyle finals (50, 100 and 200 m) of the Polish Championships. The data were obtained mostly from the publication entitled 90 Years of Polish Swimming Sport 1922–2012 edited by Adam Waclaw Parczewski and from available websites.

The results of the Polish Championship finalists were compared to the results of the European Championships recorded in a 50-m swimming pool.

In the analyzes, were made comparisons between:
- the Polish winners at the distance 50, 100 and 200 freestyle, taking into account the years 1922–2012. Certain freestyle competitions were not held in all the years, but this information was given in the text in the appropriate analysis.
- winners results (50, 100, and 200 m freestyle), was compared to the arithmetic mean (average from the Polisch Championships means) of all the Polish finalists in the competition.
– Polish winners and finalists results were compared also to the European winner’s results (in cases where this was possible, since not all swimming races were held annually in the analyzed period time, but this information was given in the text in the appropriate analysis.

The above mentioned variables which were analyzed (Polish winners, Polish finalists and European winners) were presented in the text graphically in figures. Analysis of these variables were made in order to demonstrate how over time for the 90th anniversary (1922 to 2012) developed the dynamics of changes in sports results obtained by the Polish winners and finalists in competitions 50, 100, 200m freestyle in relation to the European winners results.

The numerical results, expressed in minutes and seconds, were statistically analyzed using the basic statistical analysis and descriptive analysis. Considered results of basic statistical data: Polish finalists 50, 100 and 200 m freestyle (in the years 1922 to 2012) – the arithmetic mean (x), standard deviation (SD), minimum value (min), maximum (max) and the gap (R). The results of each competition are expressed in units of seconds and are shown graphically in figures (1–19).

RESULTS

To answer the study questions, the analyses were conducted for the results obtained in the years 1922–2012 by female and male finalists of the Polish Championships in the 50, 100 and 200 m freestyle events in reference to the results obtained in the European Championships. The winning time in each event, in both the Polish Championships and the European Championships plus the average time among all finalists in the Polish Championships are presented in the following graphs.

WOMEN’S 50 M FREESTYLE

Below in figures 1 and 2 show the female Polish winner’s results in 50m freestyle. Due to the fact that all the results of this competition in the analyzed period of time (from 1922 to 2012) could not fit on a single figure, therefore are shown in two blocks divided on a two period:

Figures 1 – from 1926 to 1990 and
Figures 2 – from 1991 to 2012.

The women’s 50 m freestyle was first contested in 1926 in the Polish Swimming Championships. There was then a 27-year break from 1927 to 1954. The event was resumed in 1955 with the female winner swimming 50 m in 31.5 s, i.e. the difference against the result recorded 27 years before was 19.9 s. There was another interval (7 years, from 1956 to 1963).

In the following years (1965–2012), the results of female winners of the 50 m freestyle at the Polish Championships showed an upward trend, except the years 1971, 1982, 1987–1992, 1996–1997, 1999, 2002, 2004–2005, 2007, and 2009 when the results slightly regressed (especially in some cases). Excluding the isolated case of the year 1926, the difference in the times obtained by the female 50 m freestyle winners of the Polish Championships between 1955 and 2012 (within 56 years) was 6.17 s.
The results achieved in the Polish Championships could be compared to the results of the European Championships solely in the years 1987–2012, because the women's 50 m freestyle event was not held earlier in a 50-m swimming pool. The times of the women who won the European gold medal in the 50 m freestyle in the years 1987–2012 ranged from 25.5 s to 24.37 s, and improved by only 1.13 s in 25 years. The results of the female gold medalists at the Polish Championships in each of the analysed periods was considerably inferior to those recorded at the European Championships, by 1.77 s on the average, from 0.96 s in 2012 (the smallest difference) to 2.5 s in 1987 (the largest difference).

MEN’S 50 M FREESTYLE

Preliminary analysis of the results in the men’s 50 m freestyle at the Polish Championships (in a 50-m swimming pool) in the analyzed period (1922–2012) showed that only the results after 1955 could be compared, because this event was not held earlier in a 50-m swimming pool, thus the detailed analysis covered only the period from 1955 to 2012.

The results of the Polish winners could be compared to the European winners only after 1987 (50 m freestyle was not held in the European Championships prior to 1987).

Due to the fact that all the results of this competition in the analyzed period of
time (from 1955 to 2012) could not fit on a single figure, therefore are shown in two blocks divided on a two period:

Figure 3 – from 1955 to 1991,
Figure 4 – from 1992 to 2012.

The results obtained by the 50 m freestyle finalists in the Polish Championships (in a 50-m pool) over the years 1955–2012 (Figure 3–4) progressively improved, with a slight regression in some years only. The best time in this event in 1955 was 26.6 s. Then there was a 7-year-long interval (1956–1963) The event was resumed in 1964, with the winner’s result being 26.7 s, i.e. 0.1 seconds slower than in 1955.

There was another 7-year interval in this event in the years 1973–1980. In 1981, the winner of the Polish Swimming Championships in the men’s 50 m freestyle achieved the result of 25.21 s, which was only marginally worse than the result recorded 9 years earlier (0.11 s).


The greatest improvement in the results in the men’s 50 m freestyle was recorded between the years 2004 and 2005 – by 1.26 s, whereas in the years 1955–2012 (that is within 58 years) the result in this event improved by 4.56 s.
The Polish finalists’ times could be compared to the European winners’ times solely in the years 1987–2012, due to the fact that this competition was not held earlier in a 50-m swimming pool. The results of the swimmers who won 50 m freestyle at the European Championships in the years 1987–2012 ranged from 22.66 s (1987) to 21.49 s (2010), and the winner’s time was improved only by 1.17 s.

The results at the Polish winners in each analysed period were considerably inferior to those recorded at the European winners, by 0.99 s on the average. The differences ranged from 1.81 s in 1987 (the largest difference) to 0.2 s in 2002 (the smallest difference), and the latter result was achieved by Bartosz Kizierowski in both Polish (22.38 s) and European Championships (22.18 s). In 2012, the difference was 0.24 s, and the winner in both Polish (22.04 s) and European Championships (21.8 s) was Konrad Czerniak.

WOMEN’S 100 M FREESTYLE

The women’s 100 m freestyle has been held at the Polish Swimming Championships since 1922. The Polish Championships were not held in the years 1940–1945. The women’s 100 m freestyle at the European Championships has been held since 1927. The analysis covered the period 1929–2012, because in the earlier years (1922–1928) the Polish Swimming Championships were not held in a pool (thus, the results are not comparable).

Due to the fact that all the results of this competition in the analyzed period of time (from 1922 to 2012) could not fit on a single figure, therefore are shown in two blocks divided on a four period:
- Figure 5 – from 1922 to 1939,
- Figure 6 – from 1946 to 2070,
- Figure 7 – from 1971 to 1992,
- Figure 8 – from 1993 to 2012.

The analysis of the results of the female 100 m freestyle finalists in the Polish Championships in the years 1922–2012 (Figure 5–8) showed that the swimmer who won in 1922 obtained 1:50.8 min., but the event was held in the Vistula river, i.e. flowing water, which made them not comparable with the results achieved in a swimming pool. In the years 1923–1924, the competition was held in the Krakowski Park Swimming Pool, but the distance was 45.5 m. The 1924 best result (1:52.6 min.) was better by 10.8 s than the 1923 result (2:30.4 min.). In the years

![Figure 5](image)

**FIGURE 5.** The results of female 100 m freestyle Polish winners in the years 1922–1939 compared to Polish finalists and European winners’
In the years 1929–2012, the results of the female winners at the Polish Swimming Championships in the 100 m freestyle showed the upward trend, but in some years they were slightly regressed. The best improvement in the results in the women’s 100 m freestyle (by 10.8 s) was recorded between 1923 and 1924, but this result is

1925–1928 the race length was not clearly specified, and the competition was not held in a standard 50-m swimming pool. The winners’ results ranged from 1:50.8 min. in 1925 to 1:33.5 min. in 1928.
unreliable due to the competition venue. In the years 1929–2012, the best result was improved by 38.38 s.

Comparisons of the results achieved by female finalists at the Polish Swimming Championships against the European winners' results was only possible after 1927 (this event was not held earlier at the European Championships), although a reliable comparison is only possible after 1929 (due to the non-standard venue chosen for the Polish Championships). The results of the 100 m freestyle winners at the European Championships in the analyzed years ranged from 70 s to 53.3 s and was improved by 16.7 s. The results of the female winners at the Polish Championships in the analyzed period were considerably inferior to those at the European Championship, by 5.58 s on the average. The differences ranged from 19.7 in 1934 (the largest difference) to 0.95 s in 2004 (the smallest difference).

MEN’S 100 M FREESTYLE

The men’s 100 m freestyle has been held at the Polish Championships since 1922 with an interval in the years 1940–1945. The same event in the European Championships has been held since 1926. The analysis covered the period 1929–2012, due to the fact that prior to 1929 the Polish Championships had not been held in a swimming pool, thus making the results impossible to compare.

Because of the fact, that all the results of this competition in the analyzed period of time (from 1922 to 2012) could not fit on a single figure, therefore are shown in two blocks divided on a four period:

Figure 9 – from 1922 to 1939,
Figure 10 – from 1946 to 2070,
Figure 11 – from 1971 to 1992,
Figure 12 – from 1993 to 2012.

The analysis of the sports results of the men’s 100 m freestyle Polish finalists in the years 1922–2012 (Figure 9–12) showed that the best result in this distance in 1922 was 1:39.4 min., but due to the fact that the competition was held in the Vistula river (flowing water) the results were not comparable with the other results obtained in a swimming pool. In the years 1923–1924, the competition was held in the Krakowski Park Swimming Pool which was 45.5 m long. The 1924 best result (1:16.8 min.) was better by 12 s than the 1923 result (1:28.8 min.).

![Figure 9](image-url)  
**FIGURE 9.** The male results Polish winners 100 m freestyle in the years 1922–1939 compared to the Polish finalists and European winners’ results.
In the years 1925–1928, the distance in the competitions was not clearly specified, and the events were not held in a 50-m swimming pool. The winning results ranged from 1:17.5 min. in 1925 to 1:07.3 min. in 1926. In the years 1929 to 2012, the results of the men’s 100 m freestyle gold medalists at the Polish Swimming Championships showed an upward trend, with slightly worse results. It seems to be a trend. In the years 1929–2012, the result in the men’s 100 m freestyle was improved by 19.45 s.
The result of the European winners in the 100 m freestyle in the years 1929–2012 ranged from 59.8 s to 47.5 s and was improved from 1931 to 2012 by 11.3 s. The results of the male Polish winners in the analyzed period were inferior to those of the European winners by 2.91 s on the average. The differences ranged from 10.1 s in 1947 (the largest difference) to 0.49 s in 2010 (the smallest difference).

WOMEN’S 200 M FREESTYLE

Comparison of results was possible in the women’s 200m freestyle only after 1949, when this competition was first included in the Polish Championships program. Although this event was suspended in the years 1954–1965, the detailed analysis included the period from 1949 to 2012. The women’s 200 m freestyle event has been held in the European Championships since 1970.

Because of the fact, that all the results of this competition in the analyzed period of time (from 1922 to 2012) could not fit on a single figure, therefore are shown in two blocks divided on a three period:

- Figure 13 – from 1946 to 2070,
- Figure 14 – from 1971 to 1992,
- Figure 15 – from 1993 to 2012.

The results of the women’s 200 m freestyle Polish winners in the years 1949–2012 (Figure 13–15) showed that the best result in the years 1949–1953 was 2:42.6 min achieved in 1952, being better than the 1949 result (3:02.4 min.) by 19.8 s. There
was a break of 11 years, from 1954 to 1965, in the women’s 200 m freestyle, that is why the results in this distance could not be analyzed. The competition was resumed in 1966, with the result of the winner was 2:26.5 min. In the following years (1967–2012), the results of female winners of the finals of the Polish Swimming Championships in the 200 m freestyle showed the upward trend, with the results in 1967, 1972, 1977, 1982, 1987–1988, 1992, 1996, 1999–2000, 2003, 2005, 2007–2008, and 2010–2011 slightly regressed. The difference in the results achieved by the Polish female winners in the 200 m freestyle over the analyzed 63 years from 1949 (3:02.4 min.) to 2012 (2:01.15 min.) was 61.25 s.

The women’s 200 m freestyle has been held at the European Championships only since 1970. The result of the female winners at the European Championships in the 200 m freestyle from 1970 to 2012, ranged from 2:08.2 min. (1970) to 1:55.45 min. (2010) and improved by 12.75 s. The results achieved at the Polish Swimming Championships were inferior to those from the European Championship, by 6.52 s on the average. The differences ranged from 14.4 s in 1970 (the largest difference) to 0.66 s in 2006 (the smallest difference). The latter was achieved (at both Polish and European Championships) by Otylia Jędrzejczak.

**MEN’S 200 M FREESTYLE**

Analysis of the results of the men’s 200 m freestyle finalists in the Polish Championships in the period from 1922 to 2012 was possible after 1926, when this event was first included in the Championships program. In the years 1927–1929, 1954, 1957, 1960, and 1964–1965, the men’s 200 m freestyle was not held, and in addition the Polish Championships were not held in the years 1940–1945. As the 1926 competition was held in the conditions which made the results incomparable with the results achieved in a swimming pool, the analysis covered only the period from 1930 to 2012, with the above mentioned omissions.

As a result of the fact, that all the results of this competition in the analyzed period of time (from 1922 to 2012) could not fit on a single figure, therefore are shown in two blocks divided on a four period:

- Figure 16 – from 1926 to 1939,
- Figure 17 – from 1946 to 2070,
- Figure 18 – from 1971 to 1992,
- Figure 19 – from 1993 to 2012.
FIGURE 16. The results of male Polish winners 200 m freestyle in the years 1926–1939 compared to Polish finalists and the European winners’ results

FIGURE 17. The results of male Polish winners 200 m freestyle in the years 1946–1970 compared to Polish finalists and the European winners’ results

FIGURE 18. The results of male Polish winners 200 m freestyle in the years 1971–1992 compared to Polish finalists and the European winners’ results
The analysis of the results of the male 200 m freestyle Polish winners at the Polish Swimming Championships in the years 1926–2012 (Figure 16–19) showed that the best result in 1926 was 3:20.3 min. (although it was not recorded in a swimming pool). In the years 1930–2012, the results of the winners in the men's 200 m freestyle finals at the Polish Championships showed an upward trend, with slightly worse results in: 1932, 1938, 1946, 1958, 1963, 1969, 1979, 1982, 1986, 1990, 1992, 1994, 1997, 1999, 2007, and 2010.

The largest improvement in swimming time was recorded between 1930 and 1931 – by 10.8 s. The results in the years 1930–2012 improved by 48.78 s. Analysis of the Polish Championship finalists against the winners' times recorded at the European Championships in the analyzed years was possible only for the years 1970–2012 (this event was not held in the European Championships prior to 1970). The European champions' results in the 200 m freestyle in the years 1970–2012 ranged from 1:55.02 min. to 1:44.89 min. This result was improved over 42 years by 10.13 s. The results of the Polish gold medalists in the analyzed period (1970–2012) were considerably inferior to those of the European Championship winners, by 5.1 s on the average. The differences ranged from 9.9 s in 1974 (the largest difference) to 2.09 s in 2008 (the smallest difference). The differences between the worst and the best results in the Polish Championships in freestyle at the distance of 50, 100 and 200 m in the years 1922–2012 are presented in Figure 20.

FIGURE 19. The results of male Polish winners 200 m freestyle in the years 1993–2012 compared to Polish finalists and the European winners' results

FIGURE 20. The differences between the worst and the best results in the Polish Championships in freestyle at the distance of 50, 100 and 200 m in the years 1922–2012
DISCUSSION

The analysis of the times recorded by the female and male winners of the Polish Championships in the 50, 100 and 200 m freestyle events (in a 50-m swimming pool) in the years 1926–2012 showed that the results progressively improved, with some years of slightly worse results. The analysis of the results showed that the men’s 50 m freestyle results in the years 1955–2012, over the analyzed 57 years, improved by 4.56 s, whereas the results of female swimmers (1956–2012) improved by 6.17 s. Thus, the progression in the results at this distance proved to be slightly better among female swimmers (by 1.61 s). Of course this is only possible to speculate upon if the quality of the level is known at the beginning. This could be done using the point tables of FINA. If e.g. the quality of performance of the women was at the same level as the men, in 1955, the simple time improvement is a valid measure and it could be stated that the women had a greater positive progression than the men.

In the 100 m freestyle over 83 years (1929 to 2012), the sports results of the Polish female gold medalists was improved by 38.71 s, and those of men by 21.51 s, thus making the progression in the sports results in this event slightly better among female swimmers than male swimmers (17.2 s). The difference in the result achieved by the female 200 m freestyle gold medalists over the analyzed 63 years, between 1949 (3:02.4 min.) and 2012 (2:01.15 min.), was 61.25 s and also proved to be better than among male swimmers, whose results in this competition during the period of 82 years (1930–2012) improved by 50.58 s.

In the analyzed period, from 1922 to 2012, the best freestyle results at the Polish Championships were mostly achieved (except for the men’s 50 m freestyle) by both female and male swimmers in 2009. These were: 1. the women’s 50 m freestyle time in 2009 – 25.31 s; 2. the men’s 50 m freestyle in 2012 – 22.04 s (although the 2009 result was 22.11 s, lasting only until 2012); 3. the women’s 100 m freestyle in 2009 – 55.29 s; 4. the men’s 100 m freestyle in 2009 – 48.49; 5. the women’s 200 m freestyle in 2009 – 2:00.53 min.; 6. the men’s 200 m freestyle in 2009 – 1:48.22 min.

CONCLUSIONS

The data analysis allowed the following conclusions:

1. The sports results of the Polish Championships winners, both female and male swimmers, in the 50, 100 and 200 m freestyle events (in a 50-m swimming pool) in the years 1926–2012 systematically showed a clear upward trend, despite slightly regressed results in some years.

2. In the analyzed 90 years (1922 to 2012), the best freestyle results at the Polish winners were mostly achieved (except for the men’s 50 m freestyle) by both female and male swimmers in 2009.

3. Progression of the results at the Polish winners in all the analyzed events: 50, 100 and 200 m freestyle, over the years 1922–2012 proved to be more apparent among women than men.

4. Sport results among Polish winners (female and male), competing in 50, 100 and 200 m freestyle (pool 50 m) in the years 1926–2012 showed a gradually increasing trend.
5. The results of the Polish winners against the comparable results in European winners were considerably worse, both in the case of women and men. Three events in the Polish Championships were exceptions to above rule: men’s 50 m freestyle in 2002, when the difference of solely 0.2 s was the lowest ever recorded (Bartosz Kizierowski) and the 2012 difference of 0.24 s (Konrad Czerniak), and at the 2006 Championships in the women’s 200 m freestyle, where the difference was 0.66 s (the results in both Polish and European Championships were achieved by Otylia Jędrzejczak).

6. The analysis of the results provides information about development of the sports level in swimming in Poland over dozens of years, especially when compared to the results obtained at the European Championships.

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Identification of risks in water parks: a survey of customers and lifeguards

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ABSTRACT
The aquatic environment is a pleasant and joyful place to spend your leisure time. Especially attractive are water parks. They offer pools with fancy shapes, waterfalls, rivers with variable currents, artificially induced waves, and even climbing walls and rope bridges. The major attractions are usually slides of various lengths and shapes. The design of these slides is to stir strong emotions, often including fear. Inventing more and more exciting forms of water recreation creates new dangers. More importantly, daring solutions are often deliberately built into various aquatic amusement devices as they increase their attractiveness. Therefore it is reasonable to ask: what is the security and safety level of water park users? Are the possible risks correctly perceived by lifeguards and swimmers? The aim of this paper is to the opinion of lifeguards and water park users about the risk of an accident while swimming in a water park. Moreover, the aim is to clarify the nature of that risk. The paper presents results of a survey conducted in one of Wroclaw’s water parks. This work is a part of deeper and broader pedagogical considerations about skills in management of personal safety.

Key words: recreation, water parks, safety, risk

INTRODUCTION
The aquatic environment is a pleasant and joyful place to spend your leisure time. Is it also a safe place for the people relaxing by the water? Water has often been the site of tragedies. In the last years of the 20th century in Poland, the number of drowning victims significantly exceeded one thousand each year. Currently, this figure has decreased to about 500 drowning accidents (http://www.statystyka.policja.pl/portal/st/958/). The same number of serious accidents is a result of unsuccessful jumps into the water, which often cause total paralysis (Kiwerski, 2004).

The risks related to water recreation will never be eliminated. A constant search for more exciting forms of water recreation creates new demand. This process shapes the needs of the society which are satisfied by the companies offering services related to extreme types of activity. For instance, extreme water sports or the so-called high-risk sports, including long-distance swimming (e.g. “Crown of the Oceans”), white water rafting, canyoning, kitesurfing, personal watercraft riding, riding behind a motorboat (barefoot skiing, on a board, on an air mattress, on a pontoon, on a “banana” pontoon, on a water chair, with a parachute), diving-related activities (free diving, exploring caves, shipwrecks and coral reefs).
As a consequence, new risks emerge. Those risks are often intentionally incorporated into various programs of physical activity in the water. Risk can be attractive, because it satisfies the need for extraordinary emotions and unusual entertainment (Cynarski, 2007). What probably motivates people to try these kinds of sports is a need for new, intense emotional experiences and sensations induced by risky behaviour (Mynarski and Veltze 2008). Although these risky types of physical activity expose our lives and health to danger, they are not suicide attempts (Wiesner, 2011a). Pawłucki (2004, 2010, 2013) strongly emphasizes that “all bodily and physically extreme acts are always morally wrong”, when they are not related to the moral value of a human being (Pawłucki, 2003, 2010, 2013). However, they are not always “killers of opportunity”.

Water parks, also referred to as aquaparks or water amusement parks (sport and recreation facilities with swimming pools as their main attraction (http://pl.wikipedia.org/wiki/Aquapark)), are nowadays very popular recreation centres and examples of a place where people look for such intense excitement. Every water park offers swimming pools with fancy shapes, waterfalls, rivers with variable currents, artificially induced waves, and even climbing walls and rope bridges. The major attractions are usually waterslides of various lengths and shapes. The design of these slides is supposed to trigger strong emotions, often including fear and terror. Are those attractions safe? Are the elements which increase the appeal of a water park potentially dangerous for the people who use them?

This paper is an excerpt from broader pedagogical considerations about the skills in risk assessment and personal safety management. The subject of those considerations is a young person who is physically active and needs to experience his or her emotions. It constitutes an important field of scientific research connected with the studies of physical culture, as well as with psychology (motivation behind undertaking risky forms of physical activity) and pedagogy (education for safety). The aim of education for safety is to increase the sense of safety and real security while using recreational facilities (Wiesner, 2011a).

SAFETY VS. RISK

Safety is the opposite of risk. The term “safety” is commonly used and requires clarification only for methodological reasons. As an axiological notion, safety is one of the absolute values. From the psychological perspective, it is one of the primary human needs which provides a sense of confidence and stability (Wiesner, 2011a; Korzeniowski, 2008; Malak, 2007). One can assume that the notion of safety is always twofold. Firstly, it is an objective situation characterized by the lack of danger. Secondly, it is a state perceived subjectively by individuals or groups. The subjective aspect concerns the mental state in which the individual feels secure and peaceful. It is expressed by the sense of safety – the individual’s awareness of danger or lack of such awareness, lack of knowledge of the possible methods of preventing danger (Janośec and Korzeniowski, 2011; Korzeniowski, 2008; Malak, 2007).

Safety should be analysed with regard to a given situation, including:

- subjective scope (who does the safety concern?)
- objective scope (which domain of human activity does the safety concern?)
- spatial scope (when and where does the activity take place?) (Malak, 2007).
Risk is the source and cause of an undesirable state which may result in an accident, an illness or damage. The existing risk does not always transform into undesirable effects (Gasparski, 2003; Studenski, 2004; Makarowski, 2008; Korzeniowski, 2008). Therefore risk is a potential cause of accident in recreation (Wiesner and Sabat 2010).

Risk can be external and/or internal. The external risks are objective and independent of human beings, as their sources are outside the subject. These sources are environmental factors: natural, social and technological. The basic external risk in water recreation has its source in the aquatic environment properties, which are additionally subject to dynamic changes induced by weather conditions (Wiesner, 2011b). The external risks in water activities include actions of other subjects, as well as defects and breakdowns of water equipment and facilities (Wiesner, 2011b). Therefore one should simply take them into consideration while participating in recreational activities.

Seemingly, internal risks depend on human behaviour, as they are inherent in every person. They include poor swimming skills and poor swimming fitness, unfamiliarity with the water environment, non-observance of swimming safety rules, excessive recklessness, etc. People, however, do not always notice their own flaws and weaknesses nor are they able to diagnose themselves and control their behaviour. As a result, they cannot accurately identify the internal risks and therefore their level of risk is very high (Wiesner, 2011a).

THE NOTION OF RISK AND ITS ASSESSMENT IN RECREATION

Every recreational action is accompanied by some kind of risk. The notion of risk is complex. In most of the cases it means 1) an action with an uncertain result, 2) probability of failure, 3) taking a risk – undertaking risky actions (Sobol 1995).

Risk is a product of the probability of damage and the consequences related to it (Figure 1).

\[
\text{RISK} = \text{PROBABILITY OF AN EVENT} \times \text{EFFECTS OF THIS EVENT}
\]

FIGURE 1. A diagram showing the level of risk in a given activity (Wiesner, 2011a)

This product’s value is above zero, as an action always leads to consequences. Safety is characterized by a low level of risk. Risk refers to an activity whose result is uncertain (Kaczmarek, 2001).

The term “risk” in the literature on physical culture appears most frequently in relation to extreme sports (explicitly called “high-risk sports”), extreme tourism or extreme recreation. Risk is a main trait of extreme forms of physical activity. Practising these types of activities requires courage and generates strong emotions which accompany every instance of danger and overcoming extreme internal and external difficulties (Ławniczak, 2011; Dąbrowski and Korneluk, 2010; Mynarski and Veltze, 2008; Andrzejewska, 2007; Plutecka and Mazurek, 2007; Sahaj, 2005; Gracz et al., 2004; Muszkieta and Gembiaik, 2004; Matuszyk, 2002; Gracz and Sankowski, 2001; Łobożewicz and Bieńczyk, 2001), whereas the attitude towards risk is the main...
difference between the traditional forms of active tourism (the risk has to be accepted), and the newer forms, where the risk is sought after (Zdebski and Kozicka, 2007).

The basic classification of risk covers the occurrence of subjective and objective risks. The objective risk can be determined on the basis of statistical analysis. The measurement of the objective risk is conducted with the use of data concerning, for instance, the number of fatal accidents in the aquatic environment. It is the quantitative aspect of risk. The level of undesirable effects expressed by quantifiable indexes is a basis of relatively objective presentation of the risk level (Studenski, 2004; Makarowski, 2008).

The subjective risk reflects the perception of the situation by an individual, the assessment and acceptance of risk. The level of risk established with the use of knowledge and experience or imagination and intuition without referring to reliable statistical data, i.e. assessed subjectively, is always a qualitative estimation (Goszczyńska, 1997; Studenski, 2004; Zaleśkiewicz, 2005; Makarowski, 2008).

Using the skills of risk management, the impact of risk on our actions can be decreased and sometimes even the occurrence of such negative actions can be limited (Wiesner, 2011). Risk management is a system of methods and actions whose aim is to reduce the degree of the influence of risk on the subject’s functioning and to make optimal decisions in that respect (Kaczmarek, 2008). The procedures of risk management constitute the key safety measures in commerce, information technology, company management and especially in financial transactions, insurance, in the event of catastrophes and natural calamities (Goszczyńska, 1997; Kaczmarek, 2008; Wolanin, 2007; Rajzer, 2001). It can be assumed that those procedures will also prove useful if applied to the actions related to physical culture. Here I suggest using the term “safety management”, as it conveys its educational message more accurately.

Safety management consists of four stages:
I. Identification of risks
II. Analysis of risk
III. Planning of the methods of coping with risk
IV. Monitoring of risk, reassessment of risk

METHODOLOGICAL ASSUMPTIONS OF THE PAPER

The analysis of the determinants of water park recreation safety requires observance of the rules arising from the procedures of safety management. The aim of the first stage (identification of risks) is to recognize the risk and its elements, detect its sources, as well as prepare its profile and classification, especially in the case of the offered water attractions. In this paper I strive to obtain the answers to the basic questions: what negative incidents may happen to people swimming in a water park? What may be the negative effects and consequences of this risk? Does it concern every user or only some of them? Are the possible risks noticed by lifeguards and water park users? What is the level of the risk undertaken by people using water park attractions? Are there any differences between lifeguards and users in the assessment of the accident risk in a water park?

The aim of the conducted research was to identify the opinions of lifeguards and water park users regarding the dangers and risks of an accident while swimming.
in a water park. Moreover, the goal of this paper was to explain the determinants of people's decisions to use the available water attractions.

A 10-grade assessment scale, created by the author, has been used: “Rating scale of the assessment of risks in water parks in Poland”. This tool has been developed on the basis of the source information from audits conducted by WOPR (Volunteer Water Rescue Service) of the Warmińsko-Mazurskie and Zachodniopomorskie Voivodeships (Wiesner, 2012; Reperowicz 2013, http://www.wodneparki.pl/). The analysis of the risks observed during audits allowed for the selection of the assessed categories. The questionnaire included questions divided into four categories. Each category consists of a number of elements thematically related to the assessed matter. The following risk categories have been assessed:

- Recreational Water Attractions (14 elements),
- Customers’ Behaviour (9 elements),
- Technological and Architectural Solutions Used in Polish Water Parks (6 elements),
- Quality of Work of the Water Park Lifeguard Service (6 elements).

The survey was conducted in one of the water parks in Dolnośląskie Voivodeship in January and February of 2014. It consisted of 100 adult park customers (38 women) and 50 lifeguards (14 women). The profiles of the respondents included basic personal data such as age, sex, education, marital status, profession and experience related to the aquatic environment (including visiting water parks). The average age of the respondents was 29.91 years, most of them had received higher education, held no form of aquatic activity license and regularly visited the water park in order to swim. Among the lifeguards the data included, in addition to the aforementioned categories, the experiences related to their profession. The average age of the lifeguards was 26 years. Most of them are students or graduates of higher education institutions (only 4 persons had received only secondary education). All surveyed lifeguards hold at least the rank of a water lifeguard and the First Aid qualifications. In this paper, only the differences in perceiving risk by both surveyed groups in various categories were analysed. The relationships between the characteristics of the respondents and the risk assessed by them are intended to be included in another study.

SURVEY RESULTS

THE PERCEPTION OF RISK AMONG THE CATEGORIES ANALYSED IN THE SURVEY

Which of the risk categories was assessed as the highest by both groups of respondents?

The diagrams in Figures 2 and 3 show the distribution of average risk ratings in four discussed categories. The results are very similar in both groups of respondents.

The categories have been arranged from the most dangerous to the safest. Due to the lack of normal distribution of each of the compared variables, the test used was the non-parametric Wilcoxon signed-rank test, which is an equivalent of the Student’s t-test for dependent groups. All of the category pairs were compared to
FIGURE 2. Average rating of risk in each category for the group of customers.
(P1 – Recreational Water Attractions, P2 – Customers’ Behaviour, 
P3 – Technological and Architectural Solutions Used in Polish Water Parks, 
P4 – Quality of Work of the Water Park Lifeguard Service)

FIGURE 3. Average rating of risk in each category for the group of lifeguards (P1 
– Recreational Water Attractions, P2 – Customers’ Behaviour, P3 – 
Technological and Architectural Solutions Used in Polish Water Parks, P4 – 
Quality of Work of the Water Park Lifeguard Service)
one another. The only pair which did not show statistically significant difference in the risk assessment consisted of categories 3 and 4. In all other relations and in both tested groups, the Wilcoxon test indicated a statistically significant difference of the calculated mean values (Table 1).

TABLE 1. The comparison of the significance of differences between the average rating of risks in all pairs of the category (P) for the group of customers (C) and the group of lifeguards (L). Wilcoxon signed-rank test (results from Statistica program, T – value of T statistic, Z – value of Z statistic)

<table>
<thead>
<tr>
<th>Categories</th>
<th>Type</th>
<th>N valid</th>
<th>T</th>
<th>Z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1 &amp; P2</td>
<td>C</td>
<td>99</td>
<td>123.000</td>
<td>8.209162</td>
<td>0.000000</td>
</tr>
<tr>
<td>P1 &amp; P2</td>
<td>L</td>
<td>50</td>
<td>26.00000</td>
<td>5.902980</td>
<td>0.000000</td>
</tr>
<tr>
<td>P1 &amp; P3</td>
<td>C</td>
<td>99</td>
<td>885.5000</td>
<td>5.547816</td>
<td>0.000000</td>
</tr>
<tr>
<td>P1 &amp; P3</td>
<td>L</td>
<td>50</td>
<td>405.5000</td>
<td>2.239561</td>
<td>0.025120</td>
</tr>
<tr>
<td>P1 &amp; P4</td>
<td>C</td>
<td>95</td>
<td>1377.0000</td>
<td>3.351809</td>
<td>0.000803</td>
</tr>
<tr>
<td>P1 &amp; P4</td>
<td>L</td>
<td>50</td>
<td>428.5000</td>
<td>2.017535</td>
<td>0.043641</td>
</tr>
<tr>
<td>P2 &amp; P4</td>
<td>C</td>
<td>94</td>
<td>784.5000</td>
<td>5.460313</td>
<td>0.000000</td>
</tr>
<tr>
<td>P2 &amp; P4</td>
<td>L</td>
<td>48</td>
<td>135.5000</td>
<td>4.641087</td>
<td>0.000003</td>
</tr>
<tr>
<td>P3 &amp; P4</td>
<td>C</td>
<td>92</td>
<td>1878.500</td>
<td>1.014360</td>
<td>0.310412</td>
</tr>
<tr>
<td>P3 &amp; P4</td>
<td>L</td>
<td>48</td>
<td>540.0000</td>
<td>0.492314</td>
<td>0.622498</td>
</tr>
<tr>
<td>P2 &amp; P3</td>
<td>C</td>
<td>98</td>
<td>536.5000</td>
<td>6.693817</td>
<td>0.000000</td>
</tr>
<tr>
<td>P2 &amp; P3</td>
<td>L</td>
<td>49</td>
<td>9.0000000</td>
<td>6.003192</td>
<td>0.000000</td>
</tr>
</tbody>
</table>

The results marked in bold are significant with p-value < .05

Considering the above, the following ranking of categories can be formed, from the most to the least dangerous: Category 1 (Recreational Water Attractions); Category 2 (Customers’ Behaviour); Category 3 = Category 4 (Technological and Architectural Solutions and Quality of Work of the Lifeguard Service...)

The respondents found the Customers’ Behaviour category to be the most dangerous (average ranking amounted to 6.46 in the group of customers and 7.64 in the group of lifeguards). In the survey conducted in the years 2008–2010 in Polkowice Aquapark, Trzos (2012) obtained similar results. The observation of the swimmers’ behaviour and interviews with the lifeguards indicated that the most frequent cause of accidents are internal risks, i.e. produced by the victims themselves (Trzos, 2012).

This suggests the existence of a serious social problem in our country, which becomes visible in road accidents, mountain tourism or swimming in open bodies of water, etc. (Wiesner, 2011 c). In his introduction to the study of education for safety, Wiesner states “… neglecting the safety rules, non-observance of the regulations and breaking the laws of prohibition constitute a serious social problem. It does not only concern the accidents related to water. Tragic accidents on the roads, during field trips, travelling, sports and entertainment events and even while performing usual professional duties happen for similar reasons (Wiesner et al. 2007, p. 5).

Road accidents are the most striking examples, as they are very well documented. 3246 fatal road accidents occurred in 2012 (Symon, 2013). “Among the
factors which have the highest impact on the road safety (human – road – vehicle as the cause of accidents), the human is definitely the most important one. It is the behaviour of individual groups of road users that generally causes road accidents. Other factors were of markedly lesser importance (Symon, 2013, p. 28). In the field of recreation and entertainment in water parks, social behaviours are not as tragic as in the case of road accidents.

The respondents found the Recreational Water Attractions to be the safest category (3.64 – customers, 4.60 – lifeguards). This result is quite surprising, as much higher ratings of risks in the category of amusement attractions were expected. The explanation of this discrepancy can be found in the diverse nature of the assessed facilities. Out of fourteen elements of this category, at least three were rated as markedly more risky – waterslides, springboards and artificial waves (Tab. 2 and 3). The rest of the elements were assessed as much safer. The differences of risk perception for those elements are discussed in the next subchapter of the study.

Lifeguards notice the risk related to the water attractions more than the customers. This suggests that water park customers consider the available water attractions safe and they feel secure while using them. This result may also indicate a distressing phenomenon – swimmers just do not take the risk arising from the offered attractions seriously enough and they are not prepared to properly assess it.

RISK PERCEPTION BETWEEN THE ELEMENTS OF EACH CATEGORY

A ranking of elements according to the assessed risk has been compiled in all four categories. Tables 2 and 3 show average ratings of four risks in each category – the two most and two least dangerous.

In category 2 (Customers’ Behaviour), assessed as the most dangerous, the respondents found the lack of child care to be the most dangerous (7.18 – customers, 8.42 – lifeguards). Parents often leave their child unattended while going out, e.g. to the sauna. It creates a serious objective risk, as it was in a tragic accident in the Cracow water park on 4 October 2006. An 11-year-old boy from Lipnica drowned during a field trip to the aquapark in Nowa Huta. The two teachers were found guilty, because they did not provide sufficient child care (Drożdżak, 2010). Insufficient care might have also been the cause of drowning of a 10-year-old boy in Termy Maltańskie in Poznań (Cieśla, 2013).

In this category, the risks arising out of the swimmers’ intoxication were assessed as high (7.24 – customers), along with the negligence of guidelines (8.10 – lifeguards) and the non-observance of instructions (8.90 – lifeguards). While observing swimmers’ behaviour, Trzos also noticed that most of them regularly ignored the rules and did not provide sufficient child care (Trzos, 2012). Insufficient care might have also been the cause of drowning of a 10-year-old boy in Termy Maltańskie in Poznań (Cieśla, 2013).

While discussing the risk category assessed as the least dangerous (Water Attractions), it must be pointed out that some of the elements were rated relatively high. The customers found turbo waterslides and springboards to be the most dangerous (6.25 and 6.41, respectively). The most dangerous facilities according to the group of
TABLE 2. Average ratings for selected elements of the category in the group of customers (C)

<table>
<thead>
<tr>
<th>Element</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
<th>Category 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jacuzzi</td>
<td>2.27</td>
<td>2.21</td>
<td>6.25</td>
<td>6.41</td>
</tr>
<tr>
<td>Paddling pool for children</td>
<td>3.64</td>
<td>5.85</td>
<td>7.24</td>
<td>5.34</td>
</tr>
<tr>
<td>Turbo waterslides</td>
<td>7.18</td>
<td>7.46</td>
<td>6.46</td>
<td>3.98</td>
</tr>
<tr>
<td>Springboards</td>
<td>4.19</td>
<td>5.93</td>
<td>5.75</td>
<td>5.02</td>
</tr>
<tr>
<td>Average rating</td>
<td></td>
<td>4.52</td>
<td>4.51</td>
<td>4.94</td>
</tr>
</tbody>
</table>

Legend: black (the most dangerous elements), gray (the safest elements)

TABLE 3. Average ratings for selected elements of the category in the group of lifeguards (L)

<table>
<thead>
<tr>
<th>Element</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
<th>Category 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waterfalls/ water jets</td>
<td>2.33</td>
<td>2.43</td>
<td>8.04</td>
<td>7.74</td>
</tr>
<tr>
<td>Jacuzzi</td>
<td>4.60</td>
<td>6.46</td>
<td>6.78</td>
<td>8.90</td>
</tr>
<tr>
<td>Artificial waves</td>
<td>8.42</td>
<td>8.90</td>
<td>7.64</td>
<td>4.48</td>
</tr>
<tr>
<td>Turbo waterslides</td>
<td>4.39</td>
<td>5.93</td>
<td>5.75</td>
<td>5.02</td>
</tr>
<tr>
<td>Average rating</td>
<td></td>
<td>4.52</td>
<td>4.51</td>
<td>4.94</td>
</tr>
</tbody>
</table>

Legend: black (the most dangerous elements), gray (the safest elements)
lifeguards were artificial waves (8.04), turbo waterslides (7.74) and springboards (7.50). The risks connected to jumping into the water are obvious. Wiesner has addressed this issue on multiple occasions (Wiesner, 2004; Wiesner and Dziegielewksa-Nawrocka, 2004; Prystupa and Wiesner, 2006). High rating of the risk connected with using waterslide and pools with artificial waves is not unsupported. Fatal accidents related to those particular facilities occurred in 2012. In Poznań, on Children’s Day, a 10-year-old boy drowned in a pool with artificial waves (Cieśla, 2013), and in Karpacz, in February, a 71-year-old man had an accident while sliding down a waterslide (GOK, 2012).

Most semi-drownings and lifeguard interventions take place in the landing area of waterslides. Upon sliding down, a person is rapidly thrown into a water basin approximately 1 metre deep, where strong undercurrents of the water continuously flowing from the waterslide prevent the swimmer from assuming a stable position. This is the key element of this facility’s attractiveness. The forms of activity related to the risk of loss of life or health are becoming increasingly popular. What probably motivates people to try these kinds of activities is a need for new, intense emotional experiences and sensations induced by risky behaviour (Mynarski and Veltze 2008).

DIFFERENCES IN RISK PERCEPTION BETWEEN LIFEGUARDS AND CUSTOMERS

Do customers and lifeguards perceive risks similarly in each of the categories? In order to answer this question, an arithmetic mean based on the answers provided to a given category of questions was calculated for each respondent. If not all the questions were answered within one category, the mean was calculated only on the provided answers, and if no answer was provided within one category, the respondent was excluded from the survey (in this category). A null hypothesis of equal average risk ratings was made in each category, in the groups of both lifeguards and customers. In order to verify this hypothesis, the Mann Whitney U test was used, since there was no normal distribution of answers in all categories for the group of customers.

Table 4 shows the Mann-Whitney U test results for each category. The test results indicate statistically significant differences in risk perception between customers and lifeguards for categories 1 and 2. These categories include the risks related to water attractions and customers’ behaviour. It suggests that the risk rating of the water attraction users in a water park may be underestimated.

For the next two categories no such differences were observed. In these two categories, the average risk rating perceived by the customers is lower than the one perceived by the lifeguards. This result proves that the subjective risk is determined by the subject’s knowledge and experience in this field of human activity that concerns safety (Studenski, 2004; Zaleśkiewicz, 2005; Malak, 2007; Makarowski, 2008). Lifeguards have to predict water-related risks due to their profession.

For further analysis of the results, the hypothesis of the equality of average answers provided by the customers and the lifeguards has been verified for all the questions of category 1. The aim of the survey was to determine in which specific cases the risk perception in both groups of respondents is markedly different. The first analysed elements were those of category 1. Due to the lack of normal distribution of the surveyed characteristics, the non-parametric Mann-Whitney U test was used again; its results are shown in Table 5.
In the Recreational Water Attractions category the respondents assessed the risk level of fourteen elements. Statistically significant differences between the lifeguards and the customers emerged in the average ratings of as many as eight elements in this category. Those differences are marked in bold in Tables 5 and 6. The risk ratings provided by the customers regarding the use of waterslides, artificial waves, springboards and a spa area (wellness, fitness or saunas) and a paddling pool for children differed from the ratings given by the lifeguards. As shown in Table 6, in all of these situations the customers’ subjective risk rating was lower than the rating provided by the lifeguards. This result clearly indicates the area of internal risks where one can predict a potential increase in negative events. This knowledge enables the lifeguard services to provide efficient safety measures to swimmers.

Only in two elements (artificial rivers and waterfalls) the risk rating given by the lifeguards was lower than that provided by the customers. In both situations the differences in risk perception between the lifeguards and the customers were not statistically significant (Tab. 6).

A similar analysis was conducted for the rest of the categories. Tables 7 and 8 show the results for the Customers’ Behaviour category. Statistically significant differences occurred in six out of nine elements assessed in this category. As in the previous table, these results are marked in bold. The difference between the subjective risk rating provided by the customers and the one given by the lifeguards regard: poor swimming skills, health indisposition, lack of knowledge, lack of risk assessment skills, neglecting the rules and lack of child care.

In all those situations the risk perceived by the customers was lower than the one perceived by the lifeguards. In this context it is especially important to emphasize the insufficient risk assessment regarding children (swimming in the paddling pool or insufficient child care). This risk refers to children under the supervision of both parents and educators. For the lifeguards, this information confirms the need of preventive control in this relation.

Both surveyed groups displayed no differences in the perception of the risk arising out of non-observance of the user guidelines for recreational facilities by swimmers and the aggressive behaviour of inebriated customers. This is an important message for the water park wardens.

Tables 9 and 10 show the U test results in category 3: Technological and Architectural Solutions Used in Polish Water Parks. The respondents assessed the risk level of six elements. The test did not show any significant differences in the rating of the elements in both surveyed groups.

### TABLE 4. Differences in risk perception between lifeguards and customers. Mann-Whitney U test (results from Statistica program)

<table>
<thead>
<tr>
<th></th>
<th>Total ranks - C</th>
<th>Total ranks - L</th>
<th>U</th>
<th>Z-corr.</th>
<th>p</th>
<th>N valid - C</th>
<th>N valid - L</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>6590.50</td>
<td>4734.50</td>
<td>1540.50</td>
<td>-3,82406</td>
<td>0,000131</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>P2</td>
<td>6851.50</td>
<td>4473.50</td>
<td>1801.50</td>
<td>-2,78375</td>
<td>0,005374</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>P3</td>
<td>7380.50</td>
<td>3944.50</td>
<td>2330.50</td>
<td>-0,67406</td>
<td>0,500274</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>P4</td>
<td>6702.50</td>
<td>4028.50</td>
<td>2046.50</td>
<td>-1,45656</td>
<td>0,145238</td>
<td>96</td>
<td>50</td>
</tr>
</tbody>
</table>

U – value of U statistic, Z-corr. – value of corrected Z statistic
The results marked in bold are significant with p < .05
TABLE 5. Differences in risk perception between customers and lifeguards regarding the elements of the Recreational Water Attractions category. Mann-Whitney U test (results from Statistica program)

<table>
<thead>
<tr>
<th>Element</th>
<th>Total ranks – C</th>
<th>Total ranks – L</th>
<th>U</th>
<th>Z-corr.</th>
<th>p</th>
<th>N valid – C</th>
<th>N valid – L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competition pools</td>
<td>7439.0</td>
<td>3886.0</td>
<td>2389.0</td>
<td>-0.449</td>
<td>0.653093</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Outdoor pools</td>
<td>6791.0</td>
<td>4087.0</td>
<td>1940.0</td>
<td>-1.914</td>
<td>0.055572</td>
<td>98</td>
<td>49</td>
</tr>
<tr>
<td>Artificial waves</td>
<td>5769.5</td>
<td>5256.5</td>
<td>819.5</td>
<td>-6.582</td>
<td>0.000000</td>
<td>99</td>
<td>49</td>
</tr>
<tr>
<td>Artificial rivers</td>
<td>7578.5</td>
<td>3746.5</td>
<td>2471.5</td>
<td>0.113</td>
<td>0.910298</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Pontoon waterslides</td>
<td>6743.5</td>
<td>4431.5</td>
<td>1793.5</td>
<td>-2.758</td>
<td>0.005821</td>
<td>99</td>
<td>50</td>
</tr>
<tr>
<td>Turbo waterslides</td>
<td>6684.5</td>
<td>4640.5</td>
<td>1634.5</td>
<td>-3.478</td>
<td>0.000506</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Spring-boards</td>
<td>6463.0</td>
<td>4268.0</td>
<td>1807.0</td>
<td>-2.465</td>
<td>0.013701</td>
<td>96</td>
<td>50</td>
</tr>
<tr>
<td>Water playards</td>
<td>6953.0</td>
<td>4222.0</td>
<td>2003.0</td>
<td>-1.932</td>
<td>0.053389</td>
<td>99</td>
<td>50</td>
</tr>
<tr>
<td>Waterfalls/ water jets</td>
<td>7425.5</td>
<td>3452.5</td>
<td>2227.5</td>
<td>0.746</td>
<td>0.455790</td>
<td>98</td>
<td>49</td>
</tr>
<tr>
<td>Paddling pool for children</td>
<td>6440.5</td>
<td>4585.5</td>
<td>1490.5</td>
<td>-3.961</td>
<td>0.000075</td>
<td>99</td>
<td>49</td>
</tr>
<tr>
<td>Jacuzzi</td>
<td>7084.0</td>
<td>4091.0</td>
<td>2034.0</td>
<td>-1.812</td>
<td>0.069941</td>
<td>100</td>
<td>49</td>
</tr>
<tr>
<td>Salt spring</td>
<td>6467.5</td>
<td>4558.5</td>
<td>1517.5</td>
<td>-3.822</td>
<td>0.000133</td>
<td>99</td>
<td>49</td>
</tr>
<tr>
<td>Sauna and wellness area</td>
<td>6590.5</td>
<td>4734.5</td>
<td>1540.5</td>
<td>-3.918</td>
<td>0.000089</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Fitness area</td>
<td>6933.5</td>
<td>4391.5</td>
<td>1883.5</td>
<td>-2.506</td>
<td>0.012200</td>
<td>100</td>
<td>50</td>
</tr>
</tbody>
</table>

U – value of U statistic, Z-corr. – value of corrected Z statistic. The results in bold are significant with p-value < .05

TABLE 6. The assessment of the risk level regarding the elements of the Recreational Water Attractions category. Average answers in the groups of customers (C) and lifeguards (L)

<table>
<thead>
<tr>
<th>Group</th>
<th>Competition pools</th>
<th>Outdoor pools</th>
<th>Artificial waves</th>
<th>Artificial rivers</th>
<th>Pontoon waterslides</th>
<th>Turbo waterslides</th>
<th>Springboards</th>
<th>Water playards</th>
<th>Waterfalls/ water jets</th>
<th>Paddling pool for children</th>
<th>Jacuzzi</th>
<th>Salt spring</th>
<th>Sauna and wellness area</th>
<th>Fitness area</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>3.26</td>
<td>4.27</td>
<td>8.04</td>
<td>3.94</td>
<td>6.12</td>
<td>7.74</td>
<td>7.50</td>
<td>3.58</td>
<td>2.33</td>
<td>3.67</td>
<td>2.43</td>
<td>3.57</td>
<td>4.24</td>
<td>3.78</td>
</tr>
<tr>
<td>C</td>
<td>2.96</td>
<td>3.56</td>
<td>5.02</td>
<td>4.07</td>
<td>4.90</td>
<td>6.25</td>
<td>6.41</td>
<td>2.90</td>
<td>2.44</td>
<td>2.21</td>
<td>2.27</td>
<td>2.31</td>
<td>2.72</td>
<td>2.89</td>
</tr>
</tbody>
</table>

The results in bold are significant with p-value < 0.05
TABLE 7. Differences in risk perception between customers and lifeguards regarding the elements of the Customers’ Behaviour category. Mann-Whitney U test (results from Statistica program)

<table>
<thead>
<tr>
<th>Element</th>
<th>Total rank – C</th>
<th>Total rank – L</th>
<th>U</th>
<th>Z-corr.</th>
<th>p</th>
<th>N valid – C</th>
<th>N valid – R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low swimming skills</td>
<td>6767.0</td>
<td>4558.0</td>
<td>1717.0</td>
<td>-3.14624</td>
<td>0.001654</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Health indisposition</td>
<td>6772.5</td>
<td>4402.5</td>
<td>1822.5</td>
<td>-2.64283</td>
<td>0.008222</td>
<td>99</td>
<td>50</td>
</tr>
<tr>
<td>Ignorance regarding the water park attractions</td>
<td>6403.0</td>
<td>4772.0</td>
<td>1453.0</td>
<td>-4.13845</td>
<td>0.000035</td>
<td>99</td>
<td>50</td>
</tr>
<tr>
<td>Improper risk assessment</td>
<td>6753.5</td>
<td>4571.5</td>
<td>1703.5</td>
<td>-3.20068</td>
<td>0.001371</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Neglecting the rules</td>
<td>6775.5</td>
<td>4399.5</td>
<td>1825.5</td>
<td>-2.64757</td>
<td>0.008108</td>
<td>99</td>
<td>50</td>
</tr>
<tr>
<td>Non-observance of guidelines</td>
<td>7139.5</td>
<td>4035.5</td>
<td>2189.5</td>
<td>-1.15725</td>
<td>0.247172</td>
<td>99</td>
<td>50</td>
</tr>
<tr>
<td>Other people’s aggressive behaviour</td>
<td>7359.0</td>
<td>3667.0</td>
<td>2409.0</td>
<td>-0.06578</td>
<td>0.947551</td>
<td>99</td>
<td>49</td>
</tr>
<tr>
<td>Intoxication</td>
<td>7631.0</td>
<td>3694.0</td>
<td>2419.0</td>
<td>0.32917</td>
<td>0.742025</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Lack of child care</td>
<td>6972.0</td>
<td>4353.0</td>
<td>1922.0</td>
<td>-2.36874</td>
<td>0.017850</td>
<td>100</td>
<td>50</td>
</tr>
</tbody>
</table>

U – value of U statistic, Z-corr. – value of corrected Z statistic). The results marked in bold are significant with p-value < .05

TABLE 8. The assessment of the risk level in relation to the elements of the Customers’ Behaviour category. Average answers in the groups of customers (C) and lifeguards (L)

<table>
<thead>
<tr>
<th>Group</th>
<th>Low swimming skills</th>
<th>Health indisposition</th>
<th>Unawareness of risks</th>
<th>Improper accident risk assessment</th>
<th>Negligence of rules</th>
<th>Non-observance of the user manuals for water attractions</th>
<th>Aggressive behaviour of others</th>
<th>Intoxication</th>
<th>Lack of child care</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>7.22</td>
<td>6.46</td>
<td>7.78</td>
<td>7.68</td>
<td>8.10</td>
<td>8.90</td>
<td>6.78</td>
<td>7.44</td>
<td>8.42</td>
</tr>
<tr>
<td>C</td>
<td>5.85</td>
<td>5.34</td>
<td>5.97</td>
<td>6.27</td>
<td>6.94</td>
<td>6.83</td>
<td>6.52</td>
<td>7.24</td>
<td>7.18</td>
</tr>
</tbody>
</table>

The results marked in bold are significant with p-value < .05
The respondents of the survey discussed in this paper were asked to give their opinions on the risks arising from the quality of the lifeguard services in the water park. Table 11 shows the results of the U test in this category. Although there were no discrepancies in average ratings in the groups of both the customers and the lifeguards, statistically significant differences occurred in some elements: “Insufficient number of lifeguards” and “Disorganized work of lifeguards”. Similarly to the previous categories, the ratings provided by the customers were lower than the ratings given by the lifeguards (Tab. 12).

This suggests that the customers do not pay as much attention to the work organisation of a lifeguard team as the lifeguards themselves. This problem, however, becomes visible only in the event of an emergency, when customers observe the actions of lifeguards during a rescue operation. Moreover, the risks connected with the number of employed lifeguards are perceived more distinctly by the lifeguards themselves than by customers. Sometimes customers regard any activity performed by lifeguards as constraints on their freedom to enjoy recreation. It should be also noted that the lifeguards’ opinions may be influenced by their fear of being made redundant. Drawing attention to the insufficient number of lifeguards can lead to an increase in employment in this sector.

The research conducted by Wiesner and Kwaśna (2004) has proven that the lifeguards working at indoor pools do not perform their duties correctly. The authors discovered that the effectiveness of lifeguards’ observations decreased due to undesirable actions taken during the shift. Allegedly such actions occurred because lifeguards were convinced there was no risk at the swimming pools. Lifeguards repeatedly left the premises while on duty (Wiesner and Kwaśna, 2004; Cieśla, 2013).

Most aquatic recreational activities are accompanied by risk. According to the conducted survey, it is not enough to formulate new legal regulations and safety rules in order to reduce risky actions of swimmers. Simply they are all ignored. Orders and restrictions may induce adverse effects (using unguarded swimming areas, ignoring the restrictions, disrespecting the law, restricting civil liberties, etc.). As the types of physical activity offered by water parks are very attractive, the existing educational safety procedures are often insufficient, probably due to the risk being so attractive. For instance, five water parks in Lower Silesia are equipped with waterslides longer than 100 metres. They are: Aquapark Wrocław (186), Aqua Park Polkowice (164), Sandra SPA Karpacz (116), Orka Water Park in Bolesławiec (110), Aqua Zdrój Wałbrzych (100). Not all of the water parks, however, provide this kind of information on their websites. There are over twenty water parks in Lower Silesia. Water parks, (http://www.wodneparki.pl/ February 2014).

The irresistible appeal of the water attractions results from our fascination with the speed of sliding down, the height of high diving and splashing into the water. For instance, the longest waterslide is in Santa Claus, Indiana, USA – 520 metres long; the fastest waterslide is Insano in Fortaleza, Brazil – over 100 km/h; the tallest waterslide is in Barra do Pirai, Brazil – the difference between the top of the tower and the landing area is 50 metres (http://www.wodneparki.pl/).

The reasons for taking risk also include the need to dominate, impress others, overcome one’s own limitations or strive to set a record (Cynarski, 2007; Mynarski and Beltze, 2008). Searching for new, spectacular forms of leisure activity is one of the contemporary trends in recreation. It implies that risk is not necessarily a pejorative phenomenon.
TABLE 9. Differences in risk perception between customers (C) and lifeguards (L) regarding the elements of the Technological and Architectural Solutions Used in Polish Water Parks category. Mann-Whitney U test (results from Statistica program)

<table>
<thead>
<tr>
<th>Element</th>
<th>Total ranks - C</th>
<th>Total ranks - L</th>
<th>U</th>
<th>Z-corr.</th>
<th>p</th>
<th>N valid - C</th>
<th>N valid - L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dangerous access to water</td>
<td>7269.5</td>
<td>3905.5</td>
<td>2319.5</td>
<td>-0.62880</td>
<td>0.529480</td>
<td>99</td>
<td>50</td>
</tr>
<tr>
<td>Narrow area around the swimming pool</td>
<td>7411.5</td>
<td>3763.5</td>
<td>2461.5</td>
<td>-0.05281</td>
<td>0.957884</td>
<td>99</td>
<td>50</td>
</tr>
<tr>
<td>Type of surface (e.g. slippery)</td>
<td>7152.5</td>
<td>4022.5</td>
<td>2202.5</td>
<td>-1.10092</td>
<td>0.270932</td>
<td>99</td>
<td>50</td>
</tr>
<tr>
<td>Restricted view of the pool</td>
<td>7180.5</td>
<td>3994.5</td>
<td>2130.5</td>
<td>-1.29746</td>
<td>0.194474</td>
<td>100</td>
<td>49</td>
</tr>
<tr>
<td>Faulty structures</td>
<td>6842.0</td>
<td>3743.0</td>
<td>2186.0</td>
<td>-0.69745</td>
<td>0.485521</td>
<td>96</td>
<td>49</td>
</tr>
<tr>
<td>Inefficient information and communication system</td>
<td>6872.5</td>
<td>3712.5</td>
<td>2312.5</td>
<td>-0.25971</td>
<td>0.795087</td>
<td>95</td>
<td>50</td>
</tr>
</tbody>
</table>

U – value of U statistic, Z-corr. – value of corrected Z statistic. No statistically significant differences

TABLE 10. The risk level assessment in relation to the elements of category 3: Technological and Architectural Solutions Used in Polish Water Parks. Mean answers in the groups of customers (C) and lifeguards (L)

<table>
<thead>
<tr>
<th>Group</th>
<th>Dangerous access to water</th>
<th>Narrow area around the swimming pool</th>
<th>Type of surface around the pools (e.g. slippery)</th>
<th>Restricted view of the pool by the lifeguards</th>
<th>Faulty structures of the recreational facilities</th>
<th>Inefficient communication system in the water park</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>4.48</td>
<td>3.98</td>
<td>6.54</td>
<td>5.94</td>
<td>6.12</td>
<td>5.02</td>
</tr>
<tr>
<td>C</td>
<td>4.19</td>
<td>3.98</td>
<td>5.93</td>
<td>5.31</td>
<td>5.75</td>
<td>4.95</td>
</tr>
</tbody>
</table>

No statistically significant differences
TABLE 11. Differences in risk perception between customers (C) and lifeguards (L) regarding the elements of the Quality of Work of the Water Park Lifeguard Service category. Mann-Whitney U test (results from Statistica program)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Undertrained lifeguards</td>
<td>6859.5</td>
<td>3725.5</td>
<td>2299.5</td>
<td>−0.31449</td>
<td>0.753150</td>
<td>95</td>
<td>50</td>
</tr>
<tr>
<td>Insufficient number of lifeguards</td>
<td>6093.5</td>
<td>4491.5</td>
<td>1533.5</td>
<td>−3.52158</td>
<td>0.000429</td>
<td>95</td>
<td>50</td>
</tr>
<tr>
<td>Disorganised work of lifeguards</td>
<td>6432.5</td>
<td>4152.5</td>
<td>1872.5</td>
<td>−2.10208</td>
<td>0.035547</td>
<td>95</td>
<td>50</td>
</tr>
<tr>
<td>Insufficient rescue equipment</td>
<td>6655.0</td>
<td>3641.0</td>
<td>2190.0</td>
<td>−0.48225</td>
<td>0.629630</td>
<td>94</td>
<td>49</td>
</tr>
<tr>
<td>Insufficient medical equipment</td>
<td>6646.0</td>
<td>3794.0</td>
<td>2181.0</td>
<td>−0.71242</td>
<td>0.476205</td>
<td>94</td>
<td>50</td>
</tr>
<tr>
<td>Violation of work rules</td>
<td>6991.5</td>
<td>3739.5</td>
<td>2335.5</td>
<td>−0.26589</td>
<td>0.790322</td>
<td>96</td>
<td>50</td>
</tr>
</tbody>
</table>

U – value of U statistic, Z-corr. – value of corrected Z statistic. The results marked in bold are significant with p-value < .05

TABLE 12. The risk level assessment in relation to the elements of category 4: Quality of Work of the Water Park Lifeguard Service. Mean answers in the groups of customers (C) and lifeguards (L)

<table>
<thead>
<tr>
<th>Risk Perception Factor</th>
<th>L</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undertrained lifeguards</td>
<td>4.70</td>
<td>4.52</td>
</tr>
<tr>
<td>Insufficient number of lifeguards</td>
<td>6.68</td>
<td>4.80</td>
</tr>
<tr>
<td>Disorganised work of lifeguards</td>
<td>5.58</td>
<td>4.51</td>
</tr>
<tr>
<td>Insufficient rescue equipment</td>
<td>4.98</td>
<td>4.76</td>
</tr>
<tr>
<td>Insufficient medical equipment</td>
<td>5.32</td>
<td>4.94</td>
</tr>
<tr>
<td>Violation of work rules by lifeguards</td>
<td>4.98</td>
<td>4.86</td>
</tr>
</tbody>
</table>

The results marked in bold are significant with p-value < .05
This research indicates that the ability to identify and analyse risk is essential for effective safety education. Sensible actions entail accurate assessment of existing risks and making optimal decisions without sacrificing the intended goals. Managing one’s safety appears to be an important goal of education. This process helps to develop responsibility for one’s own actions and the risk associated with them. The above statement has very important methodological consequences.

CONCLUSIONS

This survey indicated that there is a significant difference between lifeguards and customers in terms of their perception of risks which water park users are exposed to. In all categories, the ratings provided by the customers were lower than the ratings given by the lifeguards. This result is an important message for administrators and lifeguards. It suggests that the efficiency of information measures among water park users should be improved, and that the consequences resulting from the users’ ignorance should be foreseen.

In both surveyed groups the ratings of risk were the highest in the Customers’ Behaviour category (6.46 – 7.64). This result clearly identifies internal risk as the area where one can predict a potential increase in negative events in a water park. It also confirms the interpretation of the first conclusion.

Although danger is inherent in many architectural solutions offered by water parks, the risk resulting from those attractions was assessed as the lowest. This category comprises fourteen elements, most of which do not generate risk. As a result, the water park customers feel safe and have confidence in the safety level of the offered attractions.

Among the highlighted elements of the assessed categories, the lifeguards found the risks arising out of the non-observance of user guidelines of the recreational facilities (8.90), negligence of rules (8.10) and lack of proper child care (8.42) to be the most serious. According to the customers, the highest risks were those resulting from the intoxication of water park users (7.24) and the lack of proper child care (7.18). Therefore it can be assumed that the most frequent cause of accidents are internal risks, i.e. those produced by the victims themselves.

Artificial waves and turbo waterslides were assessed as the most dangerous by the lifeguards (8.04 and 7.74, respectively), whereas the customers found jumping into the water from the springboard and using the turbo waterslide to be the most risky (6.41 and 6.25, respectively). These results clearly indicate to the auditors and lifeguard services the areas which require intensive security. The need of risky actions and new, exciting attractions in water parks should go hand in hand with searching for ever more effective forms of security.

This research indicates that the ability to identify and analyse the risk is essential for effective safety education.
REFERENCES


Internet sources:


