LIST OF ALL ABBREVIATIONS USED IN THE TEXT

Table 1

Somatic, condition and coordination indicators used in the research studies

x_1	**HEIGHT**	height [cm]
x_2	**WEIGHT**	weight [kg]
x_3	**BMI**	body mass index
x_4	**MASS_NF**	fat-free weight [kg]
x_5	**MASS_NF%**	fat-free weight [%]
x_6	**PEAK_P**	maximum power [W/kg]
x_7	**DROP_P**	power drop [W/kg]
x_8	**PWC170**	power [W]
x_9	**VO2MAX**	maximum oxygen absorption [ml/kg/min]
x_{10}	**VO2MKG**	maximum oxygen absorption [l/kg]
x_{11}	**MOV_COU1**	difference between long jump with and without backswing
x_{12}	**MOV_COU2**	time of five-times-swapped gymnastic stick
x_{13}	**BALANCE1**	number of steps during marching on rosette
x_{14}	**BALANCE2**	number of attempts during Fleming test in 1 minute
x_{15}	**KINE_DIV**	error in jumping at 50% capacity [cm]
x_{16}	**SWIFT_R1**	reaction time in an attempt to stop falling shield
x_{17}	**SWIFT_R2**	reaction time in an attempt to stop Dietrich stick [s]
x_{18}	**SWIFT_R3**	number of properly received stimuli on Piórkowski apparatus with impulse frequency of 93/min
x_{19}	**SWIFT_R4**	number of properly received stimuli on Piórkowski apparatus with impulse frequency of 107/min
x_{20}	**SWIFT_R5**	number of properly received stimuli on Piórkowski apparatus with impulse frequency of 125/min
x_{21}	**SPAT_OR1**	successful number hits in ”throws to moving pendulum”
x_{22}	**SPAT_OR2**	score in attempt of ”marching to target with headband” [cm]
x_{23}	**RHYTHM**	score in attempt of ”run at particular rhythm” [s]
x_{24}	**COOPER**	distance covered during Cooper test [m]
x_{25}	**STR_CHES**	score in attempt of ”lifting a barbell in horizontal position” [kg]
x_{26}	**STR_LEGS**	score in attempt of ”knee band with a barbell on shoulders” [kg]
x_{27}	**STR_GRIP**	hand clasp force [kg]
x_{28}	**SPEED1**	result for 50 m run [s]
x_{29}	**SPEED2**	result for 20 m run with run-up [s]
x_{30}	**AGILITY**	result in ”envelope run” [s]
x_{31}	**LITHE**	forward bend in pitting position [cm]

Table 2.

Description of motoric skills subject to research

1	**GYMN_S1**	level of motoric skills in the first semester of gymnastics
2	**GYMN_S2**	level of motoric skills in the second semester of gymnastics
3	**GYMN_S3**	level of motoric skills in the third semester of gymnastics
4	**GYMN_A**	average grade for rolls and somersaults in gymnstics
5	**GYMN_B**	average grade for standing on one's head and hands in gymnastics
6	**GYMN_C**	average grade for gymnastic jumps
7	**GYMN_D**	average grade for exercises on gymnastic bar
8	**ATH_S1**	level of motoric skills in the first semester of athletics
9	**ATH_S2**	level of motoric skills in the second semester of athletics
10	**ATH_S3**	level of motoric skills in the third semester of athletics
11	**ATH_SPUT**	result in shot put calculated in accordance with score tables
12	**ATH_HUR**	result in hurdles calculated in accordance with score tables
13	**ATH_LJU**	result in long jump calculated in accordance with score tables
14	**ATH_JAV**	result in javelin calculated in accordance with score tables
15	**ATH_HJU**	result in high jump calculated in accordance with score tables
16	**ATH_RUN**	result in 1500 m run (men) and 800 m run (women) calculated in accordance with score tables for decathlon and heptathlon, respectively
17	**TEAMVOL**	level of motoric skills in volleyball
18	**TEAMFOOT**	level of motoric skills in football
19	**TEAMBAS**	level of motoric skills in basketball
20	**TEAMHAN**	level of motoric skills in handball
21	**SWIM_S1**	level of motoric skills in the first semester of swimming
22	**SWIM_S2**	level of motoric skills in the second semester of swimming
23	**SWIM_S3**	level of motoric skills in the third semester of swimming

Motto:

”The more you know, the more you have to learn, and it is still more and more to learn”
(Francis Scott Fitzgerald)

INTRODUCTION

Nowadays, due to rapid developments of technology and subsequent changes in lifestyle, it seems necessary to pay closer attention to the level of motoric condition of our society. In all walks of life, the level of motoric condition exerts positive influence upon health, psychological condition and, to some degree, social status of a particular person. High level of motoric condition depends to a considerable degree on human physical activity. Intense physical activity exerts positive influence on development and proper functioning of human organism. Motoric fitness (also referred to in specialist literature as motoricity) is determined by both a level of motoric capabilities as well as a level of motoric skills (Raczek 1990).

Motoric capabilities [also known in specialist literature as ”motoric abilities” or ”motor abilities”] constitute indispensible determinants of any motoric activity and as such they exert significant influence upon effectiveness of motoric activities and motoric behaviour of a particular person. Therefore the effectiveness of motoric activities and behaviour depends on the type and level of factors determining physical fitness, the co-operation of those factors and the level of influence of those factors upon particular physical task. Thus motoric effectiveness is subject to a series of factors, which together constitute an optimal fitness structure (struktura sprawnościowa) (Hirtz 1994, Raczek 1991, Mynarski 1995, Szopa i wsp. 1996, Raczek i wsp. 1998, Meinel, Schnabel 1998).

Motoric capabilities are referred to as a set of individual psychological and physical characteristics, which develop on the basis of inborn biological abilities, which determine the efficiency of a particular physical activity. (Čelikovsky, Sukop 1985, Raczek 1986).

In specialist literature, one may encounter a division of motoric capabilities into general and specific (skills), (Blahus 1983, Čelikovsky et al. 1985, Mekota, Raczek 1986, Meinel, Schnabel 1987, Willimczik, Roth 1988). General capabilities, due to their anatomical and physiological origin, are divided into physical condition capabilities (energy-based) and physical coordination capabilities [also known in specialist literature as ”coordination capabilities”], which are subject to information and controlling function of the nervous system. Physical condition capabilities determine the factors related to intensity of particular movement or physical activity, such as: power, pace and time of the activity. Physical coordination capabilities, on the other hand, determine the quality of a particular movement or physical activity as well as its adaptation to external conditions (Raczek, Mynarski 1991).

Development of science and knowledge related to motoricity of human beings, and its physical coordination determinants, is closely connected with design, creation and constant improvement of measurement methods of both manifestations and determinants of motoric capabilities. Determination of coordination motoric capabilities (CMC) essential for achieving high level of motoric skills (sports skills) is therefore an important task.

Significance of effective control and regulation of physical activities manifests itself particularly in the process of acquisition and improvement of particular motoric skills. According to many authors, high level of CMC constitutes an essential determinant of effectiveness of this process (Starosta 1987, Raczek 1989, 1991, 1998, Szopa 1993, Hirtz 1994, Meinel i Schnabel 1998, Ljach 1998).

The problem of the relationship between motoric capabilities and motoric skills is very complex and not explored empirically in much detail. The studies conducted so far cover mostly the relationship between those capabilities on the example of professional sportsmen at different stages of their careers. These studies revealed explicit relationship between physical coordination and technical and sports capabilities in numerous sport disciplines. It is necessary, however, to explore and study the relationship between motoric and physical fitness capabilities at all stages of development of physical fitness. In this context a new problem arises, which is related to the process of teaching particular physical activities. An important element in this process is the application of such solutions which would enable to optimize the effectiveness of teaching particular physical activities and to determine the most effective method of teaching and improving particular technical skills at all stages of development of physical fitness (which is also relevant for practical subjects, such as gymnastics, athletics, swimming, team sports, which are included in the curriculum of students of physical education). That is why the attempt to increase effectiveness of didactic process as regards practical academic subjects constituted the rationale behind selection of that particular research problem as worded in the title of this thesis. The pursuit of more effective solutions as regards both teaching and improving technical skills as well as the attempt to enrich current methodology of teaching the technique of movements with elements of formation of physical condition and physical coordination motoric capabilities relevant for particular sport discipline would enable faster and more effective acquisition and improvement of necessary physical fitness skills.

The accurate diagnosis of the level of motoric capabilities among students may enable to optimize their recruitment as regard such specializations as physical education, tourism and recreation and physiotherapy. As a result, it would enable to select and further recruit those candidates, whose level of motoric capabilities would enable fast, long-lasting and thorough acquisition of relevant physical skills during the course of study.

It is assumed that the results obtained throughout the study would enable to significantly increase the effectiveness of the learning process as well as the improvement and stabilization of sport and recreational physical abilities.

1. THE SUBJECT OF RESEARCH IN SPECIALIST LITERATURE

1.1. STATUS OF PHYSICAL CONDITION AND COORDINATION CAPABILITIES WITHIN THE STRUCTURE OF HUMAN MOTORICITY

Motoricity, which was referred to in the past as "entirety of physical activities of man, in other words – the area of physical activity, i.e. everything that relates to moving in space due to changes in location of entire body or its individual parts relative to themselves" (Demel, Skład 1986), is currently understood and defined more broadly as a set of categories of biological motoric functions determined by social activities of man (Blume i wsp. 1981, Raczek 1986). More and more often it is defined as "entirety of manifestations and determinants as well as behaviour and needs involving physical movement" (Raczek 1986, Szopa 1989).

Mleczko provides more comprehensive definition of motoricity whereby "it is a descriptive construct which, having taken into consideration all posible types of physical movement and complexity of its determinants, determines continuously created and regulated process of energy exchange as well as a properly controlled course of all mnemonic, sensoric, and cognitive factors in order to produce desired and observable motoric effects" (Mleczko 1992). Bogdański (1972) points out to the broad definition and origin of the term "motoricity", which is defined as a set of manifestations of motorics of a particular system (motus – movement) and its driving characteristics (driving force – motor).

When examining the problem of motoricity, it is essential to distinguish between the aspect specifying spatial and temporal relations of the body subject to movement (external aspect), and the entirety of internal motoric functions of human organism (internal aspect) (Raczek 1987, 1993, Szopa 1989, 1996). In such a situation, it is necessary to separate the mechanisms of control and regulation as well as the entirety of functional processes from its variously formulated outcome – the movement. As a result, it is possible to determine specific dimensions of motoricity, which may be subsumed uner the general structural model of human motoricity, encompassing two dimensions (Fig. 1):

- potential, which stands for internal determinants of the course of movements specifying processual characteristics related to the character of physiological activities of human organism as well as its psychological functions (Willimczik, Roth 1983, Čelikovsky i wsp. 1985, Raczek 1986, 1987, 1990, Meinel, Schnabel 1987, Měkota 1989, Kasa 1990).
- Effective, which stands for external manifestations of physical movement specifying characteristics related to the course of physical movement and its

effects. In this context, we may distinguish between structural (i.e. the view and course of physical movement in space and time) and final characteristics (i.e. the final result of physical activity) (Čelikovsky i wsp. 1985, Raczek 1986, 1987, 1990, Meinel, Schnabel 1987, Měkota 1989, Kasa 1990).

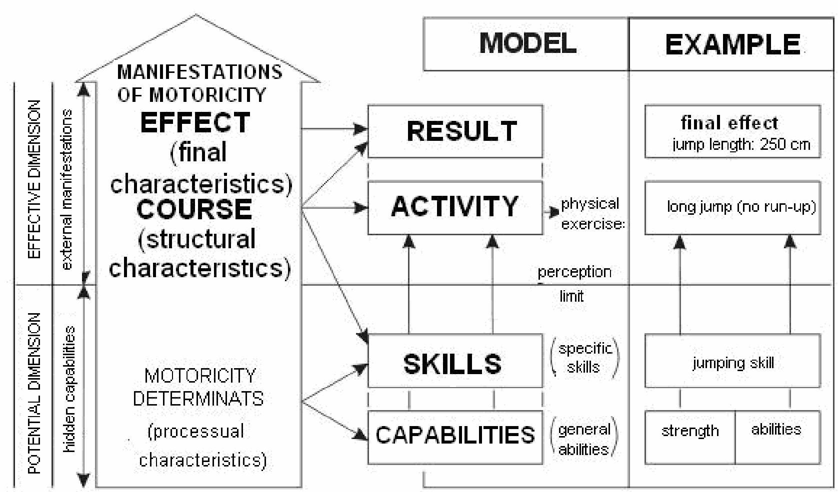


Fig. 1. Dimensions of human motoricity (Raczek 1993)

The concept presented above treats motoricity as a natural system, i.e. a coherent whole of external forms of physical activity together with relevant physiological and psychological mechanisms.

Internal determinants of the course of physical activities, which are the most interesting for the purpose of this research, determine processual characteristics related to physiological side of human organism as well as its psychological functions. These characteristics encompass general qualities, i.e. motoric capabilities, as well specific qualities, i.e. motoric skills. These characteristics determine potential and hidden motoric capabilities of any human being (Čelikovsky i in. 1985, Raczek 1986, 1993, Meinel, Schnabel 1987, 1998, Ljach 1987, Měkota 1989, Willimczik, Roth 1999).

Motoric capabilities are ”sets of individual psychophysical characteristics (predispositions) developing on the basis of inborn genetic makings, which determine the quality of the course and outcome of any physical activity” (Raczek 1990, 1991, 1993, 2002). The term ”predisposition” included in the definiton means ”elementary, structural and functional qualities of human organism, which are to the large extent determined geneticaly and measurable by means of methods relevant for elementary sciences” (Szopa i wsp. 1996, Szopa 1998). Motoric skills, which belong to specific capabilities, are commonly referred to as ”a determinant, readiness or predisposition for effective performance of a particular motoric task” (Raczek 1986, 1993).

In specialist literature one may encounter the division of motoric capabilities into general and specific (motoric skills) (Mekota, Blahus 1983, Čelikovsky i wsp. 1985, Raczek 1986, Meinel, Schnabel 1987, Willimczik, Roth 1988). General capablities, due to their various anatomic and physiological background, are divided into physical condition capabilities (energetic) and physical coordination capabilities, which are subject to information and control function of the nervous system. According to Raczek and Mynarski (1991), physical condition capabilities determine major qualities of the intensity of any movement, such as strength, pace and duration; they comprise mainly energetic and morpho-structural predispositions. Physical coordination capabilities, on the other hand, determine the quality of the course of any physical activity as well as its adaptation to external conditions; they comprise mainly neuro-sensoric and psychological predispositions (Fig. 2). Some theoreticians of motoricity agree that there is theoretical and practical rationale behind distinguishing the so-called complex capabilities (referred to as physical condition-coordination, mixed or hybrid, whereby it is extremely difficult to indicate their specific dominant (Bompa 1983, Čelikovsky i wsp. 1985, Raczek 1990, 1993, Mynarski 1995).

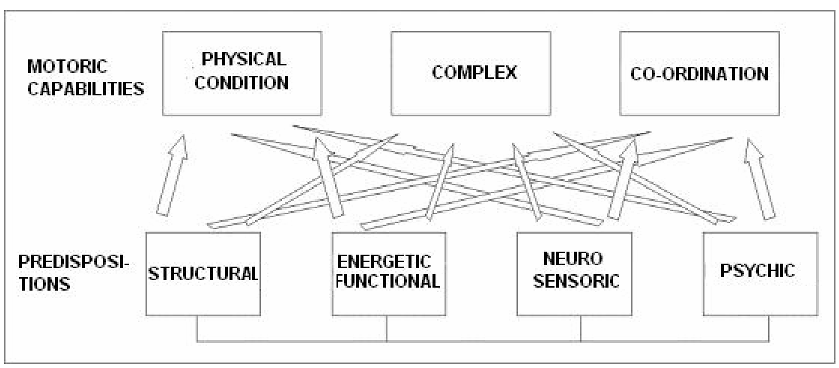


Fig. 2. Structural model of dependencies between motoric capabilities and their predispositions (Raczek 1993)

Motoric skills (specific capabilities) together with general motoric capabilities constitute internal determinants of the course of movement and therefore determine processual qualities related to the character of the course of physiological processes in human organism and its psychological functions (Raczek 1987).

Internal determinants of the course of physical movement, i.e. a potential side of motoricity, presents two opposites, category-specific and general, of the same motoric category. Capabilities constitute common determinants for numerous motoric activities; skills comprise specific predispositions for particular activities (Hirtz 1994, Raczek 1989, 1990, 1998, Ljach 1990, Wyżnikiewicz–Kopp 1992). Therefore it is erroneous to consider capabilities and skills as independent qualities. Capabilities may manifest through skills. On the other hand, skills may manifest themselves through motoric capabilities. Thus the differentiation of these two categories is possible on the basis of their various level og generality. Capabilities constitute determinants of numerous motoric activities, whereas skills lie at the bottom of specific motoric activities. (Raczek 1993).

1.1.1. The essence of physical condition capabilities

The group of unidimensional, basic motoric physical condition capabilities (energetic) encompasses maximum strength and oxygen endurance (Mynarski 2000). It is emphasized that types of physical condition capabilities should be differentiated on the basis of their hypothetical predispositions (Raczek 1993). Speed, as a motoric physical condition capability, is still a focal point of discussion as some authors emphasize that speed constitutes a borderline case between physical condition and co-ordinaton capabilities (Kasa 1983, Mekota 1983, Willimczik, Grosser 1979). The capabilities mentioned above are closely related and dependent on each other, which produces a series of motoric qualities of complex character, which constitute combinations of these capabilities (Fig. 3).

However, these qualities shall not be treated as internal aspects of particular capabilities, but rather as new motoric qualities which are the result of various dependencies. Among basic physical condition capabilities one may distinguish even more detailed types, which result from their internal structure (Fig. 4).

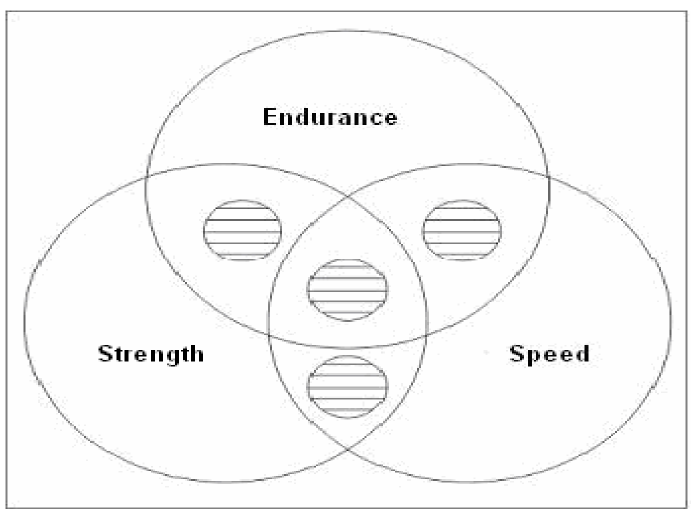


Fig. 3. Division of motoric physical condition capabilities (Raczek 1987)

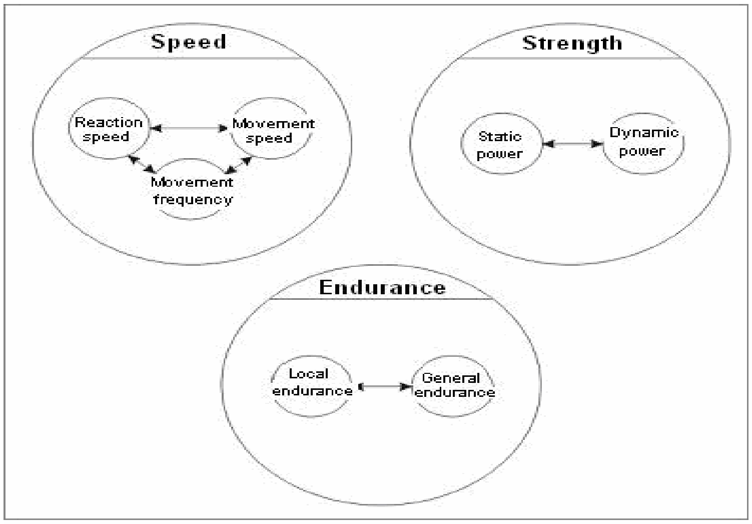


Fig. 4. Internal structure of speed, strength and endurance (Raczek 1987)

Strength capabilities determine capabilities of a human organism to overcome external or internal resistance in static conditions, or in conditions of ”low-speed movements”. Basic elements, which identify this type of capabilities, are the following ones: bio-mechanic parameter of maximum moments of force developed through contracting muscle in static conditions, and oxygen-free foundation (Szopa 1993). In sciences related to physical education one may distinguish between static, dynamic and explosive muscle force. Static force may be subsumed under the above definition and, according to Szopa, it is the moment of force developed through contracting muscle in static conditions. Dynamic force is defined as a capacity of muscle system and nervous system to overcome resistance with the fastest speed of muscle contraction (Trzaskoma & Trzaskoma 2001), and according to Szopa, dynamic force, depending on the administered test, either identifies itself with the factor of static force, or it is saturated with many factors (Szopa 1993, Szopa i wsp. 2000). Major predispositions of strength capabilities are, among others, cross-section of muscles, number and innervation level of motoric units, proportion of bone levers, and efficiency of mechanisms for energy release from phosphocreatine (Szopa 1992, 1993).

The problem of endurance as a motoric capability and its determinants has been widely studied and thorougly reported in Polish and foreign academic journals (Kozłowski, Nazar 1984, Raczek 1987, Wuest, Buchar 1991, Heyward 1997).

Raczek describes endurance as ”a capacity of the organism to perform long-lasting effort of particular intensity and retention of high resistance to tiredness in various external conditions" (Raczek 1991b). From such a perspective, a major determinant of endurance is a duration time of an activity of particular form and intensity. Endurance is divided on account of the character of energy transformations into oxygen and oxygen-free, and on account of duration of the effort it is divided into short-lasting, medium and long-lasting (Raczek 1991b, Sozański 1992).

A general problem, which is commonly referred to by authors as the very indication of endurance and which is conditioned biologically, is functional capacity; it is thoroughly defined as a physical function, aerobic function, anaerobic function, oxygen-free function, aerobic-anaerobic function etc. It enables researchers to develop new criteria of classification of the types of functions, such as aerobic, anaerobic, aerobic-anaerobic (Raczek 1991b, Cempla 1989).

The physiological foundation of endurance capabilities is the functional capacity understood as the capacity of circulation system and respiration system (releasing energy during aerobic processes). The most important predispositions of endurance is maximum absorption of oxygen (VO_2max) as well as tolerance for "acidity", which is a concentration of lactate in blood (Szopa 1993).

According to Szopa, the capacity for maximum absorption of oxygen (VO_2max) is "a capacity of absorption and utilization of oxygen in muscles, which in other words means that it is a process of functioning of both circulation and respiration systems during long-lasting effort with particular intensity, and its predispositions are parameters of action of the heart, composition of blood (number of erythrocytes, Hb level), quality of functioning of enzyme systems of Krebs cycle and respiration chain, as well as parameters determining acid-alkali balance" (Szopa 1998).

Among endurance capabilities, Szopa also distinguishes the resistance capacity of muscles for tiredness. These are the capacities of men to perform any work without any signs of fatigue, which is based on the structure of muscle fibres, mechanisms of acid-alkali balance, psychological and mental features and the aforementioned tolerance for acidity. Szopa emphasizes that on account of hybrid character of endurance capabilities, their classification as typical energy capabilities is to some extent a simplification. Endurance capabilities encompass multiple predispositions of different character. (Szopa et al. 2000).

Various forms of manifestations as well as complexity of speed capabilities contribute to the fact that this area is less researched in comparison with previously described capabilities (Mynarski 2000).

According to some of the authors, speed capabilities are classified among energy area of energy potential (Kasa 1983, Willimczik, Roth 1983, Meinel, Schnabel 1987). More often than not, speed capabilities are classified among group of complex capabilities, which are also referred to as hybrid capabilities (Měkota 1989, Bompa 1990, Szopa 1989, 1993, Raczek 1990).

According to Szopa, speed capabilities are defined as a capacity of the organism to move entire body or its parts in space in the shortest possible time.

According to Szopa, who looked at speed from energy perspective, the essence of speed capabilities is the release of maximum energy in the shortest possible time, and, from physical perspective, to set the body or its part to move with maximum acceleration (Szopa 1992, 1995).

Among essential elements integrating speed capabilities, Szopa enumerates oxygen-free sources of energy and the twitching speed of muscles (time of reaching maximum strength).

Among oxygen-free sources of energy, Szopa distinguishes the capacity to reach maximum anaerobic MMA power (MMA – no-acid-milk), which determines the capacity of the organism as regards speed of releasing energy stored in muscle phosphocreatine during short-lasting effort (5-8 seconds). It enables to reach maximum power through release (explosion) of considerable amount of energy. Maximum anaerobic MMA power consists of such predispositions as: number of fast-twitching fibres (FT), capacity to store phosphocreatine, and efficiency of enzyme mechanisms to release energy (Szopa 1995, 1998).

Among oxygen-free sources of energy, Szopa distinguishes the capacity to reach maximum anaerobic MMA power (MMA acid-milk) and describes it as efficiency of the process of oxygen-free glycolysis, which is sufficient to meet organism's energy needs during any physical effort of maximum intensity, which on average may last about 30-40 seconds. Major predispositions, which account for maximum anaerobic MMA power, are the following: proportion of muscle fibres (FT/ST), efficiency of enzyme reactions of glycolysis cycle (Szopa 1995).

The capacity for fast muscle mobilization (muscle twitching speed) is the most hybrid capacity. It is the capacity of the organism to stimulate the highest possible number of motoric units (muscle innervation, activity of controlling mechanisms) and to quickly release energy derived from MMA no-acid-milk sources (Szopa 1995, 1998).

In the light of the aforementioned conclusions, speed capabilities (not strength capabilities) encompass frequently used notion, especially in the context of practising sport, namely ”explosive force”, which is based on both types of capacities, i.e. a capacity to reach maximum anaerobic MMA no-acid-milk power, and a capacity for fast muscle mobilization (Szopa 1995, 1998).

Many authors (Szopa 1988, Bompa 1990, Raczek 1991, Raczek, Mynarski 1991, Czajkowski 1993) emphasize a hybryd (complex) character of agility capabilities. According to Raczek (1993) the latter one constitutes ”a structurally complex hybrid motoric capacity, which is a borderline case between physical condition and physical coordination capabilities, which further means that it is subject to information and energy predispositions”.

Generally, the level of agility is influenced by speed (which is an energy capacity), as well as precision and economy of movement, which are subject to coordination capabilities (Mynarski 2000).

According to Raczek, a group of complex capabilities should also encompass so-called ”secondary capabilities”, which ”arise as a result of interaction between the remaining characteristics of motoricity” (weight endurance, speed endurance etc).

Litheness, which is a motoric capability, is frequently classified as the passive element for transporting energy, and as an autonomous and functional characteristics (Wolański, Parizkowa 1976, Bös 1987, Raczek 1991, Szopa 1992).

Litheness may be defined as ”a range of movement in a single joint or multiple joints” (Osiński 2003). Litheness is also a capacity of a joint or multiple joints within the full range of mobility (Heyward 1997). The range of mobility in a joint depends on kinematic capacities of a joint, characteristics of muscles and connective tissue adjacent to a particular joint, which may be stretched within their structural limits. (Osiński 2003).

1.1.2. The essence of motoric coordination capabilities

In recent years, there has been much focus in specialist literature on the issue of motoric coordination capabilities [also known in specialist literature as ”coordination motoric capabilities” or ”CMC”), which may be defined as ”psychomotoric factors, which determine readiness to optimum regulation and control of motoric activities” (Ljach 1979); according to Raczek (1991), physical coordination capabilities reflect ”complex relations between neuropsychological factors, which enable effective regulation and control of motoric activities in a complicated multi-level system based on biological foundations”. There have been attempts to identify specific elements of their internal structure and determine their biological foundations (predispositions). This task is not as easy as the one related to energy capabilities. It is difficult to determine exact set of independent factors, which are responsible for quality of the course of movement. It is impossible to call those qualities (factors) either physical coordination or agility, because these terms are too general (Raczek 1986). The researchers studying these issues agree that a set of motoric physical coordination capabilities reflects complex relations between various neuropsychological components, which determine successful regulation and control of motoric activities (Raczek 1986, 1987, Meinel, Schnabel 1987, Hirtz 1994).

According to Raczek et al. (1998), ”processes of regulation and control take place in a similar way among all people, which does not mean that they take place with the same speed, precision, variation, mobility etc in every individual.” These individually variable qualities of processes of regulation and control determine the level of physical coordination capabilities. Physical coordination capabilities determine various operations (processes) of information character (perception, mnemonic, cognitive, effectoric) as well as forms of control and regulation of these processes (speed, precision, lability, diversity, effectiveness and others)”. In the course of any motoric activity, individual forms of the course of regulatory processes become established. Functional changes lead to generalization and transfer of the above forms of the course of these processes, and as a consequence, they lead to development of motoric physical coordination capabilities, i.e. functional determinants of the realization of entire sphere of motoric activities with common physical coordination requirements. Thus, the essence of CMC boils down to generalization and establishment of specific forms of regulatory processes. Their types are determined by various operations in the process of organization of information as well as diversity of forms of processes regulating these operations (Hirtz 1994, Raczek 1999, Raczek et al. 1998, 2002a).

A similar course of regulatory processes among all human beings does not translate into either equal level of development of CMC or their homogenous nature. Dissimilarity between these processes results from individual differences, which determine potential for effectiveness of conducting particular motoric activities (Mynarski, Żywiecka 2004).

Referring to physical coordination capabilities, Szopa (1992, 1995, 1998) represents that they determine potential of human organism to perform precise and specific movements in changing conditions (change of surfaces, direction and axis of movement. According to Szopa, the main factor integrating that type of capabilities is their biological foundation (functions of central nervous system and sense organs, capacity of neurons to record information and reproduce it when controlling movements).

According to Starosta (2003), quality of movements indirectly reflects the effectiveness of central nervous system and its manifestations. Starosta refers to physical coordination as ”a capacity to integrate different capabilities or as an organizer of their co-operation while performing various motoric activities”. He refers to motoric coordination as a ”super quality” or ”super capability” (Starosta 1989, 2003).

Physical coordination capabilities, as functional reasons determining quality of the course of movement, determine, among others, speed and precision of motoric learning and their adequate application in particular situations and conditions (Starosta 1989, 2003, Raczek et al. 1998, 2002a, Juras 2003).

Results of studies conducted in Poland and in the world over enable researchers to distinguish independent (specific) coordination capabilities, such as: sense of balance, orientation in time and space, reaction speed, rhythmization of movements, kinesthetic differentiation and frequency of movements, motoric adaptation, movement coupling movements (Mynarski 1991, 1995, Raczek 1992).

The studies conducted over recent years have also aimed at determination of internal structure of specific physical coordination capabilities and, to that end, numerous experiments have been conducted in order to optimize methods of their measurement through modification of existing motoric tests (Mynarski 1991, 1995, Juras et al. 1992, 1993, Waśkiewicz et al. 1993, Raczek et al. 1994).

Specific physical coordination capabilities exist in numerous and various structural relations, which are reflected in three complex sets of physical coordination capabilities (Fig. 5) (Blume 1981, Raczek 1987, 2002): motoric learning, control and regulation of movements and motoric adaptation. Motoric learning is intertwined with specific coordination capabilities, and control and regulation of movements is intertwined with those capabilities which are related to performance of standard movements; finally, motoric adaptation is intertwined with those capabilities which determine potential for adaptation of movements to different situations and external conditions (Raczek 1987).

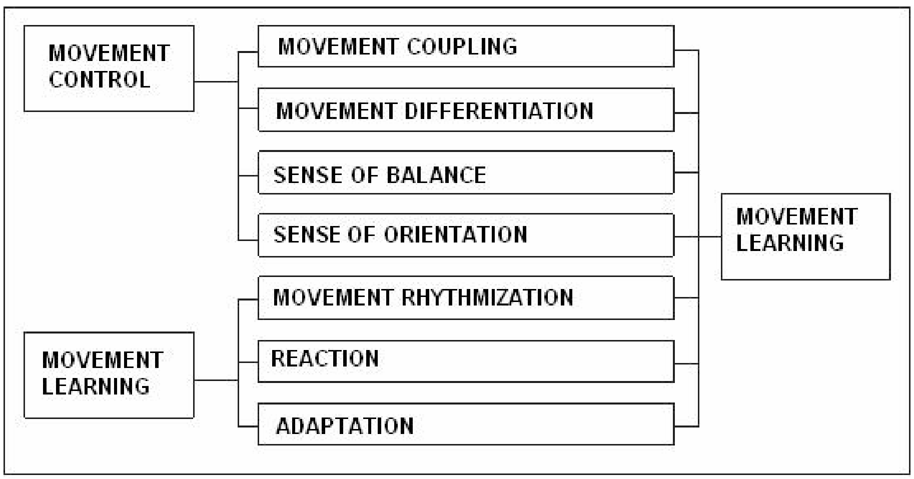


Fig. 5. Sets of physical coordination capabilities (Blume 1981)

Hirtz (1994) analyzes the issue of motoric coordination capabilities on the basis of the most up-to-date research results and practical tests, and he proposes certain taxonomic simplification, taking into account multi-element set of the so-called coordination competence, i.e. basic complexes of physical coordination capabilities (Table 1).

Farfel (1960) and Raczek & Mynarski (1992) represent that physical coordination potential of a human being is subject to spatial precision, time and variability of external conditions and situations in which a particular movement is performed. On the basis of the above criteria, they outline the following: Farfel (1960) – 3 levels of coordination requirements with various degree of complexity, and Raczek & Mynarski (1992), who modified this concept, 4 levels:

Level 1 – precision; capability for precise movement regulation; capability for control and regulation of simple, popular and supervised movement performed in standard conditions without any time limits and with continuity of feedback;

Level 2 – precision + speed; capability for coordination in limited period time; capability for control of popular, precise, short-term and quick motoric activities performed in standard conditions

Level 3 – precision + variability; capability for control of unknown, variable and precise and slow motoric activities in changeable conditions;

Level 4 – precision + speed + variability; capability for adequate adaptation and motoric redirection, capability for precise control and regulation of unknown, fast activities in changeable conditions and situations.

Table 1.

Basic complexes of physical coordination capabilities – three-part structure of coordination competence (Hertz 1994)

Parameters	Capabilities		
	Precise movement regulation	Coordination in limited time	Motoric adaptation and redirection
Method of performing movement	Precise	Precise and fast	Precise, fast and changeable
Coordination character	Constant comparisong of factual value with desired value	Generalized motoric programs	Programmed changability and redirection
Dominant brains area	Basal ganglia	Cerebellum	Motoric cortex
Diagnostics	Level tests	Speed tests	Comprehensive tests
Methodology	High precision of the task (target), precision increase	High pace, setting time, limitation of time	High changeability, counteraction, comprehensiveness increase
Forms (types) of activities/sport disciplines	Endurance-based	Strength and speed based	Games and combat sports

Characteristics of discussed classifications of physical coordination determinants has been presented in Table 2. The concepts subject to description may have the majority of basic motoric physical coordination capabilities assigned to them. Their specific types are intertwined within hierarchial levels reflecting growing physical coordination requirements (Raczek et al. 1998, 2002).

Table 2.

Levels of physical coordination requirements (Farfel 1960, modified by Raczek & Mynarski 1992)

Co-ordination levels	Co-ordination capabilities	
	General	Specific
IV. Precision+speed+variability nność Capacity to control onknown, variable, precise and fast movements Variable conditions and situations, open-ended		e.g fast and adequate adaptation to changeable conditions and situations, fast complex reaction; fast, precise and adequate differentiation and orientation.
III. Precision+variability Capacity to control unknown, variable, precise and slow movements. Conditions and situations without temporal limitations		e.g. accurate adaptation to changeable situations; changeable balance; precise differentiation in changeable conditions.
II. Precision+speed Capacity to control known, precise and short-lasting and fast movements. Standard conditions and situations, close-ended.	Rhythmization, Orientation, Coupling, Differentiation, Balance, Reaction speed, Adaptation	e.g. fast reaction resulting from choice, fast dynamic-spatial differentiation; movement frequency, fast movement coupling
I. Precision Capacity to control known, precisely controlled and slow movements. Standard conditions and situations, close-ended.		e.g. static balance, precise kinesthetic diversification, precise spatial orientation, controlled rhythmization and movement coupling

1.1.3. Characteristics of specific physical coordination capabilities

The opinions outlined in the interpretation of the essence of physical coordination capabilities enable to distinguish at least 8 specific capabilities:

- temporal and spatial orientation,
- motoric reaction,
- kinesthetic diversification,
- movement rhythmization,
- keeping balance,
- movement coupling,
- motoric adaptation,
- movement frequency.

Their characteristics has been developed on the basis of earlier studies (Blume 1981, Wilimczik, Roth 1983, Hare 1985, Meinel, Schnabel 1987, Ljach 1989, Mĕkota 1990, Raczek 1991a, Raczek, Mynarski 1992, Hirtz 1994, Mynarski 1995, Juras, Waśkiewicz 1998, Raczek i wsp. 1998, 2002, Waśkiewicz 2002, Juras 2003, Starosta 2003). The order of description of specific physical coordination capabilities was based on hierarchial concept of structurization according to the criterium of complexity of their biological foundations (Hirtz 1994).

Capability of temporal and spatial orientation

Capability for spatial orientation determines the potential of man as regards precise assessment of the position of the body and changes of its position in relation to a point of reference (area of action or moving object), and realization of movement in a desirable direction (Raczek et al. 2002). Ljach defines orientation capability in a similar way as ”a capability for precise assessment of the position of the body and changes of the position of the body, as well as a performance of movement in a desirable direction”. Spatial orientation is inextricably linked with perceptron of movement parameters and their changes.

According to Juras & Waśkiewicz (1998), spatial orientation is ”a set of predispositions (mostly neurosensoric), which enable effective control and regulation of the course of movements in space, which, depending on the task, may manifest themselves in various different ways, e.g. orientation of a player on the pitch, a dancer on the scene, an acrobat while performing activities etc. These activities mainly point out to the role of perception (recognition of a frame of reference where movement takes place) as fundamental prerequisite which has to be fulfilled so that any motoric activity may take place”.

Among criteria underlying assessment of these capabilities, Raczek et al. (2002) mention economy and precision, speed and purpose, as well as temporal relevance (recognition of space as a function of time).

Capability of motoric reaction

Capability for fast motoric reaction [also known is specialist literature as ”swiftness of the reaction”] ”enables fast initiation and performance of purposeful, short-term motoric activity as a result of a reaction to a specific signal (visual, aural, sensory)” (Raczek et al. 2002). Time, which elapses from the signal till the ending of a specific movement, enhances the level of capability for fast reaction and it constitutes the sum of hidden reaction time (sensoric component) and speed of action of muscles involved in the activity (motoric component). Thus, the capability for fast reaction can not be interpreted as a synonym of the notion ”reaction time” (Gemblewiczowa 1973, Grosser 1976, Willimczik, Roth 1983).

Hidden reaction time elapses from the moment of stimulus activation till commencement of a movement. It consists of five leg times (Waśkiewicz 2002):

- creation of activation in a receptor and transfer of activation to central nervous system;
- course of activation by a nerve centre and formation of executive signal;
- course of the signal from central nervous system to muscles;
- activation of muscles;
- movement initiation.

Time of simple target movement means the time which elapses from initiation of movement, which is a reaction to stimulus, till its ending, which is a period of time which elapses from the appearance of first signs of muscles activation till the ending of motoric task.

Weiss (1965) proposed different division of reaction time and distinguished its central and peripheral component. The analysis of registered bioelectric activity of a muscle during reactive situations shows that the muscle does not start a movement for a longer period of time. After a non-activity period (40-80 ms) the activation takes place, but the movement is still not performed. It is a so-called pre-motoric phase of reaction, when programming processes of activities in central nervous system take place. However, the time from the moment of appearance of activation till initiation of movement is referred to as motoric phase of reaction time.

In practice, one may encounter different forms of fast reaction, which determine effectiveness of motoric activities. Reaction to particular signal by a precise course of movement is referred to as simple reaction (a start to a run). The answer to a single signal may be a reaction as a result of a choice related to fast recognition of the signal, its assessment and a choice of one out of numerous motoric solutions (Raczek et al. 2002, Waśkiewicz 2002, Mynarski, Żywicka 2004).

Any sport activity is frequently performed in a complex situation, which requires fast reaction to higher number of signals; therefore a differential reaction or complex motoric reaction is a necessity. Accurate assessment of those signals enables fast reaction and optimum motoric activity. (Raczek et al. 2002, Waśkiewicz 2002, Mynarski, Żywicka 2004).

When describing the capability of fast motoric reaction, it is necessary to take into account speed of recognition of the specifics of the signal and the process of decision-making related to methods and direction of a reaction.

When assessing the capability of fast reaction, it is necessary to take into account the following factors: speed of performing a motoric activity, adequacy (correctness) of action in relation to desirable target and situation, and temporal relevance, i.e. performance of reaction at the optimum moment.

Capability of kinesthetic diversification

Capability of kinesthetic diversification [also known in specialist literature as ”kinaesthetic differentiation” or ”differentiation”] determines high precision and economy of performing both entire movements and separate stages of a movement cycle. Raczek & Mynarski (1992), who attempted to describe the essence of that capability, mention the following: reception, assessment and processing of information on angle position in joints (spatial components), tension of involved muscles (strength components) and speed of movements (temporal components). Thus the basis of the capability of kinesthetic diversification is a precise perception of strength, temporal and spatial parameters during motoric activity as regards the most favourable solution to a particular motoric task. As a result, Raczek & Mynarski differentiate the following aspects of that capability: spatial, dynamic and temporal.

Capability of kinesthetic diversification is mostly determined by precision and subtlety of motoric impressions and observations (proprioreceptors), frequently in connection with aural and visual (telereceptors). At its bottom, there are mechanisms of the so-called ”bathyesthesia” (”muscle feeling”), which are referred to as kinesthetic analyzers (Raczek et al. 2002). Therefore this capability is frequently referred to as the feeling of movement, time, strength or the tool, water, air, snow, ball, arms etc. Kinesthetic diversification has a specific character in each sport discipline.

The assessment criteria of the capability subject to our description are precision and economy of movement.

Capability of movement rhythmization

The sense of rhythm constitutes inseparable element of the majority of motoric activities, which determines their effectiveness. In many spheres of physical activity, rhythmization of movement exerts considerable influence upon the final outcome, harmony and aesthetics. In many fields of life, such as dancing, music, ballet, gymnastics, hurdles, sprint or swimming, the sense of rhythmization accounts for the major factor.

The sense of rhythm during motoric activities has been studied by many researchers. Raczek et al. (2002) claim that ”capability of rhythmization enables to grasp, remember, replicate and realize a specific temporal and dynamic structure of cyclical and acyclical movements. It manifests itself in adaptation of movements to a given external rhythm, or in acceptance of a target internal rhythm”.

According to Wyżnikiewicz-Kopp (1978), the rhythm of movement is ”a uniform, balanced consequence and steady repetition of the same subsequent elements”; it is emphasized that capability for rhythmization encompasses the following: grasping, remembering and replicating the rhythm of movement obtained in dynamic-temporal divisions of kinematic representation of sports technique. The author underscores the difference between the sense of rhythm as a manifestation (feature) of movement and as a physical coordination capability, which is an obligatory approach in contemporary research.

In the sports practice, the sense of rhythm is referred to as a capacity for exact reproduction of a specific rhythm of movement, and further as its adequate correction depending on changeable conditions (Raczek et al. 2002).

The development level of this capability depends on the quality of processes of acoustic and visual information processing, which determine motoric effectiveness as well as kinesthetic and tactile impressions. (Raczek et al. 2002).

Capability of rhythmization may manifest itself in time (slowing down or acceleration of movement), dynamics applied in the movement (changes of force of tensed and relaxed muscles) and spatial route of a movement (change of a range and direction of movement). It influences fast and exact acquisition of capabilities and skills in case of any sport discipline. (Mynarski 1995, Czajkowski 1996, Meinel, Schnabel 1987, Raczek 1999, Starosta 2003).

Among criteria of assessment of this capability, Raczek et al. (2002) mention, apart from the economy and precision, speed and purpose (e.g. selective perception of selected parameters of space, in accordance with movement needs), as well as temporal relevance (recognition of space as a function of time).

Capability to keep static and dynamic balance

Keeping balance of the body ensures effectiveness of performance of a majority of movements, because even simple movements require keeping statics of the body in place, whereas feeling and keeping a specific position of the body constitutes the main purpose of every physical activity, regardless of whether it is performed in vertical position (running, skiing), horizontal (tobogganing), or turned down, i.e. with head pointing down (gymnastics, acrobatics).

Keeping balanced position of the body in everyday life usully takes places unconsciously (Juras 2003).

According to Kuczyński (2000), balance of the body is paramount to keeping erect body position, i.e. an ability to sustain a projection of centre of mass (COM) inside supporting area marked with feet outline.

According to Raczek (1991), balance of the body is a quality which "enables to sustain balanced position of the body (static balance) and to sustain or regain such a position (dynamic balance) during any physical activity, or immediately after any physical activity."

The balance manifests itself in a various and specific way. In one case, it is necessary to keep balance in static positions (standing on hands or one one leg, positions in shooting or starting positions in hand stands or one-leg stands, shooting positions, diving. Then it is referred to as a static balance. In other situations, balance is kept while performing movements (beam exercises, skating etc).

Keeping static position of the body during above types of movements is referred to as dynamic balance (Raczek at al. 2002). Some authors distinguish the balance related to joggling (balancing) objects or on objects (Fetz 1990, Raczek et al. 2002).

The sense of balance may be also relevant for movments performed in one direction (locomotive balance) or around the axis of the body (rotational balance), (Mynarski, Żywicka 2004).

At the base of the capability to keep balance, there is mainly information extracted from a vestibule organ of inner ear, visual analyzer, the sense of bathyesthesia. In delivering information related to the balance of the body, an important role is played by vestibule analyzer, which is also referred to as the sense (organ) of balance. Impulses from vestibule organ, eyesight and priopriorecep-tors of bathyesthesia are integrated in central nervous system (Wyżnikiewicz-Kopp 1992).

The main criteria of the level of the capability subject to description are the following: precision, speed, purpose and ingenuity of movements which contribute to keeping balance or regaining balance. (Raczek et al. 2002).

Capability of movement coupling

Capability of movement coupling determines potential of man as regards harmonious connection of simultaneous and subsequent movements of the parts of the body, as well as linking various forms of movements into combinations and arrangements. (Blume, Zimmermann 1987). According to Raczek & Mynarski (1992), the capability of movement coupling ensures purposeful organization of body movements and leads to integration of spatial, temporal and dynamic parameters of movement and its submission and subordination to motoric task realized by entire body (e.g. linking arm swings, shoulder swings with locomotion movements, linking movements of shoulders, legs and torso during swimming). Temporal factor manifests itself during simultaneous or subsequent participation of partial movements in the course of entire activity. Spatial factor determines whether each subsequent movement starts when the body assumes a particular position. Share of strength should be balanced in such a way that temporal and spatial parameters are manifested in an optimal way (Raczek 1991).

Capability of movement coupling plays a dominant role in complex (from physical coordination perspective) sport activities such as figure skating, gymnastics, rhythmic gymnastics, acrobat gymnastics, team games or combat sports, where organization of movement frequently involves participation of equipment and various apparatus, or participation of a co-partner or opponent. Raczek (2002) represents that at the basis of capability of movement coupling lies kinesthetic and optical information as well as a significant role of anticipation. The major criteria underlying assessment of this capability include: precision, economy and purpose of a particular movement.

Capability of motoric adaptation

According to Raczek (1991), motoric adaptation is ”a capability which enables to implement optimum program of action as well as its modification or redirection in case any change of the situation is either predicted or expected”. These predicted changes may be minor (relatively predicted) and then the control-regulation system performs minor corrections of motoric program realized before modification. The correction boils down to adaptation of selected temporal-spatial-strength parameters of the structure of movement from the perspective of a long-term action plan. If changes are significant enough to disturb the course of physical activity, then they may lead to temporary halt in the realization of the program, or to implementation of downright different program, which is not necessarily a continuation of the previous one. In the latter case, Raczek (1991) uses the very expression ”capability” to redirect (restructure) movements. Thus, from this different perspective, Raczek represents that capability of movement adaptation (restructuring) constitutes ”a possibility of fast transformation of acquired forms of movement, or transition from one form to the other form, depending on changeable external conditions. At the basis of that capability there are the processes of acquisition and processing optical information as well as acoustic, sensory and kinesthetic information”.

Schnabel et al. (1994) refers to motoric adaptation as ”a relatively generalized and consolidated determinant of purposeful programming or transformation of motoric activity depending on constantly changing and unpredictable situations, or under the influence of direct action of an opponent”.

Mynarski & Żywicka (2004) emphasize that the very effectiveness of motoric adaptation largely depends on individual experience of performing particular movements, and the vaster the store of skills and experiences one has, the easier it is in difficult situation to develop an adequate motoric program, i.e. a concept of action, or a mode of behaviour”. In his research, Waśkiewicz (2002) emphasizes the possibility of division of adaptation behaviour into continuous and non-continuous.

In case of adaptation capability, a basic criterion of its assessement is creativity of action, which manifests itself in ingenuity of selection of motoric activities, and in repetitiveness (constancy) of the structure of movement in changeable conditions of their performance (Raczek et al. 2002, Mynarski & Żywicka 2004).

Capability of high-frequency of movements

Potential of man as regards the range of performance of high-frequency movements determines effectiveness of motoric activities in such sports as: sprints, kayaking, swimming, speed-skating. That quality determines ”possibility of man to perform maximum number of movements with the entire body or its part in a unit of time” (Zaciorski 1970). The research conducted over recent years showed that a potential of man to perform movements with maximum frequency depends largely on effectiveness of nerve centres which control antagonistic groups of muscles and lead to rapid transition from a state of excitement into a state of hampering, and the other way round, i.e. from mobility of nervous processes. (Sozański, Witczak 1981).

The capability in question relies on the functions of central nervous system, which implies its coordination character. (Raczek & Mynarski 1992, Mynarski 1995, 1998). Mynarski (1998) emphasizes that in the structure of motoric capabilities the potential of high-frequency movements should be placed on the border between speed and coordination capabilities. Szopa (1992) also emphasizes ”explicit coordination background” of frequency of movements and as a determinant of the potential of man as regards speed capabilities Szopa emphasizes the capability of fast mobilization of muscles. Moreover, Szopa underscores the most typical ”hybrid” character of its background, which is of energy and coordination background.

The main criteria underlying assessment of the frequency of movements are speed and precision of their performance.

1.1.4. The essence of motoric skills

Many contemporary theoreticians and researchers include motoric skills as components of the motoric potential of man (Willimczik & Roth 1983, Čelikovsky et al. 1985, Singer 1985, Raczek 1986, 1987, 1989, 1991, Meinel & Schnabel 1987, Měkota 1989, Kasa 1990, Szopa 1992). According to the majority of researchers, motoric skills (sports and motoric) account for specific predispositions of man for effective performance of particular motoric activities. They determine individual differences between levels of functional processes, which underlie realization of specific sports movements, and develop during the process of learning and practising on the basis of adequate motoric capabilities and previous motoric experiences (Roth 1983, Raczek 1991).

According to Raczek, ”motoric skill” accounts for a potential determinant, readiness or predisposition to effective performance of a specific motoric task”. The essence of motoric skills is not a ”qualitatively measured value”, but rather appriopriateness and effectiveness of the use of human organism’s potential as regards better performance of a particular motoric activity, and their sufficient store enables to select the most adequate motoric activity in relation to existing situation and requirements” (Raczek 1991, 1993).

Motoric skills determine proper structure of movement and therefore they may manifest themselves only during performance of a specific motoric activity (Szopa 1995). According to Raczek, ”as opposed to motoric capabilities, they have highly-specific character, manifest explicit and direct relation with a particular motoric activity. As a result, their names are generally identical with the names of performed movements” (Raczek 1993). Szopa, on the other hand, while emphasizing the relationship between motoric skills and motoric capabilities, claims that ”the very manifestation of the majority of motoric skills requires adequate level of motoric capabilities (the so-called minimum level)”. Szopa underscores the essence of the relation between acquired store of motoric skills and motoric capabilities, and refers to the said capabilities as ”a backbone” of these skills. (Szopa 1995).

Nowadays theoretical and empirical studies on structurization and classification of motoric skills are rarely conducted and therefore researchers tend to refer to information and achievements of sports practice, other sport disciplines, or other branches of science. Motoric skills are closely related to externally perceived techniques of movement, so every motoric skill corresponds locally to a specific structural form of movement, and the other way round. Thus the names of skills are identical with names of sport and motoric tasks. In order to search for specific motoric skills, which are described within the framework of a concrete technique of movement, researchers use classifications and typologies developed in every sport discipline and based on horizontal and vertical (hierarchial) systematics of a technique. As a result, their number seems to be infinite and new elements of exercises, new equipment are being developed all the time, which contributes to wider range of performed movements. As a result, it is almost impossible to develop any global systematics of sports techniques. The monographs on the above topic mostly deal with internal systematization of motoric skills in particular sport disciplines. Their authors elaborate and use two strategies of structurization, i.e. two methods of structurization based on very diverse criteria (Göhner 1992):

1. Horizontal structurization, which is a sequential configuration of structurally diverse forms of movement of a particular sport discipline. Its purpose is to organize those elements of technique which are necessary to be acquired in order to sucessfully participate in a given sports discipline. The criteria underlying the division are the following: typical operations (e.g. supports exercises), positions of equipment (front, back), parts of the body (lower limbs, upper limbs), characteristic curved paths (figure-8 runs, swings), contact points (overhand grip, underhand grip), purpose of movement (blocking, taking off) and constant relations between spatial, temporal and dynamic factors. Distinguishing between individual elements sometimes constitutes an extremely difficult task.
2. Vertical structurization, which is a hierarchial gradation of forms of physical movements in a particular sports discipline, and a major criterion underlying this structurization is establishment of logical sequence of acquisition of desirable technique of movement. Basic movements (e.g. a forward roll, a backward roll, a step in a run, basic method of swimming and moving around the pitch etc) are placed on the lowest level. Taking into account basic movements, it is necessary to develop the elements crucial for optimal acquisition of techniques characteristic for a particular sport discipline. Gradation of forms of physical movements corresponds with methodical cycles and sequences developed in order to acquire elements of those sports disciplines, in which technique plays crucial role.

The whole of motoric skills are generally divided into two groups (Willimczik, Roth 1983, Singer 1985, Raczek 1987, 1993, Měkota 1989).

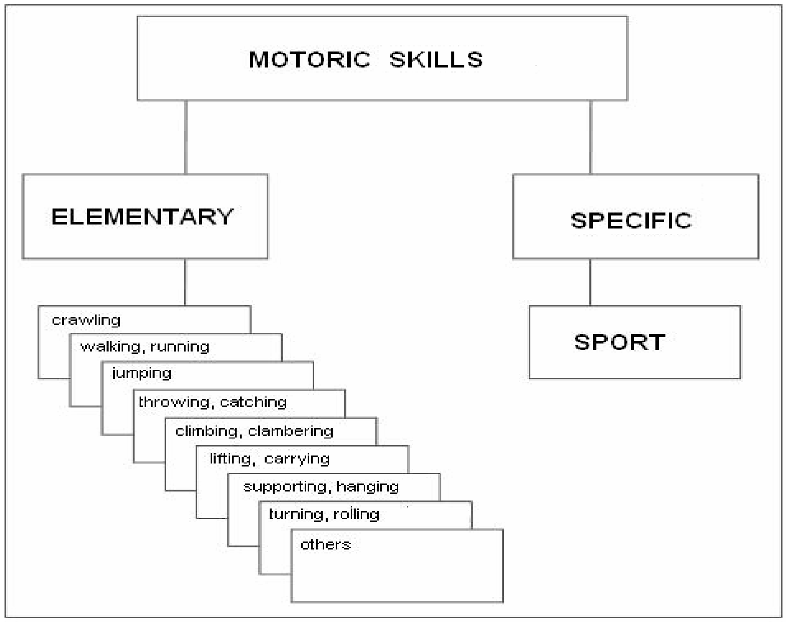


Fig. 6. Structure of motoric skills (Raczek 1993)

1. Elementary, connected with basic forms of natural movements, including locomotive movements (e.g. walk), non-locomotive (e.g. hanging) and manipulative (e.g. grip)
2. Specific, which are the basis of sports, productive and artistic movements

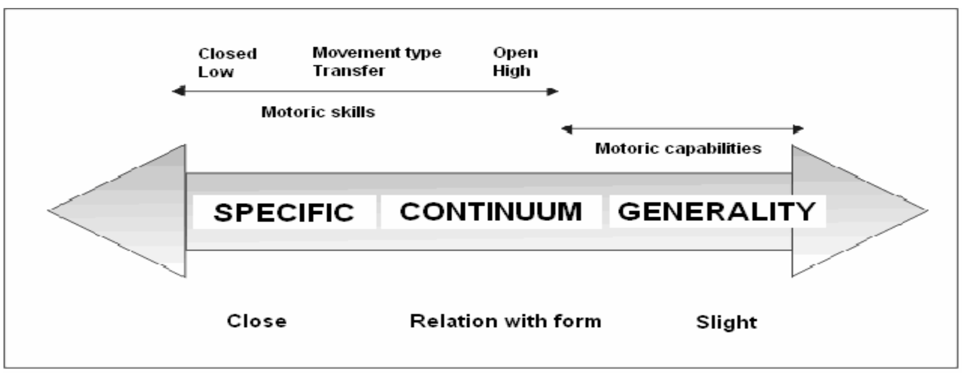
Another division of motoric skills proposed by Měkota (1989) and Kasa (1990) is the following one: elementary skills (basic movements and movement acts), specific movements (sports, professional) and communicative movements (gestures, mimics, pantomime.

1.2. RELATIONSHIP BETWEEN MOTORIC CAPABILITIES AND MOTORIC SKILLS

In specialist literature there is a small number of publications dealing with correlation between physical condition, coordination and motoric skills (Waśkiewicz, Juras 1994, Starosta 1998, Raczek et al. 2002). So far the publications broach the above correlation issue on the example of professional sportsmen at various levels of development and advancement. That issue is also extremely important from the point of view of theory and practice of both physical education and professional training. In order to understand the structure and essence of motoric skills, it is necessary to gain information related to their specific elements as well as mutual relations obtained between them (Raczek et al. 2002).

The results of numerous studies confirm that the set of coordination capabilities is made up of predispositions of the central and peripheral area of the nervous system (neuro and psycho-physiological mechanisms of regulation and control) whereas the set of physical condition capabilities (energy-related) is made up of morphologic-structural and energy-functional predispositions (physiological and biochemical transformations taking place in muscles and other organs of the body. It does not contradict the unity of information and energy processes as every physical movement action is based on simultaneous processes of information and energetic nature, which are applied in different proportions depending on the purpose of motoric activity (Raczek et al. 2002).

Integrity of motoric skills and motoric capabilities is crucial in that they account for mutually-dependent and interconnected components of the same motoric potential of man. While emphasizing their integrity, Raczek (1993) presents them as two polar opposites of the same category of motoricity: specific and general. (Fig. 7). Therefore it is erroneous to consider skills and capabilities as two independent qualities. Capabilities may manifest themselves only through skills, whereas skills manifest themselves through motoric capabilities. (Raczek 1993). According to Raczek (1993), distinguishing between these two qualities is ”possible only on the account of their varied degree of generality whereby capabilities constitute general determinants of numerous motoric activities, and skills lie at the bottom of concrete motoric activities” (Raczek 1993).



Ryc. 7. Generality of distinguishing features of motoricity (Roth & Willimczik 1999)

The assumptions presented above indicate the necessity to understand the principle of unity of formation of motoric capabilities and teaching motoric skills. It is crucial in case of sports activities characteristic of technical complexity and internal variety of movement tasks, which set high requirements in this respect.

What is also emphasized is the essence of correlations obtained between the level of motoric capabilities, in particular of physical fitness, and technical and sports skills in many sport disciplines: gymnastics and rhythmic gymnastics

(Blume 1978, Zimmerman 1984, Kioumourtzoglou et al. 1997, Fostiak 1994, 1998, Starosta 1988, 2003), handball (Kioumourtzoglou et al. 1997, Karpowicz 1992, Żak, Sakowicz 1995), basketball (Kubaszczyk 1993, Mikołajec 1998, Zając 1998, Ljach, Kubaszczyk & Juras, Waśkiewicz 1995), football (Panfil 1995) and athletics (Raczek 1990, Prus, Mynarski 1998). According to Raczek (1990), in case of team sports these correlations are much more explicit than in the case of athletics. Depending of the level of advancement among the sportsmen subject to research study, it is pronounced that there is explicit progression as regards the level of motoric coordination capabilities.

1.2.1. Diversity of physical condition requirements on account of specifics of a motoric activity

In sports practice, the possibility of continuation of a specific effort on the part of a sportsman is referred to as endurance, which is understood as the capability to oppose tiredness. The measure of endurance is duration of a particular effort without lowering its intensity. The effort made by man is closely related to processes responsible for tiredness, which are referred to in physiology as the change of functions leading to lowering the level of working capability of the human organism (Bangsbo 1999). Tiredness is determined by the type and character of the effort and it may feature different forms. According to Kubica (1995) the most frequent reasons of tiredness is the adverse influence of acidic products of functional basal metabolism, a degree of aerobic indebtedness of tissues, depletion of energy resources as well as dehydration of the body and the loss of electrolytes.

Endurance of man depends on a biological determinant, which is referred to as physical functional capacity. Kubica (1995) defines physical functional capacity as ”a capacity of the organism to perfom particular physical work, which is expressed by the maximum level of functional potential and effective course of regeneration processes”. Its systematic improvement has twofold meaning for physically active persons: it increases tolerance of the body as regards changes caused by increasing effort, and improves the processes of elimination of disorders as regards balance of the body (Naglak 2001).

Level of activity results from the character of a particular sports discipline and it always requires making considerable effort into the performance of work. Naglak (2001), who analyzed physical work performed by players of various team sports, provides an example of basketball players, who cover the distance of up to 4 kilometres during one game, handball players, who run up to 5.5 kilometres, and football players, who run up to between 10-12 kilometres during one match.

Determination of the accurate level of endurance as regards particular motoric activity constitutes both significant and difficult endeavor. That capability largely depends on energy transformations in human organism (aerobic, anaerobic), energy reserves, physical coordination as expressed in strength and speed, physical movement capabilities, thermoregulation of the body, build of the body, and psychological factors (Kubica 1995). According to Szopa et al. (1996), aerobic functional capacity, which constitutes the basis of functional capability, is measured by the capacity of maximum oxygen absorption; it is relatively controlled genetically, which for training practice means that despite genetic background there is some room for its improvement. The complexity of factors requires that there should be some rational improvement methods as regards function capabilities, which should take into account the time of making an effort and the level of intensity relevant for a particular sport discipline. (Naglak 2001).

It seems that it is hardly possible to overestimate the importance of speed capabilities in sport as their role has been crucial in almost any sport discipline. On the one hand, one may notice that more and more important for effective sport confrontation is individual speed and dynamics of particular competitors, which is relevant as regards both team sports and individual sports; on the other hand, the speed of performing any individual or team actions. ”Speed” frequently determines victory chances in sports disciplines of complex structure of movement as well as in team sports.

The speed level depends on numerous factors. In case when it is necessary to overcome high level of external resistance, speed will indubitably depend on the strength of muscles, whereas when the purpose of the activity is to perform a complex movement in a precise and immaculate manner, then the speed will be depend on coordination capabilities, such as agility, reaction speed as regards situational changes, level of technical skills etc. (Ljach 1999). In any sport activity one usually encounters complex situations, which more often than not give rise to the need to simultaneously show numerous components, which determine the speed effect of particular movement. This phenomenon is observed not only in case of the so-called complex disciplines, such as team sports or combat sports, but also in seemingly simple sports disciplines, such as sprint or swimming.

According to Osinski, (2000), ”speed capabilities” determine the potential of human organism as regards moving the body or its parts in space in the shortest period of time”. Further, Osinski (2000) lists the following components of speed capabilities:

- capability to reach maximum anaerobic non-acid-milk power;
- capability to reach maximum anaerobic acid-milk power;.

Among speed capabilities, it is necessary to single out speed as it occurs in simple and complex movements, cyclical movements, and acyclical movements. The importance of speed differs depending on a sports discipline, i.e. there are some disciplines where importance of speed is low (Prus 2000). Classification of sports disciplines on account of speed requirements is presented in Table 3.

Such a classification is ordered according to three criteria: the level required to show the components of speed, technical structure, functional structure of a start task, and a type and degree of relations between speed and other factors responsible for fitness and performance preparation (Ljach 2003, Prus 2003).

Many authors emphasize the issue of the relation between speed and other motoric capabilities, including strength capabilities. Every sports discipline and movement specialization sets its own unique requirements as regards structural connections between strength and speed. Examples of such connections are presented in Fig. 8, which is also an attempt to classify selected exercises on account of the level of connection.

Table 3.

Classification of sport disciplines on account of speed requirements (Prus 2003)

Classification criteria	Disciplines and events
Maximum manifestation of all or majority of speed components in changeable and complex situations	Team sports, freestyle/Greco-Roman wrestling, judo, boxing, fencing, tennis, alpine skiing, Eastern combat sports etc.
Maximum manifestation of majority of speed components in relatively standard situations	Athletic sprints, hurdles, jumps and throws (javelin, discus), speed-skating, cycling sprint, 50 m swimming, 100 m swimming etc
Maximum or near-maximum manifestation of particular speed components in conditions of external pressure, or coordinationally complex movements in relatively standard situations	Weightlifting, shot put, acrobatics, rhythmic acrobatics, water jumping, figure skating, water skiing, archery etc.
Manifestation of speed largely determined by endurance level.	Athletic middle- and long-distance runs, swimming on distances of 200 – 1500 m, swimming on distances of 200 – 1500 m, speed-skating on distances of 1000 – 10000 m, road cycling, orienteering, kayaking, rowing etc

Proper and adequate strength preparation has different meanings across different sports disciplines. There are some sport disciplines where strength preparation plays an important role as its lack makes it impossible to acquire a technique of movement (e.g. combat sports, apparatus gymnastics, athletic throws etc), and other disciplines where strength preparation is of minor importance (e.g. marathon run).

Strength preparation exerts positive influence upon the level of other motoric capabilities, such as speed and jumping capabilities. It also facilitates teaching certain elements of particular techniques (e.g. in case of apparatus gymnastics – bar exercises) and or tactics (e.g. team sports – striking a ball, throwing or hitting a ball with a particular force). It is also necessary to remember that the main task in the formation of strength is not its maximum increase, but rather an increase which contributes to improvement of speed and jumping capabilities (Sozański 1999, Prus 2003).

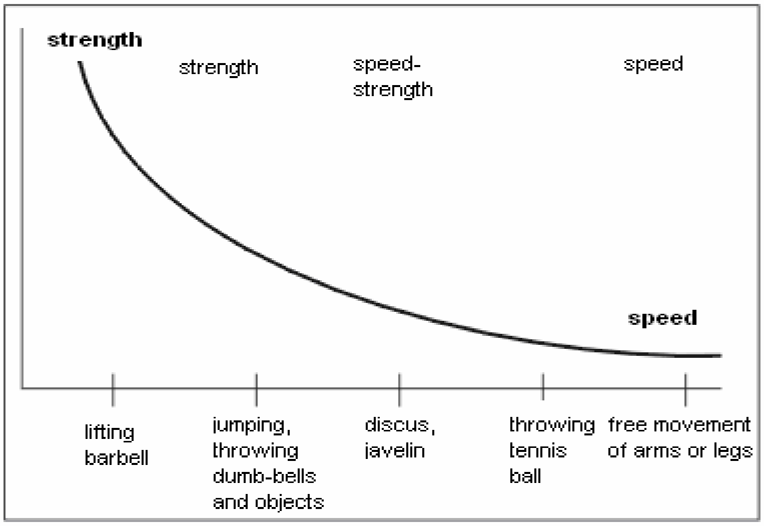


Fig. 8. Relation between indicators of strength and speed in selected movements (Zaciorski 1970)

It is also necessary to remember that when building up strength of muscles, it is crucial to draw on the resources relevant and unique for a particular sports discipline. For example, discus-throwers, hammer-throwers, shot-putters frequently prepare themselves by practicing throwing with objects of different size and weight.

1.2.2. Diversity of physical coordination requirements on account of the specifics of motoric activity

The role and importance of physical coordination requirements varies cross different sports disciplines. Putting it in simpler terms, the said requirements ensure the following (Raczek et al. 2002):

- in combat sports – effective performance of various acts resulting from general concept of fight or situation;
- in team sports – effecttive realization of technique and tactical tasks in various conditions and in constantly changing situations and tasks;
- in technique-based sports – diversity and technique perfection in technique sports, their originality and aesthetics;
- in endurance sports – high effeciveness and economy of movement during long-lasting effort, which contributes to delayed tiredness;

- in speed sports – high-frequency activities characteristic of freedom of movement and high effectiveness of using energy potential;
- in strength-speed sports – high effectiveness of using strength potential in the shortest period of time (MMA no-acid-milk).

Many authors confirm close correlation between the development level of coordination capabilities and achievements in sports, especially at early stages of sport training (Zimmermann 1984, Hirtz 1994, Raczek 1989, 1990, Ljach 1990, Wyżnikiewicz-Koop 1992, Szczepanik, Szopa 1993, Raczek i in. 1998, 2002). Rational improvement of coordination among young sportsmen exerts positive influence upon acquisition of technique in the course of training program as well as its more comprehensive use during sport competitions (Raczek et al. 2002).

Over the recent years many authors have attempted to single out the most important and specific motoric physical coordination capabilities, which determine success in particular sports discipline. The aim of their studies has been to determine and develop the method of how to reach maximum training effectiveness and, at the same time, avoid stabilization of erroneous technique (Zimmermann, Nicklisch 1981). These studies were conducted by means of various methods (interview, survey, observation, experiment, analysis of the course of sport competitions, mathematical analysis), and their outcome shows that sets of coordination capabilities, which ensure success in particular sports disciplines, are largely diverse (Blume 1981). Moreover, the results enabled researchers to develop a structural model of coordination, and to determine optimum technique and precision of movements as well as effectiveness of confrontation in particular sports disciplines.

In case of apparatus gymnastics, indispensable capabilities are the following: orientation, coupling, balance, differentiation and rhythmization (Zimmermann, Nicklisch 1981).

Table 4.

Coordination capabilities which determine manifestations of movements typical of events in athletics (Raczek et al. 2002)

Coordination manifestations	Coordination capabilities
1. Proper shifting of movements from legs onto torso and equipment, as well as from legs onto torso during swings..	Coupling, rhythmization and differentiation
2. Coordination of run-up with a spring and throw	Rhythmization and coupling
3. Fast reaction and relaxed run at high speed.	Fast reaction, rhythmization and high frequency
4. Accurate choice of the spring spot in jumping; sense of pace during a run, precision of movements.	Differentiation and spatial orientation

In case of athletics, the most important physical coordination capabilities are the following (Table 4): coupling, rhythmization and differentiation for proper organization of movements in individual parts of the body: rhythmization and coupling in coordination of run-up with spring and run-up with a throw; capability of fast reaction, rhythmization and high frequency at high speed of a run and quick start, as well as differentiation and spatial orientation for precision of performed movements, opportunity to accurately assess the best spot for spring in jumping, and sense of pace during a run (Raczek i wsp. 1998, 2002).

According to Zimmerman (1982) and many other authors (Gagajewa 1969, Brill 1980, Brandt 1985, Raczek 1990, Ljach 1994), the dominating coordination capabilities are the following ones: adaptation, spatial orientation, fast reaction and differentiation of movements. Table 5 presents dominating coordination capabilities as well as the order of their importance in different team sports (it has to be noted that the results recorded by different researchers do not overlap). It shows that the problem of identification of sets of coordination capabilities, which determine sports score in various sports disciplines is still a debatable and open-ended issue. The most frequently listed coordination capabilities essential for basketball are the following: fast reaction, kinesthetic differentiation of movements, coupling, spatial orientation and adaptation (Brill 1980, Zimmermann 1982, Ljach 1984, Brandt 1985, Raczek 1990). In case of volleyball, the most important ones are the following: capability of motoric adaptation, spatial orientation, fast reaction, kinesthetic differentiation of movement and coupling (Ljach 1988, Raczek 1990). In case of volleyball, the most important ones are the following: fast reaction, motoric adaptation, spatial orientation and kinesthetic differentiation of movement (Zimmermann 1982, Ljach 1994). In case of volleyball, the situation is likewise so the most important coordination capabilities are the following: spatial orientation, kinesthetic differentiation of movement, fast reaction, motoric adaptation and coupling (Gagajewa 1969, Bryll 1980, Zimmermann 1982, Meier 1982, Ljach 1994).

Depending on the level of advancement in team sports, it has been noticed that advanced players were better at the following: ”scope of view, high precision, speed, speed of perception of dynamic movements, fast registration and differentiation of situations, adequate choice of decisions as well as creative, varied and effective solutions”. The level of player’s advancement does not differentiate intellectual capabilities, as they remain at the same level; however, it is a motoric fitness factor which decreases among top-class sportsmen (Raczek 2000).

In case of team sports, a coordination factor is indispensable for effective realization of technique and tactical tasks, as one of major handicaps is high diversity and changeability of conditions, situations and tasks (Raczek 1991).

Against a background of analyses of the problem to date, one may easily notice the importance of motoric coordination capabilities for all sport disciplines. Their role, however, is largely varied as it depends on the character and specifics of coordination requirements of a particular sports discipline as well as on the advancement of a particular sportsmen.

Table 5.

Leading motoric coordination capabilities in different team sports in order of their importance (Ljach 1995)

Disci-pline	Motoric coordination capabilities	Autor (publication year)
Basketball	fast reaction, kinesthetic differentiation, coupling, motoric adaptation	Bryll M. (1980)
	motoric adaptation, spatial orientation, fast reaction, kinesthetic differentiation	Raczek J. (1990)
	redirection, spatial orientation, kinesthetic differentiation, fast reaction, coupling	Ljach W. (1994)
	fast reaction, kinesthetic differentiation, coupling	Zimmermann K. (1982), Brandt C. (1985)
Volley-ball	motoric adaptation, spatial orientation, fast reaction, kinesthetic differentiation	Raczek J. (1990)
	kinesthetic differentiation, spatial orientation, fast reaction, kinesthetic differentiation	Ljach W. (1994)
Hand-ball	fast reaction, motoric adaptation, spatial orientation, kinesthetic differentiation	Zimmermann K. (1982, 1986)
	redirection, spatial orientation, fast reaction, kinesthetic differentiation	Ljach W. (1994)
Football	kinesthetic differentiation, motoric adaptation, fast reaction, anticipation	Gagajewa G. (1969), Brill M. (1980)
	spatial orientation, motoric adaptation, kinesthetic differentiation, fast reaction	Zimmermann K. (1982)
	kinesthetic differentiation, spatial orientation, fast reaction, coupling, motoric adaptation	Meier H.W. (1982)
	redirection, kinesthetic differentiation, spatial orientation, fast reaction, coupling.	Ljach W. (1994)

1.2.3. Condition and coordination capabilities as primary determinants of effectiveness in teaching physical movements

When analyzing the results of research conducted by a plethora of authors, one may conclude that condition and coordination components of sports achievements feature a complex and multidimensional structure. The role and importance of particular component elements of motoric capabilities change in the course of ontogenetic development and sports development. Their internal relations as well as their correlations with other factors determine effectiveness and success in any sport discipline (Hirtz 1994, Starosta 1987, 2003, Raczek 1989, 1990, Raczek et al. 1998, 2002). Major psycho-physical functions, coordination patterns, as well as the store of both elementary motoric capabilities and motoric skills account for the foundation, which is vulnerable to both non-specific and specific training methods (Raczek et al. 2002).

High level of motoric coordination capabilities constitutes a major factor determining effectiveness of the formation process of motoric skills. (Hirtz 1994, Starosta 1987, Raczek 1989, 1990, Raczek et al. 1998, 2002). Individuals, who are generally talented as far as motoric capabilities are concerned, much easier and faster acquire correct and effective performance of desirable motoric skills (Blume 1978, 1981). The major role is played out by output level of these capabilities, which ensures optimal course of training process (Zimmermann 1984, Raczek 1986). Coordination capabilities determine ”precise, fast and adequate” solution to sport and motoric tasks” (Raczek 1991). They determine quality of learning and improving physical movements, stabilization of technique as well as proper and effective use of acquired skills in changeable conditions (Blume 1981, Hare 1985).

High level of comprehensive coordination capabilities, formed at early stages of the training process, exerts positive influence upon further improvement of technique.

With advanced technique skills, the result is more often than not an outcome of specifics (technical and functional as well as cognitive and motoric factors), complexity and individuality of coordination determinants; moreover, the scope of transfer of the results achieved in the past is also on the decrease. The best results may be achieved only through long-lasting application of intensive, specific exercise, which enable sportsmen to acquire ”specialist expert qualities” (Weinert 1991).

Therefore, ”the aim of a long-term training processes is to establish a set of motoric and cognitive capabilities (competence), specifically interrelated structures of technique skills and knowledge, whose transfer is limited to a narrow area of action” (Raczek 1999).

The coordination foundation of the action consists of rudimentary psychophysical functions and coordination patterns, as well as a store of motoric capabilities and level of motoric skills. However, when it comes to farther sports development of a particular person, then it is largely subject to his or her motoric experience (Hirtz 1994).

Raczek (1999) emphasizes that motoric skills (techniques) account for a ”motoric dictionary”, coordination capabilities account for a ”motoric grammar”, and together they enable to develop ”motoric tasks”, i.e. solving specific and complex motoric tasks. Therefore it is paramount in sports practice to use proper and adequate training methods as well as to select adequate means in order to increase the level of condition and coordination motoric capabilities, which largely determine effectiveness of learning and improving technique in a particular sports discipline, and which exert influence upon quality and speed of acquisition of specific sports skills and optimal use of energy required to perform a specific task. Optimal technique is characteristic of stability, resistance to disruptions, registration in motoric memory and automatization (Zaciorski 1999). Currently, optimization of sport technique is more and more developed algorithmization of a particular sports activity. In the processes of sports technique improvement it is indispensable to recognize particular component tasks, which make up a particular sports activity, and to create an algorithm of a solution, which ensures the highest possible level of effectiveness.

2. OBJECTIVES, HYPOTHESES AND RESEARCH QUESTIONS

An essential element in the process of teaching physical movements is the application of such solutions, which optimize effectiveness of teaching those movements and enable to search the best teaching and improvement method as regards technique skills at all levels of motoric development. That problem also refers to practical subjects, which are included in the curriculum of students of physical education.

The rationale behind conducting research is an attempt to increase effectiveness of didactic process as regards practical subjects, which are included in the curriculum of students of physical education. The search for effective solutions to teaching and improvement problems as well as the attempt to enrich current methodology with condition and coordination elements, which are relevant for a particular sport discipline, will determine speed and quality of mastering particular motoric tasks and improvement of necessary motoric skills.

The correct diagnosis of the state of motoric capabilities among students may facilitate optimization of the recruitment process as regards potential students of physical education. As a result, it would enable to select those applicants whose level of motoric capabilities would ensure fast, long-lasting and conscientious acquisition of relevant motoric skills in the course of their studies.

It is assumed that the results presented in this dissertation would enable to increase effectiveness of learning, improve and stabilize processes as regards motoric skills.

The main objective of this dissertation is to determine relations and correlations between the level of motoric capabilities as well as a degree of acquisition of motoric skills as regards practical academic subjects (athletics, gymnastics, swimming, handball, football, volleyball, basketball), which are included in the curriculum of students of physical education.

In connection with the above assumptions, the research problem has been subsumed under the following research questions:

1. Is the level of motoric capabilities of students of physical education a determinant of effectiveness of acquisition of motoric skills as regards particular practical subjects?
2. Which motoric capabilities contribute to differentiation of levels of acquired motoric skills from practical subject included in the curriculum?
3. Are there any motoric capabilities, which in a dominating way determine effectiveness of acquisition of particular motoric skills?
4. Is the structure of motoric fitness different among individuals with low and high levels of motoric skills?

5. Are there any differences in relations between motoric fitness and motoric skills, which would depend on sex?

Research hypotheses

On the basis of the reference materials and experience stemmed from didactic and training work, the author has formulated the following hypotheses:

1. There are close correlations between the level of motoric capabilities and effectiveness of acquisition of basic motoric skills.
2. These correlations have different structure depending on sex and the level of motoric skills.
3. There are different combinations of component elements of condition and coordination, which determine levels of acquisition of selected motoric skills.

3. RESEARCH MATERIAL AND METHODOLOGY

3.1. RESEARCH MATERIAL

The group tested comprised of 116 students (63 male and 53 female) of Physical Education at the Faculty of Physical Education and Physiotherapy in Opole. The age of the people tested ranged from 20 to 23 years. Thanks to such a selection of group members, the impact of developmental factor on the results was eliminated, because in this period the central and peripheral nervous system, which is the basis of motoric coordination capabilities, is anatomically formed and stabilized (Osiński 1993).

Persons possessing a rank in the unified sports classification system or longer training experience were not tested, which was due to their specific skills in a variety of sport disciplines and a higher level of physical condition capabilities.

The research study commenced with measuring basic somatic parameters including: body height, body weight, fat content percentage in the organism; litheness measured during bend of a trunk in sitting position was also taken into consideration. Motoric capabilities measurement was conducted once, whereby all members of the group were examined between 1 October 2002 and 30 January 2003. The research was concluded in January 2005, after five semesters of study; then all grades for practical subjects were collected, which defined the level of motoric skills of the examined students.

Before the analysis of motoric fitness structure of all examined persons, the group was divided into three subgroups according to their motoric skills level. There were 38 persons in the low-skilled group, 41 persons in the medium group and 37 persons in the high-skilled group. For most of variables the analysis of descriptive statistics confirms compliance of distribution of test results with normal distribution in all groups, both men and women. To verify differences between the groups, Mann-Whitney U test and chi-square test for independence were applied.

Before the measurement started, all participants had been informed about the goal, the course of experiment and the application of the results. The students were also informed about the possibility to resign, without providing any explanation, from taking part in the research. It has to emphasized that none of the tested persons claimed to have any neurological disorders.

All measurements were done in standard conditions, in full compliance with basic procedures that are obligatory in sports metrology (Zaciorski 1979).

In the research, apart from the observation method, the single diagnostic survey method was also used.

The research was conducted as a part of a research project, which had received a positive opinion of the Bioethics Research Commission.

3.2. TOOLS AND METHODS OF RESEARCH

3.2.1. Measurement of coordination capabilities

In the research on coordination capabilities the tests proposed by Raczek et al. (2002) were applied. The set of tests included the following:

Capability of kinesthetic diversification

”Long jump from the spot at 50% of the maximum capability”

The person tested performed three attempts of long jump from the spot onto the mattress, trying to achieve the maximum result each time. The best score is recorded and the tested person receives the information about it. Next, a person is told to jump with his or her eyes closed using half of the strength of the spring. After the person gets the information about the result and the difference between the last jump and the model (half of the recorded result), a person repeats it twice without any feedback. The better score is the measure of the sense of strength diversification.

Capability of spatial orientation

”Throws to a moving pendulum”

The tested person throws tennis balls at a pendulum, that is attached at 2.3 metres (the hoop that has a diameter of 60 centimetres and hangs on a string 80 cm long). The person tested stands in front of a line just the opposite of the pendulum and 3 m from the wall. The researcher lifts the pendulum so as the string is tightened and horizontal to the ground and after the command ”ready” the researcher releases it, allowing free swings back and forth. During the back movement of the pendulum a tested person attempts to throw the ball through the hoop with his or her more able hand. The sum of the subsequent ten throws is evaluated – hitting the edge of the hoop equals 1 point, throwing the ball inside the hoop equals 2 points. Before the test begins, the tested person performs only one trial throw.

”March to the target”

The tested person, standing in front of the line, assesses visually the distance from the centre of a circle. The circle has a diameter of 1 m and is drawn on a ground 5 m from the start line. In the middle of the circle there is a cross marked with a colourful tape. Next, the tested person is blindfolded and ordered to walk slowly to the centre of the circle, stop there and raise his or her hand. The distance from the point between the feet to the centre of the circle is measured in centimetres. There are five trials and the final result is the average expressed in centimetres.

Capability of motoric reaction

”Stopping a falling target”

A cardboard disc with a radius of 50 cm with a stiff hand 80 cm long (a pendulum) was used. The pendulum was hung on a wall at the height adjusted to the height of the tested person (the fastening was on the level of a stretched out arm of the tested person). On the wall, centrally to the fastening point of the pendulum, a semicircle is drawn, which describes the movement of the pendulum within 0 to 180 degrees and from 0 to 12 points (1 point = 15 degrees). The person tested stands in front of the target (the disc) in the distance of his or her arms stretched to the front, the researcher lifts the pendulum so as its arm is parallel to the ground. After the command ”ready” and additional 2-4 sec., the researcher frees the disc, which swings down and the task of the tested person is to hold it with his or her hand by pressing the target against the wall. For the right-handed people the target was lifted to the right side, for the left handed to the opposite. The disc could be pressed in any of its part. 5 trials were made with a more able hand and the result was a mean from three average results to an accuracy of 1 point.

”The Ditrich rod grip”

The test is based on the fastest possible grip on a stick (diameter of 15 cm and length of 50 cm with a centimetre scale marked on it) with a hand. The tested person is sitting astride on a chair, face to the backrest, placing his or her forearm on the backrest in the middle of its length, four fingers of the hand are put together and stretched, and the thumb is spread. The researcher begins the test holding the stick at its upper end in the distance of about 1 cm from the tested person’s palm. The result of the test is the arithmetical mean of 5 trials after rejecting the two extreme measurements. The result read off the stick in centimetres was calculated into seconds according to the following formula:

$$t = \sqrt{\frac{2s}{g}}$$

where: t – time of reaction in seconds,
s – result of the measurement in metres,
g – gravitational acceleration.

”The Piórkowski apparatus”

The tested person’s task was to respond to the light signal by pressing the key in the spot where it occurred. The test was performed in a sitting position. After a short exercise preceding the test, the tested person performed it with his or her more able upper limb within 1 minute. The result was the number of correctly received stimuli at the frequency of impulses of 93 per minute, 107 per min., 125 per min. Only those responses were regarded as correct, which appeared when the light stimulus lasted.

Capability of keeping static and dynamic balance

”Flamingo test”

This test requires from the tested person to keep balance on a wooden 50-cm-long beam, 4 cm-high and 3 cm-wide, covered with a soft material up to 5 mm thick, with supports installed crosswise at its ends (the length of the supports is 15 cm and their width is 2 cm), which guarantee stability of the apparatus. The tested person, while standing on the beam with one foot (along the beam), assumes the flamingo position: bends the knee of the free leg and grabs the foot from behind. The other hand is rested on a shoulder of the researcher or his hand. The stopwatch was turned on, when the tested person let go the shoulder of the researcher and turned off, when the tested person lost his or her balance loosing the grasp on the free foot or touching floor with any part of the body. The result of the test is the amount of trials necessary to keep balance in the given position for one minute.

”A walk along rosette”

The tested person was to march along a wooden hexagon (rosette) with dimensions: length of a side equal 55 cm, height equal 10 cm, width of the upper surface equal 2 cm. The tested person starts with any foot on one side of the rosette (feet always perpendicular to the side) with arms akimbo and walks subsequently along all sides of the apparatus until a person falls or moves his or her hands from hips. The result is the number of correctly performed steps.

Capability of movement rhythmization

”Run in a given rhythm”

11 gymnastic hoops of a diameter of 60 cm were used to perform this test. The test consisted of two stages. In the first stage, after a standing start, the tested person run a distance of 30 m at the maximum speed. Then, gymnastic hoops were laid in the same distance in a straight line: 3 hoops within 5 m from the start line and finishing line and 5 hoops lined up in a direction of the run, one next to each other; the first hoop was within 14 m from the start line. The task

was to run the distance of 30 m as fast as it is possible, putting one's feet subsequently into the lying hoops. The result of the test was the difference of the times in the first and second run. The time measurement was performed to an accuracy of 0.01 sec. with a programme and set of photocells provided by Insofter company.

Capability of movement coupling

”Taking a gymnastic stick from one hand into the other”

The tested person is standing to attention and holding a gymnastic stick in front in lowered hands, both hands spread to the width of the shoulders. After the researcher's command, the tested person crosses the stick with his right and left foot alternately five times. The result is the time of performing the whole task to an accuracy of 0.1 sec. (the time was stopped when a foot performing the last return movement touched the ground).

”Long jump from the spot with a backswing of the arms and without it”

The person tested performs three attempts of the long jump from the spot with a backswing onto the mattress, trying to achieve the maximum result each time. Next, he or she jumps from the spot three times with his or her arms intertwined on hips behind. The best results were taken into consideration and the final result is the difference between results of the jumps with and without backswing.

Capability of movement adaptation

”Long jump from the spot back and forth”

The task required to perform three long jumps from the spot on both feet to the maximum distance forward, and then performing three jumps backward (also to the maximum distance). The final result was calculated from best results in forward and backward jumps to an accuracy of 1 cm.

3.2.2. Measurement of fitness and complex capabilities

Endurance capabilities

12-minute run – ”the Cooper test”

The test was done on a Tartan running track. The task was to run as far as possible within 12 minutes. After the 12-minute run was over (information given by the researcher) the tested person stopped on the track and the result equalled the length of the covered distance in metres.

Strength capabilities

”Pressing the barbell in lying position”

The test was performed on a horizontal bench commonly used in sports training. The tested person lied on his or her back on a bench with buttocks, the whole trunk and head motionless. Feet rested on the floor with their entire soles. The bar was grasped; hands were spread to the width of shoulders. The task was to lower the barbell to the chest (the barbell had to touch the chest) and raise it till the arms were fully straighten. After the warm-up, each tested person performed one press with greater weight each time. For the purpose of this analysis, the maximum weight (in kilos) lifted properly by the tested person was taken into account.

”Knee bend and straightening with a barbell on the shoulders”

The test was performed with a barbell set on a runner limiting horizontal movements and unsteady work. Using the runner eliminated the potential influence of technique of some tested persons and increased safety of the participants. The starting position was standing upright with the barbell on the shoulders; trunk and lower limbs straight, hands on the barbell, feet spread to the width of the hips. The tested person performed a halfway knee bend (until his or her thighs and shins form a right angle) and straightened up to the starting position in one, continuous movement. After the warm-up, each tested person performed the action once, with greater weight each time. For the purpose of this analysis, the maximum weight (in kilos) lifted properly by the tested person was taken into account.

”Grip strength measurement”

The measurement was performed with the use of hand-held mechanical dynamometer. During the measurement, the following rule was obeyed: the upper limb had to be straightened in elbow, alongside the trunk and the hand during the measurement could not touch the lower limbs. The measurement was taken twice, with the stronger hand (according to the tested person) and the better result in kilos was recorded.

Speed capabilities

”Running speed in the distance of 20 m with a run-up”

Test required running at the maximum speed 20 m in straight line after a previous run-up of 10 m (so called ”flying” measurement). The time measurement was performed to an accuracy of 0.01 sec. with a programme and set of photocells by Insofter company. The run was performed once, on a Tartan track.

”Running speed in the distance of 50 m”

Test required running at the maximum speed 50 m in straight line after a standing start. The time measurement was performed to an accuracy of 0.01 sec. with a programme and set of photocells provided by Insofter company. The run was performed once, on a Tartan track.

Agility capabilities

”The envelope run”

In a rectangle of dimensions: 5 m x 3 m, there were flags placed in all corners and in the central intersection of diagonals. The tested person starting from back leg position (standing start) runs around the flags along a marked track (along lines marking shorter sides of the rectangle, passes the flags on their right, runs to the central flag, passes it on its left and again runs out of the rectangle). In the test a joint time of covering the whole route three times was measured. Each of the tested people performed two trials and the better time was assumed to be the result.

Litheness capabilities

”Bend in an upright sitting position”

For this test purposes a wooden box was used; dimensions: 35 cm long, 45 cm wide, 32 cm high, the top of the box was 50 cm long, 45 cm wide and the top surface extends 15 cm above the side used to support feet. In the middle of the top surface, parallel to the longer axis of the box, there is a scale from 0 to 50 cm. An about 30 cm long ruler was placed freely on the box’s surface perpendicularly to the longer axis of the box and was moved with hands while performing the bend forward. The tested person sits in an upright sitting position (legs straight) and reaches forward as far as a person can, moving the ruler over the surface of the box. The bend was performed twice, and the better result was analysed.

3.2.3. Physical functional capacity assessment

Anaerobic functional capacity

Wingate test

To assess anaerobic functional capacity the Wingate test was used, with a load of lower limbs equal 7.5% of body weight of the tested person. All tested persons performed 30-second test of maximum intensity on a Monark cycloergometer linked with a computer with the use of software by Monark company. The tests were preceded with a 5-minute warm-up with the load chosen individually, so as the frequency of heart muscle contraction was within the range of

120-140 heartbeats per minute (usually the loads were 50 W for women and 100 W for men). The frequency of pedalling on the cycloergometer was 50 turns in 1 minute. This stage finished with a 3-minute break. The task was to reach the highest frequency of pedalling in shortest time and maintain it as long as possible. For the purpose of the analysis the Peak Power and Power Drop was used. Both were calculated with a computer program and their relative value (in W/kg) were given.

Aerobic functional capacity

Maximal work capacity (VO_2 max)

Establishing maximal oxygen intake (VO_2 max) was achieved by an indirect method of measuring the frequency of the action of the heart during sub-maximal work. All tests were performed on a ”Monark” cycloergometer. The work was done in two stages:

1st stage: 5-minute warm-up with the load chosen individually, so as the frequency of heart muscle contraction was within the range of 120-140 heartbeats per minute (usually the loads were 50 W for women and 100 W for men). The frequency of pedalling on the cycloergometer was 50 turns in 1 minute. This stage finished with 3-minute break.

2nd stage: 5-6 minutes of sub-maximal work with a load of 50 W (women) and 100 W (men) and the speed of pedalling at 60 turns per minute. The loads were chosen so as the frequency of heart muscle contractions settled within the range of 130-170 heartbeats per minute. During the entire period of work the frequency of heart muscle contraction was recorded on a cardio monitor. During the period of functional balance, called ”steady state”, after taking into account the amount of load and age of the tested person, that frequency served calculating the maximum oxygen intake with the use of Astrand-Ryhming nomogram (1954).

PWC170 test

PWC_{170} test (Physical Working Capacity at 170) allows to determine a hypothetical value of power, which enables to achieve physiological balance at the rate of 170 heartbeats per minute (Hr=170). It is a test providing indirect results. Final results are predicted by extrapolation of achieved sub-maximal values and is based on a strict linear dependency between oxygen intake and frequency of heart muscle contractions (Kozłowski, Nazar 1984). The tests were preceded by 5-minute warm-up with the load chosen individually, so as the frequency of heart muscle contraction was within the range of 120-140 heartbeats per minute (usually the loads were 50 W for women and 100 W for men). The frequency of pedalling on the cycloergometer was 50 turns in 1 minute. This stage finished with 3-minute break.

The test consisted of two efforts with an increasing load that lead to physiological balance (steady state). After establishing HR with first load, which took place from 5^{th} to 7^{th} minute of work on the cycloergometer, the load was increased by about 50 W and the work proceeded until physiological balance was reached. The amount of the first load was 1 W/kg of the tested person's body weight. For the purpose of the analysis, the value of PWC_{170} was calculated from the formula:

$$PWC170 = \frac{PO1 + (PO2 - PO1)(170 - HR1)}{(HR2 - HR1)}$$

where:

PO1 the amount of the first load
PO2 the amount of the second load
HR1 an average value of the pulse from the last minutes of the first effort
HR2 an average value of the pulse from the last minutes of the second effort

3.2.4. Evaluation of motoric skills in selected sports disciplines

The level of possessed motoric skills in all sports disciplines was described by the final marks. In all sports disciplines the following 6-grade scale was used: 2; 3; 3.5; 4; 4.5; 5.

Marks from basic practical subjects, such as athletics, gymnastics, swimming and team sports (football, volleyball, basketball, handball), which are included in the curriculum at the Faculty of Physical Education and Physiotherapy in Opole, were used in the analysis.

Athletics

The level of possessed technical skills in athletics is described by the marks attained during 3 semesters of study.

Marking scale for athletics:

2 points – too many mistakes, failure to accomplish a task, or a result out of the accepted time, distance or height limits;
3 points – moderate performance of a technique – the amount of mistakes that occurred while performing a physical activity task allows to achieve a positive grade and meet the minima of the curriculum;
3.5 points – satisfactory performance of a technique and meeting appropriate standards;
4 points – good technique of physical task performance, small number of petty technical mistakes and meeting appropriate standards set in the curriculum;
4.5 points – achieving appropriate time, distance or height standards and good technique of performing the physical task, minimal distortion of the rhythm of performing a given physical activity;

5 points – achieving appropriate limits, very good technique, fluidity and tempo of performing a given physical activity.

1st semester

The mark in athletics in the first semester consisted of marks in techniques and achieved results of the following elements and events: skips type A, B, C, crouch start from starting blocks, shot put, race walking, discus throwing, triple jump and Cooper test, in which the covered distance was evaluated.

2nd semester

During second semester the students were fulfilling a program that included the following:

- hurdle race over a distance of 100 metres (women) and 110 metres (men),
- javelin throw,
- high jump using straight-on approach and Fosbury flop,
- passing a relay baton,
- long jump using sail and hang techniques,
- a run over a distance of 400 metres.

Following the curriculum, technique of performing particular events and results based on standards were graded.

3rd semester

The mark in the 3rd semester was subject to total number of points in decathlon (but without pole vault, so it will be called from now on: ”nonathlon”) for men and heptathlon for women as well as techniques of performing those events. Results of jumps, throws or runs were calculated into points according to Classification Charts for Athletics (1999) used to score penta-, hepta- and decathlons. ”Nonathlon” consists of 110 m hurdle race, long jump, 100 m run, shot put, high jump, 400 m run, javelin throw, 1500 m run, and heptathlon consists of 100 m hurdle race, high jump, shot put, 200 m run, long jump, javelin throw, 800 run.

Swimming

The level of swimming skills in the specified distances is described by marks attained during 3 semesters of study.

Marking scale for swimming:

2 points – failure to accomplish task from curriculum (faulty technique and crossing the time limits);

3-5 points – depending on achieved times and demonstrated technical skills;

1st semester

Mastering of backstroke technique, start jumps and turns. The condition of achieving credit is a positive mark for swimming skills in backstroke in the distance of 50 m in the appropriate time.

2nd semester

The mark for the second semester of swimming is the result of mastering swimming skills in freestyle (front crawl) in the distance of 50 m in appropriate time.

3rd semester

The mark for third semester consisted of partial marks for mastering the following swimming techniques and using them to cover a specific distance:

- 50 m breaststroke
- 50 m butterfly
- 100 m medley

The mark for a given style of swimming, apart from the level of mastering the technique, was influenced by the time in which a given distance had been covered.

Gymnastics

Marks for gymnastics describe the level of motoric skills, attained during three semesters of study. For the purpose of the analysis the final marks for given semesters were used, as well as partial marks that were the basis for the final marks.

Marking scale for gymnastics:

2 points – too many mistakes, or failure to accomplish a task;
3 points – satisfactory performance of elements of a technique, either individual elements or grouped in a form of a gymnastic routine – the number of errors that occurred while performing physical task allow to obtain a positive mark;
3.5 points – satisfactory performance of elements of a technique, either individual elements or grouped in a form of a gymnastic routine;
4 points – good technique of performance of physical task, small number of minor technical faults or lack of fluidity and tempo;
4.5 points – good technique of performance of a physical task, minimal distortion of the rhythm of performing a given physical activity;
5 points – very good technique, fluidity and tempo of performing a given physical activity.

1st semester

Following the curriculum of first semester of gymnastics, the students had to master and receive a credit for the following gymnastic manoeuvres:

- rolls (backward with straightened legs, forward to a straddle position, forward with straightened legs, forward jumped into);
- cartwheel;
- headstand (from a straddle position), handstand;
- joining separate manoeuvres into routines of so called free exercises.

2nd semester

Skills mastered by students during second semester of gymnastics:

- gymnastic vaults (in squatting position, squatting position with backward leg swing, a vault leaning to the front and to the back, pushing oneself away from the horse);
- elements of double acrobats' pyramids (climbing front and back on the partner's thighs, lying forward on the partner's feet, standing on shoulders lying on the back).

3rd semester

The mark for gymnastics in the second semester was based on the evaluation of manoeuvres performed on the following gymnastic apparatus:

- bar exercises – supporting by dorsal grip, passing to front support, swing back having straight trunk with front support, dismount through swinging under the bar forward
- pommel horse exercises (men) – supports, swing elements back and front to the front support, dismount after back swing during support;
- still rings exercises (men) – support with front swing, free hold with a bent trunk, a simple support with legs parallel to ground, dismount after a swing back with the straight trunk;
- balance beam (women) – walk on toes, balanced sit, lying back, rolls back and sideways;
- parallel bars (men) – swings supported with straightened arms, supporting in front swing to sitting astride, standing on shoulders after a swing with a straight trunk, reversed dismount;
- joining separate manoeuvres into routines of so called free exercises.

Team sports

Team sports (practical subjects) are taught one after the other in following semesters:

1. semester – football

2. semester – volleyball
3. semester – handball
4. semester – basketball

The level of technical skills in team sports is reflected by marks from 4 subsequent semesters.

Marking scale for team sports:

2 points – too many mistakes, or failure to accomplish a task;
3 points – satisfactory performance of elements of a technique, either individual elements or grouped in a form of a track – depending on the discipline, the number of errors that occurred while performing physical task allow to obtain a positive mark;
3.5 points – satisfactory performance of elements of a technique, either individual elements or grouped in a form of a track – depending on the discipline;
4 points – good technique of performance of particular tasks, small number of minor technical faults or lack of fluidity and tempo;
4.5 points – good technique of performance of a particular tasks, minimal distortion of the rhythm of performing a given physical activity;
5 points – very good technique, fluidity, tempo and depending on the sports discipline: effectiveness of performing a given physical activity.

The following technical-tactical skills were evaluated in the given team sports:

Football

Manoeuvering the ball with right and left foot, moving around the pitch with the ball and without it, kicking (straight, inner and outer instep), accepting the ball (with one's sole, inner side of a foot), hitting the ball with one's head, throw-in, shooting at a goal, dribbling, feinting with a ball, using the whole body to play the game. The final credit consists of the evaluation of the above-mentioned elements of the gameplay and putting the elements together in a form of a track.

Volleyball

The level of mastering of the following elements of volleyball technique was evaluated: ways of moving within the court and adopting volleyball stance, overhand pass and joined forearm pass, movement during attack and defence, attack (overhand,), serve (overhand, topspin, jump serve), reception of the serve, block.

Handball

Moving within the field during attack and defence (running forward and backward, walking sideways, change of the direction and tempo of running), catches and passes (upper, half-upper, lower, from the floor), throws (from the spot, while running, jumping, falling, tilting), feints (with the body or ball), intercepting and blocking the ball. The chosen elements of the attack and defence were evaluated, as well as the chosen elements of the handball playing technique in set in a form of a track.

Basketball

Moving around the court while attacking or defending, with the change of direction and tempo, stopping single and double pace, passes and catches, throws from the spot, while jumping, after dribbling from the left and right side of the basket, dribbling, spins, feints using the body or ball, spiking and running around, covering a player with or without the ball, blocking, fighting for the ball by the backboard playing offensive and defensive. The above-mentioned elements of the basketball technique put together in a form of a test determined the level of mastering technical skills.

3.2.5. Methods of analysis

The results of the research were subjected to a detailed statistical analysis. The material gathered in a form of results of sports-motoric tests and laboratory tests measuring motoric capabilities, as well as marks for motoric skills trained in separate practical subjects during the subsequent semesters of study, was used to verify the accepted hypotheses.

To check the representativeness of the tested group, the collected data were statistically analysed to compare the results of tests with the normal distribution. To attain this purpose the following indicators were applied: arithmetical mean ($\bar{x}$), standard deviation (s), coefficient of variation (V), skewness (sk) and kurtosis (λ) as well as Kołmogorova-Smirnova and Liliefors tests of all variables separately for male and female students.

To determine if the quantity distributions of the two tests differ essentially, the Kołmogorov-Smirnov test was used. If there is no significant difference of average values, the test may show a significant difference in shape of both test's distributions. When the distribution of the test was significantly different from the normal distribution, the Mann-Whitney U test (ranking sum test). Instead of comparing the average values, this test checks the significance of the difference of the sum of rankings of the compared groups, rankings, however, refer to the set being a sum of the observations of both groups.

To clarify variability of the selected quantity – so called variable dependent from another features that were taken into account (dependent variables), a multiple regression analysis was done. The method allows to calculate the coefficient of regression, which describes the quantity and direction of the influence of the particular variables on the dependent variable, significance of this influence as well as the confidence intervals and standard deviations of the regression coefficients. The multiple regression analysis allowed to determine the level of adjustment of the model and the measure of this adjustment is the standard deviation of the regression.

The search for the structure of motoric fitness and verification if it is dependant of gender and level of motoric skills forced the use of one more statistical analysis technique, namely the standardization of variables.

Standardization of variables allowed a clear illustration of differences between groups in terms of analysed features. The process is based on the transformation of values of variables in such a way, that from every observed value the medium value was deducted and divided by standard deviations.

To establish the structure of correlation between variables and to reduce the number of variables, factor analysis was used. The analysis is based on substitution of the observed variables with factors which are linear combinations of those variables. Every factor is a linear combination of all observed variables and other values of coefficients with variables for every factor. The defined coefficients must be of such type so that all factors create an orthogonal system, which means that all correlation coefficients between all factors equals zero. Factor capacities for individual variables define the level in which a factor ”represents a given variable”. It is assumed that variables for which the absolute value of the factor capacities is bigger than 0.7 are typical for a given factor. The factor is representative for those variables and a group of those variables may be replaced by this factor. The factor analysis allows to determine the value of factors for every value of the observed variables.

4. RESULTS

4.1. RESEARCH RESULTS FROM THE PERSPECTIVE OF DESCRIPTIVE STATISTICS

Descriptive statistics used to analyze the research results revealed in case of many variables a distribution close to that of Gauss (Table 9). Essential differences between men and women in functional capacity parameters as well as in parameters describing motoric capabilities may suggest the necessity to conduct separate analysis in the group of men and women (Table 7).

Table 7.

The results of a test T-student between groups of men and women in motoric capabilities (n_{women} = 53, n_{men} = 63, df = 114)

	Women average	**Men average**	**t**	**p**
PEAK_P	7,22	9,02	-11,03	**0,00**
DROP_P	3,06	3,84	-4,77	**0,00**
PWC170	181,80	261,16	-9,14	**0,00**
VO2MAX	2,99	4,48	-11,28	**0,00**
VO2MKG	52,90	62,60	-6,23	**0,00**
MOV_COU1	28,32	42,68	-9,29	**0,00**
MOV_COU2	12,28	12,12	0,53	0,59
BALANCE1	8,47	10,32	-2,31	**0,02**
BALANCE2	6,13	5,08	1,66	0,09
KINE_DIV	10,00	9,97	0,02	0,98
SWIFT_R1	9,42	10,33	-10,65	**0,00**
SWIFT_R2	0,19	0,20	-2,21	**0,03**
SWIFT_R3	90,34	90,17	0,22	0,83
SWIFT_R4	85,91	86,13	-0,06	0,95
SWIFT_R5	81,77	83,13	-0,26	0,79
SPAT_OR1	10,38	14,60	-7,41	**0,00**
SPAT_OR2	31,57	33,29	-0,77	0,44
RHYTHM	1,20	1,09	2,51	**0,01**
COOPER	2370,85	2874,21	-15,69	**0,00**

STR_CHES	32,38	70,83	-20,15	**0,00**
STR_LEGS	52,08	114,52	-22,05	**0,00**
STR_GRIP	30,49	51,16	-19,11	**0,00**
SPEED1	8,22	6,54	26,29	**0,00**
SPEED2	2,94	2,32	16,89	**0,00**
AGILITY	25,48	23,84	9,93	**0,00**
LITHE	27,91	26,57	1,35	0,17

Results of comparison of motoric skills of men and women done with the use of T-student test have revealed essential differences related to gender in the following motoric skills: hurdle race, long jump, high jump, running technique (1500 m – men, 800 m – women), football and handball playing techniques.

Table 8.

The results of a T-student test between groups of men and women in motoric skills (n_{women} = 53, n_{men} = 63, df = 114)

	Women average	**Men average**	**t**	**p**
GYMN_S1	3,83	3,84	-0,10	0,92
GYMN_S2	3,82	3,90	-0,71	0,48
GYMN_S3	3,92	3,94	-0,24	0,81
GYMN_A	3,97	3,90	0,71	0,48
GYMN_B	3,83	3,93	-0,93	0,35
GYMN_C	3,65	3,67	-0,13	0,90
GYMN_D	3,77	3,71	0,47	0,64
ATHL_S1	3,87	3,94	-0,69	0,49
ATHL_S2	4,09	4,07	0,21	0,83
ATHL_S3	3,90	3,98	-0,60	0,55
ATH_SPUT	401,15	424,60	-1,78	0,08
ATH_HUR	241,21	386,08	-8,21	**0,00**
ATH_LJU	299,09	421,03	-10,52	**0,00**
ATH_JAV	284,51	280,22	0,35	0,73
ATH_HJU	327,25	394,56	-5,13	**0,00**
ATH_RUN	252,60	343,78	-5,43	**0,00**
TEAMVOL	4,25	4,29	-0,35	0,73
TEAMFOO	3,43	4,04	-7,63	**0,00**
TEAMBAS	4,00	4,23	-1,70	0,09
TEAMHAN	3,57	3,96	-3,92	**0,00**
SWIM	3,98	3,79	1,66	0,10

It is assumed that the kurtosis index for normal distribution is within the range $\lambda \in <-3,3>$. For men only indexes of the variables: kinesthetic diversification, static balance, swiftness of reaction and frequency of movement measured on the Piórkowski apparatus with the lowest frequency (93 impulses per minute) and spatial orientation (throws at the moving pendulum) are beyond the normal distribution. They show a very large density of the results, so the most of the tested people achieved very similar results. For women, outside the normal distribution there were: loss of power in Wingate test and, similarly like with men, swiftness of the reaction measured with the Piórkowski apparatus with the lowest frequency (93 impulses per minute).

Outside the range establishing normal range for skewness there was only the result of the variable ”kinesthetic diversification (long jump from the spot with 50% of the maximum capabilities). The result is negative, which we may describe as a test easy to take for the tested group, or that the majority of the tested people possesses a similar level of kinesthetic diversification capability, which means, that the tested persons are a very homogeneous research subject. The skewness, apart from the above-mention case, characterizes the tests as well chosen, matched to the group tested.

Table 9.

Descriptive parameters of the examined variables – group of men (n = 63)

	Mean	**Median**	**Min**	**Max**	**Std.Dev.**	**Skewness**	**Kurtosis**
HEIGHT	180,92	180,00	160,00	198,00	6,73	-0,03	1,19
WEIGHT	77,08	76,70	58,80	105,40	8,63	0,56	1,58
BMI	23,53	23,32	18,42	28,59	2,13	-0,12	-0,14
MASS_NF	65,20	64,78	51,46	89,76	6,46	0,76	2,62
MAS_NF%	84,83	85,00	75,50	93,50	4,77	-0,02	-0,68
PEAK_P	9,01	9,08	6,98	10,86	0,83	-0,21	-0,01
DROP_P	3,84	3,88	1,59	5,56	0,85	-0,12	-0,27
PWC170	261,16	262,50	150,00	371,30	44,41	-0,04	-0,12
VO2MAX	4,48	4,37	2,54	7,39	0,89	0,78	1,21
VO2MKG	62,59	61,70	45,95	89,75	9,31	0,62	0,59
MOV_COU1	42,68	44,00	15,00	67,00	9,82	-0,36	0,66
MOV_COU2	12,12	12,20	9,20	15,90	1,79	0,33	-0,67
BALANCE1	10,31	10,00	3,00	19,00	4,23	0,30	-0,72
BALANCE2	5,07	5,00	1,00	17,00	3,00	1,96	**5,13**
KINE_DIV	9,97	9,30	0,80	59,30	7,12	**5,35**	**37,82**
SWIFT_R1	10,33	10,30	9,00	11,00	0,52	-0,58	-0,06
SWIFT_R2	0,19	0,19	0,15	0,21	0,01	-0,93	2,03
SWIFT_R3	90,17	91,00	67,00	93,00	4,13	-3,32	**15,46**
SWIFT_R4	86,12	91,00	30,00	107,00	18,27	-1,35	1,57

SWIFT_R5	83,12	90,00	17,00	122,00	24,93	-0,66	-0,15
SPAT_OR1	14,60	15,00	3,00	19,00	2,66	-1,81	**5,37**
SPAT_OR2	33,29	32,00	2,00	61,80	12,10	0,34	0,37
RHYTHM	1,09	1,10	0,48	1,54	0,21	-0,15	0,28
COOPER	2874,20	2880,00	2460,00	3340,00	200,30	0,05	-0,52
STR_CHES	70,83	70,00	50,00	120,00	12,81	0,84	2,28
STR_LEGS	114,52	110,00	80,00	155,00	17,10	0,08	-0,36
STR_GRIP	51,15	51,00	36,00	70,00	6,65	0,22	0,76
SPEED1	6,54	6,52	6,08	7,10	0,23	0,17	-0,32
SPEED2	2,32	2,38	1,57	2,68	0,18	-1,38	3,17
AGILITY	23,84	23,90	22,10	25,69	0,85	0,01	-0,47
LITHE	26,57	27,00	13,00	38,00	5,42	-0,25	0,11

Table 10.

Descriptive parameters of the examined variables – group of women (n = 53)

	Mean	**Median**	**Min**	**Max**	**Std.Dev.**	**Skewness**	**Kurtosis**
HEIGHT	167,75	167,00	158,00	185,00	5,71	1,05	1,44
WEIGHT	59,52	58,40	44,70	87,00	7,63	1,19	2,44
BMI	21,10	21,11	16,62	25,98	1,95	0,14	0,22
MASS_NF	44,41	43,92	37,77	53,94	3,39	0,57	0,66
MAS_NF%	75,23	75,00	62,00	87,00	6,23	-0,03	-0,58
PEAK_P	7,22	6,98	6,12	10,10	0,92	0,89	0,40
DROP_P	3,06	3,02	1,60	7,35	0,90	2,55	**10,56**
PWC170	182	176	104	315	49,06	0,73	0,23
VO2MAX	2,99	2,97	2,24	3,92	0,39	0,37	0,07
VO2MKG	52,90	52,76	35,71	71,27	7,01	0,06	0,10
MOV_COU1	28,32	27,00	15,00	45,00	5,96	0,42	0,30
MOV_COU2	12,28	12,14	9,70	14,88	1,22	0,01	-0,45
BALANCE1	8,47	8,00	3,00	22,00	4,34	0,92	0,57
BALANCE2	6,13	5,00	1,00	19,00	3,82	1,59	3,38
KINE_DIV	10,00	9,00	1,00	36,00	7,06	1,23	2,36
SWIFT_R1	9,42	9,30	9,00	10,00	0,36	0,16	-1,38
SWIFT_R2	0,19	0,19	0,15	0,24	0,02	-0,09	-0,49
SWIFT_R3	90,34	92,00	69,00	93,00	4,01	-3,33	**14,92**
SWIFT_R4	85,91	92,00	20,00	107,00	20,96	-1,38	1,40
SWIFT_R5	81,77	87,00	17,00	121,00	30,02	-0,56	-0,84
SPAT_OR1	10,38	10,00	2,00	17,00	3,47	0,03	-0,54
SPAT_OR2	31,57	32,00	8,00	57,00	11,65	-0,01	-0,61
RHYTHM	1,20	1,22	0,76	1,75	0,25	0,14	-0,71
COOPER	2371	2370	2150	2720	130,31	0,53	0,08

STR_CHES	32,38	32,50	25,00	45,00	5,84	0,49	-0,72
STR_LEGS	52,08	55,00	25,00	75,00	12,54	-0,51	-0,24
STR_GRIP	30,49	30,00	19,00	45,00	4,58	0,25	1,78
SPEED1	8,22	8,14	7,39	9,13	0,44	0,13	-0,53
SPEED2	2,94	2,91	2,56	3,47	0,20	0,41	0,26
AGILITY	25,48	25,40	23,40	27,40	0,92	0,27	-0,29
LITHE	27,91	28,00	17,00	38,00	5,11	-0,05	-0,49

The analysis of the results of descriptive statistics for motoric skills in the group of women and men shows that the distribution of all test results, both for the indexes of kurtosis and skewness, is normal (Table 11, 12).

On the basis of the established image of results of the descriptive statistics it may be claimed that the research was done correctly and its results are reliable. It allows to use more sophisticated techniques of calculation in farther statistical research.

Table 11.

Descriptive parameters of the examined motoric skills – group of men (n = 63)

	Mean	**Median**	**Minimum**	**Maksimum**	**Std.Dev.**	**Skewness**	**Kurtosis**
GYMN_S1	3,84	3,80	3,05	4,80	0,43	0,12	-0,58
GYMN_S2	3,90	4,00	3,00	5,00	0,63	0,17	-0,76
GYMN_S3	3,94	4,00	3,00	5,00	0,68	0,01	-1,27
GYMN_A	3,90	3,83	3,00	5,00	0,53	0,15	-1,04
GYMN_B	3,93	3,88	3,13	5,00	0,48	0,07	-0,79
GYMN_C	3,67	3,67	3,00	4,83	0,52	0,50	-0,67
GYMN_D	3,71	3,50	3,00	5,00	0,71	0,58	-1,08
ATHL_S1	3,94	4,00	3,00	5,00	0,57	0,16	-0,58
ATHL_S2	4,07	4,00	3,00	5,00	0,59	0,13	-0,71
ATHL_S3	3,98	4,00	3,00	5,00	0,73	0,15	-1,32
ATH_SPUT	424,60	417,00	312,00	563,00	69,40	0,28	-0,87
ATH_HUR	386,08	365,00	146,00	649,00	109,05	0,56	0,43
ATH_LJU	421,03	409,00	234,00	576,00	69,18	0,01	0,38
ATH_JAV	280,22	275,00	126,00	515,00	70,52	0,66	1,09
ATH_HJU	394,56	389,00	218,00	585,00	76,50	0,09	-0,48
ATH_RUN	343,78	328,00	179,00	600,00	94,69	0,38	-0,07
TEAMVOL	4,29	4,00	3,00	5,00	0,63	-0,24	-1,09
TEAMFOO	4,04	4,00	3,00	5,00	0,49	0,05	0,35
TEAMBAS	4,23	4,50	3,00	5,00	0,72	-0,36	-1,30
TEAMHAN	3,96	4,00	3,00	5,00	0,58	0,10	-0,62
SWIM_S1	3,74	3,50	3,00	5,00	0,68	0,60	-0,83
SWIM_S2	3,98	4,00	3,00	5,00	0,71	0,12	-1,17
SWIM_S3	3,74	3,67	3,00	5,00	0,65	0,50	-0,90

Table 12.

Descriptive parameters of examined motoric skills – group of women (n = 53)

	Mean	Median	Minimum	Maximum	Std.Dev.	Skewness	Kurtosis
GYMN_S1	3,83	3,80	3,00	4,95	0,50	0,28	-0,78
GYMN_S2	3,82	4,00	3,00	5,00	0,64	0,43	-0,58
GYMN_S3	3,92	4,00	3,00	5,00	0,66	-0,05	-1,17
GYMN_A	3,97	4,00	2,33	5,00	0,58	-0,42	0,42
GYMN_B	3,83	3,75	2,88	5,00	0,65	0,37	-1,03
GYMN_C	3,65	3,67	3,00	5,00	0,50	0,37	-0,49
GYMN_D	3,77	3,50	3,00	5,00	0,84	0,51	-1,49
ATHL_S1	3,87	4,00	3,00	5,00	0,54	0,23	-0,17
ATHL_S2	4,09	4,00	3,00	5,00	0,56	-0,04	-0,37
ATHL_S3	3,90	4,00	3,00	5,00	0,70	0,25	-1,13
ATH_SPUT	401,15	395,00	278,00	607,00	72,20	0,75	0,70
ATH_HUR	241,21	243,00	104,00	438,00	73,90	0,52	0,20
ATH_LJU	299,09	296,00	218,00	433,00	52,70	0,48	-0,46
ATH_JAV	284,51	287,00	176,00	432,00	60,62	0,34	-0,13
ATH_HJU	327,25	321,00	222,00	460,00	62,26	0,09	-0,33
ATH_RUN	252,60	259,00	37,00	409,00	84,21	-0,51	0,37
TEAMVOL	4,25	4,50	3,00	5,00	0,60	-0,36	-0,82
TEAMFOO	3,43	3,50	3,00	4,00	0,34	0,17	-0,78
TEAMBAS	4,00	4,00	3,00	5,00	0,73	0,08	-1,43
TEAMHAN	3,57	3,50	3,00	5,00	0,48	0,67	0,26
SWIM_S1	4,03	4,00	3,00	5,00	0,67	0,19	-1,14
SWIM_S2	3,84	4,00	3,00	5,00	0,80	0,35	-1,40
SWIM_S3	4,01	4,00	3,00	5,00	0,73	-0,10	-1,37

4.2. STRUCTURE OF MOTORIC CAPABILITIES

In the course of statistical analysis a factor analysis was applied, which was in order to reduce the amount of the variables and determine the structure of correlation between variables. The analysis allowed to isolate variables of the maximum factor capacity, which are the most representative for a given factor. For women, 9 factors were isolated (Table 13), which were subsequently described by the results of the measurements of motoric capabilities, and further called independent variables.

Due to the dominant character of some motoric capabilities, the factors were called as follows: swiftness, aerobic functional capacity, swift reaction capability and movement frequency, muscle strength, kinesthetic diversification, movement coupling, balance, litheness, rhythmization.

Table 13.

Factor structure of women's motoric capabilities

	Factor 1	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**	**Factor 7**	**Factor 8**	**Factor 9**
PEAK_P	-0,28	-0,67	0,19	-0,17	-0,08	0,37	-0,10	0,10	0,15
DROP_P	0,03	-0,69	0,22	-0,11	-0,30	0,06	-0,11	0,04	0,23
PWC170	-0,27	**-0,77**	-0,09	0,35	0,02	0,16	0,10	0,17	0,12
VO2MAX	0,07	**-0,73**	-0,09	0,22	0,03	-0,23	-0,10	0,00	-0,38
VO2MKG	-0,15	**-0,77**	0,01	-0,27	0,21	-0,20	-0,05	-0,13	0,00
MOV_COU1	-0,23	0,01	-0,01	0,12	0,09	**-0,76**	0,04	-0,02	0,15
MOV_COU2	0,46	0,23	0,04	0,03	0,02	0,36	0,00	0,02	-0,57
BALANCE1	-0,06	-0,12	0,10	-0,04	-0,10	-0,03	**-0,90**	0,17	-0,06
BALANCE2	0,19	0,03	0,34	0,19	-0,25	-0,21	**0,70**	0,19	-0,11
KINE_DIV	0,06	0,08	0,02	0,01	**0,82**	-0,03	0,11	0,25	0,13
SWIFT_R1	-0,37	0,15	0,23	0,35	0,40	0,00	-0,20	-0,10	0,02
SWIFT_R2	0,57	-0,25	-0,02	-0,35	-0,18	0,03	-0,08	-0,36	0,23
SWIFT_R3	0,03	0,00	**-0,77**	-0,06	-0,30	-0,20	0,14	0,19	-0,06
SWIFT_R4	-0,15	0,14	**-0,87**	0,15	0,11	0,07	0,01	0,00	0,04
SWIFT_R5	-0,15	-0,02	**-0,85**	0,09	-0,04	0,02	-0,17	-0,01	0,10
SPAT_OR1	0,01	0,05	-0,42	0,56	0,11	0,26	0,10	0,06	0,04
SPAT_OR2	0,10	-0,35	0,01	-0,48	0,15	0,06	0,22	-0,26	-0,47
RHYTHM	0,27	0,06	0,09	0,04	-0,01	0,02	-0,04	0,14	**-0,76**
COOPER	-0,15	**-0,72**	-0,10	0,21	-0,03	0,03	0,01	-0,04	0,22
STR_CHES	0,07	-0,10	-0,12	**0,78**	-0,02	-0,12	0,11	-0,20	-0,03
STR_LEGS	-0,04	0,04	0,05	**0,71**	0,07	-0,48	0,06	-0,09	-0,11
STR_GRIP	-0,04	-0,14	0,06	0,02	**0,71**	-0,12	-0,10	-0,32	-0,23
SPEED1	**0,84**	0,13	0,10	0,20	0,13	0,10	0,11	0,03	-0,13
SPEED2	**0,86**	0,09	0,26	0,07	-0,15	0,08	0,05	0,22	0,02
AGILITY	**0,74**	0,05	-0,05	0,01	0,00	0,13	0,10	0,01	-0,35
LITHE	-0,16	0,12	0,12	0,19	0,00	-0,05	0,10	**-0,81**	0,11

The maximum factor capacity variables for men were also isolated. In case of students 10 variables were isolated, and they were the most representative for a given factor (Table 14). Variables of the biggest factor capacity that characterize motoric skills of men are: swiftness of reaction, muscle strength, aerobic functional capacity, swiftness, agility, spatial orientation, balance, kinesthetic diversification, anaerobic functional capacity, spatial orientation.

Table 14.

Factor structure of men's motoric capabilities

	Factor 1	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**	**Factor 7**	**Factor 8**	**Factor 9**	**Factor 10**
PEAK_P	0,19	0,04	0,29	0,14	-0,08	-0,13	-0,04	0,15	**0,74**	0,00
DROP_P	0,02	0,32	-0,13	0,05	-0,03	0,12	0,00	-0,12	0,69	0,39
PWC170	0,11	0,15	**0,87**	0,00	0,10	0,04	0,09	-0,03	0,07	0,03
VO2MAX	-0,60	0,16	0,21	0,43	0,22	-0,19	-0,08	-0,12	-0,23	0,29
VO2MKG	-0,49	-0,21	0,51	0,30	-0,11	-0,10	0,23	-0,24	0,13	0,10
MOV_COU1	0,12	0,18	0,04	0,41	-0,43	0,23	-0,02	0,37	0,24	-0,23
MOV_COU2	-0,12	-0,45	-0,11	0,03	0,09	0,20	-0,49	0,27	0,15	0,19
BALANCE1	0,04	-0,10	0,06	0,40	-0,20	-0,44	0,32	0,03	0,03	-0,28
BALANCE2	-0,17	0,12	-0,05	-0,26	0,01	0,05	**-0,74**	0,10	-0,05	-0,02
KINE_DIV	-0,17	-0,04	-0,01	-0,16	-0,08	-0,04	0,09	**0,81**	-0,03	0,09
SWIFT_R1	0,00	0,19	-0,12	-0,10	0,16	-0,42	0,15	0,06	0,50	-0,18
SWIFT_R2	-0,11	-0,20	0,08	-0,22	0,04	**0,71**	0,00	0,03	0,07	0,18
SWIFT_R3	0,66	0,01	0,14	0,12	-0,09	0,07	0,54	-0,04	0,11	0,05
SWIFT_R4	**0,91**	0,06	0,14	0,03	0,05	-0,17	0,09	-0,10	0,09	0,05
SWIFT_R5	**0,87**	0,08	0,06	0,02	-0,01	-0,29	0,11	-0,14	0,00	0,11
SPAT_OR1	0,24	-0,17	0,16	-0,03	-0,04	**-0,71**	-0,11	0,20	0,22	0,04
SPAT_OR2	0,08	0,05	-0,10	0,00	-0,02	0,15	0,07	0,02	0,08	**0,83**
RHYTHM	-0,09	-0,48	-0,02	0,46	0,45	0,26	0,09	-0,13	0,07	-0,09
COOPER	0,08	-0,06	**0,85**	-0,14	-0,16	-0,05	0,07	-0,09	-0,02	-0,20
STR_CHES	0,03	**0,80**	-0,12	0,01	0,26	0,01	0,00	0,01	0,28	-0,02
STR_LEGS	0,05	**0,74**	0,22	0,26	0,10	-0,01	-0,23	0,07	0,13	0,17
STR_GRIP	0,03	0,16	0,11	-0,15	0,69	-0,07	-0,13	-0,14	0,23	-0,09
SPEED1	-0,01	-0,13	0,10	**-0,84**	0,07	0,16	-0,10	-0,04	-0,06	-0,07
SPEED2	0,08	-0,16	0,16	-0,41	0,08	0,22	0,62	0,16	-0,05	0,24
AGILITY	-0,03	0,17	-0,19	0,05	**0,70**	0,18	0,07	0,11	-0,25	0,07
LITHE	-0,01	-0,07	0,16	-0,19	-0,01	0,13	0,22	**-0,74**	-0,09	0,09

4.3. CORRELATIONS OF MOTORIC CAPABILITIES AND FUNCTIONAL FEATURES WITH THE LEVEL OF MOTORIC SKILLS FROM THE PERSPECTIVE OF SIMPLE CORRELATION

In the first stage of the basic statistical analyses, the values of the Pearson correlation coefficient between the results defining the level of motoric skills and motoric capabilities were calculated.

The following sports disciplines were taken into consideration: gymnastics, athletics and team sports (football, volleyball, basketball, handball)

Gymnastics

Correlation between the variables motoric skills in gymnastics and level of motoric capabilities have shown a lot of essential connections (Table 15 and 16 in the appendix). For the evaluation of the skills taught in the first semesters of teaching women the gymnastics, x_{23} (rhythmization), x_{31} (litheness), x_{30} (agility) and x_{28} i x_{29} (results of the 50 m run and 20 m with a run-up).

Correlation of the same variables in the group of men did not indicate essential relations.

The variables, which in an important way correlate with the level of skills in women gymnastics in the second semester are: x_{23} (rhythmization), x_{29} (running swiftness – the result of the 20 m run with run-up), x_{31} (litheness), x_{16} (swiftness of reaction), x_{14} (dynamic balance). Whereas in the group of men, only variable x_{12} (movement coupling) influences the mark for skills in the second semester of study.

The following variables possess essential correlation in the third semester of women gymnastics: x_{23} (rhythmization), x_{29} (running swiftness – the result of the 20 m run with run-up), x_{31} (litheness), x_{16} (swiftness of reaction), x_{14} (dynamic balance), x_{30} (agility), x_{31}.(running endurance in the Cooper test). In the case of men, in the similar way as in the second semester, only the variable x_{12} (movement coupling) influences the evaluation of skills in the third semester of teaching gymnastics.

The essential influence to the level of free exercise technique in the group of women was observed in case of: x_{28}, x_{29} (running swiftness – the result of the 20 m run with run-up and the 50 m run), x_{31} (litheness), x_{16} (swiftness of reaction), x_{14} (dynamic balance), x_{30} (agility), x_{24}.(running endurance in the Cooper test), x_{23} (rhythmization). The level of free exercise technique in the group of men correlated only with x_{27} (the grip strength).

The mark for the headstand and handstand technique in women gimnastics was essentially correlated with the following fitness and coordination variables: x_{14} (dynamic balance), x_{30} (agility), x_{16} (swiftness of reaction), x_{29} (swiftness), x_{31} (litheness). For men, no essential correlation between the mark for the handstand technique and motoric capabilities was noted.

The gymnastic vaults are strongly influenced by the variables x_{28}, x_{29} (running swiftness – the result of the 20 m run with run-up and the 50 m run) for women and x_{31} (litheness), x_{30} (agility), x_{21} (spatial orientation) for men.

The most important for mastering the basic motoric skills in bar exercises for women are the variables: x_{12} (movement coupling), x_{30} (agility), x_{28}, x_{29} (swiftness), x_{31} (litheness). The motoric skills in bar exercises for men did not essentially correlate with any of the motoric capabilities.

Athletics

The level of the particular motoric skills in athletics essentially correlates with many measurement results of fitness and coordination capabilities The mark for the women athletics in the 1st semester essentially correlates with the following variables: x_{30} (agility), x_{28}, x_{29} (running swiftness), x_{24}.(the Cooper test), x_{29} (rhythmization), x_{16} (swiftness of reaction), x_{14} (balance). The analysis of the same variables in the case of men has shown a distinct correlation with the result of the Cooper test (table 17 and 18 in the attachments section).

The analysis of the Pearson correlation has shown the correlation of the mark for the second semester of the women athletics with the following variables: x_{23} (rhythmization), x_{30} (agility), x_{28} and x_{29} (run swiftness). There was a correlation observed between the mark for the second semester of men's athletics and variables: x_{24} (Cooper test result), x_{31} (litheness), x_{18} (swiftness and frequency of the reaction) and x_{15} (kinesthetic diversification).

The mark for the third semester of women athletics was influenced by (similarly as in the second semester), x_{23} (rhythmization), x_{30} (agility), x_{28} and x_{29} (run swiftness) and additionally x_{24} (Cooper test result). The level of motoric skills for men in the third semester of athletics was influenced by (similarly as in the case of women) the variable: x_{24} (Cooper test result) and x_{18} (swiftness and frequency of reaction) i x_{15} (kinesthetic diversification).

The variables, that essentially correlate with the technique of shot put women are: x_{25} (strength of chest muscles), x_{26} (strength of the lower limbs' muscles), x_{22} (spatial orientation). Correlation of the same variables in the case of men has shown the influence of the level of x_{28} (swiftness), x_{25} (chest muscles strength), x_{26} (strength of the lower limbs' muscles), x_{27} (grip strength), x_{24} (Cooper test results), x_{14} (balance), x_6 (anaerobic power) on the shot put technique.

Hurdle race technique women belongs to the variables: x_{30} (agility), x_{28} (50 m run swiftness) and x_{29} (20 m run swiftness with run-up), x_{16} (swiftness of the reaction), x_{12} (movement coupling). The level of the hurdle race men technique correlates with: x_{28} (run swiftness), x_{17} (swiftness of the reaction), x_{14} (static balance), x_{13} (dynamic balance), x_{12} (movement coupling), $x_{9\ i}\, x_{10}$ (maximal oxygen intake).

The long jump women technique is essentially correlated with the following measurement results: x_{28} (run swiftness), x_{24} (Cooper test results), x_{11} (movement coupling). The long jump men correlates with: x_{28} (run swiftness), x_{27} (grip strength) and x_{16} (swiftness of the reaction).

Two variables influence the javelin throw women: x_{30} (agility), x_{17} (swiftness of the reaction), but among man none of the analyzed variables has shown any essential correlation with the javelin throw technique.

The variables, that essentially correlate with the technique of high jump women are: x_{30} (agility), x_{22} (spatial orientation), x_{16} (swiftness of the reaction). For the men the same correlation is with x_{28} (run swiftness), x_{27} (grip strength), x_{17} (swiftness of the reaction), (dynamic balance), x_{12} (movement coupling).

The technique of the 800 m run women and 1500 m run men is influenced by results of the measurements of the following motoric capabilities for women: x_{30} (agility), x_{28} (run swiftness), x_{29} (run swiftness), x_{24} (Cooper test results) oraz x_{16} i x_{17} (swiftness of the reaction), and for the men the variables: x_{24} (Cooper test results), x_8 (PWC_{170}), x_3 (BMI), x_{10} (aerobic functional capacity), x_{16} (swiftness of the reaction), x_{23} (rhythmization) and x_{31} (litheness) which essentially correlated with the running technique.

Team sports

To find correlation of the fitness and coordination capabilities with the level of skills taught in team sports the Pearson correlation was used.

The correlation with the level of skills in volleyball was observed in case of the swiftness of the reaction and the frequency of the movement (x_{19} i x_{20}) in the case of women and x_{24} (Cooper test results), x_{10} (maximal oxygen intake) i x_{13} (dynamic balance) in the case of men.

The influence on the skill level of the female students in football exists only in case of the variable x_{19} (swiftness of the reaction and frequency of the movement). For the male students' level of football technique is influenced by x_{14} (balance) and x_{12} (movement coupling).

The technique of performing physical activities in basketball women is essentially correlated with the measurement results of x_{23} (rhythmization) and x_{24} (Cooper test results). For men basketball technique was essentially linked only to x_{25} (chest muscles strength).

The result x_{12} (movement coupling) as the only variable of the motoric capabilities was essentially correlated with the handball skills of the women. The essential correlation of the men’s handball appeared with the variables: x_{26} (strength of the lower limbs' muscles), x_{29} (run swiftness), x_7 (anaerobic power loss).

Swimming

The variables, that essentially correlate with the technique of women's swimming are: x_{31} (litheness), x_{30} (agility), x_{28} (run swiftness), x_{29} (run swiftness), x_{16} (swiftness of the reaction). In the case of men, no essential correlation of the variables describing motoric capabilities with swimming technique was observed.

4.4. BIOMETRICAL REGRESSION MODELS FOR PARTICULAR FORMS OF PHYSICAL ACTIVITY

The most important aim of this dissertation is to present links between motoric capabilities and the level of motoric skills among students of the Faculty of Physical Education in the subsequent study semesters. The second important aim of this research work is to establish the level of possibility to diagnose the process of acquisition of motoric skills with a large number of sports-motoric and laboratory tests.

To establish the level of possibility to diagnose individual descriptive variables, the mathematical models were constructed (biometrical models of multiple regression).

The analysis of multiple regression allows to explain variability of a chosen quantity, so it will be used to expose independent variables that influence a dependent variable. The calculated coefficient of determination ($R^{\wedge 2}$), which determines a degree to which (%) independent variables – the results of measurement of motoric capabilities, determine the dependent variable – the motoric skills.

Gymnastics

The biggest influence on the evaluation of motoric skills in the first semester of women's gymnastics, have the following variables: x_{31} (litheness), x_{30} (agility), x_{18} (swiftness of the reaction), x_1 (body height), x_{16} (swiftness of the reaction), x_{17} (swiftness of the reaction), x_{21} (spatial orientation), x_9 (aerobic functional capacity), x_2 (body weight). The enumerated variables explain 51% of the tested phenomenon and in detail it is explained by the regression equation:

$$Y = 0.035 + 0.45x_{31} - 0.42x_{30} + 0.41x_{18} - 0.35x_1 + \\ + 0.34x_{16} + 0.,30x_{17} + 0.34x_{21} + 0.32x_9 + 0.35x_2$$

The evaluation of the skills taught in the second semester of women's gymnastics was influenced strongly only by x_{31} (litheness). This variable explains 23% of the tested phenomenon.

The highest predictive value for the level of technical skills in the third semester of women's gymnastics is possessed by the following variables: x_{29} (swiftness), x_{23} (rhythmization), x_{12} (movement coupling), x_{19} (reaction swiftness), x_{18} (reaction swiftness), x_{16} (reaction swiftness), x_{26} (leg muscles strength), x_{17} (reaction swiftness). They form the following regression equation:

$$Y = -3.68 - 0.48x_{29} - 0.45x_{23} + 0.36x_{12} - 0.47x_{19} + \\ + 0.46x_{18} + 0.32x_{16} + 0.29x_{26} + 0.26x_{17}$$

The variables that create optimal combinations for the level of technical skills in the third semester of the women's gymnastics explain 61% of the tested phenomenon.

In the next analysis three variables were introduced to the equation of the multiple regression: x_{29} (swiftness), x_6 (maximum anaerobic power), x_{17} (swiftness of the reaction), which means, that these variables are decisive for the possibility of mastering the technique of rolls and cartwheels. Coefficient of determination equals R^2=0.38 which means, that the above-mentioned variables determine in 38% the level of motoric skills in the third semester of women's gymnastics.

$$Y = 7.14 - 0.41x_{29} - 0.51x_6 + 0.30x_{17}$$

The following variables are decisive for mastering by women the headstand and handstand techniques: x_{31} (litheness), x_{30} (agility), x_{21} (spatial orientation), x_{18} (swiftness of the reaction), x_{16} (swiftness of the reaction), x_{17} (swiftness of the reaction), x_{25} (chest muscles strength), x_7 (decrease of the anaerobic power). Theses variables explain 49% of the examined phenomenon and it is presented in a greater detail in the multiple regression equation:

$$Y = -3.25 + 0.43x_{31} - 0.37x_{30} + 0.32x_{21} + 0.39x_{18} + \\ + 0.42x_{16} + 0.30x_{17} - 0.33x_{25} + 0.29x_7$$

The variable x_{28} (run swiftness) explains the biggest part of variables for the women gymnastic vaults and it explains 23% of the variables.

In case of women, the technique of performing exercises on horizontal bar is described through variables: x_{31} (litheness), x_2 (body weight), x_{27} (grip strength), x_{16} (swiftness of the reaction), x_{18} (swiftness of the reaction), x_{19} (swiftness of the reaction), x_{15} (kinesthetic diversification), x_{26} (strength of the lower limbs' muscles). The variables used in the regression equation explain 47% of the examined phenomenon:

$$Y = -9.29 + 0.31x_{31} - 0.40x_2 - 0.26x_{21} + 0.35x_{16} + \\ + 0.57x_{18} - 0.63x_{19} - 0.30x_{15} + 0.30x_{26}$$

The multiple regression analysis used in the group of men allows to explain variability of the chosen quantity and it serves to isolate independent variables, which significantly influence the level of motoric skills in PE students gymnastics.

The predictor variable in the first semester of men gymnastics are variables: x_{10} (aerobic functional capacity), x_8 (power), x_{24} (endurance), x_{16} (swiftness of the reaction). The variables explain 54% of the examined phenomenon.

The key significance for mastering of gymnastic exercises technique in the second semester for men bear the variables: x_{29} (swiftness), x_{14} (static balance), x_{23} (rhythmization), x_{21} (spatial orientation), x_8 (power), x_{24} (endurance). The part of the tested phenomenon explained by the variables included in the multiple regression analysis equals 33%. The influence of the examined independent variables on the dependent variables is presented by means of the equation of multiple regression:

$$Y = 2.21 + 0.35x_{29} + 0.26x_{14} - 0.28x_{28} + 0.30x_{21} - 0.39x_8 + 0.52x_{24}$$

The greatest influence on the technique of exercises carried out in the third semester of gymnastics for men have the following variables: x_{16} (swiftness of the reaction), x_{21} (spatial orientation) and x_{25} (chest muscles strength). The enumerated variables explain 23% of the examined phenomenon and the regression equation adopts the following form:

$$Y = 7.45 - 0.35x_{16} + 0.29x_{21} - 0.34x_{25}$$

For the technique of rolls and cartwheels in men gymnastics the significant influence is exposed only in the case of variable x_{10} (aerobic functional capacity). This variable explains 15% of the tested phenomenon.

The optimal technique of performing handstands and headstands in gymnastics is predominantly dependent of: x_{20} (swiftness of the reaction), x_{10} (aerobic functional capacity), x_8 (PWC_{170}) oraz x_{24} (endurance). The variables explain only 14% of the examined phenomenon. The direction of influence of the independent variables on the headstand technique is described by the regression equation:

$$Y = -1.36 + 0.29x_{20} + 0.30x_{10} - 0.35x_8 + 0.34x_{24}$$

The highest predictive value for the level of the gymnastic vaults of the PE students possesses, similarly like in the case of rolls and cartwheels' technique, only the variable: x_{10} (aerobic functional capacity). This variable explains only 20% of the tested phenomenon.

The most important for mastering the basic motoric skills in bar exercises are the variables: x_{25} (strength of chest muscles) and x_{26} (strength of the lower limbs' muscles. The coefficient of determination for both variables is $R^2 = 0.23$.

Athletics

The highest predictive value for the level of technical skills in the third semester of athletics for female PE students is carried by the following variables:

x_{29} (swiftness), x_{23} (rhythmization), x_{22} (spatial orientation), x_{26} (strength of legs' muscles), x_{24} (endurance), x_7 (anaerobic functional capacity), x_{10} (aerobic functional capacity), x_{12} (movement coupling), x_{25} (chest muscles strength), x_{19} (swiftness of the reaction), x_8 (PWC_{170}), x_{28} (run swiftness), x_{18} (swiftness of the reaction). The variables that create the optimal combinations explain 61% of the tested phenomenon.

$$Y = -0.12 - 0.56x_{29} - 0.31x_{23} - 0.44x_{22} - 0.37x_{26} + 0.31x_{24} - 0.38x_7 + 0.46x_{10} + \\ + 0.29x_{12} + 0.32x_{25} - 0.29x_{19} - 0.34x_8 + 0.35x_{28} - 0.28x_{18}$$

The independent variable, x_{29} (swiftness) as the only one significantly influences the level of mastering various events in the second semester of athletics. This variable explains only 20% of the tested phenomenon.

The following variables have decisive significance for mastering the technique in women's competition carried out in the third semester of studying athletics: x_{24} (endurance), x_{16} (swiftness of the reaction), x_{18} (swiftness of the reaction), x_{12} (movement coupling), x_{21} (spatial orientation), x_{23} (rhythmization), x_{29} (swiftness), x_{22} (spatial orientation), x_{17} (swiftness of the reaction), x_{11} (movement coupling), x_{19} (swiftness of the reaction), x_7 (anaerobic functional capacity). The part of the tested phenomenon explained by the variables included in the regression analysis equals 59%. The influence of the examined independent variables on the dependent variables is presented by the equation of the multiple regression:

$$Y = -19.33 + 0.67x_{24} + 0.26x_{16} + 0.37x_{18} + 0.33x_{12} - 0.35x_{21} - 0.40x_{23} - \\ - 0.66x_{29} - 0.39x_{22} + 0.33x_{17} - 0.27x_{11} - 0.46x_{19} - 0.28x_7$$

The biggest influence on the technique of the shot put (women) have the following variables: x_{25} (chest muscles strength), x_{22} (spatial orientation), x_{12} (movement coupling), x_{19} (swiftness of the reaction), x_{30} (agility), x_{27} (grip strength), x_7 (anaerobic functional capacity), x_{11} (movement coupling), x_{23} (rhythmization). All of the mentioned variables explain 58% of the tested phenomenon and together they form the following regression equation:

$$Y = -1112.9 + 0.49x_{25} - 0.35x_{22} - 0.33x_{12} - 0.41x_{19} + 0.45x_{30} + \\ + 0.23x_{27} - 0.34x_7 - 0.28x_{11} - 0.32x_{23}$$

The level of the hurdle race technique (women) is determined above all by the following independent variables: x_{28} (swiftness), x_7 (anaerobic functional capacity), x_{25} (chest muscles strength), x_{16} (swiftness of the reaction). The explained part of variability equals 44% of the examined phenomenon and the regression equation is formed as follows:

$$Y = 82.89 - 0.36x_{28} - 0.24x_7 - 0.30x_{25} + 0.23x_{16}$$

The level of women's long jump technique is significantly influenced by the three following independent variables. x_4 (fat free mass of body), x_{29} (swiftness) oraz x_{18} (swiftness of the reaction). The diagnostic value of the explanatory variables contained in the regression equation equals 31%. The multiple regression equation for the women's long jump:

$$Y = 1255.9 - 0.46x_4 - 0.58x_{29} - 0.40x_{18}$$

The variable x_{30} (agility), as the only one significantly conditions the level of javelin throw technique (women), and its value explaining the given phenomenon equals merely 19%.

The high jump technique is explained also by a small number of variables, because just x_{24} (endurance) and x_{22} (spatial orientation). Both variables explain 32% of the examined phenomenon.

For teaching and exercising the technique of middle distance runs (women) the most important are the variables: x_{24} (endurance), x_{27} (grip strength), x_{11} (movement coupling), x_{14} (static balance), x_{12} (movement coupling), x_{23} (rhythmization), x_4 (fat free mass of body). The multiple regression equation which explains 66% of the tested phenomenon has the following form:

$$Y = -1009 + 0.70x_{25} + 0.27x_{27} - 0.30x_{11} + 0.40x_{14} + 0.30x_{12} - 0.26x_{23} + 0.32x_4$$

A series of multiple regression analyses was carried out for students in order to explain the determinants of motoric fitness and motoric skills.

The biggest amount of information about the level of skills possessed by the students in the first semester of athletics is provided by the variables: x_{24} (endurance), x_{22} (spatial orientation), x_8 (PWC_{170}), x_{15} (kinesthetic diversification), x_{31} (litheness), x_2 (body weight) i x_{10} (aerobic functional capacity). Despite the large number of variables that are part of the regression equation they explain only 37% of the tested phenomenon.

$$Y = 0.72 + 0.58x_{24} + 0.31x_{22} - 0.46x_8 + 0.27x_{15} + 0.25x_{31} + 0.30x_2 - 0.29\,x_{10}$$

The level of the athletics events in the second semester for men is influenced significantly by the following variables: x_{11} (movement coupling), x_{24} (endurance), x_{30} (agility), x_{27} (grip strength) and x_{22} (spatial orientation). The coefficient of determination of the enumerated variables equals $R^{\wedge 2} = 0.45$ and the direction of the influence on the dependent variable is presented by the regression equation:

$$Y = -6.64 + 0.28x_{11} + 0.54x_{24} + 0.26x_{30} - 0.25x_{27} - 0.26x_{22}$$

Variables x_{24} (endurance), x_1 (body height) and x_8 (PWC_{170}) explain the greatest group of variables for the technique of the athletics events carried out in the men's third semester of study. The coefficient of determination equals 0.36.

It means that the analyzed variables explain 36% of the examined phenomenon. The multiple regression equation for the technique of athletics events in the third semester for men has the following form:

$$Y = -6.49 + 0.48x_{24} + 0.32x_1 - 0.32x_8$$

The key significance for mastering the technique of shot put (men) have the following variables: x_{10} (aerobic functional capacity), x_{24} (endurance), x_{14} (static balance), x_{31} (litheness), x_2 (body weight), x_{23} (rhythmization), x_8 (PWC_{170}), x_4 (fat free mass of body). The part of the tested phenomenon explained by the variables included in the multiple regression analysis equals 53%. The influence of the examined independent variables on the dependent variables is presented by the equation of the multiple regression:

$$Y = 746.6 - 0.51x_{10} - 0.40x_{24} + 0.53x_{14} + 0.22x_{31} - 0.97x_2 + \\ + 0.33x_{23} + 0.34x_8 + 0.77x_4$$

The hurdle race (men) technique is influenced mostly by the variables: x_{28} (run swiftness), x_{12} (movement coupling), x_{25} (chest muscles strength), x_4 (fat free mass of body) and x_6 (maximum anaerobic power). The part of the phenomenon that was explained by the variables included in the regression analysis equals 47% and the direction of the influence of the independent variables is presented by the regression equation:

$$Y = 2503 - 0.34x_{28} - 0.24x_{12} - 0.30x_{25} + 0.53x_4 - 0.33x_6$$

The highest predictive value for the level of long jump technique (men) is carried by the variables: x_{28} (run swiftness), x_{16} (swiftness of the reaction), x_{27} (grip strength), x_{11} (movement coupling), x_{14} (static balance). The variables explain 39% of the examined phenomenon. The regression equation for the above-mentioned variables has the following form:

$$Y = 1922.8 - 0.56x_{28} - 0.26x_{16} - 0.32x_{27} - 0.35x_{11} + 0.26x_{14}$$

The variables x_1 (height of body) and x_{11} (movement coupling) explain the biggest part of variables for the technique of javelin throw. The analyzed variables explain only 18% of the examined phenomenon. The multiple regression equation for the technique of javelin throw (men) has the following form:

$$Y = -112.9 + 0.29x_1 - 0.32x_{11}$$

The following variables have the key issue for mastering the high jump technique of students of PE: x_{27} (grip strength), x_{17} (swiftness of the reaction), x_1 (body height), x_{12} (movement coupling), x_{22} (spatial orientation), x_{29} (run swiftness), x_{26} (strength of the lower limbs' muscles). The enumerated variables explain 52% of the examined phenomenon and the regression equation adopts the following form:

$$Y = 572 – 0.43x_{27} – 0.26x_{17} + 0.35x_1 – 0.33x_{12} + 0.28x_{22} – 0.24x_{29} – 0.26x_{26}$$

The technique of the middle distance run on the distance of 1500 m (men), is best conditioned by the variables: x_{24} (endurance), x_{23} (rhythmization), x_{21} (spatial orientation), x_{20} (swiftness of the reaction), x_{10} (aerobic functional capacity), x_{22} (spatial orientation), x_{12} (movement coupling), x_{29} (run swiftness), x_1 (body height), x_{30} (agility), x_{26} (strength of the lower limbs' muscles). All of the mentioned variables explain 75% of the tested phenomenon and the direction of influence is shown by the regression equation:

$$Y = – 301 + 0.55x_{24} – 0.30x_{23} – 0.24x_{21} + 0.28x_{20} + 0.32x_{10} – 0.27x_{22} + \\ + 0.23x_{12} + 0.23x_{29} + 0.22x_1 – 0.18x_{30} + 0.24x_{26}$$

Team sports

The key significance for mastering elements of volleyball technique (women) have the following variables: x_{20} (swiftness of the reaction), x_{15} (kinesthetic diversification), x_4 (fat free body mass), x_{23} (rhythmization). The independent variables used in the model equation explain 25% of the tested phenomenon:

$$Y = – 0.17 + 0.40x_{20} – 0.39x_{15} + 0.59x_4 – 0.41x_{23}$$

The football playing technique of female students is influenced by the following variables: x_{19} (swiftness of the reaction), x_6 (maximum anaerobic power), x_9 (aerobic functional capacity), x_{10} (aerobic functional capacity). The variables explain 31% of the tested phenomenon and are present in the regression equation:

$$Y = 3.83 + 0.39x_{19} – 0.30x_9 + 0.52x_9 – 0.37x_{10}$$

The biggest amount of information about the level of possessed skills in basketball (women) is provided by the variables: x_{24} (endurance), x_{28} (swiftness), x_{10} (aerobic functional capacity), x_{16} (swiftness of the reaction). The variables given in the regression equation explain 32% of variability of the examined phenomenon.

$$Y = – 19.03 + 0.56x_{24} + 0.52x_{28} + 0.35x_{10} + 0.28x_{16}$$

The following variables have the key importance for mastering the handball technique (women): x_{15} (kinesthetic diversification), x_7 (anaerobic functional capacity),`x_8 (PWC_{170}),. The enumerated variables explain 27% of the examined phenomenon and the regression equation adopts the following form:

$$Y = 1.16 – 0.46x_{15} – 0.41x_7 + 0.43x_8$$

The key significance for mastering elements of volleyball technique (men) have the following variables: x_{13} (dynamic balance), x_4 (fat free body mass), x_{10} (aerobic functional capacity). The independent variables used in the model equation explain 36% of the tested phenomenon:

$$Y = -2.08 + 0.32x_{13} - 0.49x_4 - 0.43x_{10}$$

The multiple regression analysis for PE men's football did not reveal any significant relations with the independent variables.

The biggest amount of information about the level of possessed skills in basketball (men) is provided by the variables: x_{25} (chest muscles strength), x_1 (body height), x_{27} (grip strength), x_{18} (swiftness of the reaction), x_{12} (movement coupling), x_{28} (run swiftness). The variables given in the regression equation explain 27% of variability of the examined phenomenon.

$$Y = -0.53 - 0.34x_{25} + 0.38x_1 - 0.37x_{27} - \\ - 0.40x_{18} - 0.30x_{12} + 0.25x_{28}$$

The multiple regression analysis allows to determine independent variables which explain 35% of the tested phenomenon in handball. They are: x_7 (loss of anaerobic power) and x_{29} (run swiftness).

Swimming

The following variables have the biggest influence on mastering the swimming techniques (women) in the first semester: x_{28} (swiftness), x_6 (maximum anaerobic power), x_{15} (kinesthetic diversification), x_{26} (strength of the lower limbs' muscles), x_{13} (dynamic balance), x_{22} (spatial orientation), x_{17} (swiftness of the reaction), x_{12} (movement coupling), x_{29} (swiftness), x_{19} (swiftness of the reaction). The above-mentioned variables explain 65% of the tested phenomenon and form an equation of the regression analysis.

$$Y = 17.25 - 0.54x_{28} - 0.48x_6 + 0.20x_{15} - 0.32x2_6 - 0.25x_{13} - 0.34x_{22} + \\ + 0.29x_{17} + 0.35x_{29} - 0.39x_{17} - 0.42x_{19}{}^{-}$$

In the second semester the swimming technique was determined by the following variables: x_6 (maximum anaerobic power), x_{27} (grip strength), x_{28} (swiftness), x_{13} (dynamic balance), x_4 (fat free body mass). All variables included into the regression equation explain 42% of the examined ones:

$$Y = 14.12 - 0.45x_6 + 0.28x_{27} - 0.50x_{28} - 0.39x_{13} + 0.34x_4$$

The key variables for mastering swimming techniques (women) in the third semester were the following: x_{28} (swiftness), x_6 (maximum anaerobic power), X_{16} (swiftness of the reaction), x_{30} (agility), x_1 (body height), x_{29} (swiftness), x_{31}

(litheness). The independent variables used in the model equation explain 49% of the tested phenomenon:

$$Y = 8.82 – 0.43x_{28} – 0.30x_6 + 0.47x_{16} – 0.57x_{30} – 0.39x_1 + 0.39x_{29} + 0.24x_{23}$$

The following variables had the key significance for mastering the backstroke technique as well as jumps and turns during the first semester of swimming (men): x_{16} (swiftness of the reaction), x_4 (free body mass), x_8 (PWC_{170}), x_6 (maximum anaerobic power), x_{15} (diversification of movement), x_9 (aerobic functional capacity). The part of the tested phenomenon explained by the variables included in the multiple regression analysis equals 34%. The influence of the examined independent variables on the dependent variables is presented by the equation of the multiple regression:

$$Y = 3.67 – 0.35x_{16} + 0.27x_4 – 0.44x_8 + 0.32x_{25} – 0.22x_{15} + 0.28x_2$$

In the second semester the free style swimming technique was determined by the variables: x_4 (fat free body mass), x_{17} (swiftness of the reaction), x_{16} (swiftness of the reaction), x_9 (aerobic functional capacity), x_{19} (swiftness of the reaction). All variables included into the regression equation explain 42% of the tested ones

$$Y = 10.49 – 0.36x_4 – 0.33x_{17} – 0.30x_{16} – 0.34x_9 – 0.66x_{19}$$

The following variables are the most important ones for achieving the optimal technique of swimming medley (men) in the third semester of swimming: x_{16} (swiftness of the reaction), x_{23} (rhythmization), x_{17} (swiftness of the reaction), x_6 (maximum anaerobic power), x_{29} (run swiftness), x_7 (anaerobic functional capacity), x_1 (body height), x_2 (body weight). The enumerated variables explain 39% of the tested phenomenon and form the following regression equation:

$$Y = – 1.22 – 0.26x_{16} + 0.23x_{23} – 0.29x_{17} + 0.39x_6 + \\ + 0.32x_{29} – 0.49x_7 + 0.45x_1 – 0.35x_2$$

4.5. FUNCTIONAL CAPACITY AND MOTORIC FITNESS PROFILES OF STUDENTS DEPENDING ON GENDER AND MOTORIC SKILLS LEVEL

The next step of the statistical analysis is an attempt to answer subsequent research question, namely: is the structure of motoric fitness different for individuals with low, medium and high level of motoric skills?

The resultant motoric fitness was defined as a mean of all motoric skills results. All variables included into motoric capabilities and motoric skills were standardized separately in the groups of men and women.

The analysis of the variance of parameters reffered to as a functional capacity (peak power, drop power in the Wingate test, PWC 170, VO_2max, VO_2) and the resultant level of motoric skills of women revealed lack of significance of the analyzed variables (Fig. 16). It means that the tested groups of women are largely homogeneous, which entails the similar level of aerobic and anaerobic functional capacity.

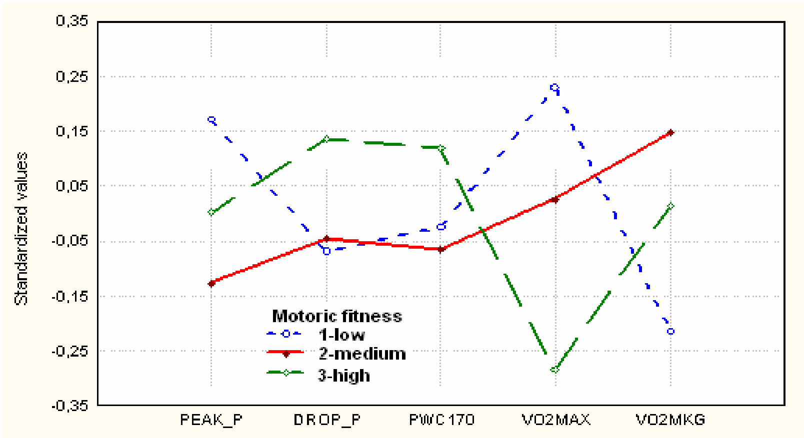


Fig. 16. Functional capacity level profiles (women) (n=53)

The analysis of the same variables in groups of men revealed a significant difference in the level of maximum oxygen intake (VO_2max) only between the ”medium” and ”high” groups, whereas differences among other functional capacity measurement results did not reveal such significance (Fig. 17).

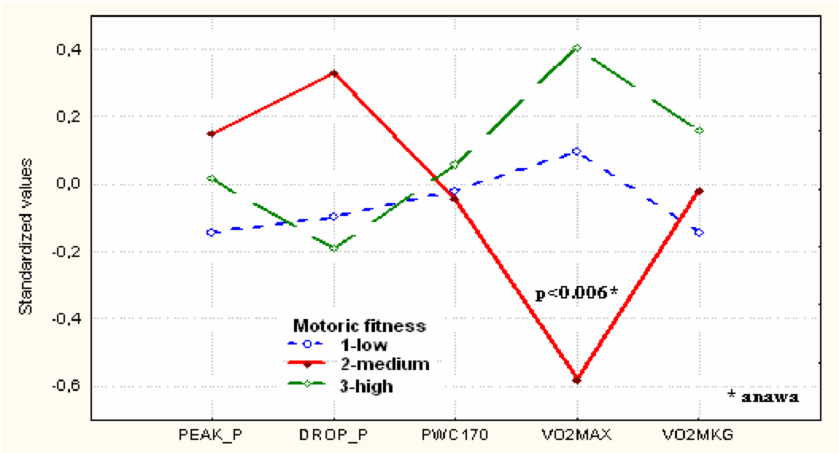


Fig. 17. Functional capacity level profiles (men) (n=63)

The analysis of coordination capabilities profiles for women revealed significant differenced only among extreme groups, that is between the groups of the highest and lowest motoric fitness; there is also the lack of such differences when we compare the group ”low” with ”medium”, as well as ”medium” with ”high”. The above-mentioned dependence occurred while comparing the variables of swiftness of reaction (x_{16}) and rhythmization (x_{23}). The analysis of the remaining coordination variables did not reveal any significant differences (Fig. 18).

Standardization of coordination variables for men did not reveal any significant differences between groups, which may be explained with high homogeneity of the received results (Fig. 19).

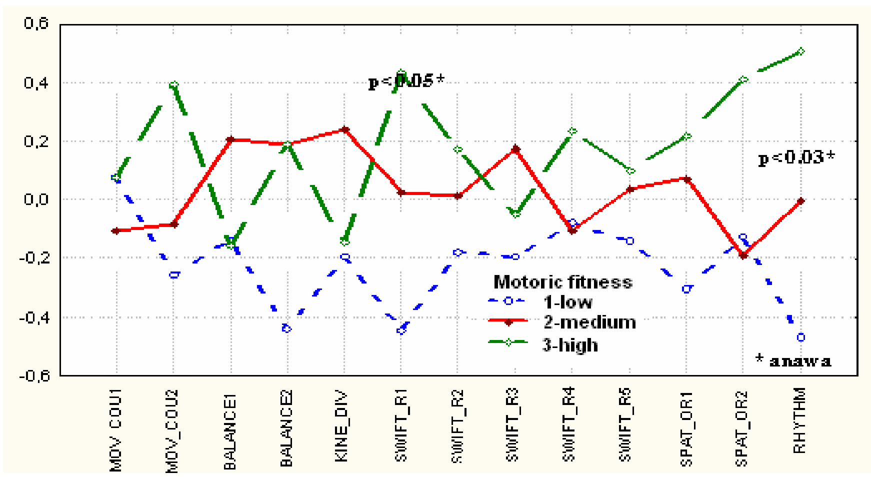


Fig. 18. Coordination capabilities profiles (women)

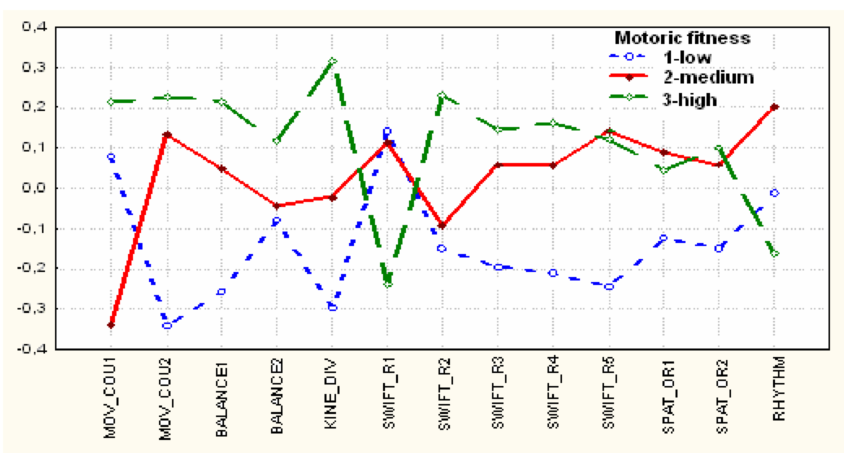


Fig. 19. Coordination capabilities profiles (men)

The analysis of the variance of variables included in coordination capabilities profile of women (Fig. 20) revelead significant dependencies between groups in the following groups of measurements: Cooper test (x_{24}), swiftness of the reaction (x_{16}) and (x_{17}), agility (x_{30}). The lack of significance of the variables appeared during comparison of levels of the variables: litheness (x_{31}) and grip strength (x_{27}). An even level of results appeared also in the measurement of the chest muscles strength (x_{25}) and strength of the lower limbs' muscles (x_{26}).

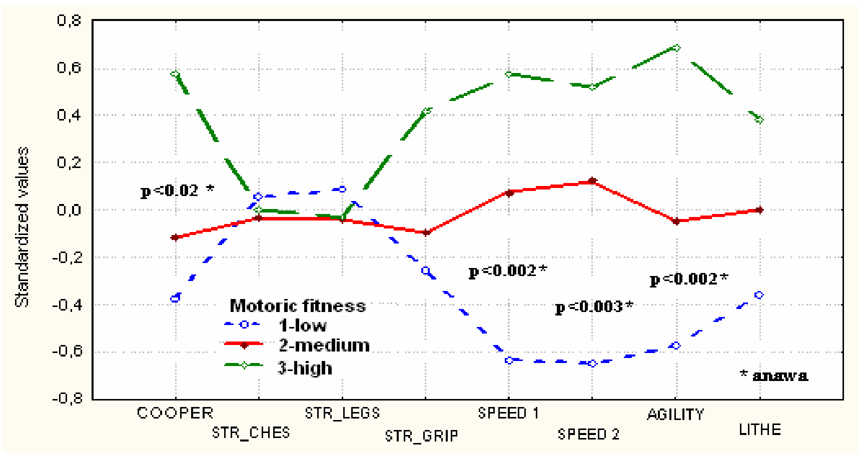


Fig. 20. Physical condition capabilities profile (women)

The analysis of physical condition capabilities profile for men (Fig. 21), similarly as the analysis of the coordination capabilities profile, did not reveal any significant differences between the compared groups.

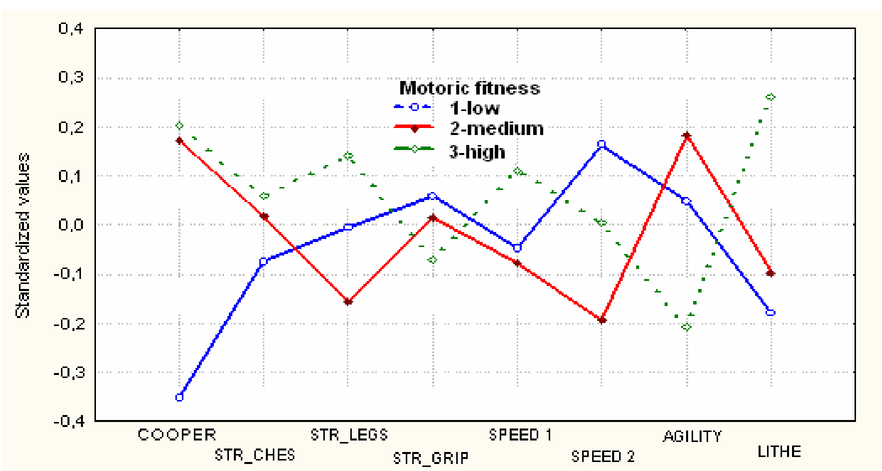


Fig. 21. Physical condition capabilities profile (men)

5. DISCUSSION

The main goal of this research is to find relations and correlations between motoric capabilities and motoric skills on the example of students at the Physical Education Faculty in Opole in chosen forms of sports-motoric activities. So far the research has broached the problem of importance of motoric capabilities as regards quality and speed of acquiring motoric skills by professional sportsmen on various levels of expertise (Zimmermann 1984, Ljach 1988, Fostiak 1994, Starosta 1987, 1994, 2003, Szczepanik 1993, Żak, Sakowicz 1995, Kioumourtzoglou et al. 1997). The problem of motoric determinants of PE students' motoric skills was researched by Kuba (2001), but only in the scope of coordination determinants of the process of acquiring and mastering motoric skills. The problem of relations and links of motoric capabilities and motoric skills on the basic level (high school and college youth) is much less known, so there is a need to conduct further research on the said phenomenon. Many authors emphasize the significance of motoric capabilities in the process of motoric learning (Blume 1981, Hare 1985, Starosta 1987, 1994, 2003, Raczek 1989, 1991). An attempt to provide answers to research problems identified in the current dissertation established a proper way of proceeding, the stages of which lead to determination of structure of physical condition and coordination, which exerts influence upon effectiveness of mastering and developing motoric activities.

The statistical analyses of the research results allow to claim that the structure of motoric capabilities, which determines acquisition and level of motoric skills of tested students, differs depending on the sports discipline and gender.

The results of the research confirm that in cae of gymnastics the key significance for mastering motoric skills characteristic for that sports discipline is placed on rhythmization, litheness, agility, locomotion swiftness, balance, swiftness of the reaction, movement coupling for female students and litheness, agility, spatial orientation, hand strength, movement coupling and balance for male students. Kuba (2001) in his research differentiates also spatial orientation, movement coupling, balance and rhythmization as the most crucial. In case of the professional sportsmen Zimmermann & Nicklisch (1981) differentiate spatial orientation, movement coupling, balance, diversification and rhythmization. Agility, litheness and swiftness of the reaction seems to be the key capabilities in gymnastics on the college level, since it influences significantly on the level of most activities taught during the gymnastics classes.

The range of variability explained through the above-mentioned capabilities for women equals: 51% (1st semester), 23% (2nd semester), 61% (3rd semester), 38% (rolls and cartwheels), 49% (headstands and handstands), 23% (gymnastic vaults), 47% (bar exercises). The structure of motoric capabilities that condition effectiveness of acquisition of motoric skills during those semesters was changing due to the change in the character of those exercises during individual semesters on the women's gymnastics classes.

Explaining the range of variability apart from determining motoric capabilities that are most crucial for the process of acquiring motoric skills in gymnastics allowed also to single out tests which enable measurement of those capabilities. For the female students those tests are: litheness (bend of a trunk while sitting), swiftness of the reaction (the Piórkowski apparatus measurement with 93 impulses per minute), swiftness of the reaction (stopping the falling target-pendulum), agility (running over the ”envelope”), swiftness of the reaction (stopping the Ditrich’s stick) and strength of the lower limbs' muscles (knee bend with the barbell on the shoulders).

Explaining the range of variability for men looks as follows: 54% (1st semester), 33% (2nd semester), 23% (3rd semester), 15% (rolls and cartwheels), 14% (headstands and handstands), 20% (gymnastic vaults), 23% (bar exercises). In the group of men there is a much greater changeability of structure of motoric capabilities that condition the effectiveness of acquiring motoric skills in particular semesters of studying gymnastics, which causes that it is impossible to single out motoric capabilities tests which predict correctly mastering and developing of gymnastic technical skills.

In athletics, specific motoric coordination skills in professional sport are the following: coupling, rhythmization, diversification, spatial orientation, capability of swift and frequent reaction (Raczek et al. 1998). On the level of technical expertise of female PE students the most important for mastering athletics skills appear to be agility, run swiftness, Cooper test results, rhythmization, swiftness of the reaction, balance, chest muscles strength, strength of the lower limbs' muscles, spatial orientation, movement coupling hand strength.

The range of variables describing motoric skills in athletics for men is similar as in the case of women, except that it includes maximum anaerobic power, maximum oxygen intake and kinesthetic diversification, PWC_{170} and litheness. The explained range of variability for women equals: 61% (1st semester), 20% (2nd semester), 39% (3rd semester), 58% (shot put), 44% (hurdle race), 31% (long jump), 19% (javelin throw), 32% (high jump) and 66% (800m run). The range of variability for men in athletics equals: 37% (1st semester), 45% (2nd semester), 36% (3rd semester), 53% (shot put), 47% (hurdle race), 39% (long jump), 18% (javelin throw), 52% (high jump) oraz 75% (1,500m run).

Despite the significant changeability of motoric capabilities structure in particular semesters of athletics, the performed statistical analyses allowed to single out the following motoric capabilities tests that predict well mastering and developing athletic skills techniques by men, and include the following: the Cooper test (endurance) and 50 m run and 20 m run with run-up (swiftness).

In volleyball on the professional level the key physical condition capabilities are the following: swiftness, endurance, strength of the upper limbs and jumping ability (Naglak 2001, Prus 2000), whereas the coordination capabilities are: motoric adaptation, spatial orientation, swiftness of the reaction, kinesthetic diversification, (Raczek 1990, Ljach 1994). The results of research on students differ slightly from the above-mentioned, since in case of women the key capabilities to master volleyball skills were the following: kinesthetic diversification, swiftness of the reaction, frequency of the movement, rhythmization and endurance (the Cooper test result). The analysis of the group of male students has revealed that these factors are the following: maximum oxygen intake and dynamic balance.

In case of football the key capabilities for the professional sportsmen are the following: kinesthetic diversification of movement, motoric adjustment, swiftness of the reaction, anticipation, spatial orientation, movement coupling (Gagajewa 1969, Brill 1980, Zimmermann 1982, Meier 1982, Ljach 1994), as well as swiftness and anaerobic functional capacity (Bangsbo 1999, Prus 2000). The specific motoric capabilities useful to master and develop motoric skills in football (women) are the following: swiftness of the reaction and frequency of the movement, whereas in case of men these are the following: balance and movement coupling.

According to Raczek (1991) and Zając (1992), factors determining sports results in basketball are the following: anaerobic power, swiftness, agility, explosive strength of upper and lower limbs as well as maximum strength. Many authors single out specific coordination capabilities for professional competitors, and these are the following: swiftness of the reaction, kinesthetic diversification of movement, movement coupling, spatial orientation and adjustment (Brill 1980, Raczek 1990, Ljach 1994, Zimmermann 1982, Brandt 1985). Multiple regression analysis and Pearson correlation have shown that rhythmization, swiftness of the reaction and endurance play essential role for women, and swiftness of the reaction, movement coupling and chest muscles strength are significant for men.

According to Zimmermann (1982) and Ljach (1994), competitors playing handball have the following motoric capabilities: swiftness of the reaction, motoric adjustment, spatial orientation, kinesthetic diversification. In case of women, movement coupling is the only coordination capability which significantly characterizes the level of handball technique of playing, whereas the physical condition capabilities, which influence the level of playing handball, are aerobic and anaerobic functional capacity. In case of men such capabilities are the following: kinesthetic diversification, swiftness, strength of the lower limbs' muscles and anaerobic functional capacity.

The analysis of the research results allows to isolate motoric capabilities which form the optimal structure for achieving the best possible results in particular team sports; however, they constitute only a small percentage of the explained resource of variability, which equals the following: in case of women:

25% (volleyball), 31% (football), 32% (basketball), 27% (handball) and in the case of men: 36% (volleyball), 27% (basketball), 35% (handball).

The attempt to compare usefulness as regards diagnostic purposes of the prognostic tests for mastering and developing motoric skills in team sports has revealed that both for men and women the share of motoric capabilities in the process of teaching technical elements is on the similar level.

In the diagnosis of motoric capabilities determining the level and quality of acquiring motoric skills the most useful are tests measuring swiftness of the reaction (stopping the falling target), anaerobic functional capacity (Wingate test), movement coupling (passing a gymnastic stick), kinesthetic diversification (jump for 50%) and aerobic functional capacity (maximal oxygen intake).

The search for publications concerning establishment of motoric structure in swimming was unsuccessful. One may notice a shortage of works concerning swimming on the professional sports level as well as on the academic sports level. Only Prus (2003) differentiates locomotive speed as an indicator of the level of swimming, and Kunicki (2004) points to the occurrence of specific links between the effectiveness of swimming, level and structure of motoric coordination skills of young swimmers. According to Kunicki (2004), especially significant dependence concerns the following: special coordination fitness, balance, movement diversification, sense of pace, swiftness of the reaction and precision of movement. These factors explained 81% of the resource of variability of swimming in case of children. In swimming on the academic level, the most important motoric capabilities which determine effectiveness of acquisition of new motoric skills are the following: litheness, agility, swiftness, spatial orientation, kinesthetic diversification, movement coupling, swiftness of the reaction and both aerobic and anaerobic functional capacity.

The resource of variability explained by the above variables equals 65% (1st semester), 42% (2nd semester), 49% (3rd semester) for women and 34% (1st semester), 42% (2nd semester), 39% (3rd semester) for men.

The most useful as regards predicting swiftness and precision of acquisition of new swimming skills by PE students are the following tests: Wingate test (anaerobic functional capacity), run in the distance of 50 m (locomotive swiftness), stopping the falling target (swiftness of reaction), maximal oxygen intake (maximum work capacity).

The results of statistical analyses, which were to determine the structure of motoric fitness for individuals of low, medium and high level of motoric skills, have revealed differences in the level of only several measurements of motoric capabilities. Groups of women isolated in such a way differed only as far as swiftness of reaction and rhythmization were concerned. The difference in the level of those capabilities occurred only between two extreme groups, that is the weakest and the strongest one. This fact confirms also the lack of significance of the differences between the tested groups of female students as regards remaining coordination capabilities and all other functional capacity parameters. The differences between the groups of women on the level of both physical condition and coordination capabilities appeared only between two ”extreme” groups. The group of those skills may be referred to as a running factor, since the said skills are the results of tests based on running: the Cooper, 50 m run and 20 m run with run-up as well as agility. The ”strength factor” and litheness is equal for all groups.

Standardization of both variables and profiles developed in order to examine the structure of motoricity in the group of men allows to claim that the only parameter which differentiates the level of motoric skills is the maximal oxygen intake. It confirms the statement made during the analysis of the group of women, whereby each group of students constitutes a specific ”research subject”, which is due to the selection for the first year of study (students become a quite homogenous group as far as motoric capabilities are concerned).

The research analyses allow to isolate motoric capabilities, which are crucial from the perspective of individual practical subjects. However, the tests aimed to measure motoric capabilities and used during the research fail to clarify entire variability of the examined phenomenon. The lack of clarification of entire picture of motoric determinants does not allow to develop a complementary structure of those capabilities, determining the level of mastering skills in case of particular practical subjects. That is the reason why further search for factors determining the effectiveness of the didactic process seems to be so important. Acquisition of all motoric capabilities may facilitate the acquisition process as regards motoric skills and improve the quality of teaching and developing elements of technique.

Determination of diagnostic value of applied motoric capabilities tests enables to select the most informative and comprehensive tests.

Due to the necessity of explaining the remaining factors of psychological nature (e.g. motivation, courage, concentration), which also influence acquisition process as regards motoric skills, the continuation of the research is strongly recommended. Development of new tests aimed to measure specific fitness for particular sports disciplines would enable researchers to make more comprehensive diagnosis of potential possibilities and predispositions for specific sports disciplines, in case of both secondary school children and applicants for Physical Education studies.

6. CONCLUSIONS

The research results and its comparison with current state of knowledge about the relations and corelations between motoric capabilities and motoric skills enable to arrive at the following conclusions:

1. Level of motoric capabilities of PE students determines to various degrees the effectiveness of their acquisition of motoric skills in particular practical subjects.
2. Structure of motoric capabilities differentiates the level of the acquired skills in particular practical subjects.
3. The above relation features a different structure depending on sex and motoric skills level.
4. There are no motoric capabilities which in a dominating way determine the effectiveness of mastering motoric skills.
5. Individual elements of motoric fitness structure and their combinations differentiate individuals into those with low, medium and high level of motoric skills.
6. In case of relations between motoric fitness and motoric skills there are differences as regards sex.
7. Motoric components determine only a part of the researched phenomenon, and the complete structure also encompasses psychological and physiological factors.
8. Teaching and training technical elements should be developed simultaneously with selected components of fitness and coordination capabilities essential for particular skills.

SUMMARY

This dissertation deals with physical condition and coordination determinants of motoric skills of the Physical Education students.

In the theoretical part, traditional and current trends in describing issues connected with motoricity were characterized. Theoretical part of this dissertation includes the following: characteristics of human motoric capabilities necessary for an effective process of teaching motoric activities, classification of fitness and motoric coordination capabilities and motoric skills, relations obtained between them, as well as diversification on account of specificity of motoric activity on the basis of available Polish and foreign literature.

On the basis of the review of Polish and foreign specialist literature concerning current research problem, it has been revealed that the majority of earlier publications on human motoricity covered mainly the research problem of physical condition or coordination potential.

It contributed to determination of the main goal of the research, which was an attempt to determine connections and dependencies between the level of motoric capabilities and the level of mastering motoric skills in case of selected practical subjects, which were included into the curriculum of the Faculty of Physical Education and Physiotherapy in Opole.

In subsequent chapters, characteristics of tested groups was presented, programme and organization of the research, description of the sports-motoric tests and laboratory measurements, assessment criteria, and curriculum of particular practical subjects.

The research was conducted on the group of 53 female and 63 male students of the Faculty of Physical Education and Physiotherapy of the Technical University of Opole, aged between 20 and 23 years. In order to verify the hypotheses and provide answers to research questions, the research results were subjected to a series of statistical methods and analyses.

The statistical analyses of the research results enable to arrive at the conclusion that the structure of motoric capabilities differs depending on the sports discipline and gender.

As a result of factor analysis, specific motoric physical condition and coordination capabilities were isolated as specific elements of the motoric potential.

The multiple regression analysis allowed to explain variability of a given quantity. The conducted analysis was also applied in order to isolate independent variables (motoric capabilities) that influence the level of motoric skills. The calculated coefficient of determination ($R^{\wedge 2}$) allowed to identify a degree to which fitness and motoric coordination capabilities influence the level of motoric skills.

The conducted analyses of research results also allow to provide answers to the question whether individual elements of structure of motoric fitness and its combinations differentiate the individuals with low, medium or high level of motoric skills.

The research results also allowed to verify credibility of measurement tools of motoric physical condition and coordination capabilities, and to point to some more informative methods in this respect.

In the conclusions section, the necessity of verification of presented results and interpretations in the course of further scientific experiments was emphasized since motoric components, which were established in the course of this study, provide only a partial explanation to the researched phenomenon, and the complete structure may also encompass other psychological or physiological factors.

SUMMARY IN RUSSIAN (КРАТКОЕ СОДЕРЖАНИЕ)

В данной работе затронута тематика причинной и координационной детерминации двигательных навыков студентов курса физического воспитания.

В теоретической части приводится характеристика традиционных и современных тенденций в понимании проблем моторики. Теоретическая часть работы также включает в себя характеристику моторических способностей человека, необходимых для эффективного процесса обучения двигательным функциям, квалификацию причинных и координационных моторических способностей, взаимосвязи между данными способностями, как и отличия между ними в связи со спецификой двигательной активности, основываясь на доступных отечественных и заграничных источниках.

На основании обзора заграничной и отечественной литературы по данной исследовательской тематике выявлено, что большинство прежних публикаций, касающихся моторики человека, относились главным образом к сфере причинных либо координационных возможностей.

Данное обстоятельство определило главную цель работу, которой является попытка определения взаимосвязей и зависимости между уровнем моторических способностей и уровнем двигательных навыков по избранным практическим темам, предусмотренным учебной программой для студентов факультета физического воспитания и физиотерапии в Ополе.

Далее будут представлены: характеристика исследуемых групп, программа и организация исследований, описание используемых спортивно-моторических и лабораторных тестов, равно как и условия получения оценки и программные требования по отдельным практическим предметам.

Исследования проведены в группе из 53 студенток и 63 студентов факультета физического воспитания и физиотерапии в Политехническом университете в Ополе. Возраст группы от 20 до 23 лет. Для получения ответа на поставленные гипотезы и исследовательские вопросы результаты исследования были проверены при помощи ряда методов и статистических анализов.

Использованные статистические анализы результатов исследований позволяют утверждать, что структура моторических способностей отличается в зависимости от вида спортивной дисциплины и пола.

По результатам проведенного причинного анализа специфических элементов структуры моторического потенциала студентов факультета физического воспитания выявлены специфические причинные и координационные моторические способности.

Использованный метод множественной регрессии позволил выяснить переменность избранной величины. Проведенный анализ также продемонстрировал независимые переменные (моторические способности), значительно влияющие на уровень двигательных навыков. Полученный коэффициент детерминации (R^^{2}) позволяет определить, в какой степени кондиционные и координационные моторические способности влияют на уровень двигательных навыков.

Проведенный анализ результатов исследований позволяет также ответить на вопрос, являются ли отдельные элементы структуры моторических способностей и их комбинации отличительными для индивидуумов с низким, средним и высоким уровнем двигательных умений.

Результаты исследований позволили также проверить достоверность используемых инструментов для проверки причинных и координационных моторических способностей и на указание наиболее эффективных тестов в данной области.

В заключении подчеркивается необходимость верификации представленных выводов и их интерпретации при дальнейших научных экспериментах, когда моторические компоненты, определенные в ходе работы, объясняют лишь часть исследуемого явления, а полная структура может включать в себя также другие психические или физиологические факторы.

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ATTACHMENTS

Table 1.

Correlation of results of physical movement capabilities/skills
in gymnastics and motoric skills (women)
Labelled correlation coefficients are crucial with p <.05000, N = 53

	GYMN_S1	GYMN_S2	GYMN_S3	GYMN_A	GYMN_B	GYMN_C	GYMN_D
HEIGHT	-0,22	-0,07	-0,19	-0,30	-0,07	-0,28	-0,11
p=	*0,11*	*0,63*	*0,18*	***0,03***	*0,62*	***0,04***	*0,45*
WEIGHT	-0,21	-0,13	-0,29	-0,30	-0,08	-0,20	-0,30
p=	0,14	0,34	**0,04**	**0,03**	0,58	0,16	**0,03**
BMI	-0,10	-0,12	-0,23	-0,18	-0,04	-0,06	-0,32
p=	0,46	0,38	0,10	0,20	0,77	0,69	**0,02**
MASS_NF	-0,23	-0,06	-0,23	-0,39	-0,11	-0,20	-0,23
p=	0,10	0,65	0,09	**0,00**	0,44	0,16	0,10
MASS_NF%	0,09	0,12	0,19	0,10	0,00	0,12	0,23
p=	0,53	0,38	0,17	0,49	0,97	0,41	0,10
PEAK_P	-0,13	0,03	0,01	-0,14	-0,11	-0,06	0,12
p=	0,37	0,83	0,96	0,31	0,44	0,69	0,40
DROP_P	0,09	0,04	0,02	0,06	0,06	0,11	0,01
p=	0,50	0,80	0,90	0,65	0,65	0,41	0,92
PWC170	-0,08	-0,02	0,03	-0,04	-0,06	-0,07	0,10
p=	0,59	0,91	0,85	0,76	0,67	0,61	0,46
VO2MAX	-0,09	-0,24	-0,13	-0,05	-0,07	-0,04	0,01
p=	0,53	0,08	0,36	0,73	0,60	0,75	0,92
VO2MKG	0,17	0,04	0,15	0,16	0,10	0,22	0,08
p=	0,22	0,77	0,27	0,25	0,46	0,11	0,57
MOV_COU1	0,09	0,12	0,10	0,24	0,02	0,06	-0,01
p=	0,52	0,40	0,46	0,08	0,87	0,69	0,93
MOV_COU2	-0,23	-0,10	-0,16	-0,25	-0,21	-0,14	-0,17
p=	0,10	0,47	0,25	0,07	0,14	0,30	**0,02**
BALANCE1	0,07	-0,05	0,03	0,12	-0,03	0,10	0,05
p=	0,60	0,73	0,82	0,41	0,84	0,50	0,73
BALANCE2	-0,23	-0,24	-0,35	-0,17	-0,19	-0,23	-0,14
p=	0,09	**0,00**	**0,01**	0,21	**0,00**	0,10	0,32
KINE_DIV	-0,12	-0,01	0,06	-0,15	-0,07	-0,12	-0,03
p=	0,40	0,93	0,65	0,29	0,60	0,41	0,82
SWIFT_R1	0,22	0,25	0,28	0,15	0,28	0,08	0,21
p=	0,12	**0,01**	**0,04**	0,28	**0,04**	0,57	0,13
SWIFT_R2	0,08	-0,12	-0,17	0,09	0,03	0,13	-0,13
p=	0,56	0,38	0,24	0,53	0,81	0,35	0,36
SWIFT_R3	0,15	0,02	0,07	0,12	0,14	0,16	0,08
p=	0,28	0,86	0,64	0,39	0,32	0,26	0,55
SWIFT_R4	0,09	0,14	0,04	0,12	0,12	0,03	-0,06
p=	0,51	0,31	0,77	0,39	0,40	0,81	0,66
SWIFT_R5	0,19	0,13	0,11	0,23	0,19	0,10	0,04

p=	0,18	0,35	0,45	0,09	0,17	0,48	0,75
SPAT_OR1	0,17	0,14	0,04	0,13	0,19	0,14	-0,02
p=	0,22	0,30	0,78	0,37	0,18	0,33	0,91
SPAT_OR2	-0,14	-0,15	-0,08	-0,06	-0,17	-0,03	-0,06
p=	0,31	0,28	0,55	0,67	0,22	0,81	0,67
RHYTHM	-0,35	-0,36	-0,45	-0,41	-0,26	-0,23	-0,24
p=	**0,01**	**0,01**	**0,00**	**0,00**	0,06	0,10	**0,05**
COOPER	0,24	0,24	0,33	0,32	0,16	0,17	0,34
p=	0,08	0,09	**0,02**	**0,02**	0,25	0,22	**0,01**
STR_CHES	0,00	0,04	0,02	0,04	0,04	0,00	-0,03
p=	0,97	0,79	0,87	0,77	0,80	0,97	0,83
STR_LEGS	0,11	0,07	0,14	0,10	0,14	0,00	0,11
p=	0,43	0,61	0,33	0,48	0,31	1,00	0,42
STR_GRIP	0,20	0,08	0,11	-0,01	0,26	0,18	-0,09
p=	0,15	0,57	0,43	0,95	0,06	0,19	0,52
SPEED1	-0,32	-0,24	-0,50	-0,39	-0,20	-0,30	-0,44
p=	**0,02**	0,08	**0,00**	**0,00**	0,16	**0,03**	**0,00**
SPEED2	-0,36	-0,32	-0,53	-0,38	-0,33	-0,29	-0,42
p=	**0,01**	**0,02**	**0,00**	**0,01**	**0,02**	**0,03**	**0,00**
AGILITY	-0,34	-0,25	-0,39	-0,33	-0,29	-0,27	-0,36
p=	**0,01**	0,07	**0,00**	**0,02**	**0,03**	0,05	**0,01**
LITHE	0,40	0,33	0,41	0,26	0,45	0,20	0,39
p=	**0,00**	**0,02**	**0,00**	0,06	**0,00**	0,16	**0,00**

Table 2.

Correlation of results of physical movement capabilities/skills
in gymnastics and motoric skills (men)
Labelled correlation coefficients are crucial with p <.05000, N = 63

	GYMN_S1	**GYMN_S2**	**GYMN_S3**	**GYMN_A**	**GYMN_B**	**GYMN_C**	**GYMN_D**
HEIGHT	-0,09	-0,03	-0,14	-0,08	-0,04	-0,15	-0,09
p=	*0,46*	*0,82*	*0,27*	*0,55*	*0,77*	*0,25*	*0,48*
WEIGHT	-0,10	-0,10	-0,24	-0,05	0,01	-0,21	-0,12
p=	0,46	0,42	0,06	0,67	0,96	0,09	0,34
BMI	-0,04	-0,10	-0,16	-0,01	0,04	-0,14	-0,07
p=	0,76	0,42	0,21	0,97	0,75	0,27	0,57
MASS_NF	-0,05	-0,05	-0,20	0,00	0,02	-0,17	-0,10
p=	0,71	0,68	0,12	0,97	0,85	0,18	0,44
MASS_NF%	0,13	0,10	0,14	0,14	0,04	0,14	0,08
p=	0,33	0,42	0,29	0,28	0,74	0,26	0,54
PEAK_P	0,02	-0,10	-0,11	-0,01	0,06	-0,04	-0,05
p=	0,90	0,46	0,38	0,94	0,62	0,76	0,72
DROP_P	-0,03	0,04	-0,14	-0,07	0,06	-0,10	0,06
p=	0,80	0,78	0,28	0,56	0,66	0,46	0,63
PWC170	-0,06	-0,04	-0,01	-0,12	0,00	-0,04	-0,04
p=	0,64	0,76	0,96	0,35	0,98	0,78	0,78

VO2MAX	0,03	0,04	0,05	-0,03	0,00	0,12	-0,03
p=	0,79	0,74	0,73	0,79	0,99	0,36	0,82
VO2MKG	0,23	0,12	0,14	0,16	0,14	0,30	-0,03
p=	0,07	0,34	0,29	0,20	0,29	0,07	0,79
MOV_COU1	-0,04	0,01	-0,09	-0,05	0,05	-0,14	0,10
p=	0,74	0,93	0,48	0,72	0,72	0,28	0,44
MOV_COU2	-0,16	-0,28	-0,32	-0,18	-0,19	-0,02	-0,14
p=	0,21	**0,03**	**0,01**	0,17	0,13	0,86	0,27
BALANCE1	0,17	0,11	0,14	0,16	0,14	0,12	-0,06
p=	0,19	0,41	0,26	0,22	0,27	0,37	0,66
BALANCE2	-0,11	0,07	-0,21	-0,08	-0,12	-0,08	-0,11
p=	0,38	0,57	0,10	0,54	0,36	0,52	0,38
KINE_DIV	-0,08	-0,06	-0,18	-0,07	-0,16	0,05	-0,14
p=	0,53	0,65	0,17	0,57	0,21	0,70	0,29
SWIFT_R1	-0,03	-0,06	-0,21	0,01	0,06	-0,16	-0,04
p=	0,81	0,65	0,10	0,95	0,66	0,20	0,75
SWIFT_R2	-0,17	-0,06	-0,15	-0,10	-0,21	-0,09	-0,23
p=	0,18	0,63	0,23	0,44	0,10	0,46	0,07
SWIFT_R3	0,14	0,12	0,17	0,05	0,21	0,07	0,21
p=	0,29	0,34	0,18	0,71	0,10	0,58	0,10
SWIFT_R4	0,13	0,04	0,13	0,05	0,21	0,06	0,12
p=	0,30	0,73	0,30	0,71	0,09	0,66	0,37
SWIFT_R5	0,15	0,11	0,15	0,07	0,24	0,05	0,12
p=	0,24	0,41	0,24	0,61	0,06	0,70	0,35
SPAT_OR1	0,15	-0,12	0,13	-0,02	0,18	0,19	0,11
p=	0,24	0,33	0,29	0,85	0,15	**0,03**	0,40
SPAT_OR2	-0,18	-0,06	-0,02	-0,17	-0,16	-0,11	-0,08
p=	0,16	0,63	0,87	0,17	0,20	0,41	0,51
RHYTHM	-0,08	-0,24	-0,04	-0,12	-0,14	0,08	-0,15
p=	0,55	0,06	0,76	0,37	0,29	0,52	0,25
COOPER	0,20	0,22	0,19	0,08	0,20	0,19	0,07
p=	0,12	0,08	0,14	0,52	0,11	0,13	0,61
STR_CHES	-0,02	0,05	-0,02	-0,01	0,11	-0,18	0,24
p=	0,86	0,70	0,86	0,92	0,40	0,17	0,05
STR_LEGS	-0,02	0,00	-0,22	0,03	0,10	-0,22	-0,15
p=	0,86	0,99	0,08	0,83	0,42	0,08	0,25
STR_GRIP	-0,17	-0,23	-0,05	-0,26	-0,06	-0,13	0,04
p=	0,18	0,07	0,69	**0,04**	0,65	0,32	0,77
SPEED1	0,01	0,01	-0,02	0,00	0,03	-0,03	0,11
p=	0,96	0,94	0,87	1,00	0,81	0,85	0,39
SPEED2	0,09	0,25	0,22	0,06	0,06	0,11	0,11
p=	0,46	0,05	0,08	0,62	0,63	0,37	0,39
AGILITY	0,01	-0,01	-0,03	0,03	0,05	-0,07	-0,01
p=	0,95	0,93	0,83	0,82	0,68	**0,01**	0,96
LITHE	0,16	0,17	0,13	0,20	0,09	0,13	-0,10
p=	0,21	0,17	0,31	0,11	0,48	**0,01**	0,45

Table 3.

Correlation of results of motoric skills in athletics and motoric capabilities (women)
Labelled correlation coefficients are crucial with z p <.05000, N = 53

	ATH_S1	ATH_S2	ATH_S3	ATH_SPUT	ATH_HUR	ATH_LJU	ATH_JAV	ATH_HJU	ATH_RUN
HEIGHT	-0,29	-0,20	-0,17	0,36	-0,08	-0,14	0,07	-0,14	-0,12
p=	***0,03***	*0,14*	*0,22*	***0,01***	*0,55*	*0,33*	*0,60*	*0,32*	*0,39*
WEIGHT	-0,32	-0,18	-0,20	0,52	-0,15	-0,24	-0,15	-0,16	-0,17
p=	**0,02**	0,20	0,16	**0,00**	0,27	0,08	0,27	0,24	0,22
BMI	-0,20	-0,06	-0,13	0,41	-0,14	-0,20	-0,28	-0,12	-0,14
p=	0,16	0,65	0,34	**0,00**	0,32	0,15	**0,04**	0,38	0,32
MASS_NF	-0,22	-0,18	-0,19	0,40	-0,14	-0,35	-0,17	-0,15	-0,10
p=	0,12	0,20	0,16	**0,00**	0,33	**0,01**	0,23	0,29	0,47
MASS_NF%	0,24	0,05	0,10	-0,38	0,07	-0,01	0,10	0,08	0,14
p=	0,08	0,74	0,47	**0,01**	0,60	0,96	0,47	0,55	0,33
PEAK_P	0,18	0,02	0,17	-0,08	0,10	-0,14	-0,05	0,03	0,19
p=	0,19	0,88	0,21	0,58	0,46	0,31	0,70	0,82	0,18
DROP_P	-0,09	-0,05	-0,08	-0,14	-0,20	-0,15	0,01	-0,09	0,06
p=	0,54	0,70	0,56	0,32	0,14	0,27	0,94	0,53	0,68
PWC170	0,16	0,10	0,13	0,24	0,06	-0,05	-0,04	-0,03	0,20
p=	0,24	0,47	0,36	0,09	0,70	0,72	0,77	0,84	0,15
VO2MAX	-0,05	-0,05	-0,07	0,14	-0,15	-0,05	-0,13	-0,19	0,05
p=	0,70	0,74	0,64	0,30	0,30	0,70	0,35	0,16	0,74
VO2MKG	0,23	0,10	0,17	-0,04	0,06	-0,06	-0,03	-0,03	0,26
p=	0,10	0,50	0,23	0,77	0,67	0,65	0,83	0,80	0,06
MOV_COU1	0,16	0,11	0,11	0,12	0,12	0,31	0,01	-0,01	0,01
p=	0,24	0,43	0,41	0,39	0,40	**0,03**	0,96	0,97	0,94
MOV_COU2	-0,35	-0,23	-0,18	-0,19	-0,27	-0,17	-0,07	-0,24	-0,16
p=	**0,01**	0,10	0,21	0,18	**0,05**	0,22	0,60	0,09	0,26
BALANCE1	0,00	-0,19	0,06	-0,09	0,06	0,02	0,05	0,04	0,11
p=	0,97	0,17	0,65	0,51	0,68	0,88	0,74	0,76	0,41
BALANCE2	-0,29	0,03	-0,20	0,23	-0,25	-0,11	-0,14	-0,19	-0,09
p=	**0,03**	0,83	0,16	0,10	0,07	0,42	0,32	0,17	0,52
KINE_DIV	0,05	0,13	0,02	0,14	0,11	0,00	0,08	0,07	0,11
p=	0,73	0,37	0,88	0,32	0,45	0,98	0,57	0,62	0,43
SWIFT_R1	0,33	0,11	0,43	0,22	0,34	0,15	0,27	0,28	0,30
p=	**0,02**	0,43	**0,00**	0,12	**0,01**	0,27	0,06	**0,04**	**0,03**
SWIFT_R2	-0,14	-0,14	-0,17	-0,10	-0,22	-0,18	-0,29	-0,19	-0,30
p=	0,31	0,31	0,21	0,46	0,11	0,20	**0,04**	0,18	**0,03**
SWIFT_R3	0,04	0,03	-0,01	-0,06	-0,09	-0,13	-0,08	-0,01	-0,14
p=	0,78	0,82	0,96	0,66	0,53	0,35	0,57	0,94	0,31
SWIFT_R4	0,22	0,06	0,14	0,00	0,19	0,00	-0,14	0,19	0,09
p=	0,12	0,69	0,32	1,00	0,18	0,98	0,33	0,16	0,50
SWIFT_R5	0,20	0,02	0,14	0,07	0,05	-0,01	-0,17	0,10	0,06
p=	0,14	0,91	0,31	0,60	0,75	0,97	0,23	0,46	0,67
SPAT_OR1	0,10	0,21	-0,04	0,12	0,01	0,00	-0,08	0,01	0,05

p=	0,46	0,13	0,76	0,39	0,96	0,99	0,55	0,92	0,72
SPAT_OR2	-0,20	-0,17	-0,21	-0,29	-0,22	-0,21	-0,14	-0,37	0,01
p=	0,16	0,22	0,13	**0,03**	0,12	0,12	0,32	**0,01**	0,97
RHYTHM	-0,45	-0,37	-0,29	0,03	-0,22	-0,23	-0,16	-0,23	-0,25
p=	**0,00**	**0,01**	**0,03**	0,84	0,12	0,09	0,27	0,09	0,07
COOPER	0,55	0,23	0,58	0,13	0,50	0,30	0,19	0,41	0,64
p=	**0,00**	0,09	**0,00**	0,37	0,05	**0,03**	0,17	0,05	**0,00**
STR_CHES	-0,02	0,14	-0,13	0,57	-0,19	0,01	-0,15	-0,18	-0,15
p=	0,90	0,33	0,34	**0,00**	0,18	0,96	0,28	0,20	0,28
STR_LEGS	-0,12	0,16	-0,08	0,36	0,06	0,23	0,11	0,03	-0,08
p=	0,41	0,26	0,57	**0,01**	0,69	0,10	0,43	0,82	0,58
STR_GRIP	0,13	0,06	0,16	0,10	0,06	0,02	0,17	0,00	0,28
p=	0,37	0,67	0,26	0,47	0,66	0,91	0,23	0,98	0,06
SPEED1	-0,47	-0,27	-0,48	0,13	-0,54	-0,23	-0,20	-0,25	-0,53
p=	**0,00**	**0,05**	**0,00**	0,34	**0,00**	0,10	0,15	0,07	**0,00**
SPEED2	-0,64	-0,31	-0,54	0,15	-0,51	-0,34	-0,17	-0,21	-0,54
p=	**0,00**	**0,02**	**0,00**	0,28	**0,00**	**0,01**	0,22	0,14	**0,00**
AGILITY	-0,49	-0,34	-0,32	0,09	-0,48	-0,23	-0,31	-0,29	-0,46
p=	**0,00**	**0,01**	**0,02**	0,53	**0,00**	0,10	**0,03**	**0,04**	**0,00**
LITHE	0,20	0,26	0,18	0,15	0,09	0,25	0,18	0,03	0,08
p=	0,14	0,06	0,21	0,30	0,51	0,07	0,19	0,82	0,58

Table 4.

Correlation of results of motoric skills in athletics and motoric capabilities (men)
Labelled correlation coefficients are crucial with $p < .05000$, $N = 63$

	ATH_S1	**ATH_S2**	**ATH_S3**	**ATH_SPUT**	**ATH_HUR**	**ATH_LJU**	**ATH_JAV**	**ATH_HJU**	**ATH_RUN**
HEIGHT	0,02	0,20	0,21	0,38	0,18	0,05	0,32	0,22	0,07
p=	*0,86*	*0,12*	*0,10*	***0,00***	*0,16*	*0,68*	***0,01***	*0,08*	*0,06*
WEIGHT	0,04	0,09	0,05	0,30	-0,05	-0,08	0,17	-0,08	-0,16
p=	0,74	0,51	0,72	**0,02**	0,67	0,51	0,19	0,53	0,22
BMI	0,03	-0,06	-0,12	0,04	-0,21	-0,15	-0,07	-0,28	-0,25
p=	0,84	0,62	0,36	0,73	0,10	0,23	0,56	**0,03**	**0,05**
MASS_NF	0,11	0,19	0,22	0,34	0,12	0,04	0,31	0,09	0,02
p=	0,40	0,13	0,08	**0,01**	0,36	0,76	**0,02**	0,48	0,89
MASS_NF%	0,09	0,14	0,27	-0,02	0,30	0,22	0,20	0,31	0,34
p=	0,50	0,28	**0,03**	0,87	**0,02**	0,08	0,11	**0,01**	0,08
PEAK_P	0,14	-0,01	-0,01	0,36	-0,15	0,07	0,04	0,05	0,00
p=	0,28	0,96	0,92	**0,00**	0,23	0,59	0,74	0,68	0,99
DROP_P	0,14	0,21	0,06	0,22	-0,11	-0,02	-0,05	0,08	-0,17
p=	0,29	0,10	0,64	0,08	0,41	0,90	0,71	0,54	0,18
PWC170	0,00	0,10	0,10	-0,07	0,14	-0,04	0,07	-0,05	0,53
p=	0,98	0,43	0,44	0,58	0,29	0,76	0,59	0,69	**0,00**
VO2MAX	-0,22	-0,06	-0,05	0,09	0,30	0,17	0,16	0,17	0,22
p=	0,09	0,63	0,71	0,50	**0,02**	0,19	0,20	0,17	0,09

VO2MKG	0,18	0,16	0,22	-0,22	0,31	0,13	0,09	0,34	0,42
p=	0,17	0,22	0,08	0,08	**0,01**	0,30	0,50	0,07	**0,00**
MOV_COU1	0,20	0,20	0,13	-0,03	-0,04	-0,10	-0,21	0,06	0,00
p=	0,11	0,12	0,30	0,79	0,79	0,43	0,10	0,67	0,98
MOV_COU2	-0,11	-0,15	-0,33	-0,06	-0,34	-0,14	-0,18	-0,27	-0,10
p=	0,38	0,26	**0,01**	0,65	**0,01**	0,29	0,17	**0,04**	0,46
BALANCE1	0,21	0,18	0,40	-0,02	0,32	0,23	0,21	0,27	0,17
p=	0,10	0,17	**0,00**	0,86	**0,01**	0,07	0,10	**0,03**	0,17
BALANCE2	-0,16	-0,17	-0,18	0,30	-0,27	0,05	-0,04	-0,13	0,00
p=	0,20	0,18	0,15	**0,02**	**0,03**	0,71	0,78	0,33	0,98
KINE_DIV	-0,01	-0,28	-0,13	-0,03	-0,01	-0,06	-0,04	-0,11	0,02
p=	0,91	**0,03**	0,32	0,80	0,93	0,64	0,73	0,38	0,90
SWIFT_R1	0,01	0,12	0,20	0,15	0,04	-0,30	0,14	0,23	-0,11
p=	0,91	0,35	0,12	0,23	0,74	**0,02**	0,27	0,07	**0,04**
SWIFT_R2	0,05	0,03	-0,08	-0,12	-0,27	-0,07	-0,03	-0,28	-0,08
p=	0,69	0,80	0,55	0,34	**0,04**	0,60	0,79	**0,03**	0,52
SWIFT_R3	0,20	0,30	0,23	-0,04	0,05	0,00	0,12	0,16	0,16
p=	0,13	**0,02**	0,07	0,78	0,71	0,98	0,36	0,20	0,21
SWIFT_R4	0,09	0,18	0,12	0,10	0,05	0,03	0,07	0,06	0,11
p=	0,50	0,16	0,35	0,44	0,69	0,82	0,60	0,63	0,41
SWIFT_R5	0,09	0,19	0,16	0,06	0,06	0,10	0,09	0,13	0,12
p=	0,48	0,14	0,22	0,63	0,66	0,42	0,48	0,32	0,35
SPAT_OR1	0,05	-0,13	0,02	-0,07	0,00	0,01	0,13	0,13	-0,02
p=	0,72	0,29	0,88	0,60	0,99	0,92	0,32	0,30	0,86
SPAT_OR2	0,19	0,00	-0,09	0,17	0,01	0,09	-0,14	0,11	-0,22
p=	0,13	1,00	0,46	0,18	0,92	0,46	0,28	0,38	0,08
RHYTHM	0,08	0,00	-0,08	0,03	-0,05	0,00	0,17	-0,05	-0,27
p=	0,52	0,97	0,51	0,79	0,72	0,98	0,18	0,68	**0,04**
COOPER	0,30	0,30	0,34	-0,31	0,12	-0,06	0,11	0,04	0,69
p=	**0,02**	**0,02**	**0,01**	**0,01**	0,37	0,62	0,37	0,77	**0,01**
STR_CHES	-0,13	0,07	-0,05	0,43	-0,13	-0,16	0,05	-0,02	-0,09
p=	0,32	0,58	0,69	**0,00**	0,30	0,20	0,72	0,90	0,46
STR_LEGS	0,05	0,23	0,13	0,35	0,13	-0,09	0,00	-0,01	0,12
p=	0,68	0,07	0,29	**0,01**	0,30	0,50	0,97	0,93	0,36
STR_GRIP	-0,20	-0,17	-0,12	0,29	0,00	-0,29	0,19	-0,33	-0,03
p=	0,12	0,18	0,36	**0,02**	0,98	**0,02**	0,15	**0,01**	0,80
SPEED1	-0,06	-0,03	-0,14	-0,26	-0,42	-0,36	-0,19	-0,27	0,14
p=	0,66	0,83	0,27	**0,04**	**0,00**	**0,00**	0,14	**0,04**	0,27
SPEED2	0,08	-0,01	-0,07	-0,21	-0,20	0,03	-0,03	-0,22	0,17
p=	0,52	0,97	0,57	0,11	0,11	0,82	0,80	0,08	0,18
AGILITY	-0,10	0,14	-0,11	0,08	-0,11	-0,20	0,17	-0,24	-0,20
p=	0,42	0,29	0,40	0,55	0,37	0,12	0,19	0,06	0,12
LITHE	0,21	0,32	0,15	-0,06	0,15	0,06	-0,02	0,06	0,28
p=	0,11	**0,01**	0,24	0,62	0,25	0,66	0,90	0,66	**0,03**

Table 5.

Correlation of results of motoric skills and motoric capabilities (women)
Labelled correlation coefficients are crucial with p <.05000, N = 53

	TEAMVOL	TEAMFOOT	TEAMBAS	TEAMHAN	SWIM
HEIGHT	-0,0857	-0,0332	-0,1215	0,1075	-0,1506
p=	*0,54200*	*0,81300*	*0,38600*	*0,44400*	*0,28200*
WEIGHT	-0,0607	0,102	-0,1899	-0,0117	-0,0498
p=	0,66600	0,46700	0,17300	0,93400	0,72300
BMI	-0,0174	0,1669	-0,1571	-0,0914	0,0401
p=	0,90200	0,23200	0,26100	0,51500	0,77500
MASS_NF	0,0588	0,1404	-0,1829	-0,0579	-0,0216
p=	0,67600	0,31600	0,19000	0,68000	0,87800
MASS_NF%	0,135	-0,0223	0,1009	-0,0243	0,0527
p=	0,33500	0,87400	0,47200	0,86300	0,70800
PEAK_P	0,042	-0,2579	0,0301	0,0725	-0,2643
p=	0,76500	0,06200	0,83000	0,60600	0,05600
DROP_P	-0,0072	-0,1863	0,0577	-0,0675	-0,2039
p=	0,95900	0,18200	0,68200	0,63100	0,14300
PWC170	0,0564	-0,1667	0,1171	0,1891	-0,1977
p=	0,68900	0,23300	0,40400	0,17500	0,15600
VO2MAX	0,0021	-0,0115	0,096	-0,1024	-0,2241
p=	0,98800	0,93500	0,49400	0,46600	0,10700
VO2MKG	0,0962	0,1302	0,2154	0,2025	-0,0591
p=	0,49300	0,35300	0,12100	0,14600	0,67400
MOV_COU1	-0,084	0,0059	0,2109	0,0025	0,124
p=	0,55000	0,96700	0,13000	0,98600	0,37600
MOV_COU2	-0,1168	0,1873	-0,1741	-0,2727	-0,2238
p=	0,40500	0,17900	0,21300	**0,04800**	0,10700
BALANCE1	0,0507	-0,0111	-0,1118	-0,1352	-0,0562
p=	0,71900	0,93700	0,42500	0,33400	0,68900
BALANCE2	-0,0688	-0,2078	-0,1441	-0,1201	-0,1907
p=	0,62400	0,13500	0,30300	0,39200	0,17100
KINE_DIV	-0,1808	-0,058	0,0261	-0,2032	0,1429
p=	0,19500	0,68000	0,85300	0,14500	0,30700
SWIFT_R1	0,0211	-0,105	0,2459	0,0011	0,3687
p=	0,88100	0,45400	0,07600	0,99400	**0,00700**
SWIFT_R2	-0,0475	0,0422	-0,0222	-0,0426	-0,1082
p=	0,73500	0,76400	0,87400	0,76200	0,44100
SWIFT_R3	0,1998	0,235	-0,0718	0,033	0,0634
p=	0,15100	0,09000	0,60900	0,81500	0,65200
SWIFT_R4	0,3222	0,3093	-0,0375	-0,0213	0,1194
p=	**0,01900**	**0,02400**	0,79000	0,88000	0,39400
SWIFT_R5	0,3515	0,2141	-0,0991	-0,0223	0,0969
p=	**0,01000**	0,12400	0,48000	0,87400	0,49000
SPAT_OR1	0,1621	0,2088	0,2341	-0,0728	0,0818

p=	0,24600	0,13400	0,09200	0,60400	0,56100
SPAT_OR2	-0,1235	0,2226	-0,0198	-0,025	-0,1639
p=	0,37800	0,10900	0,88800	0,85900	0,24100
RHYTHM	-0,1299	-0,0308	-0,2832	-0,1083	-0,2002
p=	0,35400	0,82700	**0,04000**	0,44000	0,15100
COOPER	0,1322	0,0523	0,3288	0,0636	0,2835
p=	0,34500	0,71000	**0,01600**	0,65100	**0,04000**
STR_CHES	-0,1351	0,0443	-0,0707	-0,1273	-0,0019
p=	0,33500	0,75300	0,61500	0,36400	0,99000
STR_LEGS	-0,174	0,106	-0,0444	-0,0312	-0,01
p=	0,21300	0,45000	0,75200	0,82500	0,94300
STR_GRIP	0,0183	0,1137	0,0973	0,0549	0,2618
p=	0,89600	0,41700	0,48800	0,69600	0,05800
SPEED1	-0,1009	-0,0852	-0,0111	-0,0895	-0,4261
p=	0,47200	0,54400	0,93700	0,52400	**0,00100**
SPEED2	-0,2096	-0,1397	-0,1967	-0,1291	-0,3452
p=	0,13200	0,31900	0,15800	0,35700	**0,01100**
AGILITY	-0,1283	0,0399	-0,0668	-0,088	-0,4291
p=	0,36000	0,77700	0,63500	0,53100	**0,00100**
LITHE	-0,1926	-0,0645	-0,0282	0,2062	0,2862
p=	0,16700	0,64600	0,84100	0,13800	**0,03800**

Table 6.

Correlation of results of motoric skills and motoric capabilities (men)
Labelled correlation coefficients are crucial with p <.05000, N = 63

	TEAMVOL	TEAMFOOT	TEAMBAS	TEAMHAN	SWIM
HEIGHT	0,1469	0,0059	0,226	0,3767	0,1902
p=	*0,25100*	*0,96300*	*0,07500*	***0,00200***	*0,13500*
WEIGHT	0,0428	-0,1023	0,1456	0,2047	0,069
p=	0,73900	0,42500	0,25500	0,10800	0,59100
BMI	-0,0756	-0,1269	0	-0,063	-0,0483
p=	0,55600	0,32200	1,00000	0,62300	0,70700
MASS_NF	0,2198	-0,0297	0,2275	0,3047	0,1463
p=	0,08400	0,81700	0,07300	**0,01500**	0,25200
MASS_NF%	0,2789	0,1419	0,0926	0,119	0,0882
p=	**0,02700**	0,26700	0,47000	0,35300	0,49200
PEAK_P	0,2209	-0,1229	0,1422	0,2238	0,1887
p=	0,08200	0,33700	0,26600	0,07800	0,13900
DROP_P	0,1252	-0,2343	-0,0586	0,3991	0,1116
p=	0,32800	0,06500	0,64800	**0,00100**	0,38400
PWC170	0,1668	0,0924	0,1489	0,0113	-0,0354
p=	0,19100	0,47200	0,24400	0,93000	0,78300
VO2MAX	-0,1242	-0,0136	-0,023	0,2352	0,1077
p=	0,33200	0,91600	0,85800	0,06400	0,40100
VO2MKG	0,2644	0,1392	0,0972	0,0947	-0,073
p=	**0,03600**	0,27700	0,44800	0,46000	0,57000

MOV_COU1	0,0217	-0,0108	-0,0568	0,1861	0,0338
p=	0,86600	0,93300	0,65800	0,14400	0,79300
MOV_COU2	-0,2132	-0,2665	-0,0493	0,1032	-0,1536
p=	0,09300	**0,03500**	0,70100	0,42100	0,22900
BALANCE1	0,3545	0,0448	0,111	0,015	0,0308
p=	**0,00400**	0,72800	0,38600	0,90700	0,81100
BALANCE2	-0,2476	-0,2946	0,0288	0,0891	-0,0813
p=	0,05000	**0,01900**	0,82300	0,48800	0,52700
KINE_DIV	-0,2078	-0,1219	0,0375	-0,1878	-0,2349
P=	0,10200	0,34100	0,77100	0,14100	0,06400
SWIFT_R1	0,1788	-0,0986	-0,1254	0,0154	-0,2477
P=	0,16100	0,44200	0,32700	0,90400	0,05000
SWIFT_R2	-0,0907	-0,0784	0,1416	0,0642	-0,1916
P=	0,48000	0,54100	0,26800	0,61700	0,13300
SWIFT_R3	0,2324	0,197	-0,1224	-0,2174	0,12
P=	0,06700	0,12200	0,33900	0,08700	0,34900
SWIFT_R4	0,232	0,1265	0,01	-0,1839	0,0296
P=	0,06700	0,32300	0,93800	0,14900	0,81800
SWIFT_R5	0,1762	0,1559	-0,0413	-0,2073	0,0079
P=	0,16700	0,22200	0,74800	0,10300	0,95100
SPAT_OR1	0,0834	0,0745	0,0906	0,0467	-0,0088
P=	0,51600	0,56200	0,48000	0,71600	0,94600
SPAT_OR2	0,0401	-0,0638	-0,0418	-0,1011	-0,045
P=	0,75500	0,61900	0,74500	0,43000	0,72600
RHYTHM	0,0646	0,1714	0,0099	-0,0195	0,1802
P=	0,61500	0,17900	0,93800	0,88000	0,15700
COOPER	0,3041	0,1083	0,1709	0,0083	0,0458
P=	**0,01500**	0,39800	0,18000	0,94800	0,72100
STR_CHES	-0,0176	-0,0993	-0,2559	0,2012	0,1707
P=	0,89100	0,43900	**0,04300**	0,11400	0,18100
STR_LEGS	0,1257	0,0726	0,0354	0,3229	0,0905
P=	0,32600	0,57200	0,78300	**0,01000**	0,48000
STR_GRIP	-0,0874	-0,1714	-0,1749	0,151	0,1261
P=	0,49600	0,17900	0,17000	0,23800	0,32500
SPEED1	0,0474	-0,1788	0,0596	-0,1643	-0,1149
P=	0,71200	0,16100	0,64300	0,19800	0,37000
SPEED2	0,1235	0,0383	-0,0592	-0,3346	0,0917
P=	0,33500	0,76500	0,64500	**0,00700**	0,47500
AGILITY	0,0598	0,1683	0,0768	0,0581	0,0568
P=	0,64200	0,18700	0,55000	0,65100	0,65900
LITHE	0,1623	0,1564	0,0879	-0,0538	-0,0546
P=	0,20400	0,22100	0,49300	0,67500	0,67100

Table 7.

Statistical parameters of somatic and motoric variables in a group with low motoric fitness N = 38

	Average	Median	Min	Max	Std. Dev	Skewness	Kurtosis
HEIGHT	175,45	176,00	163,00	192,00	7,41	0,14	-0,87
WEIGHT	71,05	71,00	54,00	105,40	11,75	0,64	0,21
BMI	22,94	22,61	18,56	28,59	2,37	0,34	-0,40
MASS_NF	56,06	56,60	38,86	79,58	10,68	0,10	-1,18
MASS_NF%	78,86	79,50	62,00	92,50	7,51	-0,36	-0,34
PEAK_P	8,26	8,27	6,22	10,41	1,19	0,02	-0,90
DROP_P	3,58	3,37	2,13	5,96	0,91	0,84	0,26
PWC170	226,72	218,66	136,36	333,82	57,40	0,05	-1,18
VO2MAX	3,94	3,75	2,34	6,38	0,99	0,58	-0,37
VO2MKG	57,11	55,70	42,68	89,75	9,19	1,24	2,85
MOV_COU1	36,00	34,50	16,00	60,00	11,67	0,28	-0,73
MOV_COU2	12,67	12,35	9,30	15,90	1,63	0,22	-0,31
BALANCE1	8,66	8,50	3,00	17,00	3,89	0,51	-0,37
BALANCE2	6,37	5,00	1,00	19,00	4,04	1,47	2,35
KINE_DIV	11,80	10,40	0,90	59,30	9,22	3,83	**19,46**
SWIFT_R1	9,92	10,00	9,00	11,00	0,67	0,03	-1,23
SWIFT_R2	0,20	0,20	0,15	0,22	0,02	-1,34	2,55
SWIFT_R3	89,45	91,00	67,00	93,00	5,71	-3,04	**9,71**
SWIFT_R4	83,13	94,00	30,00	107,00	22,70	-1,08	0,01
SWIFT_R5	77,24	86,50	17,00	121,00	29,37	-0,59	-0,67
SPAT_OR1	12,18	12,50	6,00	18,00	3,42	-0,07	-1,17
SPAT_OR2	34,23	34,85	8,00	60,80	11,72	0,04	-0,02
RHYTHM	1,19	1,18	0,67	1,75	0,26	0,32	-0,33
COOPER	2600,66	2575,00	2180,00	3100,00	283,15	0,10	-1,18
STR_CHES	54,22	57,50	25,00	90,00	20,88	0,06	-1,38
STR_LEGS	88,62	93,75	30,00	140,00	33,44	-0,08	-1,45
STR_GRIP	42,18	44,00	21,00	64,00	12,54	-0,03	-1,41
SPEED1	7,37	6,74	6,17	9,13	1,02	0,47	-1,52
SPEED2	2,62	2,48	1,57	3,47	0,45	-0,01	-0,56
AGILITY	24,73	24,61	22,70	27,40	1,35	0,38	-0,69
LITHE	25,79	25,50	13,00	37,00	5,54	0,09	-0,24

Table 8.

Statistical parameters of somatic and motoric variables in a group with medium motoric fitness N = 41

	Average	Median	Min	Max	Std. Dev	Skewness	Kurtosis
HEIGHT	172,95	173,00	160,00	189,00	8,87	0,05	-1,27
WEIGHT	66,67	68,00	44,70	89,40	12,07	0,10	-1,05
BMI	22,14	22,31	16,62	27,15	2,60	-0,20	-0,73
MASS_NF	53,73	48,43	37,77	72,86	11,44	0,25	-1,57
MASS_NF%	80,43	81,00	65,00	93,50	7,08	-0,24	-0,44
PEAK_P	8,05	8,34	6,12	10,55	1,31	0,00	-1,25
DROP_P	3,31	3,22	1,59	7,35	1,05	1,24	**4,18**
PWC170	216,00	217,92	104,17	326,92	60,45	-0,08	-0,79
VO2MAX	3,44	3,41	2,24	4,87	0,72	0,43	-0,70
VO2MKG	57,87	57,87	35,71	81,20	9,15	0,03	0,50
MOV_COU1	36,86	36,00	20,00	67,00	11,15	0,57	-0,34
MOV_COU2	12,15	12,20	9,70	15,60	1,49	0,05	-0,42
BALANCE1	9,90	8,00	3,00	22,00	5,01	0,50	-0,75
BALANCE2	5,32	4,00	1,00	19,00	3,72	1,96	**4,36**
KINE_DIV	9,14	9,00	1,00	36,00	5,96	2,39	**9,91**
SWIFT_R1	9,88	9,70	9,00	11,00	0,64	0,33	-0,92
SWIFT_R2	0,19	0,20	0,15	0,24	0,02	-0,27	0,25
SWIFT_R3	90,76	92,00	82,00	93,00	2,88	-1,48	1,61
SWIFT_R4	85,29	87,00	20,00	107,00	19,70	-1,55	2,75
SWIFT_R5	84,61	87,00	17,00	122,00	27,46	-0,65	-0,37
SPAT_OR1	12,59	14,00	2,00	19,00	4,14	-0,93	0,08
SPAT_OR2	33,24	33,60	8,00	57,00	10,82	0,13	-0,13
RHYTHM	1,13	1,14	0,48	1,58	0,24	-0,54	-0,12
COOPER	2611,95	2500,00	2150,00	3220,00	314,11	0,34	-1,20
STR_CHES	50,18	42,50	25,00	120,00	22,73	0,88	0,53
STR_LEGS	79,51	65,00	25,00	155,00	34,42	0,40	-0,90
STR_GRIP	39,88	34,00	19,00	70,00	12,17	0,54	-0,78
SPEED1	7,43	7,57	6,08	8,78	0,88	-0,02	-1,61
SPEED2	2,66	2,68	2,09	3,36	0,33	0,02	-0,90
AGILITY	24,67	24,90	22,10	27,10	1,23	-0,12	-0,38
LITHE	27,05	27,00	15,00	36,00	4,82	-0,31	-0,01

Table 9.

Statistical parameters of somatic and motoric variables in a group with high motoric fitness N = 37

	Average	**Median**	**Min**	**Max**	**Std. Dev**	**Skewness**	**Kurtosis**
HEIGHT	176,51	176,00	158,00	198,00	10,62	0,25	-0,82
WEIGHT	69,67	72,00	51,40	102,00	12,01	0,31	-0,26
BMI	22,21	22,10	17,79	26,47	2,09	0,26	0,04
MASS_NF	57,54	59,20	40,74	89,76	12,79	0,30	-0,67
MASS_NF%	82,09	83,00	66,00	93,50	7,07	-0,49	-0,34
PEAK_P	8,30	8,38	6,15	10,86	1,27	-0,11	-0,92
DROP_P	3,57	3,36	2,09	5,56	0,89	0,50	-0,44
PWC170	232,91	230,00	112,50	371,43	65,59	-0,02	-0,67
VO2MAX	4,05	4,03	2,35	7,39	1,26	0,72	0,08
VO2MKG	59,59	58,67	42,23	87,26	10,61	0,52	0,02
MOV_COU1	35,43	36,00	15,00	56,00	10,16	0,09	-0,39
MOV_COU2	11,75	11,84	9,20	14,60	1,43	0,23	-0,82
BALANCE1	9,84	9,00	3,00	19,00	4,03	0,45	-0,18
BALANCE2	5,00	5,00	1,00	10,00	2,07	0,28	0,07
KINE_DIV	9,06	9,30	0,80	24,80	5,25	0,57	0,82
SWIFT_R1	9,95	10,00	9,00	11,00	0,63	0,14	-0,88
SWIFT_R2	0,19	0,19	0,15	0,23	0,02	-0,43	0,09
SWIFT_R3	90,51	92,00	80,00	93,00	3,01	-1,75	3,21
SWIFT_R4	89,81	92,00	50,00	107,00	14,99	-1,17	0,81
SWIFT_R5	85,59	90,00	35,00	121,00	24,60	-0,52	-0,91
SPAT_OR1	13,27	14,00	4,00	18,00	3,51	-0,91	0,10
SPAT_OR2	29,92	28,00	2,00	61,80	13,00	0,53	0,50
RHYTHM	1,10	1,08	0,78	1,54	0,20	0,75	-0,09
COOPER	2724,73	2700,00	2240,00	3340,00	307,32	0,22	-1,06
STR_CHES	55,69	55,00	25,00	95,00	21,77	0,01	-1,52
STR_LEGS	90,47	100,00	25,00	140,00	36,17	-0,28	-1,25
STR_GRIP	43,27	46,00	21,00	66,00	10,75	-0,12	-0,57
SPEED1	7,10	6,75	6,15	8,93	0,79	0,54	-1,04
SPEED2	2,53	2,44	1,94	3,14	0,30	0,28	-0,66
AGILITY	24,36	24,43	22,10	26,25	0,97	-0,16	-0,35
LITHE	28,76	28,00	14,00	38,00	5,28	-0,42	0,74

Table 10.

Statistical parameters of somatic and motoric variables in a group of women with low motoric fitness N = 16

	Average	Median	Min	Max	Std. Dev	Skewness	Kurtosis
HEIGHT	169,50	168,50	163,00	183,00	5,18	1,52	2,50
WEIGHT	62,64	60,20	54,00	87,00	8,43	1,99	3,97
BMI	21,72	21,44	18,91	25,98	1,77	0,94	1,37
MASS_NF	45,24	44,60	38,86	53,94	3,54	0,69	1,51
MASS_NF%	72,81	74,00	62,00	83,00	6,22	-0,06	-0,92
PEAK_P	7,37	7,11	6,22	10,10	1,01	1,31	2,34
DROP_P	3,12	2,92	2,13	5,96	0,89	2,40	**7,08**
PWC170	180,57	178,68	136,36	275,53	40,04	1,04	0,62
VO2MAX	3,08	3,00	2,34	3,92	0,40	0,40	0,43
VO2MKG	51,40	51,93	42,68	56,71	4,43	-0,48	-0,91
MOV_COU1	27,88	26,00	16,00	45,00	7,27	0,95	0,95
MOV_COU2	12,59	12,19	10,70	14,88	1,16	0,52	-0,23
BALANCE1	7,88	7,50	3,00	16,00	3,69	0,47	-0,18
BALANCE2	7,81	7,50	1,00	19,00	4,46	0,99	1,44
KINE_DIV	11,38	10,35	1,00	24,10	6,11	0,37	-0,26
SWIFT_R1	9,26	9,30	9,00	10,00	0,30	1,15	0,85
SWIFT_R2	0,19	0,20	0,15	0,22	0,02	-0,91	0,24
SWIFT_R3	89,56	91,50	69,00	93,00	5,97	-3,07	**10,45**
SWIFT_R4	84,31	93,50	44,00	107,00	22,05	-0,95	-0,46
SWIFT_R5	77,50	81,00	18,00	121,00	30,16	-0,46	-0,54
SPAT_OR1	9,31	8,50	6,00	14,00	2,36	0,86	0,10
SPAT_OR2	33,03	33,50	8,00	49,00	11,98	-0,47	-0,28
RHYTHM	1,32	1,32	0,79	1,75	0,29	-0,33	-0,90
COOPER	2321,56	2345,00	2180,00	2490,00	109,97	0,01	-1,55
STR_CHES	32,69	33,75	25,00	45,00	6,26	0,47	-0,62
STR_LEGS	53,13	55,00	30,00	70,00	9,98	-0,65	0,69
STR_GRIP	29,31	29,00	21,00	37,00	4,30	0,01	-0,28
SPEED1	8,49	8,53	7,66	9,13	0,44	-0,43	-0,61
SPEED2	3,07	3,09	2,72	3,47	0,21	0,30	-0,17
AGILITY	26,00	25,85	24,70	27,40	0,89	0,24	-1,37
LITHE	26,06	25,50	19,00	37,00	4,86	0,66	0,06

Table 11.

Statistical parameters of somatic and motoric variables in a group of women with medium motoric fitness N = 22

	Average	Median	Min	Max	Std. Dev	Skewness	Kurtosis
HEIGHT	166,91	164,50	160,00	181,00	5,68	0,90	0,24
WEIGHT	57,82	56,75	44,70	71,00	7,33	0,32	-0,82
BMI	20,74	20,39	16,62	25,46	2,32	0,20	-0,60
MASS_NF	43,97	43,65	37,77	52,46	3,48	0,27	0,51
MASS_NF%	76,66	76,50	65,00	87,00	6,48	0,02	-0,74
PEAK_P	7,10	6,78	6,12	8,85	0,88	0,70	-0,90
DROP_P	3,10	3,09	1,60	7,35	1,15	2,33	**8,77**
PWC170	178,67	177,55	104,17	314,86	49,34	0,75	1,51
VO2MAX	3,00	3,01	2,24	3,92	0,42	0,35	0,28
VO2MKG	53,93	55,30	35,71	71,27	8,28	-0,19	0,33
MOV_COU1	28,95	28,00	20,00	38,00	5,32	0,39	-0,97
MOV_COU2	12,38	12,27	9,70	14,50	1,25	-0,32	-0,30
BALANCE1	9,36	8,00	3,00	22,00	5,28	0,85	-0,18
BALANCE2	5,41	4,50	1,00	19,00	3,80	2,40	**7,47**
KINE_DIV	8,29	6,60	1,00	36,00	7,99	2,30	**6,48**
SWIFT_R1	9,43	9,66	9,00	10,00	0,34	-0,26	-1,58
SWIFT_R2	0,19	0,19	0,15	0,24	0,02	0,16	-0,31
SWIFT_R3	91,05	92,00	82,00	93,00	2,92	-2,17	**4,65**
SWIFT_R4	83,68	90,50	20,00	107,00	24,35	-1,43	1,45
SWIFT_R5	82,86	89,00	17,00	116,00	32,42	-0,69	-0,81
SPAT_OR1	10,64	11,00	2,00	17,00	3,91	-0,30	-0,48
SPAT_OR2	33,80	34,00	8,00	57,00	11,88	-0,14	-0,22
RHYTHM	1,20	1,26	0,76	1,58	0,23	-0,55	-0,57
COOPER	2355,45	2367,50	2150,00	2680,00	119,00	0,68	1,24
STR_CHES	32,16	30,00	25,00	45,00	6,19	0,65	-0,74
STR_LEGS	51,59	55,00	25,00	70,00	12,36	-0,66	-0,39
STR_GRIP	30,05	30,00	19,00	35,00	3,42	-1,66	**4,43**
SPEED1	8,19	8,16	7,43	8,78	0,35	-0,17	-0,16
SPEED2	2,91	2,91	2,56	3,36	0,18	0,51	1,16
AGILITY	25,52	25,43	24,08	27,10	0,79	0,38	-0,10
LITHE	27,91	28,50	17,00	36,00	4,70	-0,50	0,14

Table 12.

Statistical parameters of somatic and motoric variables in a group of women with high motoric fitness N = 16

	Average	Median	Min	Max	Std. Dev	Skewness	Kurtosis
HEIGHT	167,13	167,00	158,00	185,00	6,25	1,49	**4,33**
WEIGHT	58,69	58,00	51,40	77,20	6,58	1,59	3,72
BMI	20,97	20,83	17,79	23,00	1,44	-0,53	0,29
MASS_NF	44,18	43,50	40,74	51,34	3,14	1,22	1,11
MASS_NF%	75,70	75,00	66,00	85,00	5,45	-0,15	-0,12
PEAK_P	7,22	6,87	6,15	9,16	0,92	0,70	-0,47
DROP_P	2,94	2,97	2,09	3,56	0,42	-0,49	-0,40
PWC170	187,71	175,00	112,50	290,00	59,30	0,56	-0,96
VO2MAX	2,87	2,93	2,35	3,47	0,35	0,24	-0,61
VO2MKG	53,01	52,76	42,23	63,42	7,38	0,08	-1,34
MOV_COU1	27,87	28,00	15,00	38,00	5,64	-0,43	0,81
MOV_COU2	11,80	11,84	9,98	13,64	1,16	0,10	-0,96
BALANCE1	7,80	8,00	3,00	14,00	3,36	0,36	-0,81
BALANCE2	5,40	5,00	1,00	10,00	2,56	0,25	-0,33
KINE_DIV	11,03	11,50	2,00	24,80	6,45	0,30	-0,05
SWIFT_R1	9,58	9,70	9,00	10,00	0,39	-0,36	-1,41
SWIFT_R2	0,19	0,18	0,15	0,23	0,02	0,19	-0,21
SWIFT_R3	90,13	91,00	84,00	93,00	2,72	-1,04	0,24
SWIFT_R4	90,87	92,00	62,00	107,00	13,56	-0,87	0,05
SWIFT_R5	84,73	90,00	37,00	115,00	27,62	-0,53	-1,22
SPAT_OR1	11,13	11,00	4,00	17,00	3,72	-0,23	-0,60
SPAT_OR2	26,75	25,00	10,00	48,00	10,18	0,56	0,04
RHYTHM	1,07	1,07	0,78	1,53	0,18	0,98	2,42
COOPER	2446,00	2450,00	2240,00	2720,00	140,24	0,33	-0,79
STR_CHES	32,37	32,50	25,00	42,50	5,18	0,27	-0,48
STR_LEGS	51,67	55,00	25,00	75,00	15,69	-0,30	-0,61
STR_GRIP	32,40	32,00	21,00	45,00	5,90	0,35	0,77
SPEED1	7,97	8,12	7,39	8,93	0,39	0,65	1,43
SPEED2	2,83	2,84	2,57	3,14	0,17	-0,03	-0,64
AGILITY	24,85	24,70	23,40	26,25	0,76	0,14	0,19
LITHE	29,87	31,00	18,00	38,00	5,51	-0,44	0,10

Table 13.

Statistical parameters of somatic and motoric variables in a group of men with low motoric fitness N = 22

	Average	Median	Min	Max	Std. Dev	Skewness	Kurtosis
HEIGHT	179,77	179,00	166,00	192,00	5,57	-0,15	1,14
WEIGHT	77,17	77,35	58,80	105,40	9,97	0,73	1,98
BMI	23,83	23,49	18,56	28,59	2,38	-0,16	0,01
MASS_NF	63,93	64,19	51,46	79,58	6,15	0,14	1,31
MASS_NF%	83,25	82,50	75,50	92,50	4,88	0,17	-0,71
PEAK_P	8,90	8,92	6,98	10,41	0,86	-0,11	-0,21
DROP_P	3,92	3,89	2,76	5,47	0,77	0,47	-0,41
PWC170	260,27	270,19	179,76	333,82	43,11	-0,27	-0,83
VO2MAX	4,57	4,41	3,40	6,38	0,80	0,54	-0,29
VO2MKG	61,27	62,23	45,95	89,75	9,58	1,00	2,45
MOV_COU1	41,91	42,50	16,00	60,00	10,74	-0,36	0,26
MOV_COU2	12,73	12,65	9,30	15,90	1,93	0,10	-0,77
BALANCE1	9,23	9,00	3,00	17,00	4,01	0,52	-0,47
BALANCE2	5,32	5,00	1,00	17,00	3,43	2,20	**6,35**
KINE_DIV	12,10	10,65	0,90	59,30	11,08	3,94	**17,48**
SWIFT_R1	10,40	10,30	9,70	11,00	0,39	0,23	-0,90
SWIFT_R2	0,20	0,20	0,18	0,21	0,01	-0,33	-0,53
SWIFT_R3	89,36	91,00	67,00	93,00	5,65	-3,26	**12,24**
SWIFT_R4	82,27	94,50	30,00	107,00	23,63	-1,21	0,38
SWIFT_R5	77,05	88,50	17,00	118,00	29,50	-0,73	-0,62
SPAT_OR1	14,27	15,00	10,00	18,00	2,39	-0,40	-0,44
SPAT_OR2	35,10	35,85	15,80	60,80	11,73	0,42	0,16
RHYTHM	1,10	1,12	0,67	1,46	0,18	-0,23	0,47
COOPER	2803,64	2825,00	2550,00	3100,00	173,52	0,08	-1,05
STR_CHES	69,89	71,25	50,00	90,00	11,40	0,11	-0,84
STR_LEGS	114,43	113,75	90,00	140,00	15,53	0,03	-0,64
STR_GRIP	51,55	51,50	36,00	64,00	6,76	-0,39	0,18
SPEED1	6,55	6,50	6,17	7,10	0,22	0,84	1,02
SPEED2	2,29	2,37	1,57	2,56	0,24	-1,56	2,54
AGILITY	23,80	23,84	22,70	24,90	0,71	-0,17	-1,29
LITHE	25,59	25,50	13,00	36,00	6,09	-0,07	-0,41

Table 13.

Statistical parameters of somatic and motoric variables in a group of men with medium motoric fitness N = 19

	Average	Median	Min	Max	Std. Dev	Skewness	Kurtosis
HEIGHT	179,95	180,00	160,00	189,00	6,38	-1,55	**4,65**
WEIGHT	76,92	77,00	63,20	89,40	7,39	-0,15	-0,77
BMI	23,75	23,96	19,82	27,15	1,90	-0,37	-0,03
MASS_NF	65,02	65,52	52,46	72,86	5,07	-0,69	0,94
MASS_NF%	84,79	85,00	76,00	93,50	5,01	0,13	-0,43
PEAK_P	9,14	9,10	7,28	10,55	0,75	-0,36	1,12
DROP_P	3,56	3,76	1,59	4,67	0,89	-0,53	-0,64
PWC170	259,22	261,76	150,00	326,92	40,06	-0,76	2,16
VO2MAX	3,96	3,87	2,54	4,87	0,65	-0,41	-0,31
VO2MKG	62,43	61,22	46,22	81,20	8,08	0,39	0,67
MOV_COU1	46,01	46,00	29,00	67,00	8,87	0,06	1,09
MOV_COU2	11,89	11,70	9,70	15,60	1,71	0,47	-0,26
BALANCE1	10,53	11,00	4,00	19,00	4,74	0,12	-1,09
BALANCE2	5,21	4,00	1,00	15,00	3,74	1,58	1,97
KINE_DIV	10,13	9,70	8,30	14,00	1,58	1,16	0,68
SWIFT_R1	10,39	10,33	9,30	11,00	0,51	-0,53	-0,56
SWIFT_R2	0,20	0,20	0,16	0,22	0,01	-0,57	1,12
SWIFT_R3	90,42	92,00	84,00	93,00	2,87	-0,84	-0,47
SWIFT_R4	87,16	87,00	64,00	105,00	12,79	-0,33	-0,73
SWIFT_R5	86,63	86,00	56,00	122,00	20,99	0,05	-1,23
SPAT_OR1	14,84	15,00	3,00	19,00	3,18	-3,00	**11,56**
SPAT_OR2	32,59	31,00	18,20	56,60	9,73	0,61	0,43
RHYTHM	1,05	1,08	0,48	1,39	0,24	-0,71	0,29
COOPER	2908,95	2890,00	2600,00	3220,00	170,94	0,16	-0,34
STR_CHES	71,05	70,00	50,00	120,00	15,71	1,78	**4,64**
STR_LEGS	111,84	110,00	80,00	155,00	19,95	0,44	0,28
STR_GRIP	51,26	51,00	37,00	70,00	7,78	0,13	1,31
SPEED1	6,56	6,60	6,08	6,94	0,25	-0,43	-0,60
SPEED2	2,36	2,39	2,09	2,68	0,16	-0,08	-0,10
AGILITY	23,69	23,90	22,10	25,10	0,86	-0,23	-0,61
LITHE	26,05	26,00	15,00	36,00	4,88	-0,13	0,50

Table 14.

Statistical parameters of somatic and motoric variables in a group of men with high motoric fitness N = 22

	Average	Median	Min	Max	Std. Dev	Skewness	Kurtosis
HEIGHT	182,91	181,00	169,00	198,00	7,84	0,32	-0,71
WEIGHT	77,15	75,90	59,70	102,00	8,59	0,73	2,50
BMI	23,06	22,84	18,43	26,47	2,07	-0,04	-0,02
MASS_NF	66,64	65,74	55,82	89,76	7,71	1,27	2,51
MASS_NF%	86,45	86,50	79,00	93,50	4,08	-0,06	-0,82
PEAK_P	9,03	9,08	7,28	10,86	0,90	-0,19	0,10
DROP_P	4,00	4,01	2,12	5,56	0,87	-0,10	-0,49
PWC170	263,72	261,61	185,00	371,43	50,78	0,33	-0,53
VO2MAX	4,85	4,69	3,25	7,39	0,99	0,98	0,98
VO2MKG	64,07	62,96	46,40	87,26	10,22	0,42	-0,24
MOV_COU1	40,59	38,50	15,00	56,00	9,33	-0,67	1,29
MOV_COU2	11,71	11,70	9,20	14,60	1,62	0,30	-1,00
BALANCE1	11,23	11,00	4,00	19,00	3,91	0,46	-0,29
BALANCE2	4,73	5,00	2,00	7,00	1,67	-0,34	-1,11
KINE_DIV	7,71	8,50	0,80	13,00	3,86	-0,39	-0,96
SWIFT_R1	10,21	10,30	9,00	11,00	0,65	-0,46	-0,70
SWIFT_R2	0,19	0,19	0,15	0,22	0,02	-0,96	1,70
SWIFT_R3	90,77	92,00	80,00	93,00	3,22	-2,21	**5,36**
SWIFT_R4	89,09	92,50	50,00	107,00	16,16	-1,29	1,05
SWIFT_R5	86,18	91,00	35,00	121,00	22,99	-0,51	-0,62
SPAT_OR1	14,73	15,50	7,00	18,00	2,53	-1,49	2,85
SPAT_OR2	32,09	30,30	2,00	61,80	14,44	0,31	0,36
RHYTHM	1,13	1,10	0,84	1,54	0,22	0,61	-0,77
COOPER	2914,77	2925,00	2460,00	3340,00	235,51	-0,21	-0,54
STR_CHES	71,59	75,00	50,00	95,00	11,89	-0,30	-0,26
STR_LEGS	116,93	120,00	85,00	140,00	16,42	-0,18	-0,70
STR_GRIP	50,68	50,00	42,00	66,00	5,73	1,34	1,92
SPEED1	6,51	6,51	6,15	7,09	0,25	0,34	-0,42
SPEED2	2,32	2,38	1,94	2,53	0,15	-1,05	0,60
AGILITY	24,02	23,94	22,10	25,69	0,97	0,07	-0,54
LITHE	28,00	27,50	14,00	38,00	5,10	-0,55	1,85