

Differentiation of the somatic structure and the level of motor potential of athletes in mixed martial arts (MMA) and Brazilian jiu-jitsu (BJJ) sections

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Abstract

The aim of the research was to assess the differentiation of the body structure and the level of motor potential of the athletes practising different disciplines in the field of combat sports in Legion Team Sports Club in Tarnów. The athletes, aged 19-20, with training experience of 3-5 years, were compared in two groups. The first group consisted of athletes practising mixed martial arts, so called MMA, and the other group, of athletes practising Brazilian jiu-jitsu, so called BJJ. 30 practitioners were examined. The basic elements of the somatic structure, i.e. body height, body weight, body fat content and BMI were measured and BMI indexes were calculated. Selected manifestations of motor potential were also measured: static balance, plain reaction time to a visual stimulus, trunk flexibility, static strength of forearms, relative strength, explosive strength of lower limbs, MAW, muscle activation speed and resistance of abdominal muscles to fatigue as anaerobic strength. In the course of the analyses it was found that: the body structure of the athletes training in different combat sports sections does not significantly differentiate them. The athletes in both (BJJ and MMA) sections displayed a similar level of the basic somatic build. The level of motor skills in the BJJ and MMA sections significantly differentiated the athletes in these sections in terms of static strength ($p = 0.045$), relative strength ($p = 0.044$) and fatigue resistance, i.e. anaerobic strength ($p = 0.002$). The higher level of these elements of motor skills was demonstrated by the BJJ section athletes.

Keywords: martial arts, somatic structure, motor potential

Introduction

Combat is a confrontation of opposing forces, both physical and mental, with the aim of determining the victor [1]. Humans have always been accompanied by combat, perceived as a way to survive (to get food, to win a war). Today, combat sports are very popular, and due to complex training and sports competition, they have a comprehensive impact on the human body. Direct competition with an opponent, within the framework of the binding regulations, creates a unique opportunity to get to know the corporeality of the other person, enriching the personality of

each player. This interaction creates a specific form of respect between the opponents which can then be transferred to other people or other spheres of life [2]. Currently such an analogy can be distinguished in relation to relatively young non-Olympic martial arts-related disciplines, which include mixed martial arts (MMA) and Brazilian jiu-jitsu (BJJ). Their popularity is growing very dynamically in the world as well as in Poland. MMA and BJJ disciplines are not only merely sports disciplines or forms of combat. Academies and clubs where these disciplines are practised provide a lot more, showing players a way of life built on the basis of a credible philosophy. Teachers or instructors comprehensively shape the personality of the players, based on such values as friendship, loyalty, modesty. At the same time, they develop technical details of the discipline in

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their students. The outcome of such an organised training leads to the formation of the full personality of a human being. It can be stated that MMA and BJJ forms are lifestyles and therefore they are recommended as an activity for an entire life.

The formation of the Legion Team Sports Club in Tarnów in 2011 initiated the practice and competition in mixed martial arts at the competitive level in Tarnów. In 2015 the Club extended its training offer to include trainings in the Brazilian jiu-jitsu section. Both disciplines have noted a very dynamic development in Tarnów ever since, which resulted in numerous and outstanding achievements of its athletes in the domestic and foreign arenas.

Mixed martial arts are referred to as the sport of warriors. It is a sports discipline expressing one of the contemporary directions of martial arts development. One of the phenomena of this form is the athletes' use in a duel of basic techniques taken from other martial arts disciplines such as boxing, Thai boxing, wrestling [1]. These techniques are a very important part of the whole compilation of mixed martial arts, and by perfecting them the practitioners gain technical versatility, a richer repertoire of opportunities and greater chances of winning [3]. A professional MMA athlete is exposed to enormous physical and psychological pressure, and their training process is very long and demanding. The basis of the energy-absorbing training, with frequent injuries, is maximum concentration. The athletes will most often only pay attention to dangerous injuries, trying to show no pain or weakness in the case of minor incidents. They often force themselves to perform training at the borderline of their physiological and mental capabilities, thus taking great risks.

Brazilian jiu-jitsu is commonly referred to as a ground sport. It is a hybrid martial art derived from traditional jiu-jitsu, wrestling and judo. The BJJ philosophy is complex and still evolving. According to Machado [4], the message of the BJJ protoplast Carlos Gracie is that you can practise BJJ as a martial art or a martial sport. BJJ was created for self-defense, in order for the weaker to defend themselves against the bigger and the stronger. The BJJ discipline is one of the most effective combat systems in the world, where physical conditions and strength are important, but the technical knowledge and structure of this art being the most significant [5]. A special feature of BJJ is the emphasis on ground combat, where specialized movement techniques are used, such as limb leverages, chokeholds, rolling, throwing and overthrowing. The form and structure of movements used in BJJ result from scientific analyses which have been used over the years by various lecturers and coaches, working out and improving an entire technical range of this discipline [6]. Ground floor combat is

fascinating because of the complexity of the various aspects contained therein. It is very technical in nature, and even a little mistake can lead to a loss. This discipline has an infinite wealth of offensive and defensive technical capabilities, which, combined with tactics, makes it a highly strategic competition. A good BJJ practitioner will try to achieve their goal by thinking four or five moves ahead. That is why in the combat sports environment BJJ is often called "human chess".

Over the last few years, among authors representing various scientific centres, interest in the body building and motor skills of combat sports adepts has been observed. Various studies containing reflections on athletes practising various martial arts have included, among others, the importance of the level of coordination motor skills in the course of combat and in the level of achievement of judo seniors [7]; a review of physical fitness tests in selected sports and martial arts [8]; an assessment of the body balance level of judokas at the age of 15-42 [9]; testing the motor potential of karate athletes from 5 KYU to 3 DAN at the age of 19-39 and a training period of 4-20 years [10]; a proposal to assess the special potential of kickboxing practitioners with a minimum of 4 years of training experience and a high level of national rank [11]; physical potential of taekwon-do athletes and its conditions with different levels of training [12]; special fitness of jiu-jitsu athletes with a high level of training [13]. Going deeper into narrow subject areas, one can observe studies which addressed the problem of comparing the level of the development of athletes from different combat sports disciplines, undertaking to clarify issues and problems related to, among others, the level of special fitness of males practising combat sports depending on the influence of the source style [14], evaluation of the differences in physical potential between young free and Greco-Roman wrestlers [15], comparison and evaluation of the anthropometric and motor profile of Turkish free and Greco-Roman wrestlers before their performance in the Rio 2016 Olympic Games [16], the difference in levels of physical potentiality between classic and free wrestlers in the group of members of the Polish junior team [17]. Achieving a sports championship is a dream of every athlete. To be stronger, faster, more durable, to move more economically, to improve motor skills, to constantly extend the limits of one's capabilities higher and higher, are also goals of combat sportsmen and sportswomen.

The aforementioned premises having been taken into account, the main goals of the work were determined, in which the most important task was to assess the level of motor potential and its diversity among the martial arts athletes, who carry out their training on an everyday basis in the sports sections of the Legion Team Sports Club in Tarnów, which differ in terms of

techniques and competitive tactics. Detailing the objectives of the research, the following research question was posed:

What is the inter-group variation in the body structure and motor potential of the athletes under examination, taking into account their belonging to different sports sections?

Material and Methods

Assessment of the (somatic) body structure and motor potential of men aged 19-20 years was conducted in the Legion Team Sports Club in Tarnów. The measurements were carried out from 18 November to 20 November 2019. The study included two sports groups of fifteen that consisted of athletes practising mixed martial arts – MMA (group 1) and athletes practising Brazilian jiu-jitsu – BJJ (group 2). The training period of the athletes in both sections ranged from 3 to 5 years. The measurements took place in the training room, where sports trainings of both groups are conducted on a daily basis. All measurements were carried out between 5 p.m. and 8 p.m. at specially prepared stations, during standard four training units. Each training unit lasted 90 minutes. There was always only one of the studied groups present. Evaluation of each group was carried out during two consecutive training units. The participants were thoroughly acquainted with the instructions for performing all tests and assessments. Selected traits of the somatic structure were measured according to the recommendations of anthropometry [18], i.e.: body height – measured in centimeters (cm) with an accuracy of 1 cm; body weight – measured in kilograms (kg) with an accuracy of 0.1 kg, and the percentage of fat in body weight.

Before the somatic measurements were taken, the participants were asked to remove their clothes and remain in their underwear. The body height was determined by the distance between vertex (v) and base (B), which is the highest point of the head in the Frankfurt plane and the base on which the examined person stands in an upright position with their upper limbs lowered along the trunk [19]. During the measurements the heels remained joined and the feet slightly spaced. Distance v-B was measured with anthropometer A213. To assess the body weight, a certified electronic TANITA TBF-538 weight was used. The body weight in kilograms and the percentage of body fat were read and recorded from the scales display.

Selected samples from EUROFIT batteries were used to assess the level of motor potential [20], including the one assessing the sense of balance, but following the Žak modification [21]. The modification consisted in maintaining the balanced position for as long as possible while standing on a slat in the flamingo stance. Moreover, the time of the simple reaction to

a visual stimulus was assessed according to the proposal of Klock et al. [22]. Each time, before the measurements were taken, both groups participated in standard shaping exercises preparing the body for physical effort. The warm-up lasted about 15 minutes. Assessment of motor potential was always carried out in the order established before the measurements. Static balance was the first to be measured [20]. Next, other components followed: the time of plain reaction to a visual stimulus [22]; trunk flexibility [20]; the maximum local static strength of forearms [23,24] using a hand dynamometer clamp [20]; explosive force of the lower limbs, the standing long jump [20]; the speed of muscle mobilization [23,24] by means of a 10 x 5 m shuttle run [20]; resistance of abdominal muscles to fatigue [23,24], as anaerobic strength by means of a sit up from lying down [20]. On 18 November 2019 the first four tests were conducted in both groups, and on 20 November 2019 the remaining ones. While making the aforementioned measurements, rest breaks were maintained between consecutive tests, which lasted about 10 minutes. All tests were carried out with the athletes wearing sportswear. The results collected during direct measurements were used to indirectly estimate the following indices: body mass index – BMI, which was calculated according to the recommendations of Malinowski and Bozilow [25]; relative force – RF, as a quotient of the assessment of the maximal local static strength and body mass [23] and the maximal anaerobic work – MAW, which is highly correlated with the maximal non-acidic anaerobic power [23,24].

All the results were processed with the use of descriptive and mathematical statistics in Statistica v. 13 Pl. Evaluation of the compliance of the distribution of the analysed dependent variables with normal distribution was carried out using the Shapiro-Wilk test. The inter-group variation of the analysed dependent variables was determined, in the context of the results of the evaluation of the distribution of variables, by means of the Student's t-test (normal distribution) or Mann-Whitney's test (abnormal distribution), in both cases for independent groups. The level $-p$ for $p \leq 0.05$ was assumed to be statistically significant. Detailed average and dispersion measures are shown in Tab. 1 and Tab. 2.

Results

In terms of the assessment of the basic features of the somatic structure (Tab. 1) it was found that the athletes in both sections did not show any significant variation. The athletes in the MMA section compared to the BJJ athletes presented a slightly higher body height, body weight, fat percentage in the body composition and had a slightly higher BMI.

Table 1. The somatic build of the MMA i BJJ practitioners

Parameter	Group	\bar{x}	Me	sd	min	max	R	V	Shapiro-Wilk <i>p</i> level	<i>t</i> -Student's test or Man- n-Whitney's <i>p</i> level
Body height [cm]	MMA	175.81	174.8	7.72	159.6	189.6	30	4.39	0.628	0.925
	BJJ	175.54	173.8	7.64	159.4	189.4	30	4.35		
Body weight [kg]	MMA	77.65	77.4	11.07	60.7	95.2	34.5	14.26	0.394	0.809
	BJJ	76.77	79	8.58	59.3	93.9	34.6	11.17		
BMI	MMA	25.07	24.46	2.86	20.29	31.99	11.7	11.42	0.286	0.859
	BJJ	24.91	25.09	2.27	21.01	29.02	8.01	9.1		
Body fat content [%]	MMA	19.57	20	5.08	12	32.5	20.5	25.99	0.082	0.491
	BJJ	18.4	19.5	4.01	11	24.5	13.5	21.77		

Table 2. The motor potential of the MMA i BJJ under examination

Parameter	Group	\bar{x}	Me	sd	min	max	R	V	Shapiro-Wilk <i>p</i> level	<i>t</i> -Student's test or Man- n-Whitney's <i>p</i> level
Static balance [s]	MMA	8.04	6.65	5	3.01	22.05	19.04	62.12	0.000*	0.431
	BJJ	10.35	7.12	8.07	3.62	35.34	31.72	77.95		
Plain reaction time [s]	MMA	0.235	0.234	0.024	0.187	0.289	0.102	10.317	0.155	0.875
	BJJ	0.237	0.235	0.019	0.203	0.281	0.078	8.058		
Trunk flexibility [cm]	MMA	25.2	25	6.41	13	36	23	25.42	0.520	0.721
	BJJ	26.13	28	7.72	12	40	28	29.53		
Static strength of the hand [kg]	MMA	46.48	50.3	9.76	29.6	59.4	29.8	21	0.206	0.045*
	BJJ	54.46	54.7	11.03	31.2	71.5	40.3	20.25		
Relative strength of the hand	MMA	0.61	0.58	0.14	0.41	0.87	0.45	22.99	0.256	0.044*
	BJJ	0.71	0.73	0.14	0.42	0.91	0.48	19.06		
Standing long jump (explosive strength) [cm]	MMA	229.27	233	21.6	170	256	86	9.42	0.269	0.136
	BJJ	241.27	234	21.19	211	274	63	8.78		
MAW [J]	MMA	1736.54	1776.16	232.56	1333.85	2095.48	761.64	13.39	0.211	0.374
	BJJ	1822.24	1850.21	284.9	1227.46	2155.51	928.06	15.63		
10 x 5m shuttle run [s]	MMA	20.41	19.85	1.49	18.15	22.63	4.48	7.28	0.115	0.445
	BJJ	20.77	20.47	1.07	19.44	22.58	3.14	5.17		
Sit up from lying down (anaerobic endurance) [num- ber of repetitions]	MMA	27.6	28	2.95	22	32	10	10.68	0.262	0.002*
	BJJ	33	33	5.22	23	42	19	15.83		

* Statistically significant difference.

From the analysis of the results in Tab. 2, it can be concluded that in terms of assessing the level of the selected aspects of motor potential and their inter-group variation, the athletes of both groups did not differ significantly. The BJJ section athletes demonstrated a slightly higher level of static balance, trunk flexibility, explosive strength of the lower limbs and maximal anaerobic work, while the MMA section athletes showed an

insignificantly higher level of plain reaction time to a visual stimulus and muscle mobilization rate. In the comparative analyses (Tab. 2; Fig. 1-3) the exceptions were static force (SF) [23] and relative strength (RF) as well as resistance to fatigue [24] – understood as anaerobic endurance – for which the BJJ section athletes showed a significantly higher level.

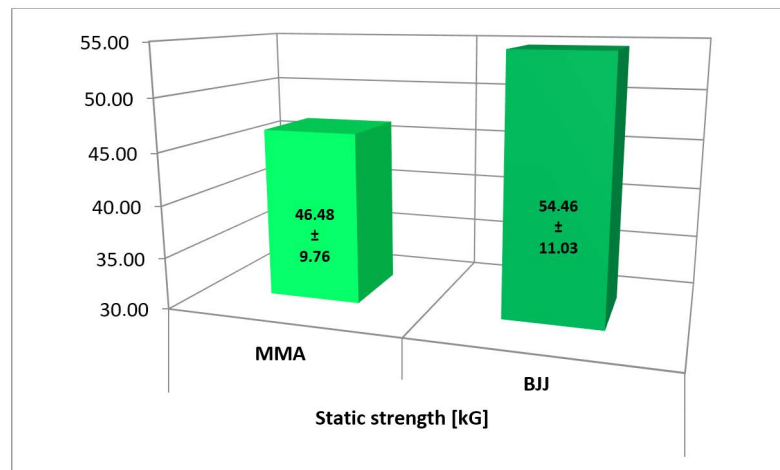


Fig. 1. Level of static strength of both groups under comparison

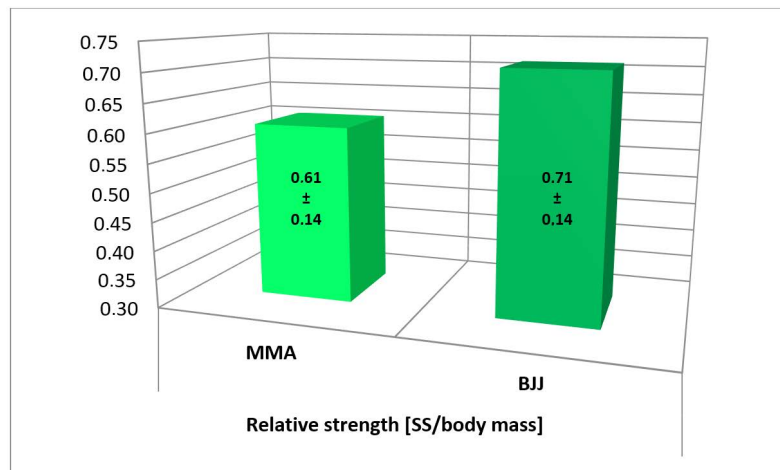


Fig. 2. Level of relative strength of both groups under comparison

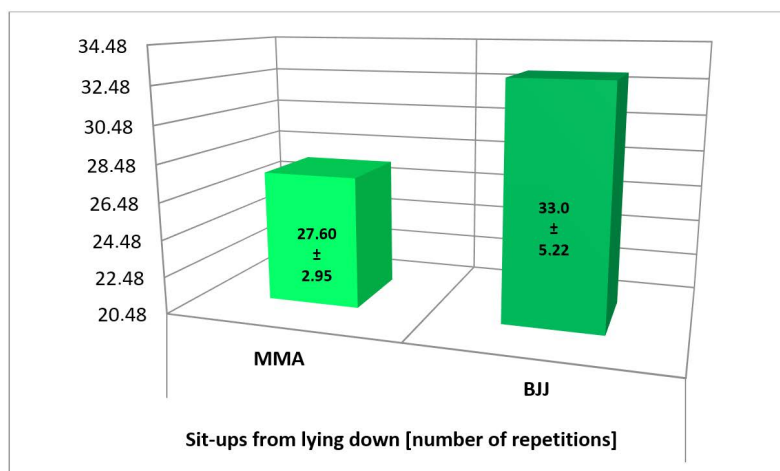


Fig. 3. Number of repetitions of sit-ups from lying down

Discussion

Progress in the world of sport and inevitable changes in the structure of the training process have a huge impact on the level of the motor potential of athletes and their somatic structure. Research conducted among athletes representing combat sports in different disciplines enriches and verifies auxological knowledge, thanks to which coaches or instructors can modify the motor potential of the athletes depending on the formal requirements of the discipline and the desired motor profile of the athlete.

A review of the literature on the subject indicates that the development of trainees should be monitored in order to exert influence on its level. Athletes of relatively young, non-Olympic martial arts disciplines, such as MMA and BJJ, which grow in popularity in Poland and around the world year after year, will need up-to-date information on how to professionally implement physical effort, which need be paid special attention to, and how to train in order to maximise the effects of their work. The analysis of the results of our own research concerning the assessment of the level of the basic features of the somatic structure allowed us to conclude that the groups compared did not show significant differences in terms of height and weight, BMI index and percentage of body fat content. The groups under examination presented a similar level of basic somatic features. Slightly higher values of analyzed traits and indicators were characteristic of the MMA competitors. The observed lack of intergroup differences in the level of variables under analysis is probably due to similar recruitment and systematic selection carried out in both forms of sports activity, which gives preference to athletes with such somatic parameters. It should be noted that this study did not analyse in detail the rules of recruitment and the sports selection carried out. It is worth stressing, though, that it would be appropriate to extend the analyses and assessments of this type of research activity to include detailed information on the level of all relevant predispositions and motor skills that determine efficiency in specific specialisations of combat sports.

Analysing the level of motor skills, our own research found that the groups of MMA and BJJ athletes differed significantly in terms of static strength, relative strength and anaerobic strength. The higher levels of these performance components were found with the BJJ section athletes. It is likely that their significantly higher level of anaerobic strength and anaerobic capacity of the abdomen were significantly influenced by their specialist training. In the course of the training units in the BJJ section, special motor skills based on gripping, squeezing, carrying, holding or hanging as well as those aspects of motor potential that were intended to increase their level of strength, were systematically developed.

During the training, a BJJ practitioner performs many movement activities based on muscle work, which most often involves overcoming high external resistance in the form of the opponent's body and resistance of his own body. He must very often undertake offensive actions based on grabbing individual parts of the opponent's body. This is the so-called NO GI form, i.e. fight without kimonos. In equally frequent cases, a BJJ practitioner fights in the kimono form, the so-called GI form. This type of work develops the strength of hand grip by means of gripping the opponent during the fight and by means of combinations of exercises while hanging from a bar, or wearing kimonos, or possibly hanging from a rope during standard training sessions.

The role and importance of the hand grip of the fighting athletes was discussed by Sanchez et al. [27], who demonstrated the utilitarian sphere of this form of movement with appropriate technical preparation. They stated that techniques used in grappling combat sports such as judo, wrestling or BJJ, used in teaching self-defense, are very important in situations where it is necessary to prevent an attack. An analogous role and importance of the strength of hand grip among judokas, where the specificity of the discipline is inseparable from BJJ, was also stressed by Adamczyk et al. [14]. The same assertions in the field of strength variation analysis were made by Ambroży [27], who showed that jiu-jitsu practitioners, who have a wide range of grips, demonstrated an advantage of strength over karate practitioners, who have clearly fewer grips and among whom hits and kicks dominate, as is the case with MMA practitioners. Consequently, it can be said that in BJJ specialization the static strength of the hands is formed in a specific and unique way. The muscle work in this discipline is of an isometric character, based primarily on holding the opponent in order to control them. In this specialization, in isometric muscle tension, the number of repetitions is less important; what is really important is how long the muscles remain tense. Therefore, during a training session of BJJ athletes, attention is paid to withstanding the opponent's grip. Such a training action will also result in the athlete's increase of strength as well as their resistance to fatigue. In addition, it is known that in order to effectively control the opponent on the ground level, many muscle groups need to be tightened, and that to a maximum capacity. Kalym [28] argues that "the more muscles involved in the exercise, the greater the gain in strength." During ground level combat a BJJ athlete generates and at the same time develops a specific strength which results from a synergy of different muscle groups, including primarily arms and hands. His/her hands work in almost every movement. In BJJ the priority is to make the hands and forearms as strong as possible because this determines the grip force,

which seems invaluable in this discipline. A great deal depends on efficient forearms, hands and fingers, without which a BJJ athlete will not be able to perform and master most techniques. This is emphasised by Kałym [28], according to whom: “You may have very strong back muscles, but this will not work if your hands and forearms are too weak to use this strength.”

The specific technique and tactics of BJJ often result in a competitor seeking to fight while lying on their back and being crushed by their rival. This would appear to be an unfavourable position for them. In fact, a well-trained athlete in terms of technique, tactics and motor activity, having at their disposal a wide range of finishing and point-scoring techniques, can attack (levers, strangulation, point-scoring rolling) their opponent and win. In order to carry out this type of action, high competences are needed in terms of the anaerobic capacity of, among others, abdominal muscles. During a training session, an athlete performs many exercises that shape the resistance of abdominal muscles to fatigue. These include the BJJ's flagship exercise, closed guard sit-ups, or pulling the opponent in a posture in closed guard, all kinds of end techniques from the back. Based on thermographic analysis of muscle work, Andrysiak and Awrejcewicz [29] stated that Brazilian jiu-jitsu is a specific sport. They showed that during a training session BJJ athletes involve large muscle groups, e.g. the quadriceps of the thigh, gluteal muscles, the widest back muscle, and make the most use of abdominal muscles and dorsal rectifiers. This is due to frequent and intensive hip work in many techniques used in this discipline.

The training loads carried out by practitioners of various combat sports, with particular emphasis on the specificity of BJJ, and a review of other authors' studies, seem to explain the significant diversity of the observed groups in the field of anaerobic strength and endurance, found in our own research.

Analysing the level and inter-group differentiation of the other aspects of motor skills under examination, it was found that the efficiency of the BJJ athletes was not significantly higher in terms of static balance, trunk flexibility, explosive strength of the lower limbs and maximal anaerobic work (MAW), and an insignificantly higher efficiency among the MMA section athletes in terms of simple reaction time to a visual stimulus and mobilisation speed (Tab. 2).

Ambroży [27] believes that karate training, one of the source disciplines for MMA, has a more positive effect on speed, leg and abdominal muscle strength and flexibility, than jiu-jitsu, the source discipline for BJJ. The results of our own research confirm it in reference to speed, but are not consistent with the aforementioned reports when it comes to flexibility and explosive strength of the muscles of the lower limbs. This ambiguity of the compared assessments may have resulted from different

research methodologies and different training programmes, which could significantly stimulate other areas of motor potential in the groups being compared. Our own observations as well as suggestions of other authors [30] undoubtedly indicate that a compilation of results of the assessment of the basic features of the somatic structure and motor potential, with sporting results can provide the coach, at any time during training, with a range of relevant information concerning the construction and modification of the combat athlete's sporting form.

To conclude the analyses carried out, it should be stated that training a combat sports practitioner to the rank of a champion requires the implementation of a very complex, planned and a long-term training process. This process should be based on cooperation between the coach and the athletes in order to shape their morphological structure, predisposition and motor skills, equipping them with specific technical skills, and teaching them different strategies and combat tactics. This approach to training of combat athletes is emphasised by Ambroży et al. [31].

It should be reiterated once again that not all aspects of motor potential and of the training process have been assessed. Therefore, it seems justified to postulate a continuation of this type of research with a view to extending it to include measurements of special fitness, technical and tactical skills, as well as a study and detailed analysis of sports struggle, training and performance loads, in order to achieve desired control of the training process.

Conclusions

The results of the conducted observations and measurements, their analysis and evaluation have led to the following conclusions:

1. The body structure of athletes in different sections of combat sports does not make any significant difference. The athletes of both (BJJ and MMA) sections demonstrated a similar level of the basic somatic structure.
2. The motor performance of BJJ and MMA section athletes differs significantly in static strength, relative strength and resistance to fatigue (anaerobic strength). A higher level of the development of these aspects of motor skills was found with the BJJ section athletes.

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Zróżnicowanie budowy somatycznej oraz poziomu potencjału motorycznego zawodników sekcji mieszane sztuki walki (MMA) i brazylijskiego jiu-jitsu (BJJ)

Abstrakt

Celem badań była ocena zróżnicowania budowy ciała i poziomu sprawności motorycznej zawodników uprawiających w KS Legion Team Tarnów odmienne dyscypliny w zakresie sportów walki. Zawodników w wieku 19-20 lat, o stażu treningowym 3-5 lat, zestawiono porównawczo w dwóch grupach. Pierwszą grupę stanowili zawodnicy uprawiający mieszane sztuki waliki tzw. MMA, a drugą trenujący brazylijskie ju-jitsu tzw. BJJ. Zbadano 30 zawodników. Wykonano pomiary podstawowych cech budowy somatycznej, takich jak: wysokość ciała, masa ciała, procentowa zawartość tkanki tłuszczowej oraz wyliczono wskaźniki BMI. Zmierzono także wybrane przejawy potencjału motorycznego: równowagę statyczną, czas reakcji prostej na bodziec wzrokowy, głąbkość tułowia, siłę statyczną przedramion, siłę względną, siłę eksplozywną kończyn dolnych, MPA, szybkość mobilizacji mięśni i odporność mięśni brzucha na zmęczenie, jako wytrzymałość anaerobową. W toku analiz stwierdzono, że budowa ciała zawodników trenujących w odmiennych sekcjach sportów walki nie różnicuje ich istotnie. Zawodnicy obu sekcji (BJJ i MMA) prezentowali podobny poziom podstawowych cech budowy somatycznej. Poziom sprawności motorycznej w sekcjach BJJ i MMA znacząco różnicował zawodników tych sekcji w zakresie siły statycznej ($p = 0,045$), siły względnej ($p = 0,044$) i odporności na zmęczenie, czyli wytrzymałości anaerobowej ($p = 0,002$). Wyższy poziom tych aspektów sprawności motorycznej prezentowali zawodnicy sekcji BJJ.

Słowa kluczowe: sporty walki, budowa somatyczna, sprawność motoryczna