# The proceedings book of 1st International Conference on Science and Medicine in Aquatic Sports : Split, Croatia, 1st - 4th September 2022.

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# The proceedings book of

# 1st International Conference on Science and medicine in Aquatic Sports

Split, Croatia, 1st-4th September 2022

# 1st International Conference on Science and Medicine in Aquatic Sports

# PROCEEDINGS

EDITORS:

Ognjen Uljević
Mia Perić
Dinko Pivalica

Split, 1st - 4th September 2022.

# 1ST INTERNATIONAL CONFERENCE ON SCIENCE AND MEDICINE IN AQUATIC SPORTS

PROCEEDINGS

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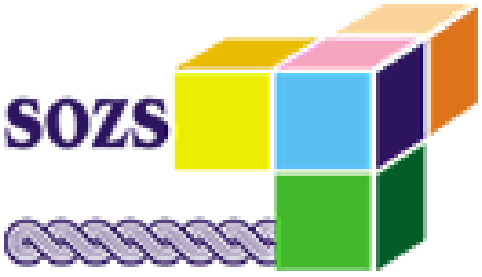

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|---|---|
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# KEYNOTE SPEECHES

## Blood Lactate Evaluation in Swimming Testing and Training

Argyris Toubekis[1]

[1]National & Kapodistrian University of Athens, School of Physical Education and Sport Science Division of Aquatic Sports, Greece

**ABSTRACT**

The scientific community has recognized that lactate is not a "waste product", it is not causing fatigue, but on the contrary, it is a dynamic metabolite that may be extremely helpful for the characterization of training intensity and planning of training in many sports, including swimming, water polo and artistic swimming. The speed versus lactate concentration curve assists in defining appropriate swimming intensities to be used during training. Despite several limitations related to the protocols and methods used for the location of the "first" (aerobic) and "second" (anaerobic) lactate thresholds, the speed versus lactate curve is accepted for testing swimmers of all levels and ages. An obvious advantage on testing to draw the speed vs. lactate curve is to collect physiological and biomechanical data in one single testing session. Using a 5x200 or 7x200-m progressively increasing speed test, stroke rate, stroke length, stroke index may be easily calculated while other more sophisticated data may be also collected such as intra-cyclic velocity variation, hip speed, and various segmental kinematics. Combining all data, a sport scientist can provide to the coach a detailed set of information concerning not only the physiological but also the biomechanical profile of the individual swimmer. Despite its usefulness, reliability, and validity, such a progressively increasing speed test may fail to accurately predict appropriate intensity for endurance training in individual cases. To confirm the validity of the results obtained by such a test, a confirmation training set (or sets) should be used within few days following testing. Young swimmers may reach lower peak lactate values despite they achieve higher performance compared to their best competitive speed, during a progressive test (i.e. 5x200 or 7x200-m). Regular testing for lactate concentration during training assists in the evaluation of training load and subsequently applying appropriate modifications within periods of training. Improvements in the second lactate threshold and other related variables may be observed in aquatic sports athletes, depending on the period of preparation, training content, duration, and level of athletes.

**Key words:** testing swimmers, training evaluation, training load

# Anthropological Analysis of Factors for Success in Water Polo

Mladen Hraste[1]

[1]Faculty of Science, University of Split, Croatia

## ABSTRACT

Anthropological analysis is based on the knowledge of the entire anthropology of athletes in general. Water polo requires specific anthropological characteristics. Anthropological analysis of water polo includes at least the following areas: (1) basic determination of influence of anthropological characteristics on water polo achievement that is development of a specification equation in water polo; (2) scientific findings on anthropological characteristics, models of male and female water polo players of various age groups (motor, morphological, functional, cognitive, conative, sociological, technical and tactical) and the influence of specific anthropological characteristics on water polo achievement. The simplest form of the water polo specification equations is the following:

WPA = f (a1M + a2PM + a3FC + a4COGC + a5CONC + a6SF + a7TETAC + a8S + E)

(WPA – water polo achievement; f – dependence function; a1 to a8 = coefficients of significance of a specific dimension or capacity; M – morphological structure and constitution of water polo players; PM – psychomotor characteristics, FC – functional characteristics; COGC – cognitive capacity, CONC – conative characteristics, SF – social features; TETAC – technical and tactical characteristics, S – specific factor, E – measurement error factor). Based on the schematic illustration and the elaborated analysis of the influence of anthropological characteristics on water polo achievement, scientific research tends to present and explain anthropological characteristics, models of male and female water polo players of various age groups, selection in water polo and the influence of specific anthropological characteristics on water polo achievement.
The previous research suggests that the selection, training methodology and specific sports nutrition has reflected on the somatotype characteristics of both male and female water polo players in terms of the prevalence of endo-mesomorphic component. Higher numerical values in terms of skeletal dimensionality, voluminosity and body height and mass have proven to be significant indicators of athletic achievement of water polo players. Since water polo belongs to the group of aerobic-anaerobic sports, it requires the development of both aerobic and anaerobic capacities. It has been determined that the tactical offence strategies in water polo affect physiological responses within certain parts of the game and almost equally affect defence and offence players. It is believed that elite water polo is dominated by more genetically conditioned motor capacities, such as speed, explosive power and coordination. In the selection process, it is assumed that water polo players with a suitable genetic predisposition regarding conative and cognitive capacities are generally more successful, as well as those who are predisposed to develop personality traits and intellectual capacities under the influence of the environment and training. It can be concluded from the sociological research about water polo that the members of a successful team are able to perform tasks together and that they have a certain affection towards each other. Furthermore, it is quite reasonable and logical to build a team composed of members who get on well and enjoy playing together. Such a team is more successful than those who are lacking in that aspect.

# Concussion in Aquatic Sports: Water Polo, Swimming, Diving

Mark Herceg[1]

[1]Headstrong Diagnostics, LLC, Fellow, Sports Neuropsychology Society, New York, USA

## ABSTRACT

Sports related concussions, or mild brain injuries, are more commonly associated with contact or collision sports such as football, ice hockey, rugby or American football.

Concussion can occur without loss of consciousness and one does not need to hit their heads to sustain an injury. Additionally, concussions occur without structural changes to the brain but result in physiological changes. This has been well documented by researchers at UCLA with the neurometabolic cascade of concussion, showing a reduction in blood flow and increase in certain neurotransmitters immediately post injury. None of these are discoverable on imaging such as CT scans or MRIs.

Common symptoms are headache, balance problems, light sensitivity, visual deficits, and cognitive/behavioral changes. However, research and clinical evidence over the last 20 years has found that concussions can occur in any sport, and the brain in fact does not need to be hit or hit something in order to sustain a concussive type of brain injury. Aquatic sports such as water polo, swimming, diving or synchronized swimming are also sports in which concussions can occur but are less studied or topics of conversations. For example, swimmers or water polo players are sometimes slow to recognize they have a concussion because many of the symptoms, like dizziness and blurred vision, can be caused by swimming upside down and holding their breath for long periods.

A 2016 study found that 36% of USA Water Polo respondents report sustaining a concussion while playing water polo, with an average of two concussions reported. Among player positions, goalies logged the highest rate of head injury. Forty-seven percent said they'd suffered at least one concussion, with an average of 2.49 concussions per person. A majority of these head traumas occurred during practice rather than games, when defensive players are present and interposed between offensive players and goalies.

Concussion research has found that after a brief period of rest (approximately 72 hours) active rehabilitation post injury, particularly physical therapy to address vestibular changes of balance and vision are vital to ensuring a more robust recovery. New data in 2021 from the Care Consortium in the United States has found that it takes an average of 30 days for the brain to physiologically recover. During this time, active rehabilitation is optimal.

As such, the approach to concussions identification and treatment needs to be the same regardless of sport and remain vital to ensure health and safety. In addition to improvements in symptom identification and treatment, it is important that the athlete, trainers and physicians become educated about concussions and the latest guidelines and research. Education and training remain a need and are lacking in many countries.

This talk will discuss the prevalence of concussion in aquatic sports, proper diagnosis, symptoms, and eventual targeted and specific treatments.

# High-intensity training and workload management in elite water polo

Petros Botonis[1]

[1]University of Athens, School of Physical Education and Sports Science, National and Kapodistrian Athens, Greece

**ABSTRACT**

Water polo is one of the most dynamic team sports and the oldest team sport of the modern Olympic Games. The knowledge of the average distance that water polo players swim in horizontal position during a competitive match, the actual playing time as well as the specific activities that produce low, moderate and high intensity may help coaches to construct efficient training plans. Applied research studies have shown that the average distance that players swim in horizontal position during a competitive match is 1600 m approximately, while the average actual playing time during a game is 17 min approximately. Heart rate and blood lactate data have shown that match intensity declines towards the end of the game. However, a high level of aerobic fitness has been found to preserve match intensity and physical performance decay in the middle and post game.

High-intensity training is often applied with the aim to improve players' aerobic and anaerobic potential. Apart from swimming itself, high-intensity training is often applied in ball drills format. A recent study compared long-interval (3 X 4 min with 3 min of passive rest), high-intensity swimming without and with the ball (counterattacks; 3:2) and revealed that both modes of training produce similar cardiovascular responses, but high-intensity ball drills induce lower rate of perceived exertion and blood lactate concentration. Hence, both modes of high-intensity training can be applied in training procedure to improve players' fitness status; however, swimming without ball is more efficient to improve players' anaerobic potential, while ball drills are more efficient to improve players' tactical efficacy.

A modern, elite water polo player participates in a number of demanding training sessions and competitive matches throughout a year and an efficient management of workload is paramount for performance optimization. It has been suggested that resting (3-5 min) heart rate variability (HRV) and heart rate recovery (HRR) are useful means in identifying players' fatigue and recovery status. In particular, a recent study in elite water polo players demonstrated that following an intensified preseason training, a reduction of training load was accompanied by significant increments of HRV values. Another study also, found that following a two-day of heavy load training, the average HR of the last 15 s of recovery (HR60) was higher and the absolute difference between HR at the end of exercise and HR60 was lower compared to the respective values observed after two days of low-load training. Despite inherent constraints, the present results suggest that systematic use of HR values in training procedure will help coaches and training staff to identify players' training adaptations and fatigue-recovery status.

# Injuries of hand and wrist in sports

Tomislav Vlahović[1]

[1]Traumatology clinic, KBC Sestre milosrdnice, Croatia

## ABSTARCT

**Introduction:** Hand is complicated, multifunctional organ which gives perfect and optimized function to human upper extremity – fine motor skills. Optimized function of numerous muscles in forearm and hand, makes motion of osteoarticular structures for individual and precise movement, manipulations and firm but precise grips. Injuries of hand and wrist in athletes are common (25% injuries in sport) and have significant impact on return to competition and training, especially if they did not have adequate care. Sport injuries of hand and wrist are in a range from small ligament injuries to bone fractures and luxation of joints due to extensive ligament injuries. Differential diagnostics include disorder of bones, tendons, nerves, ligaments and joint capsule. During diagnostics and treatment of hand and wrist injuries in sport patient's anamnesis is used, to establish whether the injurie is chronic or acute. In acute injuries most often, we see fractures or ligament injury, while in chronic injuries tendonitis or nerve compression are more often due to overuse syndrome. Physician needs to develop understanding of specific need which are unique for sport and athlete. Acute injuries are more common in contact sports and can result in fractures or ligament sprains. Chronic injures, most often overuse syndrome, like tendonitis or carpal tunnel syndrome, can show in sports with racquets or throwing motion, when athlete repeats same movement numerous times. Physicians should include data about training routine, playing time or training intensity and number of movement repetitions in time period. Failure in diagnosis or incorrect diagnosis can lead to prolonged absence from sport, also it culd lead to permanent termination from professional sport. **Clinical examination and diagnostics:** Evaluation of athlete in area of hand and wrist need to have examination of whole upper extremity and cervical spine together with examination of contralateral upper extremity as comparison. During examination, it is necessary to evaluate differences of deformity in soft tissue which can be caused by chronical load or system diseases. Palpation in pain site could determine differences like deformity and pathological mobility, joint instability. Diagnostics should include neurovascular palpation pathology of a. radialis and a. ulnaris together with examination of neurological periphery status by using test of percussion over peripheral nerves. During examination it is necessary to evaluate mobility and stability of joints in comparison to contralateral extremity. Evaluation of raw muscle power is examined with load motions or by using dynamometer, other hand use is mandatory. In case of suspicion on sort of pathology it is necessary to include other diagnostics assessments (RTG, MRI, EMNG)

**Table 1.** Diffential diagnostics according to location of symptoms in wrist.

| | |
|---|---|
| 1. Acute injuries on radial side of wrist | • Fractures of scaphoid bone<br>• Injuries of scapholunate ligament<br>• Luxation of carpal bones<br>• Fracture of bones in distal forearm |

| | |
|---|---|
| 2. Chronic injuries on radial side of wrist | • De Quervains tenosynovitis<br>• Intersection syndrome (Oarsmans wrist)<br>• Anglion cyst<br>• Syndrome of carpal canal |
| 3. Acute injuries on ulnar side of wrist | • Injuries of TFCC-a (triangular fibrocatilangiozni complex)<br>• Fracture of hook on os hamati |
| 4. Chronic injuries on radial side of wrist | • Kienbecks sickness<br>• In stability of distal radioulnar joint<br>• Ulnar match syndrome<br>• Tendonitis of flexor carp ulnaris tendon<br>• Tendonitis and instability of extensor carpi ulnaris tendon<br>• SY Guyonovog canal |

**Conclusion:** Wide range of hand and wrist injuries which has been seen in athletes, can include injuries of boney, ligament, tendon and neurovascular structures. Proper diagnostics are based on understanding of demands and specifics of injuries which prevail in certain sport, precisely history of patient and precise clinical examination. Proper use of radiographic examination or other diagnostic methods and specific tests, is best option in determining correct diagnosis so that proper and timely treatment can be done.

# Overtraining Syndrome

Boris Labar[1]

[1]Profesor Emeritus of the Faculty of Medicine Zagreb in retirement, member of the Health Commission of the Croatian Olympic Committee,

## ABSTRACT

Overtraining syndrome (SPI) is a clinical disorder of athletes that is manifested by an inadequate response to the training process. The syndrome is observed in all sports, primarily endurance sports, but also in sports based on strength and anaerobic work. For SPI, the athlete often vividly mentions only two words: "I'm burnt out". It is caused by an imbalance between physical activity and rest, and the term "burnout" is a consequence of the athlete's mental load.

Overtraining is determined by changes that can be expressed differently and occur during the training process. These are:

(i) Acute fatigue as a direct result of training load. Although he feels tired, the athlete does not report reduced physical abilities.

(ii) Functional overfatigue is defined as a short-term reduction in an athlete's physical abilities after a certain period of training overload. Functional excessive fatigue is a short-term (less than two weeks) training-induced fatigue and reduction of physical abilities and is essentially transitory. It usually follows an increased training process.

(iii) Non-functional excessive fatigue is determined by intense training overload that leads to a reduction in physical abilities over a longer period of time, usually two weeks to two months. Adequate rest leads to full recovery. Non-functional excessive fatigue is often accompanied by psychological and neuroendocrine symptoms in contrast to functional excessive fatigue which does not have these symptoms.

(iv) Overtraining syndrome is defined by prolonged (usually longer than 2 months) weakness and reduction in physical abilities. Symptoms and signs of SPT are: rapid fatigue, emotional instability, loss of motivation, frequent injuries and infections (most often respiratory system infections). The speed of recovery is different. It often takes several months before the athlete returns to the level of his basic training capabilities.

There is no standardized therapy for SPT. It is very important to understand that there is no quick fix in cases of Dysfunctional Excessive Fatigue or SPT. Rest is the most important part of therapy and usually leads to healing. The approach to therapy begins with a reduction of physical load or training by 50% to 75% within 1-2 weeks. For a certain number of athletes, this is enough and their physical ability significantly improves to competitive level. If the symptoms worsen due to reduced activity, a significant restriction of the training process and sometimes absolute rest is required.

# Sleep Quality in Elite Athletes – Does it Really Matter?

Tea Galić[1]

[1]University of Split School of Medicine Study of Dental Medicine, Department of Prosthodontics, Department of Neuroscience, Croatia

## ABSTRACT

Sleep is essential for physiological and psychological recovery in athletes. According to the American Academy of Sleep Medicine, adults require between 7 and 9 h of sleep for optimal performance and health, while adolescents require additional sleep, ideally between 8 and 10 h. For elite athletes, the frequent exposure to high intensity training and competition increases their need for recovery, and therefore may increase their overall requirement for sleep. It has been reported that Olympic athletes sleep 6.5-6.8 h, they frequently have longer sleep latency (increase in the time it takes to fall asleep) and lower sleep efficiency (lower quality of sleep) than non-athletes. Elite athletes also have extensive postgame commitments such as press conferences, recovery practices, and social functions, which could lead to later bedtimes and disrupt sleep quality and duration. Additionally, youth and collegiate athletes may be at an even greater risk of sleep deprivation, since they are required to sacrifice sleep time to fully accomplish academic and athletic duties. This can not only reduce athletic performance but also threaten classroom performance, potentially increasing an athlete's stress, anxiety, and perceived pressure, resulting in further deficiency of sleep duration and quality. Athletes from individual sports such as swimming or diving, usually obtaine less sleep and have lower sleep efficiency than athletes from team sports due to early morning training sessions, athough there are limited physiological reasons why individual sports train early in the morning.

The measured physical effects of sleep deprivation in some previous studies included decreased running performance, decreased muscle glycogen concentration and reduced submaximal strength, isokinetic peak torque, minute ventilation, distance covered, sprint times, tennis serve accuracy, soccer kicking skills, swim turn, and time to exhaustion, as well as cognitive functions including decreased psychomotor functions, mood, and vigor (a subjective feeling of energy and enthusiasm), and increased reaction time and confusion. In elite sports, where highly trained athletes are often considered similar regarding their physical ability, high-level cognitive functions such as reaction time, judgment and decision-making may be crucial in competition outcome. Sleep deprivation and sleep restriction are associated with cognitive impairments in reaction time and accuracy and may significantly minimize tasks that require flexible thinking, while sleep extension appears to have a beneficial effect on performance of these tasks. One night of sleep deprivation also has been found to have significant negative effects on inhibitory control, potentially undermining decision-making during athletic competition.

Impaired sleep also negatively affects growth hormone and cortisol secretion. Sleep deprivation increases pro-inflammatory cytokines, which impairs immune system function, interferes with muscle recovery and repair from damage, leads to autonomic nervous system imbalance

(simulating overtraining symptoms), results in slower accurate cognitive performance, and alters pain perception. Furthermore, if the stress-recovery balance of team-sport athletes is disrupted by either an increase in training load or inadequate recovery, it may lead to an overreached, or even overtrained state. Consideringly, disturbed sleep is believed to be one of many symptoms of either overreaching or the overtraining syndrome.

The available evidence also suggests that impaired or decreased sleep is associated with an increased risk of injury. The underlying mechanism for the relationship between sleep loss and injury is unclear, but may be related to resulting impairments in reaction time and cognitive function after sleep deprivation that could predispose to acute injury. On the other hand, impaired sleep may contribute to higher levels of fatigue that can similarly contribute to injury risk in athletes.

Healthy sleep can be trained and improved by implementing sleep hygiene measures. Typical recommendations include waking up at the same time each day, establishing the same evening routine, and avoiding stimulants and distractions. The restorative nap lasting about 30 minutes is commonly used sleep strategy among athletes. There are additional options that have been suggested, such as getting natural light, avoiding blue light (smartphones, tablets, computers, TV), stress reduction and meditation, and dietery measures. For instance, higher carbohydrate (high glycemic index foods) at night may improve sleep, as well as high protein including tryptophan. High fat intake at night may disrupt sleep. Inadequate total caloric intake during the day may impair sleep at night. Athletes may not be able to adopt all sleep hygiene recommendations but should attempt to integrate as many as possible to maximize this vital body function.

Sports medicine professionals, coaches and team administrative staff should set priorities such as proper scheduling, travel protocols, time management, stress management, and sleep hygiene in athletes to improve overall health and performance. By placing a greater emphasis on sleep education and sleep hygiene strategies, athletes may be able to maximize the quantity and quality of sleep they obtain, consequently improving overall physiological and psychological recovery.

# ABSTRACTS

## Muscle Oxygenation during the All-out Eggbeater Kick Test in Youth Water Polo Players

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### ABSTRACT

**INTRODUCTION:** Water polo is a high-intensity sport in which the most crucial actions occur in the quasi-vertical floating position with hands out of the water. The eggbeater kick (cycling leg movement) is crucial for performing fighting and passing moves. Therefore, this study aimed to evaluate the muscle oxygenation of the lower limbs during the eggbeater kick movement. **METHODS:** The research included ten junior water polo players (14-17 years old). Variables included anthropometric indices (body mass, body height, body mass index) and muscle oxygenation variables. Players performed an all-out eggbeater kick test with hands out of the water and additional weight around the waist. The portable near-infrared spectroscopy device was placed on the *vastus lateralis* muscle of the dominant leg and was used for evaluating the muscle oxygen kinetics during the test and rest phases. Descriptive statistics (means and standard deviations) were calculated for all variables, and the Spearman rank correlation was used to determine the correlations between muscle oxygenation parameters, anthropometric variables, and test performance. **RESULTS:** No statistically significant correlations were observed between muscle oxygenation variables and eggbeater kick performance time. Body height was correlated with minimal oxygen saturation ($r=0.68$, $p<0.05$). **DISCUSSION:** The finding that higher players were unable to reach low muscle oxygenation, which is an indicator of muscle oxidative capacity, could be explained by the length of the limbs and long body levers and the inability of the tested muscle to use the oxygen more efficiently. **CONCLUSIONS:** Future studies should consider a great variability in body mass and body height of water polo players (probably related to playing positions) when evaluating the muscle oxygenation dynamics. However, this study encourages scientists to further evaluate muscle oxygenation in water polo players and determine the factors contributing to sustained performance in the crucial water polo moves.

**Keywords:** sports performance, aquatic sports, youth athletes, physiology, NIRS

# Kinesitherapy for Shoulder Injuries in Water Polo

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## ABSTRACT

**INTRODUCTION:** The aquatic sport with the highest incidence of injuries, of which shoulder pain is the most common, is water polo. Water polo is a popular contact sport that combines throwing actions, technical ball skills, explosive speed and continuous swimming. These repetitive overhead activities can increase the risk of shoulder injuries. **METHODS:** One of the most important aspect of prevention and rehabilitation in general is kinesitherapy. Kinesitherapy use all potentials of the treated player to achieve optimal recovery and return to sports field. **RESULTS:** Understanding risk factors and targeting preventive methods are fundamental elements when attempting to prevent shoulder injuries in water-polo players. With a high level in the training process, skills, the ability to adapt to a high level of effort, we can conclude that physiologically it is extremely demanding. **DISCUSSION:** The most important thing is to assess the whole shoulder girdle and functional status in general when forming the kinesitherapy plan. **CONCLUSIONS:** Forming a goal of prevention or rehabilitation program and kinesitherapy methods depends on the assessment and targeted imbalances. The type of exercises that will be included in the program depends on the physiotherapist's creativity.

**Keywords:** kinesitherapy, water polo, shoulder injuries

# Treatment for Achilles tendon ruptures

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## ABSTRACT

**INTRODUCTION:** The aim of this study was to compare the efficiency of surgical procedures in the treatment of ruptured Achilles tendon. About 90% of these injuries occur 2-6 cm from the bone tendon grip, which is an ideal indication for treatment with the percutaneous method. About 10% of ruptures are at the distance of the transition of the muscle in the tendon, which poses a potential danger when using the percutaneous method due to the presence of the sural nerve. **METHODS:** From 1982 to 2012, a total of 2128 patients were surgically treated for Achilles tendon ruptures. 1316 patients were treated with the open method while 812 injured were treated with the percutaneous method. In the period from 2013 to 2021, 1,027 patients had surgical repair, of which 668 patients underwent percutaneous surgery, while 359 patients had open surgery. **RESULTS:** An isokinetic dynamometer was used to compare the open and percutaneous methods in the second group who had surgical treatment between 2013 and 2021. The final outcomes for the patients treated by both methods were similar, although rehabilitation process was faster in the patients treated by the percutaneous method. There were no postoperative infections in the patients treated by the percutaneous method. **DISCUSSION and CONCLUSION**: The percutaneous method was technically easier to perform than the open method. Time spent in hospital was 14.5 times shorter with the percutaneous procedure in comparison to the open procedure. Return to normal activities was faster with the percutaneous procedure compared to the open procedure. We had no complications in terms of infections, reruptures or sural nerve injuries with the percutaneous method. We believe, based on our indicators in the postoperative condition that the percutaneous method is the right method of choice for the adequate indication in patients with Achilles tendon ruptures.

**Keywords:** Achilles, treatment, conservative, open, percutaneous

# Blunted Hypoxic Pulmonary Vasoconstriction in Apnoea Divers

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## ABSTRACT

**INTRODUCTION:** Competitive apnoea divers repetitively dive to depths beyond 50m. During the final portions of ascent, Divers experience significant hypoxaemia. Additionally, hyperbaria during diving increases thoracic blood volume while simultaneously reducing lung volume, increasing pulmonary artery pressure. We hypothesized that Divers would have exaggerated hypoxic pulmonary vasoconstriction leading to increased right-heart work due to their repetitive hypoxaemia and hyperbaria, and that the administration of sildenafil would have a greater effect in reducing pulmonary resistance in Divers. **METHODS:** We recruited 16 Divers and 16 age and sex matched non-diving controls (Controls). Using a double-blinded, placebo-controlled, cross-over design, participants were evaluated for normal cardiac and lung function, then their cardiopulmonary responses to 20-30 minutes of isocapnic hypoxia (end-tidal $PO_2$ = 50 mm Hg) were measured one hour following ingestion of 50 mg sildenafil or placebo. **RESULTS:** Cardiac structure and cardiopulmonary function were similar at baseline. With placebo, Divers had a significantly smaller increase in total pulmonary resistance than controls after 20-30 minutes isocapnic hypoxia ($\Delta$ -3.85 ± 72.85 vs 73.74 ± 91.06 dynes/sec/cm$^{-5}$, p = .0222). With sildenafil, Divers and Controls had similarly blunted increases in total pulmonary resistance after 20-30 minutes of hypoxia. Divers also had a significantly lower systemic vascular resistance following sildenafil in normoxia. **DISCUSSION:** These data indicate that repetitive apnoea diving leads to a blunted hypoxic pulmonary vasoconstriction. **CONCLUSIONS:** We suggest this is a beneficial adaption allowing for increased cardiac output with reduced right heart work and thus reducing cardiac oxygen utilization under hypoxemic conditions.

**Keywords:** Breath Hold, Diving, Hypoxia, Hypoxic Pulmonary Vasoconstriction

# Does the Balance Influence Performance of Vertical Position in Artistic Swimming?

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## ABSTRACT

**INTRODUCTION:** Artistic swimming is a complex sport that is performed in water, combining various motor abilities and skills. Swimmers compete in routines (dancing part) and figures (technical part). In all of those performances, swimmers are scored by judges. Elements that they perform are consisted of static and dynamic movements and most often contain a vertical position. Although it seems simple, it is the high demanding element containing technical skills and motor abilities. **METHODS:** The aim of this study was to determine whether the motor ability basic balance (on dry land) affects the performance of vertical position in water. The research was conducted on 26 synchro swimmers of different age groups from artistic swimming club form Split, Croatia. The static and dynamic balances were tested on BIODEX platform and the results were compared with the scores of three different elements in the water that contain vertical positions. **RESULTS:** Significant correlation between basic balance and vertical position was not achieved. **DISCUSSION:** However, given the small sample, large age range within the participants and the level of technical ability, the connection of balance with these elements cannot be excluded. **CONCLUSION:** It would be desirable to repeat the testing in the elderly population with more developed technical skills and/or on a larger and homogenous sample.

**Keywords:** Synchro swimmers, Figures, Stability, Correlation, Transition

# Eggbeater Swimming and Lower Body Power Characteristics of Female Canadian Water Polo Players

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## ABSTRACT

**INTRODUCTION:** Water polo involves swimming, passing, shooting, and grappling with opponents. Lower body strength and power are fundamental for these actions and for successful performance overall in the sport. This study aimed to describe both on-land and in-water measures of lower body power among female water polo athletes of different playing position. **METHODS:** Historical data was collected for two lower body tests performed between 2005 and 2022 by female Canadian water polo players. The on-land test was the Wingate 30 seconds test and the in-water test were a 25m eggbeater sprint. Results were grouped by player position into four categories: center, utility (or center defender), driver, and goalkeeper. Median values and ranges for each of the tests were determined. **RESULTS:** The sample used in this study included 108 eggbeater sprint results and 930 Wingate results. The median eggbeater sprint times for all players was 30.9 s (range: 25.1 – 40.4 s). Median absolute peak power and relative peak power were 753 W (range: 502 – 1039 W) and 10.1 W/kg (range: 3.4 – 13.2 W/kg), respectively. Preliminary analyses suggest that positional differences exist for both the eggbeater sprint times and the absolute peak power achieved during the Wingate test. Centers produced the highest absolute power output during the Wingate test, but it appears, however, that differences between the groups are attenuated when comparing relative peak power. **DISCUSSION:** Peak power values were highest among centers, who are also typically the heaviest players on the team and who engage in the most amount of grappling with opponents. Differences between the groups did not follow the same patterns for the eggbeater sprint and Wingate peak power, highlighting that these two tests of lower body power do not measure identical fitness parameters. **CONCLUSIONS:** This study adds to a body of literature evaluating fundamental physical fitness parameters that benefit performance in water polo. It suggests that there may be test-specific positional differences in lower body power, which may be reflective of the role of these positions on the field. This may indicate that normative values for fitness evaluations should be position-specific for tests of lower body power, but potentially for other assessments, as well.

**Keywords:** playing position, aquatics, female athletes, team sports

# Relations Between Anthropometric Characteristics, Sport-Specific Tests, and Wingate Arm Crank Test in Youth Swimmers

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## ABSTRACT

**INTRODUCTION**: Swimming is a nonstructural cyclic sport. Furthermore, most swimming events last from 22-24 s to 3-4 min and demand contribution from anaerobic energy systems. Therefore, the evaluation of these systems plays an important role in monitoring swimming. Apart from energy systems, anthropometry is one of the factors for achieving the best performance. This research aimed to investigate the correlation between some anthropometric, functional, and motoric skills of swimmers. This research aimed to investigate the correlation between some anthropometric, functional, and sport-specific skills of swimmers. **METHODS**: The sample of participants included 15 swimmers from 6 clubs in Croatia. The mean chronological age of participants is 17,4±0,68, all males. Variables included anthropometric/body-built indices (body mass, body height, body fat percentage, arm span). Other test variables included: Wingate arm crank test, countermovement jump, and laying medicine ball throw; and for in-water tests: 25, 50, and 100-meter sprint. Correlations between the anthropometric and sport-specific tests were conducted along with the dry and in-water tests. **RESULTS and DISCUSSION**: Correlation between anthropometric variables and in-water tests revealed negative relation in body mass (-0.58) and body height (-0.72) but did not in other measured variables. For the other tests, positive correlations were found in laying medicine ball throw for arm span (0.79), body height (0.69), and mass (0.79). Similar results were found in Wingate arm crank test variables. A positive relation was found for body mass, body height, and wing span. Further correlation analysis showed positive relation was found between medicine ball throw and power output variables. Correlation between in-water tests and Wingate arm crank test revealed negative relation between power outputs and tests. **CONCLUSION**: The results could imply that anthropometric variables are good indicators of success in this type of test, and therefore serve as indicators for swimming performance. Furthermore, it could be concluded that the Wingate arm crank test is a suitable method to show the anaerobic power of swimmers.

**Keywords:** in-water tests, correlations, youth swimmers, assessment, motor skills.

# Anthropometric characteristics and specific functional swimming capacities in youth U12 water polo players

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## ABSTRACT

**INTRODUCTION:** Water polo is a physically high-demanding team sport; therefore, players' physical abilities and anthropometric characteristics are important factors to achieve a good level of quality in technical-tactical actions. The aim of this study was to determine the association of the chronological age with the anthropometric characteristics and specific functional swimming capacities in youth U12 male water polo players. **METHODS:** There were 170 youth U12 water polo players who attended the Croatian Water Polo Foundation training camps included in this cross-sectional study. Measurements included anthropometric characteristics and specific functional swimming capacities. **RESULTS:** Players were divided according to their chronological age: Q1 (January-March) – 59 players (34.7%), Q2 (April-June) – 35 players (20.6%), Q3 (July-September) – 46 players (27.1%) and Q4 (October-December) – 30 players (17.6%). Older players born in Q1 presented higher values of body height and weight than their younger peers born in Q4 (Q1 165.96±7.88 cm vs. Q4 159.46±5.44 cm, P=0.001; Q1 60.14±13.99 kg vs. Q4 51.35±7.09 kg, P=0.023), while there were no statistically significant differences in specific functional swimming tests between different age groups. **DISCUSSION:** Contrary to what was hypothesized, older water polo players presented only better anthropometric characteristics than their younger peers, probably due to the biological maturity influence on functional skills, as well as small range of chronological age differences. **CONCLUSION:** Such data might provide an understanding of the general and specific water polo player's development process, which should be considered by coaches of youth players to improve their skills as a result of developing better training programs.

**Keywords:** water polo, chronological age, age-groups, development, performance

# Did the ball possession time and the number of passes affect scoring during the Water polo men's final of the 2020 Olympic Games?

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## ABSTRACT

**INTRODUCTION:** The purpose of the current case study was to examine whether the two competed teams in the men's Water polo final of the 2020 Olympic Games differed in the ball possession time (BPT) and the number of passes (NOP) on the "even" or "extra player" condition. **METHODS:** The final match between Serbia and Greece was analyzed twice for the winning and losing team separately, culminating in a sample of 78 offences when teams played on "even" and 24 on "the extra player" condition. **RESULTS and DISCUSSION:** On even condition concerning the NOP, both national teams accomplished more of their attacks with an "average" NOP (4-6 passes). Regarding the BPT, the Greek squad completed more of the attacks with an "average" (11-20 sec), while the Serbian team with a long BPT (21-30 sec). On the extra player, both teams, similar to the "even" condition, played most of the attacks with an "average" NOP (4-6 passes). About the BPT, most of the Greek offences were completed with 11-15 sec and 16-20 sec possession time. For the Serbian squad, attacks with a long possession time (16-20 sec) were noted. However, no statistically significant differences between Greece and Serbia were shown for the mean values of NOP and BPT on even (NOP 4.87 ± 1.92 vs 5.03 ± 2.36 passes; BPT 18.87 ± 5.69 vs 20.89 ± 6.21 sec) and extra player condition (NOP 5.94 ± 1.98 vs 5.75 ± 1.75 passes; BPT 13.62 ± 4.56 vs 15 ± 2.67 sec), respectively ($p$ = 0.05). **CONCLUSION:** Based on this case, it seems that those two factors probably did not affect the game's final result. However, recognition of these tendencies could motivate coaches to apply this information to construct specific workouts during routine practices and when making decisions during matches.

**Keywords:** performance analysis, final game, even condition, extra-player, team sports

# Rehabilitation of overuse shoulder injuries in overhead athletes

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## ABSTRACT

**INTRODUCTION:** The shoulder joint is one of the most movable joints in the human body. **METHODS:** This high mobility is also the reason why it's one of the most injury-prone joints in the locomotor system. Shoulder needs to be loose enough to enable external rotation and stabile enough to prevent humeral subluxation. Imbalance leads to injury, and treatment of injury can be operative and non-operative. Factors that increase chance of injury are increased external rotation and limited internal rotation, and also scapular dyskinesis. **RESULTS and DISCUSSION:** Most common injuries are: subacromial impingement, sub coracoidal impingement, internal or glenoidal impingement, secondary impingement, SLAP lesion and biceps tendon syndrome. **CONCLUSION:** Rehabilitation involves structured multiphase approach and is divided into 4 phases. Phase 1- pain and inflammation management, electro and cryotherapy. Phase 2 -restore balance between muscle groups, ROM exercises, kinetic chain exercises, flexibility exercises. Phase 3- full active and passive ROM, at least 4/5 strength MMT. Phase 4 - pain free ROM, more demanding sport specific exercises. Injury prevention is very important, and we use exercise protocols (core exercises, scapula stabilization, rotator cuff exercises).

**Keywords:** Arm rotation, Impingement, Joint injury

# Improving Balance; Training Effects on Water Floating Mat

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## ABSTRACT

**INTRODUCTION:** In fitness world, relatively new trend is the usage of the water floating mat. It is used on water surface, and plenty types of exercises and trainings could be performed on it. Training on water mats is fun and the main difference from other fitness programs is that through doing any type of training, athletes/participants practice balance. The aim of the study was to evaluate the training effects on floating water mat. **METHODS:** The basic balance was tested initially on BIODEX platform, 5-week training programme in the pool with floating mats was conducted, and finally, the balance was finally tested on same platform including dynamic and static tests. **RESULTS:** The participants were 15 male and 13 female students (aged 23.5±3.65, BH=173.8 ±11.26cm, BM=70.6±12.7 kg) of Faculty of Kinesiology in Split, Croatia. Statistical analysis included calculation of descriptive statistics and normality of distribution for tested variables, T-test for independent samples comparing initial and final testing of basic balance performance on BIODEX platform. There was no significant difference in static balance results between initial and final testing although there were 3-fold changes in the results on overall sample (p=0.10/0.04, T-value-1.67/-2.1). However, the results of dynamic balance significantly improved on final testing. **DISCUSSION:** Whole training process on water floating mats improved both static and dynamic balance on land. Dynamic balance improved significantly more because of the training process itself. Even though the static balance exercises were included, due to the unstable surface of the water dynamic balance was present all the time. **CONCLUSION:** Water floating mats are suitable for training and improving balance, especially dynamic balance. In future studies, more participants and athletes should be included.

**Keywords:** Aqua fitness, Balance training, Stability, Biodex, Testing

# Technical and tactical evaluation of ball possession in international youth water polo matches

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## ABSTRACT

**INTRODUCTION:** For the development of youth water polo players, it has been suggested that technical and tactical knowledge could be more relevant than physical aspects (Falk et al., 2004). The Team Sport Assessment Procedure (TSAP) (Grehaigne et al., 1997), which represents an assessment procedure developed to measure the players' individual performance in a game situation, has been demonstrated to produce an objective indication of teams' offensive performance also in water polo (Perazzetti & Tessitore, 2021). The purpose of this study was to provide an analysis of offensive actions, by means of the TSAP, of the best four youth national teams during the 20th FINA Junior Water Polo World Championships (Kuwait, 2019). **METHODS:** Twenty-nine elite youth water polo matches, involving the national teams of Greece (n=7), Serbia (n=7), Italy (n=7) and Croatia (n=8) were selected for the analysis. The TSAP included: a) two indicators of gaining possession of the ball; b) four indicators of disposing the ball. Using these indicators, the following indices of technical performance were computed: Volume of play (VP), Efficiency index (EI) and Performance score (PS) (Richard et al., 2000). The field was divided in twelve zones according to the previous procedure of Lupo et al. (2014). **RESULTS:** The one-way Anova showed no significant differences between teams for all parameters ($p>0.05$), except that for offensive ball (OB) and successful shot (SS) occurred in specific zones of the field: for OB significant differences were found in zone 1 ($p=.019$), in zone 2 ($p=.014$) and in zone 5 ($p=.007$); for SS significant differences were found in zone 1 ($p=.026$) and in zone 2 ($p=.008$). **DISCUSSION:** In particular, when the analysis included the data distribution in relation to the different zones of the field, the main reason of some differences could be given by the presence of a left-hand player for one team compared to the others and by the tactical behaviour of coaches and players. **CONCLUSIONS:** The TSAP instrument could offer productive feedback to coaches to perceive the different requirements of playing and to evaluate how players understand the game collectively or individually.

**Keywords:** match analysis, offensive phase, performance index

# Daily monitoring in three water polo goalkeepers leading into the 2021 Tokyo Olympic Games: a case series

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## ABSTRACT

**INTRODUCTION:** Measurement of training in water polo goalkeepers has focused mainly on psycho-physiological variables (heart rate, session RPE, etc.), with some authors also exploring measures of external volume estimated with wearable sensors (number of jumps, etc.). However, there are limited studies exploring training monitoring in water polo goalkeepers longitudinally. **METHODS:** All three female goalkeepers from the Canadian senior national team participated in this study from May to August 2021. Session internal loads were defined through self-reported measures of session RPE (intensity x duration). Tri-axial accelerations and angular velocities were measured with an inertial measurement unit (IMU) (Xsens Dot, Xsens Technologies, Enschede, Netherlands) placed on the lower back by a staff member. These signals were filtered and analyzed with a custom Matlab® script (Mathworks, Natick, USA) to create volume metrics. Relationships between session RPE and IMU-derived metrics were explored using Pearson correlations. Exploratory two-way ANOVA (session type x athlete) were used to assess differences between practices and matches and between athletes. **RESULTS:** In total, 247 sessions were collected during both trainings and matches, with 155 sessions having complete data. The largest missing data category was session RPE (32%) while IMU recordings were missing for only 5% of sessions. IMU metrics such as number of kicks, number of jumps or player-load showed high correlation with each other ($r \geq 0.87$ to 1.00, $p < 0.05$), however there was low correlation with session RPE ($r = 0.4$, $p < 0.05$). ANOVA with the complete data sessions showed that there were significant differences between athletes and between training types for session RPE, and number of jumps and kicks ($p < 0.05$), but only training type had an effect on player-load ($p < 0.05$). There was no interaction between athlete and training type. **DISCUSSION:** The large amount of missing data highlights the challenges with adherence in longitudinal monitoring. Furthermore, perceived training intensity differed between goalkeepers within similar sessions although IMU metrics did not (i.e. player-load). This suggests that coaches should consider both self-reported and external measures for each player before making changes to training plans. Given the missing data, a secondary analysis is necessary with imputation as well as to examine temporal relationships between these variables. **CONCLUSIONS:** Monitoring can be performed longitudinally in water polo goalkeepers using a combination of self-reported and external training measures to inform coaching decisions. However, in order to obtain high quality and reliable data, it is important to have dedicated staff to help collect and verify the information rigorously.

**Keywords:** aquatic, RPE, inertial measurement unit

# What do athletes and their coaches/support staff think about training load and upper limb injuries in elite women's water polo?

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## ABSTRACT

**INTRODUCTION:** Within Australian water polo, 25% of all training days are lost to shoulder injuries (Hams *et al*, 2019). No management or prevention guidelines on addressing upper limb injury exist in Australia and there is a lack of evidence of perspectives of key stakeholders. We interviewed athletes, coaches and support staff about their experiences with managing/preventing upper limb injuries and monitoring training loads to understand perceived barriers and enablers. **METHODS:** We used an inductive qualitative design. We recruited participants who either had experienced an upper limb injury or had managed an athlete with an upper limb injury. Twenty elite women's players, coaches and support staff participated in a semi-structured interview. Interviews were audio-recorded, de-identified, transcribed verbatim and thematically analysed. **RESULTS:** Our analysis revealed five inter-related themes: (1) upper limb injury management is adequate— however prevention, communication and knowledge need improvement, (2) current training load monitoring generates uncertainty and lack of consistency of processes (3) optimal training load monitoring requires objective measurement of training load (4) athlete-centred philosophy matters—including facilitation of individually tailored rehabilitation programmes and the athlete's inclusion in management decisions, (5) mental, social and emotional aspects of upper limb injury management matter – recognising athlete emotions such as loss of team inclusion, fear of missing out and frustration as well as emotional labour felt by coaches when supporting injured athletes. **DISCUSSION:** Our themes indicate that upper limb injury management is evolving – with wearable technologies fostering improved inter-personal processes such as communication, collaboration, consistency of processes and system-wide coordination. We suggest that a consistent, coordinated approach to injury management/prevention would require evidence informed guidelines. **CONCLUSIONS:** The development of upper limb injury prevention and management guidelines could, not only strengthen inter-personal qualities such as trust and care in athlete-coach-support staff relationships as well further lead to the development of measures to ensure consistency of processes. **REFERENCES:** Hams, A., Evans, K., Adams, R., Waddington, G., & Witchalls, J. (2019). Epidemiology of injury in sub-elite level water polo players. *Phys Ther Sport, 35*, 127-132.

**Keywords:** women, water polo, injury, qualitative

# Injuries in Windsurfing: Injured Body Sites and Gender Differences

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## ABSTRACT

**INTRODUCTION:** Windsurfing is physically highly demanding sport in which surfer tries to maintain balance on the board and move it forward on the water surface with the usage of wind. Although it is very popular on both recreational and competitive levels, and is Olympic sport, limited body of knowledge is present about this sport in general and about injuries in particular. The main aim of this study was to investigate injury prevalence among windsurfers and possible gender differences. **METHODS:** Sample of participants included 18 international elite windsurfers (8 female, 10 male). All participants filled newly constructed questionnaire through online survey. Variables included sociodemographic parameters, sport factors and injury factors. Statistical analysis included descriptive parameters (arithmetic mean and standard deviation and frequencies and percentages, depending on the character of variable). For the analysis of differences between genders, T-test was used for parametric and Mann-Whitney test for nonparametric variables. Statistica 13.0 was used for all calculations. **RESULTS:** Total number of 80 injuries were reported with significantly higher prevalence among women (n=56; t=-2.37, p=0.03) comparing to men (n=24). Most frequently injured body sites were lower back (n=16; 20% of all injuries), chest and shoulders (n=11; 14%), knee (n=9; 11%) and head and neck (n=9; 11%). Significant differences between observed groups were found in injury prevalence for lower back (t=2.04, p=0.04) and head and neck (t=2.08, p=0,04) injuries. Around two thirds of injuries (n=54; 68%) occurred during the training, while 26 happened on competitions. Among sport factors, only significant gender differences were found for the number of conditioning trainings per week, with women recording higher numbers (Z=-1.99, p=0.05). **DISCUSSION:** Although the mechanism and type of injuries were not analyzed, results suggest that windsurfers need to include lower back prevention exercise as that body site is under biggest load while surfing. Previous studies reported highest prevalence of lower body injuries, while results of this study showed that distribution of injuries is equal with high prevalence of injuries among upper body parts. **CONCLUSIONS:** In future studies more details about mechanism, type and severity of injuries should be investigated in order to have clearer picture. These findings provide valid and useful information for windsurfing coaches in order to adjust training programs and prevent future injuries.

**Keywords:** windsurfing, male, female, lower back

# Validation of Newly Developed Tests for Specific Dynamic Aquatic Balance

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## ABSTRACT

**INTRODUCTION:** Balance is ability of maintaining body center of gravity within the base of support. It is one of the most important motor abilities that has huge utilization in every day humans' activity and sports. In different sports activity balance appears differently. Literature review shows lack of studies that deal with specific balance on unstable aquatic surfaces. Hence, main purpose of this study is construction and validation of new tests that assess specific aquatic dynamic balance. **METHODS:** Four tests were constructed and all were performed on floating water mat (220x81x12cm). Two tests included jumps (Scissors and Jump test) and two walking movements on the mat (Circle and Skip test). Subjects of the study were 15 male and 13 female students of Faculty of Kinesiology in Split, Croatia. (Male; age=23.53 yrs., BH=179.86 cm, BM=78.26 kg; Female; age=23.46 yrs., BH=166.69 cm, BM=61.69 kg). Statistical analysis included calculation of descriptive statistics and normality of distribution for test's sensitivity, correlations between the items of newly constructed tests and reliability coefficients (inter-item correlation, Crombach's alpha) for test's reliability, analysis of variance for test homogeneity, and correlation with basic balance test performance on BIODEX platform for practical validity. Scissors and Jump test showed weak and Circle and Skip test good sensitivity. **RESULTS and DISCUSSION:** Obviously, jumping and landing on unstable mat significantly ruin stability and increases possibility of test interruption much more than just walking on the mat. High and significant correlations between the items (0.47-0.89), and high reliability coefficient values (IIr-0.66-0.83; α-0.84-0.92) direct to high reliability of all newly constructed tests. Accordingly, these tests are reliable tools for measurement this particular balance form. Homogeneity of all tests, except Circle test, is weak, since analysis of variance showed significant differences between the items of measurements. Learning effect was noticed in all tests (significantly better results in every next item) so longer familiarization with test performance is mandatory to avoid its weak homogeneity. **CONCLUSION:** Practical validity of newly constructed test is proven since high and positive correlations were found with basic dynamic balance test performed on BIODEX platform (0.31-0.52). Since, no significant correlations with static balance test were found; we may conclude that all newly constructed tests measure specific form of dynamic aquatic balance.

**Keywords:** Metric Characteristics, Stability, Reliability, Floating mat

# Front crawl sprint standards in different technical condition of swimming at youth water polo players: International normative approach

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## ABSTRACT

**INTRODUCTION:** Beside the technical skills and tactical knowledge, physical abilities, also, play important role in water polo successfulness. Game analyses have shown that most physical activities in water polo last for <20 seconds, with intense movements and sprints averaging only 7 to 14 seconds, where players use crawl stroke most frequently. The purpose of the study was to define front crawl sprint international standards in different condition of swimming for youth players. **METHODS:** Ninety (90) youth water polo players (Age=14.3±0.9 yrs., BH=177.1±9.0 cm, BM=67.5±11.3 kg), from the national teams of Serbia (n=36), Italy (n=28), Turkey (n=15), and Slovenia (n=11) were tested. The testing was carried out by field testing method, where subjects swam a distance of 25 m at maximum intensity using the following three swimming modalities: crawl with head in water ($25C_{HeadIN}$), out of water ($25C_{HeadUP}$), and with ball ($25C_{Ball}$), expressed in seconds. Also, two different swimming skill indexes were calculated, as: crawl skill index, $25C_{SkillIndx} = 25_{HeadIN}/25_{Ball}$, expressed in %; corrected crawl skill index, $25C_{SkillIndxCORR} = (25/25_{Ball}) \bullet 25C_{SkillIndx}$, expressed in arbitrary unit. Descriptive, distributive and percentile statistical analyses was used. **RESULTS:** Descriptive statistics showed normal distribution and homogeneity for all variables. Mean values, standard deviation and 95% lower and upper confidence interval was: $25C_{HeadIN}$ - 14.41±1.09, 14.17-14.65; $25C_{HeadUP}$ - 14.74±1.14, 14.49-14.99; $25C_{Ball}$ - 15.50±1.32, 15.21-15.78; $25C_{SkillIndx}$ - 0.931±0.035, 0.923-0.939; and $25C_{SkillIndxCORR}$ - 1.514±0.160, 1.480-1.549, respectively. Results of percentile distributive statistics showed that excellent (5 ‰), averaged (50 ‰) and bad (95 ‰) normative qualitative criteria can be establish as: $25C_{HeadIN}$ – 12.92, 14.32, 16.30; $25C_{HeadUP}$ – 13.22, 14.66, 17.28; $25C_{Ball}$ - 13.53, 15.49, 17.47; $25C_{SkillIndx}$ - 0.996, 0.928, 0.878; and $25C_{SkillIndxCORR}$ - 1.795, 1.484, 1.280, respectively. **DISCUSSION:** The obtained results indicate the high practical applicability and discriminability of the used field swimming tests and skill indexes at youth water polo players. **CONCLUSIONS:** We can conclude that the obtained quantitative (normative) standards can be validly used in the quality control of the training process of analysed age-group as a stage age phases of the development of young water polo players in assessment of the maximum abilities of the given modalities of crawl stroke swimming.

**Keywords:** swimming skills, sprint swimming performance, water polo, young players

# Correlation between biomechanical indicators of performance and effectiveness in student rowing

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## ABSTRACT

**INTRODUCTION:** Good rowing technique is based on the correct application of basic biomechanical principles. The goal is to achieve efficient rowing stroke in accordance with the mechanical laws by which the boat moves forward. Review of recent studies indicate that connection between biomechanical performance indicators including boat speed and crew success has not been sufficiently investigated. The goal of this research was to investigate the correlation between biomechanical indicators of performance and success in rowing among novice students. **METHODS:** The sample consisted of 72 students of the Faculty of Kinesiology, of which 27.78% male students (N = 20) and 72.22% female students (N = 52), who had the task of rowing as fast as possible over a section of 500 meters in a quadruple scull with a coxswain. All subjects had the same initial level of rowing technique as they were all adult beginners. **RESULTS:** Results indicated that greater number of strokes during a 500-meter race for beginners doesn't have a positive effect on the total rowing time. Also, results in variables of speed and acceleration suggest that faster crews had higher mean values of speed and acceleration, but not maximum speed and acceleration in comparison with slower crews. Also, it is reported that faster crews made fewer mistakes during the 500 meters course. **DISCUSSION:** Higher stroke rate over a 500 meters course didn't have a positive effect on the total rowing time. This is opposite of elite rowing where rowers want to achieve and maintain high stroke rate per minute as it will have a positive effect on speed and rowing time. The stroke impulse variable was highly correlated with the total rowing time, which suggest that crews with higher values achieved better results. Unsurprisingly, crews with higher mean values of speed and acceleration outperformed and made less mistakes compared to crews with higher maximum values in those variables. **CONCLUSION:** For novice rowers, higher stroke rate is not necessarily going to bring better performance, and the success of the crew is largely determined by the number and size of technical errors.

**Keywords***:* rowing performance, biomechanical analysis, inertial sensor, student

# Incidence of concussions in elite female water polo

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## ABSTRACT

**INTRODUCTION:** Evidence for the prevalence of sport-related concussions in water polo is currently inconsistent. Although a large survey of nearly 1500 USA Water Polo participants has revealed a lifetime prevalence of 36% of self-reported concussions, this is not reflected in surveillance studies in this sport. Therefore, the goal of this study was to examine the incidence of concussions in elite female water polo players from surveillance tools implemented over entire seasons. **METHODS:** Data were collected retrospectively from the medical charts of female players of the Canadian senior national water polo teams from 8 seasons spanning between 2012 and 2021. Available data included number of episodes, recurrence, mechanisms of injury and duration of days before full return to play. **RESULTS:** In total, 32 concussions were identified over the eight seasons observed, with a median count of 3 concussions per season. Fifty percent of the injured players had reported suffering a previous concussion. Days lost for the whole team per year spanned from 25 to 349 days. Two-thirds of goalkeepers in the sample suffered a concussion in this period (2/3 players), compared to one quarter of centers and one third of drivers. **DISCUSSION:** High quality surveillance studies available to date have mainly focused on injuries occurring during the short periods spanning the summer Olympic Games as well as aquatic World Championships. These events last two to four weeks, which may be insufficient to capture incidence in this sport. Furthermore, increasing evidence suggests that hits to the head are common in water polo, which would expose these players to concussions as they play more games. Limitations include a gap year in the current dataset occurred because of staff changeover, where surveillance was interrupted between seasons. Furthermore, the dataset may underestimate the true injury rates given that a subset of the players also concurrently competed in professional leagues where injury surveillance was not implemented. Further standardization of surveillance protocols such as participation exposure would help to establish rates and compare across sports. **CONCLUSIONS:** This study suggests that concussions occur in elite female water polo players with a rate of nearly 14.3 injuries per 100 player*seasons. As was found in previous self-reported studies, players at the goalkeeper position show higher rates of concussion episodes. This adds to a body of knowledge suggesting that improved surveillance methods are needed to detect and care for concussions in this population.

**Keywords:** head injury, mild TBI, epidemiology

# Sports-related head and orofacial injuries and mouthguard use in elite water polo players

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## ABSTRACT

**INTRODUCTION:** Water polo is a sport with intense physical contacts between players with very little protective equipment, therefore players are at very high risk of traumatic head injuries, as well as orofacial injuries. Mouthguards use can reduce orofacial trauma and also prevent concussion injuries by reducing the amount of force transmitted to the skull. Therefore, the main objective of this study was to assess the incidence of traumatic head injuries and orofacial trauma in elite water polo players, as well as their attitudes about the use of mouthguards. **METHODS:** A total of 81 elite water polo players aged 17-36 years participated in this study, which was conducted during the 2021/2022 water polo season. The players were selected from seven water polo clubs participating in the Regional League. Questionnaires including 36 questions about the incidence of head and orofacial injuries, knowledge about the first aid procedures and dental trauma prevention, as well as the knowledge, attitudes and the use of mouthguards were administered. **RESULTS:** Sports-related head injuries were experienced by 36 elite water polo players (44.4%), with 24 injuries (29.6%) requiring interruption of the game, 19 injuries (23.5%) requiring medical interventions – four (4.9%) on the field, 13 medical interventions out of the field (16.0%) and two hospitalizations (2.5%), respectively. Sports-related orofacial injuries were experienced by 30 players (37.0%). Soft tissue injuries occurred in nine players (11.1%), four players (4.9%) had experienced facial bone structures injuries, 15 players (18.5%) experienced tooth injury while two players (2.5%) had both, soft tissue and tooth injury. Only two players (2.5%) used a mouthguard and the main reason for non-use was the discomfort of the mouthguard (33 players, 40.7%). **DISCUSSION:** Besides traumatic head injuries, elite water polo players are prone to sports-related orofacial and dental injuries. The results of this research showed a high incidence of sports-related head, orofacial and dental injuries among elite water polo players. Although the vast majority of players were aware of the importance of preventing dental injuries, they did not use mouthguards. **CONCLUSIONS:** In order to decrease the incidence of such injuries, it is extremely important to raise awareness about the use of mouthguards and the prevention of possible injuries among water polo players, as well as other professionals working in water polo.

**Keywords:** water polo, dental injuries, traumatic head injuries, prevention

# Correlation Between Technique and Maximum Performance of Kayaking in Adult Beginners

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## ABSTRACT

**INTRODUCTION:** Kayaking is taught at the University of Zagreb, Faculty of Kinesiology as part of the Water Sports class in the third year of study. The aim of this research was to determine whether there is a connection between technique and maximal kayaking performance in adult beginners. **METHODS:** Through the research sit on top kayaks were used. The sample of respondents consisted of 104 male students who had taken kayaking lessons. At the end of the lesson, the maximum rowing time of each subject was measured on short sections, and their performance of the technical start and sprint elements was recorded. The maximum speed at 100 meters and passing time on first and second 50 meters were measured. Through video analysis, the respondents were evaluated with grades from 1 to 5 on a Likert scale. The data was analyzed in Statistica 14 program. **RESULTS:** The average passing time for 100 meters is 44.66 seconds. The average time for the first fifty meters is 23.1 seconds, and for the second fifty meters it is 21.57 seconds. The average score for the variable start is 2.88, and for the variable sprint is 3.14. The correlation between the evaluation of the start and the passing time for 100 meters is -0.67, between the start and the passing time for the first 50 meters is -0.57, between the start and the time for the second 50 meters is -0.6, between the evaluation of the sprint and time of maximum rowing performance at 100 meters is -0.65, between the score of the sprint and the time of maximum rowing performance in the first 50 meters is -0.5, between the score of the sprint and the time of maximum rowing performance in the second 50 meters is -0, 63. **DISCUSSION:** It is noticed that the test subjects on average performed technical element sprint better than the start, we can assume that during rowing lessons they performed more strokes rowing the kayak at maximum speed than they performed for the purpose of starting the kayak from a complete standstill. We can also attribute the slower passing time in the first 50m to the fact that the subjects start rowing from a resting position. **CONCLUSIONS:** Based on the obtained results, we can conclude that there is a statistically significant relationship between the technique and the speed of maximum kayaking performance in adult beginners. The technical element of the start is more important the shorter the section of the race is, and it can be assumed that by increasing the race distance, the influence of the sprint technique becomes more significant. All the results obtained from this research should be used for the purpose of teaching adult beginners, recreationists who have no prior experience in kayaking.

**Keywords:** Kayaking, start, sprint, technique, correlation

# Rehabilitation of Bankart lesion in water polo player-case report

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## ABSTRACT

**INTRODUCTION:** The frequent appearance of labral pathology is displacement of the anteroinferior labrum called Bankart lesion. In water polo players the frequency of glenoid labrum injuries is high. **METHODS:** In the present study, we report the case of a 21-year-old water polo player diagnosed with Bankart lesion on MRI. Last two years he felt pain in his shoulder during striking phase and during longer load. He performed nine training sessions weekly and in a competitive season he plays between 25-40 games. In spite of physical therapy and saving from full load, he didn't have long term improvement when returning to full training. After arthroscopic fixation of anteroinferior labrum the athlete had to wear stabilizing shoulder brace for 3 weeks. In agreement with the surgeon the water polo player underwent an accelerated rehabilitation protocol which is predicted for professional athletes. Three weeks after the surgical procedure, as a follow up, a control ultrasound of the shoulder was performed, which presented with subacromial bursitis and smaller amounts of effusion around the long head of biceps brachii. The rehabilitation protocol consists of exercises with passively aided and active movement, exercises aiming the stabilizators of the scapula, rotator cuff muscle strengthening, mobilization of the shoulder's soft tissue and progression of the shoulder's active movement. **RESULTS:** Rehabilitation is performed in accordance to the accelerated protocol for professional athletes. The player is tolerating the current degree of load without complications. It is expected that he will return to his sport activities in the estimated timeline. **DISCUSSION:** It is considered that the reduced, accelerated protocol applies better to professional athletes in consideration to their better muscle function, motor skills and faster healing. **CONCLUSIONS:** In case of the water polo player with chronically painful shoulder one should suspect the possibility of labral damage or Bankart lesion. After the diagnosis is made and surgical treatment of Bankart lesion is performed, sport rehabilitation is initiated so that the player could return to full intensity trainings and competition.

**Keywords:** shoulder, anteroinferior labrum, postoperative protocol for athlete

# Sport-Specific and General Fitness Tests Relations in Female Water Polo Players

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## ABSTRACT

**INTRODUCTION**: Water polo is a highly demanding activity that combines intensive work which is followed by periods of lower intensity. In addition to numerous changes in game rhythms, players have intensive periods of mutual contact. A high level of strength and anaerobic endurance is needed because of specific demands in water polo. Therefore, this research aimed to investigate the correlation between some anthropometric, general fitness, and sport-specific skills of female water polo players. **METHODS**: The sample of participants included 11 female water polo players, all members of the Switzerland national team. The mean chronological age of participants is 27,11±3,98, all females. Variables included anthropometric/body-built indices (body mass, body height, body fat percentage, arm span). General fitness test variables included: Wingate arm crank test, countermovement jump, and Reactive strength index; sport-specific tests included: 25, 50, and 100-meter sprints. Correlations between the anthropometric and sport-specific tests were conducted along with the general and sport-specific tests. **RESULTS and DISCUSSION**: The results showed that body mass (0.91) and body fat (0.68) percentage are in positive correlation with Wingate arm crank test outputs. Also, body mass has a positive relation with reactive strength index (0.71), other variables did not perceive relations. Furthermore, analyzed sport-specific and general fitness tests, showed positive relations only between the reactive strength index and Wingate outputs (Peak power 0.86; average power 0.72; power drop 0.68). Correlations between sport-specific tests and outputs were not found. **CONCLUSION**: These results could imply that the Wingate arm crank test is not a good indicator of success in sport-specific tests. Also, 25, 50, and 100-meter sprints were not done in water polo swimming style, which could have affected on the performance athletes. Moreover, future research should include a bigger sample of participants and a more detailed sport-specific assessment.

**Keywords:** Wingate arm crank, reactive strength index, anthropometry, in-water test, power outputs.

# Assessment of Psychological Characteristics of Perfectionism and Optimism in Water polo

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## ABSTRACT

**INTRODUCTION**: The present study examined the level of perfectionism and optimism in water polo players. Water polo is a highly technical and complex sport which demands a high level of psychological responses from athletes. **METHODS**: The sample of participants included 70 water polo players. Participants were dived into 2 groups, juniors (age 16.23±1.37 years) and seniors (age 20.53±3.76 years), according to the highest category where they play. The Revised Life Orientation Test (LOT-R) was used for optimism quantification. For assessment of perfectionism Sport Multidimensional Perfectionism Scale (SMPS-2) was used. Basic descriptive statistics and T-test were applied to determine the differences in the psychological questionnaire between the groups. The data were analyzed by the Statistica version 13.0 software. **RESULTS and DISCUSSION**: Descriptive statistics revealed that participants had biggest values in optimism (AS±SD=3.59±0.79) and personal standards category (AS±SD=3.66±0.68). The differences in the psychological characteristics observed in relation to players category were not found, except in one dimension. T-test revealed significant differences ($p<0.008$), only in doubts about actions. **CONCLUSION**: Precisely, juniors perceived smaller results in the aforementioned dimension, which implies bigger doubts. The results could be explained by the specific sport selection in water polo. Precisely, big number of junior players are playing for senior team also. Furthermore, values of optimism and personal standards could imply that the participants are still young and they are still evolving in sport. Differences found in doubts about actions, imply that senior players are more experienced than juniors and therefore show less doubt in their act.

**Keywords:** Water polo players, LOT-R questionnaire, Sport-MPS-2 questionnaire.

# FULL TEXTS

## Activity parameters of amateur spearfisherman: a case study

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### ABSTRACT

The present case study examined activity parameters of amateur spearfisherman. The sample consisted of one 42-year old amateur spearfisherman that was monitored for total 27 diving sessions. Descriptive statistic and correlation analysis were conducted. Physical activity and physical measures were assessed with Garmin Descent Mk1 watch-sized dive computer. Results showed that total number of dives per diving session directly affects total time of spearfishing activity, that average depth of amateur spearfishermen can be influenced by water temperature, and that heart rate can't present measure of physical load in amateur spearfishing. The results imply specificity of amateur spearfishing activity and metabolic mechanisms, rules and markers for load monitoring.

**Keywords:** training load, freediving, depth, heart rate, diver

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### INTRODUCTION

Spearfishing or underwater fishing is a method of fishing that involves impaling the fish with a straight pointed object such as a spear, gig or harpoon (Coll, Linde, García-Rubies, Riera, & Grau, 2004). It has been deployed in artisanal fishing throughout the world for millennia (Ahmed, Ravikumar, Krishnan, & Jeyakumar, 2013; Sbragaglia et al., 2016; Matthew AL Young, Foale, & Bellwood, 2015). Modern spearfishing usually involves the use of underwater swimming gear and slingshot-like elastic powered spearguns or compressed gas powered pneumatic spearguns, which launch a tethered underwater projectile to strike the target fish (Gordoa, Dedeu, & Boada, 2019; Smith, Bell, Pollard, & Russell, 1989). Specialised techniques and equipment have been developed for various types of aquatic environments and target fish. Spearfishing may be done using free-diving, snorkelling or scuba diving techniques, but spearfishing while using scuba equipment is illegal in some countries. Spearfishing is highly selective fishing method that normally uses no bait and has no by-catch (Matthew AL Young et al., 2015).

Since spearfishing is underwater activity and mostly practiced with breath holding, it is very physically demanding, dangerous and health risky (Giunta, Liberati, Pellegrino, Ricci, & Rizzo, 2019). Hence, even on amateur or recreational level practitioners need to be physically and mentally prepared and adjusted to specific environmental conditions (Mier & Kegeles, 2002; Matthew Alan Young, 2015). In a certain way, spearfishing is a form of freediving but with different aims and demands. Aim of spearfishing is catching the fish, while freediving has aim to dive as deep or as far as possible. Major difference between

those two sports/activities are in number of dives per session and maximal and average depths that athletes achieve during activities. Namely, freedivers dive significantly deeper and for those deep dives need to have significantly longer surface preparations that in the end results with small number of dives (Rodríguez-Zamora et al., 2018; Stanford, 2019). Contrary, spearfisherman perform significantly more, but also significantly shallower dives. In general, spearfishing has significant psycho-physical demands so data about number of dives, it's depth, surface time, apnea time, recovery time, etc., could help in spearfishing demands description but also in adjustment of training process and recovery planning.

Despite the relatively high number of spearfishing practitioners worldwide, scientific information on spearfishing is limited. Especially about theirs diving activity. Hence, the aim of this case study is description of some activity parameters of one amateur spearfisherman.

## METHODS

*Participant*: The subject in this case study was one 42 years old amateur spearfisherman (body height=180 cm; body mass=80,4 kg, BMI= 24,8 kg/m$^2$, muscle mass: 62,6 kg, body fat=18%) that practice spearfishing seasonally from May to November for minimally 7 years.

*Variables and procedure:* Body composition of the subject was assessed by body composition analyser TANITA MC780MA (Japan). Physical activity and physical measures were assessed with Garmin Descent Mk1 watch-sized dive computer (Garmin Ltd.). Built-in sensors include 3-axis compass, gyroscope and barometric altimeter as well as GPS and GLONASS capability that mark dive entry and exit points for surface navigation, supports gauge and apnea diving, store and review data from up to 200 dives, and share them online via Garmin connect mobile app. Features elevate wrist heart rate technology with multisport activity profiles, performance metrics and smart notifications. Set of variables included: underwater time (*apnea*), time spent on the surface (*surface time*), sum of underwater and surface time (*time total*), average depth (*deep X*), deepest dive of the session (*deep max*), total number of dives (*dives total*), average heart rate (*HR X*), maximal heart rate of the session (*HR max*), total calorie expenditure during diving session (*cal*), and average sea temperature (*temp X*). In total, 27 diving sessions were recorded and all in the island of Vis (Croatia) water area.

*Statistical analysis*

Descriptive statistics parameters were calculated: arithmetic mean and standard deviation, minimal and maximal results. Kolmogorov-Smirnov test was calculated for estimating normality of distribution in each variable. Pearson's correlation was calculated for analysing relations among activity and physical parameters.

## RESULTS

Results of descriptive statistics are presented in table 1. According to Kolmogorov-Smirnov test calculation, it can be seen that all variables (except "apnea") has normal distribution and therefore suitable for parametric statistical methods. Variable "apnea" has huge span in minimal (15.00 min) and maximal (94.98 min) result which, along with standard deviation, influenced distribution pattern in this variable.

**Table 1.** Descriptive statistics (N=27)

| Variable | Mean | SD | MIN | MAX | Max D | KS test |
|---|---|---|---|---|---|---|
| **apnea (min)** | 33.96 | 19.74 | 15.00 | 94.82 | 0.24 | p < .05 |
| **surface time (min)** | 159.08 | 90.01 | 59.16 | 433.84 | 0.23 | p < .10 |
| **time total (min)** | 193.04 | 108.47 | 74.16 | 528.66 | 0.21 | p < .15 |
| **deep X (m)** | 5.32 | 1.36 | 3.00 | 8.50 | 0.15 | p > .20 |
| **deep max (m)** | 12.35 | 3.13 | 7.00 | 17.00 | 0.18 | p > .20 |
| **dives total** | 53.67 | 30.07 | 23.00 | 150.00 | 0.19 | p > .20 |
| **HR X** | 74.62 | 3.70 | 67.00 | 82.00 | 0.15 | p > .20 |
| **HR max** | 108.13 | 13.58 | 86.00 | 146.00 | 0.16 | p > .20 |
| **cal** | 394.95 | 138.79 | 178.13 | 688.00 | 0.14 | p > .20 |
| **temp X (C°)** | 23.48 | 2.15 | 17.60 | 26.20 | 0.19 | p > .20 |

**Legend: apnea-**underwater time, **surface time-**time spent on the surface, **time total-**sum of underwater and surface time**, deep X-**average depth, **deep max-**deepest dive of the session, **dives total-**total number of dives, **HR X-**average heart rate, **HR max-**maximal heart rate of the session, **cal-**total calorie expenditure during diving session, **temp X-**average sea temperature

Table 2. shows results of correlation analysis among physical and physiological activity parameters. Significant correlations were noticed among total dive numbers and times spent underwater, on surface and total time spent in spearfishing activity. Also, no significant correlations were established among heart rate measures and energy expenditure and spearfishing activity parameters.

**Table 2.** Correlation between activity parameters

| Variable | dives total | HR X | HR max | cal | temp X (C°) |
|---|---|---|---|---|---|
| **apnea (min)** | 0,97 * | -0,10 | -0,08 | -0,14 | 0,12 |
| **surface time (min)** | 0,94 * | -0,11 | -0,14 | -0,21 | 0,06 |
| **time total (min)** | 0,96 * | -0,11 | -0,13 | -0,20 | 0,07 |
| **deep X (m)** | 0,22 | -0,09 | -0,02 | -0,15 | 0,41 * |
| **deep max (m)** | 0,24 | -0,09 | -0,01 | 0,01 | 0,35 |

**Legend: apnea-**underwater time, **surface time-**time spent on the surface, **time total-**sum of underwater and surface time**, deep X-**average depth, **deep max-**deepest dive of the session, **dives total-**total number of dives, **HR X-**average heart rate, **HR max-**maximal heart rate of the session, **cal-**total calorie expenditure during diving session, **temp X-**average sea temperature, ***-**significant correlations

## DISCUSSION

This case study has several interesting findings: 1) total number of dives per diving session directly affects total time of spearfishing activity, 2) average depth of amateur spearfishermen can be influenced by water temperature, and 3) heart rate can't present measure of physical effort in amateur spearfishing.

During the spearfishing diver needs to combine several physical activities: snorkelling, swimming, finning, freediving and fishing zone observation. Since, different terrains, general and local weather conditions (waves, winds, currents, tides, solunar parameters) and fish activity influence a lot spearfishermen's movement, it also directly influences his physical activity and demands (Sbragaglia et al., 2018). In shallow waters, can be situations in which spearfishermen doesn't dive at all. He

sneaks along the coast line and trying to ambush feeding fish while he is snorkelling. In these terrains, he can also use shallow ambush technique (up to 10 meters) that is not very exhausting and doesn't demand too much time to recover. This way spearfishermen can repeat numerous dives in shorter period of time. On the other side, in deeper waters, whether he is exploring reef wholes or performing deep ambush technique (from 10 to 20 meters) recovery lasts longer, there is less finning and swimming and also fewer total dives. In general, we may state that more dives increase total underwater and surface time in amateur spearfisherman.

Spearfisherman tries to find and shoot the fish in the thermocline. Thermocline is the transition layer between the warmer mixed water at the surface and the cooler deep water below (Brenner, Rozentraub, Bishop, & Krom, 1991). In thermocline fish feel most comfortable and therefore most suitable for catching. The problem is that thermocline is not at the same depth, especially in the Mediterranean during summer season (Brenner et al., 1991; Sparnocchia, Pinardi, & Demirov, 2003). Sometimes, it is almost impossible to notice any fish activity in shallow waters or above the thermocline level. Obviously, thermocline and sea temperature variation govern average spearfishermen depth activity.

In many individual and team activities and sports heart rate is used as measure of internal load and considered to be reliable measure of training and recovery (Keytel et al., 2005; Wilmore & Haskell, 1971). Yet, in our case study average and maximal heart rate was very low with average 74,62 and maximal 108,13 beats per minute. Highest recorded HR was 146 bpm. These data wrongly suggest that there is no any physical effort in amateur spearfishing activity. One reason for low HR is a constant need of spearfisherman to be relaxed physically and mentally (Alkan & Akış, 2013; Christoforidi, Koutlianos, Deligiannis, Kouidi, & Deligiannis, 2012). Relaxed muscles that don't contract during freediving and spearfishing consume less oxygen and, in that way, allow person to spent more time and be more efficient underwater. This is possible only on low heart rate frequencies and by breath-up techniques that stimulate parasympathetic nervous system (Ostrowski et al., 2012). When, analysing activity of spearfisherman, physical effort while fasting, equipment that is being used (weighted vest and belt, long fins, diving suits, speargun), duration and length of dives' descent and ascent, muscle work without receiving oxygen and any possibility of continuous carbon dioxide exhalation, it is impossible to think that this type of activity corresponds to HR recovery zone or activity such as walk in the park. Obviously, there are different metabolic mechanisms, rules and markers used for load monitoring while spearfishing that should be taken in the consideration rather than heart rate (Schagatay, 2014). This all direct us to think that HR is not real measure of demands that amateur spearfisherman overcome.

## CONCLUSION

This is one of the first study that tried to describe amateur spearfisherman activity and open academic discourse about its demands and benefits. Literature show lack of such studies most probably because of small, heterogenic and specific sample characteristics.

The biggest limitation of this study is a small sample. Only one subject can't represent whole amateur spearfisherman population. Also, study was conducted in specific water area and spearfishing season (spring/summer). Different water area/season can significantly change spearfisherman's' technique, equipment and in the end physical demands. In future studies, larger sample and studies in different water areas are mandatory. Also, rate of perceived exertion should be included after

every session to additionally measure load significance of spearfishing effort.

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# State and perspective of recreational sailing of people with disabilities in Croatia

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## ABSTRACT

The aim of this research was to investigate opinions and thoughts of persons with disabilities on the topic of development of recreational sailing and determine current condition and possible new ways of developing the mentioned activities. In this research two questionnaires were used. One survey was created to question people with physical disabilities, and other for people with developmental disabilities. The total number of people who participated in both surveys is 110, but the exclusion method reduced the number of incomplete answers to 107. Most of the people with physical disabilities and people with developmental disabilities that were questioned (90%) support the idea of recreational sailing, 72 of them (67%) would practice that kind of activity if it would be available near their place of residence. Respondents (48%) are fully agree that the current infrastructure of the coastal areas and marinas is not appropriately developed and that there's a need for improvements. Most of the respondents (82%) is not familiar at all with the existence of sail boats which are design or the use of people with disabilities. One of the biggest problems is the insufficient informed population of people with disabilities about this type of activity. Given the results, it can be concluded that the current state and knowledge of sailing of people with disabilities is due to the lack of federations and clubs to promote and develop and that the necessary infrastructure is not at the required level.

**Keywords:** sailing, disabilities, rehabilitation

## INTRODUCTION

Sailing of people with disabilities has been developed worldwide. Over the last few years, there have been improvements in suitable infrastructure and increase in newly formed associations and clubs for sailors with disabilities. Studies have shown positive effects of sailing on mental and physical well-being for people with disabilities.

In regard to their health condition, people with disabilities can be divided into four groups: intellectual, mental, physical and autism-related disorders (Dadić et al., 2018). In Croatia, people with disabilities account for 14.4 % (586 153) of the population (HZJZ, 2021). At the moment of writing, there is not a single registered sailing club for people with disabilities. Sports including sailing is not for professionals only, but for all who want to enjoy its benefits. Thus, such activities should be available to all (Bačić, 2017). Organizations such as *Sailability* and *Un mar sin* promote sailing for people with disabilities and therefore foster inclusiveness. Through their missions, they demonstrate that sailing enhances teamwork, social interaction, skills, self-respect, trust, imagination, and relaxation.

Consequently, it augments quality of life of people with disabilities measured not only by specific outcomes of a rehabilitation process, but also by interaction of external factors and individual characteristics (Bratković, 2003). Continuing on the same idea, Carta et al. (2014) argue that sailing as an everyday activity or as a rehabilitation instrument tends to improve mental health and quality of life.

Technology opens new possibilities for water sports. For example, virtual tools allow for intuitive learning of basics of sailing and boat controls (Recio et al., 2013). Technological tools enable one to experience sailing (on land), which serves as a preparation for a real experience – sailing on water. In addition, rehabilitation through technological means contributes to both psychological and physical well-being (Aprile et al. 2016). Croatia as nautical and touristic centre has the potential to develop sailing for people with disabilities. Sailing projects at a European level focused on people with developmental difficulties offer unique opportunity to boost self-confidence and peer-to-peer interaction (Sailaway, 2022). Such projects give a positive outlook on further development of sailing for people with disabilities. Against this backdrop, the aim of this article is to provide a contemporary overview of recreational sailing among people with disabilities in Croatia. The findings aim to point to a direction in which the future of sailing clubs for people with disabilities may develop.

## METHODS

Two surveys constitute the main method for the analysis. The total sample is 107. One survey targeted people with disabilities (n= 57), whereas the other survey focused on people with developmental difficulties (n= 50). Responds from both surveys are merged into a single interpretation. Respondents come from six Croatian regions (see Table 1).

*Table 1. Survey sample across Croatian regions*

| *Region* | *Number of respondents:* | *Proportion of sample:* |
|---|---|---|
| *Istria and Kvarner* | *27* | *25 %* |
| *Gorski Kotar and Lika* | *1* | *1 %* |
| *Central Croatia* | *27* | *25 %* |
| *Dalmatia* | *7* | *7 %* |
| *Slavonija and Baranja* | *45* | *42 %* |

Out of 107 respondents, 37 (32%) are female and 73 (68%). (see Table 2).

*Table 2. Gender of respondents*

| *Gender* | *Number of pearsons* | *Percentage of answes* |
|---|---|---|
| *Male* | *73* | *68 %* |
| *Female* | *34* | *32 %* |

*Table 3. Age of the respondents*

| *Age* | *Number of respondents* | *Answers frequency* |
|---|---|---|
| *Younger than 18* | *22* | *21 %* |
| *18 do 24* | *10* | *9 %* |

| | | |
|---|---|---|
| *25 do 34* | *26* | *24 %* |
| *35 do 44* | *36* | *33 %* |
| *45 do 54* | *7* | *7 %* |
| *55 do 64* | *6* | *6 %* |
| *Older than 65* | - | - |

The most represented age group is 35-45 years old (33%), followed by 25-34 years old group (24%) (Table 3). There are no respondents in age group 65+. The online surveys were set up and distributed to respondents via email. Introductory note explaining the research aims and instructions preceded the questions in the surveys. The two surveys consisted of 16 identical questions. Two, rather than one surveys were preferred due to distinguished response state of people of with disabilities in relation to people with developmental difficulties. The survey for people with developmental difficulties were filled by their parent or caretaker, while the one for the people with disabilities were filled by themselves (without the help of others). The analysis below is based on descriptive statistics and frequency occurrence of responses.

**RESULTS and DISCUSION**

The results of the surveys show da the vast majority of the respondents (87%) is physically active. Out of physically active respondents, 41% do a sports activity 1-2 times per week, followed by those who are active 3-4 times per week (35%). 65% of respondents deem that they do not have fear of water, 34% deem that they have good swimming abilities (17% do not agree with the mentioned statements). 86 respondents (80%) do not have experience in dinghy class sailing. 8 respondents have sailing experience in dinghy sailboats, while 11 respondents has experience in crusaders. To question "did you know that there are boats (dinghy) purposively built for people with disabilities?" 88 respondents (82%) answered "don't know". To question "if you had an opportunity to sail close to your place of living – would you try it?", 35 respondents (33%) answered "no". 96 respondents (90%) fully agree with the statement "I support the idea of development of recreational sailing for people with disabilities and people with developmental difficulties in Croatia with an emphasis on rehabilitation effects". 51 respondents (48%) stated that completely agree with the statement. The results indicate that people with disabilities and people with developmental difficulties generally support the idea to develop recreational sailing (90% of respondents), while 67% would try sailing if such activity was close to their place of living. 48% of respondents fully agree that current infrastructure around the coastal area and marines is not sufficiently developed and that it needs adaptation. 40% of respondents could answer the question about the current state of infrastructure due to lack of information. Majority of respondents (80%) do not have any sailing experience. 82% of the respondents are not familiar with the fact that there are boats purposively build for people with disabilities. More than half of the respondents (57%) fully or partially agree with the statement concerning good swimming abilities, while 65% do not agree with the statement regarding having the fear of water.

It is known that sports activities have a positive effect on mental and physical health and that is without a doubt that people with disabilities should participate in them. Mihović (2018) states that "rehabilitation sport is a part of secondary rehabilitation. Every person with a disability requires long-lasting rehabilitation. The aim of rehabilitation sport is to empower a person with disability for independent living

and improve physical and psychological health". Sailing is good and scientifically demonstrated rehabilitation activity, but if one considers the level of familiarity of people with disabilities with sailing, the situation is rather disappointing, as shown by the surveys. We could have expected greater familiarity had there been more respondents from the coastal regions of Croatia (Istria, Kvarner, Lika, Dalmatia). Additionally, a big obstacle is the fact that there is no federation/association and clubs as these are the main actors in fostering and promoting inclusiveness in sports. The fact that significant number of respondents would not participate in sailing potentially due to lack of information/education about sailing and relatively small number of respondents with good swimming abilities (34%). An advantage of sailing as an outdoor sport is being in nature, which is especially important in the context of the COVID-19 pandemic. To this end, as argued by Iličić (2021): "Outdoor sports increased the average time spent outside for 23,08%". Most importantly, in addition to evident interest of people with disabilities to participate in such outdoor activities, prospects for sailing and water sports in general appear promising.

## CONCLUSION

The aim of the article is to provide an overview of recreational sailing for people with disabilities in Croatia. The findings of surveys show that current state of sailing for people with disabilities is particularly poor. Necessary infrastructure as well as clubs are practically non-existent. This is compatible with observations that 48% of respondents deem that the adaptation of the infrastructure is necessary and that 82% respondents were not aware of the fact that there are boats purposively built for people with disabilities. Nonetheless, respondents' confidence in their swimming abilities and their general perception of the sea and water serve as a pre-condition for their participation in sailing and risks it entails (e.g., unpredictable situations and weather conditions). Water sports including sailing have a historical footprint in Croatia, which, due to is geographical position, bears pre-conditions for their development should be more accessible to all. There is an unquestionable interest of people with disabilities in Croatia to partake in such activities, so it could be argued that investments in this direction across Croatian regions would inspire more people to engage in sailing.

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# Notation analysis of the Women's Olympic Water Polo Tournament held in Tokyo in 2021

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## ABSTRACT

Notation analysis is a great tool for water polo coaches, fitness coaches and sports scientists to be aware of the real requirements of the game. The aim of this paper is to determine and explain the results and differences in technical and tactical efficiency in women's water polo. The sample of the entities are the matches of the women's tournament of the Olympic Games in Tokyo 2021. The sample of variables are 18 defense and attack parameters of efficiency. Using a t-test for independent samples the winning and losing teams differ statistically significantly in eight variables. Statistically significant differences in swimming for the ball and shots from the counterattack between winning and losing teams can very likely be attributed to swimming superiority and the skill of timely counterattack. The dominance of winning teams in the realization with an equal number of players, man-up and counterattack situations probably stems from better skills in achieving optimal conditions in the preparation and implementation of all offensive actions. The reasons for the superiority of the winning teams in the part of defensive actions can probably be found because of better and more coordinated actions of all defensive players in blocking the ball, reducing the opponent's shots and goalkeeper shot saves. These findings encourage coaches both on the one hand to improve the player's skills in providing optimal conditions for the execution of shots and on the other hand to improve the ability to cover and guard the direct opponent who plays on multiple inside and perimeter playing positions on attack.

**Keywords:** women water polo players. match analysis, technical indicators, tactical indicators

## INTRODUCTION

Although women's water polo has a long tradition of over a hundred years at the Olympics it appeared first in Atlanta in 1996 as a demonstration sport and then in Sydney in 2000 as an official sport. Throughout history, water polo has undergone major changes, and they have been most affected by the improvement of organizational conditions, training and competition, the development of training technologies, but also frequent changes in water polo rules (Hraste et al., 2013).

Some findings characterize today's women's water polo as a high-intensity intermittent sport (Tan et al., 2009). Success in any sport, including water polo, depends on a number of factors such as morphological structure, psychomotor abilities, cognitive abilities, conative characteristics, physiological and functional characteristics, technical and tactical knowledge, theoretical knowledge of water polo players and other

aspects. (Hraste, 2021). There are a lot of tactical variants in attack and defense. In defense there are pressing, zone and combined defense, while in attack the team can rely on a quick transition, outside shot, play with one or two center forwards, etc. The team will develop some style of play according to their fitness and technical capabilities. In addition to adjusting the tactics according to one's own abilities, the tactics are also adjusted depending on the opponent, in various ways that try to annul the opponent's advantages and take advantage of the disadvantages. Differences between winning and losing teams in women's water polo emerged for duration of actions, number of players, passes, exclusions and penalties achieved, shots originating inside and outside the 5-m area, and occurrence of goals during the even situation; exclusions and penalties achieved, shots following up fake, and goals during the counterattacks; and passes, and goals during the power-play actions (Lupo et al., 2011).

Takagi et al., (2005) based on data from 108 matches from the 2001 World Cup in waterpolo, factorized the structure of both men's and women's water polo games and found that out of 32 variables, only two determine the winner of a water polo match: (1) The ability to realize counterattacks and players more and (2) Success in blocking and rescuing from the opponent's shots in a game with a player less.

According to Mirvic (2019) and García-Marín (2017) only unbalanced games are affected by technical and tactical aspects able to discriminate winning and losing performance in women's water polo. The game-related statistics were found to have a high discriminatory power in predicting the result of matches with shots and goalkeeper-blocked shots being discriminatory variables in women's water polo (Escalante et al., 2012).

The aim of this paper is to determine and explain the results and differences in technical and tactical efficiency in women's water polo. There is an assumption that top women water polo players will differ in some variables of technical and tactical efficiency.

## METHODS

The sample of the entities are the matches of the women's tournament of the Olympic Games that took place in 2021. The results of matches of teams that lost more than 2 games with 8 goals difference and more (South Africa and Japan) were excluded from the sample of entities. So, called “out layers” were left out of the overall tournament statistics so that we get relatively homogeneous teams that participated (Canada, Australia, USA, Spain, China, the Netherlands, Hungary and the Russian Olympic Committee). One match that ended in a draw was left out of the entity sample. At the Olympic Games in Tokyo, 36 matches were played in the women's tournament, and for the purposes of this research, 23 matches were processed.

The sample of variables are 18 parameters of efficiency: total number of shots (TS), shots in a situation with an equal number of opposing players (SE), goals in a situation with an equal number of opposing players (GE), shots from fouls (SF), goals from fouls (GF), number of penalties (TP), goals from the penalties (GP), shots from the counterattack (SC), goals from the counterattack (GK), man-upshots (MS), man-up goals (MG), goalkeeper shot save (GS), opponent's shots on goal (OS) , blocks (BL), stolen balls (SB), swimming for the ball (SB), exclusions (E) and lost balls (LB).

For the purposes of this study, basic statistical parameters in the form of arithmetic mean (AM), median (MED), minimum score (MIN), maximum score (MAX), standard deviation

(SD), skewness (SK) and kurtosis (KUR) were calculated, and a t-test for independent samples was calculated.

The data for this research was collected from the Total Water Polo platform, which allowed us to use it.

## RESULTS and DISCUSSION

***Table1:*** *arithmetic mean (AM), median (MED), minimum score (MIN), maximum score (MAX), standard deviation (SD), skewness (SK) and kurtosis (KUR) for the variables of situational efficiency of the winning teams*

| VAR | AS | MED | MIN | MAX | SD | SK | KUR |
|---|---|---|---|---|---|---|---|
| TS | 29,78 | 31,00 | 23,00 | 40,00 | 4,61 | 0,38 | -0,44 |
| SE | 19,65 | 19,00 | 11,00 | 33,00 | 5,50 | 0,57 | -0,05 |
| GE | 7,39 | 7,00 | 4,00 | 13,00 | 2,55 | 0,56 | -0,51 |
| SF | 0,57 | 0,00 | 0,00 | 2,00 | 0,79 | 0,99 | -0,58 |
| GF | 0,13 | 0,00 | 0,00 | 1,00 | 0,34 | 2,35 | 3,86 |
| TP | 0,83 | 1,00 | 0,00 | 4,00 | 1,03 | 1,47 | 2,62 |
| GP | 0,65 | 0,00 | 0,00 | 4,00 | 0,98 | 2,06 | 5,19 |
| SC | 0,91 | 1,00 | 0,00 | 4,00 | 1,08 | 1,13 | 1,17 |
| GC | 0,52 | 0,00 | 0,00 | 3,00 | 0,79 | 1,74 | 3,27 |
| MS | 7,83 | 8,00 | 3,00 | 11,00 | 2,55 | -0,38 | -1,10 |
| MG | 4,43 | 4,00 | 1,00 | 8,00 | 2,11 | 0,23 | -0,69 |
| GS | 9,87 | 9,00 | 4,00 | 17,00 | 3,48 | 0,53 | 0,15 |
| OS | 18,83 | 19,00 | 13,00 | 24,00 | 3,45 | 0,02 | -1,09 |
| BL | 4,87 | 4,00 | 1,00 | 10,00 | 2,16 | 0,54 | 0,05 |
| STB | 5,96 | 5,00 | 2,00 | 13,00 | 3,04 | 0,66 | -0,34 |
| SWB | 2,61 | 3,00 | 0,00 | 4,00 | 1,27 | -0,78 | -0,34 |
| E | 10,96 | 11,00 | 6,00 | 17,00 | 3,35 | 0,22 | -0,94 |
| LB | 11,22 | 11,00 | 4,00 | 18,00 | 3,92 | 0,19 | -0,67 |

**Legend:** TS - total number of shots, SE - shots in a situation with an equal number of opposing players, GE - goals in a situation with an equal number of opposing players, SF - shots from foul, F - goals from foul, TP - number of penalties, GP -goals from the penalties, SC - shots from the counterattack, GC - goals from the counterattack, MS - man-up shots, MG - man-up goals, GS - goalkeeper shot save, OS - opponent's shots on goal, BL - blocks, STB - stolen balls, SWB - swimming for the ball, E – exclusions, LB - lost balls

***Table 2:*** *arithmetic mean (AM), median (MED), minimum score (MIN), maximum score (MAX), standard deviation (SD), skewness (SK) and kurtosis (KUR) for the variables of situational efficiency of the defeated teams*

| VAR | AS | MED | MIN | MAX | SD | SK | KUR |
|---|---|---|---|---|---|---|---|
| TS | 31,26 | 31,00 | 24,00 | 37,00 | 3,40 | -0,37 | -0,24 |
| SE | 21,61 | 23,00 | 14,00 | 29,00 | 4,44 | -0,23 | -1,03 |
| GE | 4,91 | 4,00 | 2,00 | 11,00 | 2,70 | 0,88 | -0,15 |
| SF | 0,48 | 0,00 | 0,00 | 2,00 | 0,67 | 1,10 | 0,19 |
| GF | 0,04 | 0,00 | 0,00 | 1,00 | 0,21 | 4,80 | 23,00 |
| TP | 0,91 | 1,00 | 0,00 | 4,00 | 1,16 | 1,70 | 2,76 |
| GP | 0,78 | 1,00 | 0,00 | 4,00 | 1,00 | 1,68 | 3,64 |
| SC | 0,26 | 0,00 | 0,00 | 2,00 | 0,54 | 2,06 | 3,82 |
| GC | 0,09 | 0,00 | 0,00 | 1,00 | 0,29 | 3,14 | 8,61 |
| MS | 8,00 | 8,00 | 3,00 | 13,00 | 2,84 | 0,36 | -0,60 |
| MG | 3,13 | 3,00 | 1,00 | 5,00 | 1,32 | 0,13 | -1,21 |
| GS | 7,91 | 8,00 | 3,00 | 13,00 | 2,68 | 0,21 | -0,70 |
| OS | 21,04 | 19,00 | 17,00 | 27,00 | 3,35 | 0,69 | -1,02 |
| BL | 3,00 | 3,00 | 0,00 | 7,00 | 1,81 | 0,15 | 0,09 |
| STB | 5,83 | 6,00 | 2,00 | 12,00 | 2,55 | 0,84 | 0,85 |
| SWB | 1,39 | 1,00 | 0,00 | 4,00 | 1,27 | 0,78 | -0,34 |
| E | 10,22 | 11,00 | 4,00 | 16,00 | 3,23 | 0,10 | -0,37 |
| LB | 10,57 | 11,00 | 6,00 | 16,00 | 2,83 | 0,20 | -0,61 |

**Legend:** TS - total number of shots, SE - shots in a situation with an equal number of opposing players, GE - goals in a situation with an equal number of opposing players, SF - shots from foul GF - goals from foul, TP - number of penalties, GP - goals from the penalties, SC - shots from the counterattack, GC - goals from the counterattack, MS - man-up shots, MG - man-up goals, GS - goalkeeper shot save, OS - opponent's shots on goal, BL - blocks, STB - stolen balls, SWB - swimming for the ball, E – exclusions, LB - lost balls

**Table 3:** T-test for independent samples (AS DEF -arithmetic mean of defeated women's teams; AS WIN -arithmetic mean of winning women's teams; tvalue-t value; p-level of significance)

| VAR | AS DEF | AS WIN | t value | p |
|---|---|---|---|---|
| TS | 31,26 | 29,78 | 1,24 | 0,22 |
| SE | 21,61 | 19,65 | 1,33 | 0,19 |
| GE | 4,91 | 7,39 | -3,20 | 0,00 |
| SF | 0,48 | 0,57 | -0,40 | 0,69 |
| GF | 0,04 | 0,13 | -1,04 | 0,31 |
| TP | 0,91 | 0,83 | 0,27 | 0,79 |
| GP | 0,78 | 0,65 | 0,45 | 0,66 |
| SC | 0,26 | 0,91 | -2,58 | 0,01 |
| GC | 0,09 | 0,52 | -2,48 | 0,02 |
| MS | 8,00 | 7,83 | 0,22 | 0,83 |
| MG | 3,13 | 4,43 | -2,51 | 0,02 |
| GS | 7,91 | 9,87 | -2,14 | 0,04 |
| OS | 21,04 | 18,83 | 2,21 | 0,03 |
| BL | 3,00 | 4,87 | -3,18 | 0,00 |
| STB | 5,83 | 5,96 | -0,16 | 0,88 |
| SWB | 1,39 | 2,61 | -3,25 | 0,00 |
| E | 10,22 | 10,96 | -0,76 | 0,45 |
| LB | 10,57 | 11,22 | -0,65 | 0,52 |

**Legend:** TS - total number of shots, SE - shots in a situation with an equal number of opposing players, GE - goals in a situation with an equal number of opposing players, SF - shots from foul GF - goals from foul, TP - number of penalties, GP - goals from the penalties, SC - shots from the counterattack, GC - goals from the counterattack, MS - man-up shots, MG - man-up goals, GS - goalkeeper shot save, OS - opponent's shots on goal, BL - blocks, STB - stolen balls, SWB - swimming for the ball, E – exclusions, LB - lost balls

According to the results from Tables 1 and 2, we can conclude that the arithmetic means of the winning and defeated women's teams are quite equal in the following variables of statistical efficiency: man-up shots (AM 7.83; AM 8.00), shots from foul (AM 0.57; AM 0.48), number of penalties (AM 0.83; AM 0.91), stolen balls (AM 5.96; AM 5.83), the total number of shots (AM 29.78; AM 31.26), shots in a situation with an equal number of opposing players (AM 19.65; AM 21.61), goals from fouls (AM 0.13; AM 0.04), goals from penalties (AM 0.65; AM 0.78) and lost balls (AS 11.22; AS 10.57) and exclusions (AM 10.96; AM 10.22). Significant differences were observed in the variables: goals in a situation with an equal number of opposing players(AM 7.39; AM 4.91), shots from the counterattack (AM 0.91; AM 0.26), goals from the counterattack (AM 0.52; AM 0.09), man-up goals (AM 4.43; AM 3.13), goalkeeper shot saves (AM 9.87; AM 7.91), opponent's shots on goal (AM 18.83; AM 21.04), blocks (AM 4.87; AM 3.00) and swimming for the ball (AM 2.61; AM 1.39).

In women's water polo, the winning and losing teams differ statistically significantly in eight situational variables: goals in a situation with an equal number of opposing players, shots from the counterattack, goals from the counterattack, man-up goals, goalkeeper shot save, opponent's shots on goal, blocks and swimming for the ball.

Statistically significant differences in swimming for the ball and shots from the counter attack between winning and losing teams can very likely be attributed to swimming superiority and the skill of timely counterattack. Swimming superiority also contributes to the preparation of a longer attack with an equal number of players. The dominance of winning teams in the realization with an equal number of players, man-up and counterattack situations probably stems from better skills in achieving optimal conditions in the preparation and implementation of all offensive actions (Hraste et al., 2008). The reasons for the superiority of the winning teams in the part of defensive actions can probably be found in better and more coordinated actions of all defensive players in blocking the ball, reducing the opponent's shots and goalkeeper shot saves (Hraste et al., 2010). This research confirms some previous research in differentiating top female water polo players according to match outcomes (Takagi et al.2005; Lupo et al., 2011).

## CONCLUSION

This research showed that the technical and tactical indicators of the top women’s water polo competitions vary in relation to the outcome of the match. The higher number of goals scored by the winning teams during the actions of an equal number of opposing players, counterattack and man-up suggests better skills in preparation and execution. Better indicators of winning teams in most defensive actions confirm their overall superiority. Notation analysis is a great tool for water polo coaches, fitness coaches and sports scientists to be aware of the real requirements of the game. These findings encourage coaches on the one hand to improve the player's skills in providing optimal conditions for the execution of shots and on the other hand to improve the ability to cover and guard the direct opponent who plays on multiple inside and perimeter playing positions on attack.

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# Influence of Motor Skills and Morphological Characteristics on Success in Kayak

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## ABSTRACT

The aim of this research is to determine whether there is an influence of morphological characteristics and motor skills on the success of students in the 50-meter kayak sprint. It will be determined to what extent the result is influenced by morphological features and motor skills,and how important is the acquisition of knowledge of the basic techniques of paddling and managing a kayak, considering that all the respondents are beginners and encounter kayaking for the first time. The research was conducted on a sample of 74 respondents, which consistedof 27 female and 47 males 3rd year students of the Faculty of Kinesiology in Zagreb. The averageage of male students was 21.68 years old, and female students were 21.86 years old.

The predictor variables consisted of tests to determine morphological characteristics: body weight (mass), body height, fat percentage, and tests to determine motor abilities: figure eight with bending, backward polygon, steps to the side with a 360º turn, non-rhythmic drumming, leg drumming and hand drumming, Oreb's rhythm test, hand tapping, foot tapping, standing long jump, standing high jump. The criterion variable was a test for assessing success in kayaking - a 50-meter sprint. Regression analysis found that there is no significant influence of morphological characteristics and motor skills on the success in paddling a 50-meter kayak among beginners.

**Keywords:** *beginner, students, teaching, kayak*

## INTRODUCTION

Motor skills, according to Zatsiorski (2002), are those aspects of intensity (strength and speed) and extent (duration or number of repetitions) of motor activity that can be described by the same parameter system, measured and evaluated by an identical set of measures and in which analogous physiological, biochemical, morphological and biomechanical mechanisms work together. Motor skills describe actions that result in physical outcomes, the success and level ofmotor skills determine the quality of the final performance. Most actions in kayaking are a combination of two skills, motor skills (the ability to complete an action) and cognitive skills (the ability to judge when and how to complete an action).

Morphological measures describe the structure of the body, that is, the somatotype characteristics of athletes. While in some sports morphological characteristics significantly influence success, in others, their influence is very small or negligible. Training can influence the development of muscle mass or the reduction of subcutaneous fat tissue, while some morphological characteristics such as the longitudinal and transvesical measurements of the skeleton, cannot be changed by any training. (Milanović, 2010).

The research available so far has mainly been conducted on Olympians, top athletes and people who actively engage in and train kayaking. Mainly anthropometric and physiological characteristics were measured. Previous research, which was conducted with

Olympic kayakers, showed that above-average height and weight in combination with an athletic build affects rowing results (Shapiro and Kearney, 1986). Likewise, according to Forbes (Forbes et al., 2009), motor skills, and especially upper body strength, is a good predictor of success in rowing.

Very few analyzes have been conducted on recreationalists and beginners, and this will definethe goal of this research. We will try to establish to what extent motor skills and morphological characteristics influence the performance in kayaking, and to what extent the acquisition of knowledge of rowing techniques and kayak management among beginners plays a role.

## METHODS

27 female and 47 male third year students of the University of Zagreb's Faculty of Kinesiology participated in the research. The average age of male students was 21.68 years old and female students was 21.86 years old. All respondents were beginners in kayaking.

Students were measured in:

1. morphological characteristics: weight (mass) of the body (ATT), height of the body(ATV), percentage of fat (%) – KG/FAT,
2. motor skills:
    a. coordination: figure eight with bending (MAGOSS), backward polygon(MREPOL), steps to the side with a 360º turn (MAGKUS360)
    b. realization of rhythmic structures: non-rhythmic drumming (MKRBUB), drumming with feet and hands (MKRBNR), Oreb's rhythm test (OREBMR)
    c. movement frequency: hand tapping (MBFTAP), foot tapping (MBFTAN)
    d. explosive strength: standing long jump (MFESDM), standing high jump(MFESVM)

The aforementioned measurements of the predictor variables, that is, the morphological characteristics of the students were carried out in the laboratory of the Faculty of Kinesiology in Zagreb, while the tests for assessing motor skills were held in the halls of the faculty.

The test for assessing success in kayaking, the 50-meter sprint, is a criterion variable measured at regular water sports classes in the Korčula waters near the island of Badija in the academic year 2015 / 2016. Students underwent six-day instruction in kayaking for a total of 9 hours, and on the seventh day, the survey was conducted. The subjects rowed to a mark (buoy) placed 50 meters from the starting position. All respondents had approximately the same conditions: the sea was completely calm, the test took place in the morning and the wind speed did not exceed 3 knots. Time was measured with a stopwatch, where a shorter time needed to cover a given distance indicated a better result.

Data processing was done using the Statistica 12 programming language, in which descriptive,correlation and regression analysis was performed in accordance with the research objective. The difference between the predictor set of variables and each individual criterion was analyzedby multiple regression analysis, using the forward stepwise method.

## RESULTS

The metric characteristics of the tests for the assessment of motor skills were taken from Vlašić(2010). By grouping the tests according to the abilities that are evaluated, the following resultswere obtained:

### *Analysis of assessment of motor coordination ability*

The results of the descriptive parameters of the particle to particle motor coordination tests are slightly improved due to the process of learning - which is the characteristic of the coordination

tests. For the figure of eight with bending (MAGOSS) and side steps (MAGKUS) tests, the results of the examinees tend to be scattered, which is not the case for the other two coordination tests, the backward polygon (MREPOL) and side steps with a 360° turn (KUS360). The results of the Kolmogorov-Smirnov test of normality of distribution (p>0.20) indicate a normal distribution of the coordination assessment tests.

*Table 1: Metric characteristics of motor tests for assessment of coordination.*

| TEST | AVR | alpha | psi | lambda1 | beta | tau | rho | H1 |
|---|---|---|---|---|---|---|---|---|
| **Magoss1** | | | | | | | | 0.90 |
| **Magoss2** | | | | | | | | 0.97 |
| **Magoss3** | | | | | | | | 0.94 |
| **MAGOSS** | 0.93 | 0.93 | 0.97 | 0.62 | 0.93 | 0.87 | 0.94 | |
| **Mrepol1** | | | | | | | | 0.93 |
| **Mrepol2** | | | | | | | | 0.94 |
| **Mrepol3** | | | | | | | | 0.91 |
| **MREPOL** | 0.92 | 0.92 | 0.95 | 0.61 | 0.92 | 0.79 | 0.89 | |
| **Magkus1** | | | | | | | | 0.94 |
| **Magkus2** | | | | | | | | 0.97 |
| **Magkus3** | | | | | | | | 0.95 |
| **MAGKUS** | 0.95 | 0.95 | 0.98 | 0.64 | 0.95 | 0.88 | 0.94 | |
| **kus3601** | | | | | | | | 0.94 |
| **Kus3602** | | | | | | | | 0.96 |
| **Kus3603** | | | | | | | | 0.93 |
| **KUS360** | 0.94 | 0.94 | 0.97 | 0.63 | 0.94 | 0.84 | 0.92 | |

AVR-average correlation between particles; alpha-Cronbach reliability coefficient; psi- representativeness of the test; lambda1- test reliability based on the first principal component in the Guttman metric; beta-reliability of the first principal component; tau-reliability test based on the first principal component in image metrics; rho-reliability of the test based on the first principal component in the Harris metric; H1-correlation of particles with the first principal component of the measurement.

The values of the average correlations between measurement particles (AVR) as well as the values of correlations of particles with the first main component of measurement (H1) for all 4 coordination tests are extremely high, which confirms the common object of measurement for all particles of individual tests. The same is visible in the measure of representativeness (psi). Cronbach's reliability coefficient of all tests for coordination assessment is higher than 0.92 despite slightly lower reliability coefficients in the Guttman metric (lambda1).

*Analysis of assessment of motor ability of rhythmic structures*

The values of the distribution coefficients indicate a slightly positively asymmetric distributionof the results, that is, the grouping of the results of the respondents with slightly worse results.At the same time, it is necessary to observe the homogeneity of the results of the examinees inthe foot and hand drumming test (MKRBNR), which is not the case in the other two tests. It isalso necessary to emphasize that the distribution of the results of any test does not deviate statistically significantly from the normal distribution (p>0.20).

*Table 2: Metric characteristics of motor tests for evaluating the realization of rhythmicstructures.*

| TEST | AVR | alpha | psi | lambda1 | beta | tau | rho | H1 |
|---|---|---|---|---|---|---|---|---|

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Mkrbub1** | | | | | | | | 0.91 |
| **Mkrbub2** | | | | | | | | 0.92 |
| **Mkrbub3** | | | | | | | | 0.85 |
| **MKRBUB** | 0.87 | 0.87 | 0.90 | 0.58 | 0.87 | 0.70 | 0.84 | |
| **Mkrbnr1** | | | | | | | | 0.89 |
| **Mkrbnr2** | | | | | | | | 0.94 |
| **Mkrbnr3** | | | | | | | | 0.93 |
| **MKRBNR** | 0.91 | 0.91 | 0.94 | 0.61 | 0.91 | 0.78 | 0.89 | |
| **Orebmr1** | | | | | | | | 0.91 |
| **Orebmr2** | | | | | | | | 0.95 |
| **Orebmr3** | | | | | | | | 0.93 |
| **OREBMR** | 0.92 | 0.92 | 0.95 | 0.62 | 0.92 | 0.80 | 0.90 | |

AVR-average correlation between particles; alpha-Cronbach reliability coefficient; psi- representativeness of the test; lambda1-test reliability based on the first principal component in the Guttman metric; beta-reliability of the first principal component; tau-reliability test based on the first principal component in image metrics; rho-reliability of the test based on the first principal component in the Harris metric; H1-correlation of particles with the first principal component of the measurement.

A look at table 2 shows high values of average correlations between measurement particles (AVR) and correlation of particles with the first main measurement component (H1) of the tests that assessed the realization of rhythmic structures, thus confirming the common object of measurement for all particles of individual tests. The test representativeness measure (psi) for all three tests is greater than 0.90. Cronbach's reliability coefficient is slightly lower in the non- rhythmic drumming test (MKRBUB) 0.87 (alpha), but the fact that the reliability is still at a satisfactory level is indicated by the fact that some authors in their research obtained slightly lower values of the coefficient of that test (0.72; Hošek, Horga, Viskić, Metikoš, Gredelj, Marčelja, 1973). The values of other reliability measures are also high.

*Analysis of the motor ability of movement frequency*

The distribution of results in tests for assessing the motor ability of movement frequency indicates a slightly negatively asymmetric distribution (-2.20 MBFTAP and -0.78 MBFTAN, Skew), i.e. an accumulation of results at slightly higher values and a homogeneous sample of respondents. The results of the Kolmogorov-Smirnov test show that the distributions of both tests do not deviate statistically significantly from the normal distribution.

*Table 3: Metric characteristics of motor tests for assessing movement frequency.*

| TEST | AVR | alpha | psi | lambda1 | beta | tau | rho | H1 |
|---|---|---|---|---|---|---|---|---|
| **Mbftap1** | | | | | | | | 0.92 |
| **Mbftap2** | | | | | | | | 0.94 |
| **Mbftap3** | | | | | | | | 0.94 |
| **MBFTAP** | 0.93 | 0.93 | 0.95 | 0.62 | 0.93 | 0.80 | 0.89 | |
| **Mbftan1** | | | | | | | | 0.95 |
| **Mbftan2** | | | | | | | | 0.96 |
| **Mbftan3** | | | | | | | | 0.96 |
| **MBFTAN** | 0.95 | 0.95 | 0.98 | 0.64 | 0.95 | 0.87 | 0.93 | |

AVR-average correlation between particles; alpha-Cronbach reliability coefficient; psi- representativeness of the test; lambda1- test reliability based on the first principal component in the Guttman metric; beta-reliability of the first principal component; tau-reliability test based on the first principal component in image metrics; rho-reliability of the test based on the first principal component in the Harris metric; H1-correlation of particles with the first principal component of the measurement.

A look at the presented metric characteristics (table 3) of the motor tests for assessing movement frequency shows high values of average correlation between individual particles (AVR) and high values of reliability coefficients (alpha, lambda1, beta, tau and rho) in both tests. The representativeness measure values (0.95 MBFTAP and 0.98 MBFTAN, psi) and the particle correlation with the first principal component of the measurement are also high (0.92 to 0.94 MBFTAP and 0.95 to 0.96 MBFTAN, H1).

*Analysis of explosive power capabilities*

Arithmetic mean scores vary minimally from particle to particle in both explosive power motor ability tests. The distributions of the results are slightly positively asymmetric, that is, the results of the respondents are somewhat worse and scattered. The distributions do not deviate statistically significantly from the normal distribution.

*Table 4: Metric characteristics of motor tests for evaluation of explosive power.*

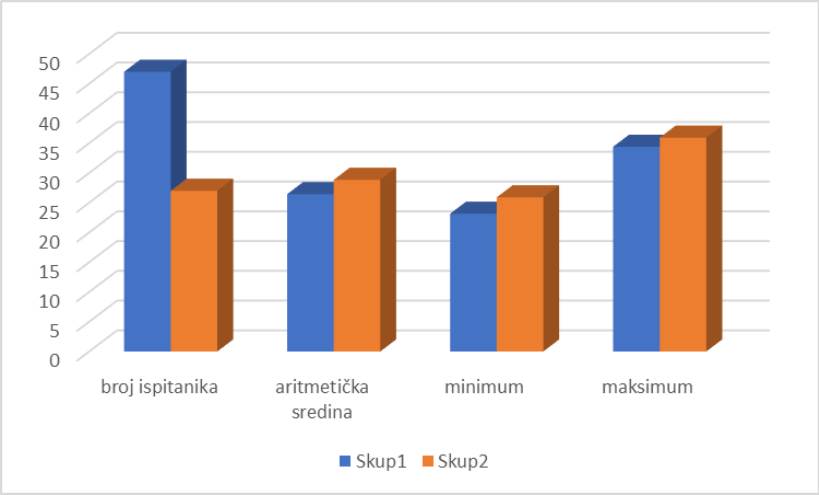
| TEST | AVR | alpha | psi | lambda1 | beta | tau | rho | H1 |
|---|---|---|---|---|---|---|---|---|
| **Mfesdm1** | | | | | | | | 0.98 |
| **Mfesdm2** | | | | | | | | 0.98 |
| **Mfesdm3** | | | | | | | | 0.95 |
| **MFESDM** | 0.97 | 0.97 | 0.99 | 0.65 | 0.97 | 0.93 | 0.97 | |
| **Mfesvm1** | | | | | | | | 0.98 |
| **Mfesvm2** | | | | | | | | 0.99 |
| **Mfesvm3** | | | | | | | | 0.99 |
| **MFESVM** | 0.99 | 0.99 | 1.00 | 0.66 | 0.99 | 0.96 | 0.98 | |

AVR-average correlation between particles; alpha-Cronbach reliability coefficient; psi- representativeness of the test; lambda1- test reliability based on the first principal component in the Guttman metric; beta-reliability of the first principal component; tau-reliability test based on the first principal component in image metrics; rho-reliability of the test based on the first principal component in the Harris metric; H1-correlation of particles with the first principal component of the measurement.

Analysis of the metric characteristics of the standing long jump (MFESDM) and standing high jump (MFESVM) tests revealed that the tests have high coefficients of reliability, representativeness and homogeneity.

Descriptive analysis of assessment of morphological characteristics, motor skills and success of students in kayaking shows a wide range of results in almost all motor tests.Huge differences were also observed in non-rhythmic drumming (MKRBUB) and drumming with feet and hands (MKRBNR). The smallest dispersion in the result is in the bending figure eight test (MAGOSS).

*Picture 1. Comparison of descriptive parameters of the criterion test - Kayak 50 m for maleand female students*




The minimum, i.e. the fastest test execution time for male students was 23.15 seconds, while for female students it was 25.90 seconds. The maximum, that is the slowest time to reach the goal, is 34.40 seconds for male students and 35.93 seconds for female students. Most of the other results are close if we consider the standard deviation (1.85) and arithmetic mean (26.43).The average time of all female students is 28.84 seconds. It should be emphasized that female students performed the test almost as well as male students, which means that physical strengthis not crucial in this test.

*Table 5: Regression analysis of motor skills and variable kayak 50m*

| | Male Students | | | | | Female Students | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | R=0.51 $R^2$=0.26 Adj.$R^2$=0.02 F=1.09 p<0.4 Std. pog. prog.=1.87 | | | | | R=0.67 R2=0.44 Adj.R2=0.33 F=3.97 p=0.00 Std. pog. prog.=5.97 | | | | |
| **Variable** | **B** | **Std. pog** | **Beta** | **t** | **p** | **B** | **Std. pog** | **Beta** | **t** | **p** |
| TAP | -0.29 | 0.21 | -0.11 | 0.08 | 0.18 | -0.27 | 0.40 | -0.12 | -0.66 | 0.52 |
| TAN | -0.11 | 0.23 | -0.10 | 0.23 | 0.65 | -0.23 | 0.28 | -0.27 | -0.82 | 0.43 |
| SDM | -0.12 | 0.27 | -0.01 | 0.02 | 0.66 | 0.18 | 0.53 | 0.03 | 0.35 | 0.74 |
| SVM | -0.13 | 0.31 | -0.04 | 0.09 | 0.67 | -0.05 | 0.55 | -0.02 | -0.09 | 0.93 |
| NB | -0.06 | 0.21 | -0.04 | 0.13 | 0.78 | 0.17 | 0.30 | 0.14 | 0.56 | 0.58 |
| BNR | 0.27 | 0.20 | 0.17 | 0.12 | 0.19 | -0.20 | 0.32 | -0.19 | -0.63 | 0.54 |
| MAGOSS | 0.19 | 0.23 | 0.33 | 0.40 | 0.41 | 0.02 | 0.38 | 0.05 | 0.06 | 0.95 |
| MAGKUS | 0.03 | 0.17 | 0.07 | 0.35 | 0.85 | 0.00 | 0.45 | 0.00 | 0.00 | 1.00 |
| POL | -0.14 | 0.22 | -0.24 | 0.38 | 0.53 | -0.17 | 0.37 | -0.29 | -0.47 | 0.65 |
| OREBMR | -0.20 | 0.24 | -0.58 | 0.70 | 0.41 | -0.02 | 0.33 | -0.07 | -0.06 | 0.95 |

R-coefficient of multiple correlation; R2-coefficient of determination of multiple correlation; Adj. R2-corrected coefficient of determination of multiple correlation; F-coefficient of multiple correlation with the number of degrees of freedom; p-level of significance of multiple correlation coefficients; Std. pog. prog.-standard error of the forecast; B-standard error of forecast; Std. pog.-standard error of the forecast; Beta-standardized (partial) regression coefficient; t-value of degrees of freedom when testing the significance of regression coefficients; p-level of significance of the regression coefficient.

Regression analysis of the predictor set of variables and success criteria in the 50 m kayak sprint did not establish a significant relationship. An insight into previous research has established that motor skills are an important factor in success in kayaking. Buljan (2015).

*Table 6: Regression analysis of morphological features and variable kayak 50m*

| | Male Students | | | | | Female Students | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | R=0.25 R2=0.62 Adj.R2=0.33 F=0.64 p<0.63 Std. pog. prog.=1.94 | | | | | R=0.3 R2=0.86 Adj.R2=0.33 F=0.5 p<0.74 Std. pog. prog.=2.15 | | | | |
| **Variable** | **B** | **Std. pog** | **Beta** | **t** | **p** | **B** | **Std. pog** | **Beta** | **t** | **p** |
| KG OF FATS | -0.80 | 1.43 | -0.40 | -0.56 | 0.58 | -2.36 | 1.99 | -1.44 | -1.18 | 0.25 |
| FAT PERCENTAGE | 0.63 | 1.14 | 0.34 | 0.55 | 0.59 | 1.23 | 1.35 | 0.66 | 0.91 | 0.37 |
| BODY HEIGHT | -0.03 | 0.31 | -0.01 | -0.09 | 0.93 | -0.29 | 0.41 | -0.10 | -0.70 | 0.49 |
| BODY WEIGHT | 0.47 | 0.60 | 0.09 | 0.79 | 0.43 | 1.41 | 1.06 | 0.43 | 1.34 | 0.20 |

R-coefficient of multiple correlation; R2-coefficient of determination of multiple correlation; Adj. R2-corrected coefficient of determination of multiple correlation; F-coefficient of multiple correlation with the number of degrees of freedom; p-level of significance of multiple correlation coefficients; Std. pog. prog. -standard error of the forecast; B-standard error of forecast; Std. pog.-standard error of the forecast; Beta-standardized (partial) regression coefficient; t-value of degrees of freedom when testing the significance of regression coefficients; p-level of significance of the regression coefficient.

Regression analysis of the predictor set of variables and success criteria in the 50 m kayak sprint did not establish a significant relationship. Although Hamano et al. (2015) determined the connection between morphological characteristics and success in kayaking, in here, this connection is not highlighted because the more important item was the rowing technique.

## DISCUSSION

In almost all 10 motor tests conducted on male and female students, the range of results is quite large. In the tests to assess coordination among male students, the smallest difference was in the figure of eight with bending, which we attribute to a somewhat simpler movement structure compared to the other two tests. In tests of explosive power, frequency of movement and realization of rhythmic structures, the range of results is extremely wide.

In the tests to assess the coordination of female students, there is also a relatively small difference in the range of results in the figure of eight test with bending, as well as in the Oreb rhythm test. The performance of female students in the tests is very similar to the performanceof male students, which means that the sample of respondents has above average motor skills or that female students simply approached the tests more professionally and seriously.

A comparison of rhythmic structures in male and female students shows rather small differences in the results. In non-rhythmic drumming, female students achieved better results. In the research of Vlašić (2010), a significant connection was established between tests of the realization of motor structures and success in performing social and folk dances, where femalestudents achieved better results. It can be concluded that female students are more successful inrhythm (and hearing) assessment tests.

In the percentage of body fat, the range between the lowest and the highest results is 15.3% for female students and 15.4% for male students. These results are interesting if you consider that women have been proven on average to have a higher percentage of fat than men (Blaak 2001). In this research, this did not come to the fore, and the results of the male and female population do not differ much. The differences in height between the smallest and largest measurement results are 28.8 cm for female students, and 35.1 cm for male students.

The results in the 50 m kayak sprint vary a lot, as in the previous tests for the assessment of motor skills and morphological characteristics. The difference between the best and worst results among male students was 11.25 seconds, where the best result was 23.15 seconds. For female students, the difference was 10.03 seconds, and the best result was 25.90 seconds. Given the equal conditions that the respondents had and the training they received, it would be expected that in such a short distance the results would be somewhat more even. The reason forthis is the level of adoption of the rowing technique.

Regression analysis of the predictor set of variables and success criteria in the sprint 50 m kayak did not establish a significant relationship, neither among male students nor among female students.

If we consider previous research where it was determined that morphological characteristics as well as motor skills influence the prediction of success in kayaking, it is interesting that similar results were not obtained in this research. Through their research, Shapiro and Kearney (1986) concluded that above average

height and weight combined with an athletic build are necessary for success in rowing. In the research carried outfor beginners, weight is an aggravating circumstance because with heavier students the kayak goes deeper into the water and offers more resistance.

The height of the respondents also did not come to the fore and taller students did not have better results, as is the case with Forbes and colleagues (2009), who conducted their research on top kayakers. Van Someren (2008) concludes that increasing the power by 1% increases the speed of the kayak by 0.33%. 500 m performance was predicted by measures of muscular strength and power and anaerobic capacity, which accounted for 79% of the variation in performance with an estimation error of 2.49 seconds (2.0%). It is difficult to transfer his conclusions to our novice respondents, who performed the test at a distance of only 50 meters where the rowing technique played a key role. Hamano et al. (2015) in their research found out that in kayakers the performance test was positively correlated with morphological features and motor skills. The reason why this research did not get the same results should be found in the fact that the mentioned research, unlike ours, was conducted on experienced kayakers and top athletes and Olympians. As the main reason why, they would state the level of adoption of therowing technique, for it is that which made the difference in the results of our respondents. Wecould say that the students who made fewer mistakes in those 50 meters were more successful.In the relatively short period that the students had to master the technique and familiarize themselves with kayaking, not all of them were equally successful, which resulted in the fact that physical predispositions and motor skills did not come to the fore to the extent they shouldhave done.

## CONCLUSION

With regard to the goal of the research, the regression analysis established that there is no statistically significant connection between the mentioned variables. Numerous studies have undoubtedly established a correlation between morphological characteristics and motor skills, and success in kayaking, but it should be noted that none of these studies were conducted on beginners, as is the case in ours. On the basis of previous research, it can be concluded that with further instruction and bringing all respondents to approximately the same level of adoption of rowing technique, morphological characteristics and motor skills would surely come to the foreas predictors of success.

In conclusion, this is the first study where such tests were used to assess the relationship between motor skills and kayaking performance in beginners. Although no significant correlation was found, we found out that rowing technique is more important than morphological features and motor skills for beginners, which means that kayaking, as a great physical activity, is available to everyone.

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# Kinesiological Activity of Students in Lower Classes of Elementary School

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## Abstract

The purpose of this paper was to determine quantity of kinesiological activity in children in lower classes at elementary school. The sample of respondents included 51 students, 21 girls and 30 boys. All students attend *Antunovac* elementary school. The sample was taken on students born in 2004, 2005 and 2006. Data were processed by descriptive statistics method. Cronbach reliability coefficient was calculated as well as average correlation among particles. The analysis proved reliability of survey and the connection with test-retest. Data have revealed a large quantity of kinesiological activity in children who play different sports, but, on the other hand, a large quantity of kinesiological inactivity among respondents. We may draw a conclusion that respondents play certain sports in their free time, but still there are a great number of children who spend most of their time sitting. These data are rather disturbing considering the fact that the children involved attend lower classes.

**Key words:** physical activity, children, activity survey.

## INTRODUCTION

Physical activity is defined as any body movement performed by the activation of skeleton muscles, resulting in energy consumption (Caspersen, Powell and Christenson, 1985). It has also been defined by World Health Organization (WHO). According to WHO, physical activity involves all movements, i.e. moving in everyday life, including work, leisure time and sport activities, and it is categorised according to the level of intensity from low to moderate and strong, i.e. high intensity (Pan American Health Organisation, 2002). Being a natural necessity, kinesiological activity represents a very important segment of human life. There are a large number of positive influences of kinesiological activity on health. Kinesiological activity may be defined as energy consumption achieved by repeating body movements with a certain purpose (Armstrong, 1993; Eaton and Yu, 1989). (Reilly et al. 2004) claimed that pre-school children have a low level of kinesiological activity and a high level of inactivity.

During physical activity, an organism undergoes a range of biochemical processes manifested both physically and mentally. Speaking of kinesiological activity, one must bear in mind that physical activity is manifested in a child's first steps. Further on, in contemporary life, especially with sedentary lifestyle, kinesiological activity should come first in order to preserve health and organism vitality. Implementation of regular and organized physical activity since early age contributes to body mass regulation, correct posture, positive influence on mental state by increasing physical condition and satisfaction with one's own appearance. By being involved in sport and physical activity, students acquire information on how to preserve and improve individual health and the health of their environment which makes them more capable of following and taking measures to develop

and improve their own personal characteristics, abilities, knowledge and achievements. Children aged 6 to 12 need physical activity in order to strengthen their skeleton, build up coordination, self-confidence and lay grounds for a healthy life in future. This period of life is also time when children have more control over their activity. American National Association for Sport and Physical Education considers every school child should have at least 60 minutes or more physical activity every day and avoid inactivity periods lasting for two hours or more. Nowadays, school systems where children have two or three classes of physical education a week are not sufficient for kinesiological development in children. Many authors consider the solution for this problem is in synergy of the parent-teacher relation, who should encourage children to play sport as much as possible. In contemporary society, health in children has been seriously harmed. Proofs may be found in various scientific papers written by Croatian or foreign authors. One of the crucial problems which cannot be avoided is obesity in the young and the main reason for it is sedentary behaviour (Andersen, 1999). Sedentary lifestyle is most frequently connected to watching TV on daily basis or to using computers and other IT tools. All of these questions the future of our children. Parents should give more attention to kinesiological raise of children. Nowadays there are numerous clubs and universal sport schools with programmes for different age groups in children. Additionally, there are sport pre-schools in Croatia which tend to develop an active lifestyle in children from their early age by making them like sports and leisure.

Kinesiological activity in children may be measured by: a pedometer, an accelerometer, movement sensors etc. or by surveys filled in by children themselves or their parents. We find these most applicable, at least in Croatia. The purpose of this paper was to determine the quantity of kinesiological activity in school children based on test-retest survey done by the children's parents.

## METHODS

A survey is a method used to collect data by questionnaires prepared in advance where respondents give their answers about the monitored characteristics of a statistical set.

Questionnaire used in this paper was written by Amanda Telford, Jo Salmon and David Crawford and we had the permission to use it.

The sample of respondents were 51 male and female students in lower classes in Antunovac elementary school, boys (n=30) and girls (n=21) born in 2004, 2005 and 2006. The survey was done by their parents, 39 mothers and 12 fathers, out of which 46 are married, 3 are divorced, 2 widowed, 45 are employed and 6 parents are unemployed.

The survey questionnaire consists of three sets of questions. On the first page, there are 21 questions related to the kinesiological activity in children, regarding their sport activity, following a typical week in a school year. The second page involved 4 questions related to kinesiological activity of children when travelling to school during a typical school week over the school year. On the third page, there are 15 questions about kinesiological activity of children regarding their free time over one week in a school year. The sample of test is enclosed in appendix. The test has 40 questions in total.

The first survey was conducted in April, 2015 at Antunovac elementary school. The survey was done in a way that teachers at the lower classes of elementary school handed it out to children who had to take it home for their parents to fill it in. The teacher clearly explained the purpose of the survey. The survey was filled in by children's parents who have regularly attended classes during the previous month. The other part of test-retest was conducted 9 days after the first test measuring, at a parents' meeting at school, where the parents have filled in the same

survey for the second time. Only valid surveys underwent further analyses of the experimental procedure, i.e. those surveys that were filled in both measurings of the test and retest and those which were filled in by the same parent twice. Out of 60 surveys, 51 were analysed in this paper, while the remaining ones were not analysed.

All data have been descriptively statistically processed. Arithmetic mean was calculated for each variable in addition to standard deviation and maximum and minimum of the variables, while KS test was used was description purposes. Multivariate statistical method was used to calculate test and retest reliability. Cronbach alpha reliability parameter was calculated for each variable as well as the average inter item correlation. Variance analysis was calculated by One-Way ANOVA statistical test to determine differences between variables based on the students' ages.

Statistical package Statistica for Windows ver. 7.0. was used in all data processing.

## RESULTS and DISCUSSION

Observing table 1 we may conclude the respondents spend their free time mostly playing football, cycling and playing on the playground. Football is an expected answer since the place they live in has two football clubs, unlike a basketball or a gymnastics club. Interestingly, they spend a lot of time doing chores (AS-81.68). This was expected since they live in a village, so we may assume they spend a lot of time helping parents in the garden. The respondents also spend a lot of time communicating verbally with their parents (AS 188.824, MIN 0.000-MAX 4.200), doing homework (AS 269.412, MIN 0.000-MAX 960.000), listening to music (AS 116.765, MIN 0.000-MAX 540.000) and they talk while sitting (AS 140.980, MIN 0.000-MAX 840.000). The most disturbing results in this table refer to other variables marked with 3, relating to the part of the survey about the free time, with no sport activity. Students spend too much time watching TV (AS 483.137, MIN 0.000-MAX 1560. 000) and on the internet (AS 157.647, MIN 0.000-MAX 840.000) which is evident from variable 3-TOTAL (AS 1779.804, MIN 0.000-MAX 5280. 000). Comparing the obtained results with other variables, we may draw a conclusion that the respondents spend their free time playing certain sports, but still a large number of children spend their free time in a sedentary style. This information is particularly alarming since students involved attends lower classes.

Elgar et al. (2005) have concluded that sedentary behaviour and the lack of activity in early adolescent age have an impact on body mass in further development. From their earliest age, children spontaneously show interest in moving, whether imitating activities they see around or by directly showing interest for a certain sport. Thus, taking them to game rooms or taking part in a sports practice, physical education at school, dancing classes or playing is what forms their lives. Parents should encourage their children to perform various activities and through physical exercise, consciously and responsibly influence physical and psychological health. Researches have shown that children taking part in physical exercise have a more balanced growth and maturity of all organ systems, particularly vascular, pulmonary and musculoskeletal systems (increase in muscular and skeleton mass as well as in vital capacities of heart and lungs). Further on, these children suffer less from chronic diseases caused by not moving and by unbalanced diet as well as from sleeping disorders. Apart from the impact on their health, exercising regularly brings positive impact on socio-emotional development. While playing, children make new friends, have a sense of belonging to society and empathy for others, they socialize and this is particularly important if they are an only child. By playing, they learn how to win and lose and how to handle these emotions.

***Table 1.*** *Descriptive results of energy consumption (arithmetic means AS, standard deviation SD, N-factor number), based on children's birth year (2004, 2005, 2006)*

| | | | MET1 | | MET2 | | MET3 | |
|---|---|---|---|---|---|---|---|---|
| | | | AS | SD | AS | SD | AS | SD |
| **GOD ROĐ** | 2004 | 19 | 291.82 | 163.82 | 13.81 | 17.73 | 81.59 | 63.53 |
| | 2005 | 26 | 238.61 | 238.61 | 13.81 | 17.07 | 71.51 | 52.09 |
| | 2006 | 6 | 317.042 | 317.04 | 14.64 | 12.45 | 54.65 | 49.59 |
| **TOTAL** | | 51 | 267.66 | 150.92 | 13.91 | 16.57 | 73.28 | 55.89 |

**Legend:** Level of factor-age, N-number of students, MET total 1 AS-arithmetic means, MET TOTAL 1 SD-standard deviation, MET total 2 AS-arithmetic mean, MET TOTAL 2 SD-standard deviation, MET TOTAL 3 AS-arithmetic means, MET TOTAL 3 SD-standard deviation

Table 1 reveals the greatest arithmetic mean of MET TOTAL 1 AS variable is found among students born in 2006 (AS 317,042). Students born in 2006 are the youngest respondents and according to this table their greatest energy consumption during the week is spent on sport activities. The same respondents have the greatest arithmetic mean in MET TOTAL 2 AS variable (AS 14.639). The respondents born in 2004 have the highest arithmetic mean in MET TOTAL 3 AS variable (AS 63.529). The oldest students spend most energy at home, i.e. while watching TV, playing on the computer or elsewhere indoors. Contemporary lifestyle has imposed that earning money, intellectual knowledge and fun is a priority in setting criteria for good living, while physical exercise, with the purpose of keeping good health, is considered a less important factor. Thus, insufficient physical activity is frequently justified with the lack of time.

***Table 2.*** *Univariant results, significance and test value of energy consumption, based on age.*

| | MET1 | | MET2 | | MET3 | |
|---|---|---|---|---|---|---|
| | F | p | F | p | F | p |
| **GODROĐ** | 1.05 | 0.36 | 0.01 | 0.99 | 0.55 | 0.58 |

**Legend**: MET TOTAL 1 F – test value, MET TOTAL 1 p-significance, MET TOTAL 2 F-test value, MET TOTAL 2 p-significance, MET TOTAL 3 F-test value, MET TOTAL 3 p-significance).

Variable MET TOTAL 1 p (0.358) has the smallest significance. Variable MET TOTAL 2 F (0,006) has the lowest test value, and variable MET TOTAL 1 F (1.049) has the highest test value.

It is crucial to invest far more in building sport objects for mass physical activity of general population, starting with school gyms and enabling everyday physical activity to children and teenagers. The habit of regular physical exercise should be acquired at a young age since, clearly, two lessons of Physical education a week are not enough to develop those. We should make more cycling and running paths, pools, hiking paths, outdoor playgrounds etc.

Due to the influence of contemporary times and all those circumstances it brings (stress, work, lack of time), we seem to look after our physical and biological health less than ever. The research has revealed the respondents do different sports, primarily football and cycling. It is a positive fact that respondents spend a lot of time doing chores, communicating verbally with their parents and teachers and fulfilling school tasks. What is discouraging is the amount of time they spend in front of the TV and other monitors, i.e. the period of the so-called kinesiological inactivity while surfing online and being indoors. The results have shown that the respondents spend most time indoors. In their free time, students spend more and more time doing activities not involving

any physical effort, while kinesiological activities are being neglected.

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# Differences in Motivation for Exercise Between High School Students of Different Ages

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## ABSTRACT

It is common knowledge that physical exercise is an important factor for a healthy lifestyle. It is important to understand what motivates young people to exercise and what is the difference between different age groups regarding exercise so that we can create tools for further physical activity. The aim of our paper would be to confirm differences and motivation tied to exercise between high school students of different ages. Our test sample involved 147 pupils (male and female) from the 1st and 4th classes off "Civil Engineering and Geodesy Technical School" and "Design, Graphics and Sustainable Civil Engineering School", 74 students were from the 1st class and 73 students from the 4th class. Variables, shown through 14 factors: weight management, health avoidance, revitalization, appearance, social recognition, stress management, health, strength and endurance, enjoyment, affiliation, health pressures, competing, nimbleness and challenge. The results show significant discrepancies from common findings so in order to confirm the differences we used the Kruskal–Wallis Test. Our conclusion demonstrated that there were significant differences between younger and older students tied to six motivational factors regarding physical exercise. The most significant differences were attached to health avoidance and revitalization favoured by older high school students. We can assume that older high school students have a higher level of responsibility towards their health than their younger colleagues. The final four significant factors (stress management, health, strength and endurance, nimbleness) also show a difference between older and younger students, which again favour the older group so we can confirm that younger students need to be more conscious of the importance of physical exercise for improved health. We can again assume that younger generation does not view physical health as a priority because they are preoccupied with social and other activities that are not tied to physical activity.

**Key words:** adolescents, EMI-2, factors, health, physical activity.

## INTRODUCTION

It is a well-known fact that exercise and physical activity are aspects essential for good and quality status in an individual. In the context of this paper, we have taken young people as representative individuals. It is extremely important for young people to be engaged in sports or to include some sort of physical activity into their life. Sedentary lifestyle is prevailing nowadays which is, to a certain degree, the result of technology development, thus going to a playground, for a walk or cycling are easily replaced by having a cup of coffee with a mobile in one's hand. Further on, hectic lifestyle and busy schedule lead to a wide selection of fast food and low-quality meals eaten on the go. Data reveal that 75% of adolescents do not follow present guidelines (60 minutes of moderate to intensive activity most of the days in a week) for activity (Fakhouri et al, 2012). All this

contributes to a non-quality health status in young people while trying to cope with various disorders and emotions resulting from their physical appearance. They are frequently unsatisfied, without any self-confidence, filled with the feeling of shame, feeling they are not self- sufficient or worth since they are e.g. overweight (or sometimes even underweight). We know that we should primarily focus on health, but at high school age, physical appearance also defines an individual and may create big issues. In this paper we are trying to understand how students are motivated and what kind of motivation makes high school students active or makes them do exercise or get engaged in some sort of physical activity. Engaging in physical exercise enables control of body mass and body composition, as well as greater endurance and preservation of functions, which increases the likelihood of long-term and regular physical activity (LaMonte, M. J., Nichaman, M. Z., & Blair, S. N. 2004). In adolescence, exercising influences even the skeleton system and lowers the risk of osteoporosis at an older age by increasing bone mass (Bailey and Martin, 1994), relieves depression, anxiety and stress and increases self-confidence (Calfas and Taylor, 1994).

It is important to know what makes young people exercise and what is the difference between males and females in this aspect in order to create tools to additionally stimulate physical activity, but at the same time to preventively influence certain disorders such as eating disorders, and to work on an individual's emotional stability as well. Motivation is a psychic process which stimulates mental or physical activities while affecting our behaviour from the inside. It gives explanation to why people decide to behave in a specific way at a specific moment (Barić, 2012).

Namely, children at pre-school and elementary school age are frequently engaged in sports meaning they actively play sports in a sport club, while being physically active in their free time as well. Thus, we already know for a fact that boys usually participate in football, handball or basketball training, while girls are mostly engaged in dancing, gymnastics, volleyball etc. Some children develop interest by themselves, some undergo parental influence and some are under peer influence. At adolescence age, when starting high school, many students leave sport trainings they were previously engaged at due to other priorities coming into their attention. A recent meta-analysis revealed this progressive decline in moderate to strong intensity exercising appears even before adolescence, starting in early and middle childhood (Farooq et al. 2020). Generally speaking, they become more interested in going out, hanging out with their friends in cafés and similar places and less in physical activity. Considering these are all young people who should primarily be focused on their health, followed by their physical appearance, psychological aspects etc, it is crucial to establish what motivates them to do any form of exercise. It can be going to a fitness club, cycling, hiking, playing different sports etc. High school age is the age when a person is completely formed and when an individual's character is finalised. Many aspects previously mentioned (insecurity, lack of confidence, shame, introversion, fear) resulting from unsatisfaction with one's own physical appearance and health status have a great impact on an individual's psychological status. It is thus important what may encourage young people to return to or make physical activity a part of their lifestyle.

The purpose of this paper is to establish differences in motivation for exercise between younger and older male and female students in high school.

## METHODS

*Sample of respondents*

The sample consists of 147 students of both sexes attending Civil Engineering and Geodesy

Technical High School in Split. Out of the total number of male and female students, 74 attend the first grade, while 73 male and female students attend the fourth grade. According to students attending lower or higher grades, we divided the sample in two groups: the younger one and the older one.

*Sample of variables*

Variables have been presented in 14 survey factors (weight management, health avoidance, revitalization, appearance, social recognition, stress management, positive health, strength, enjoyment, affiliation, health pressures, competition, nimbleness, challenge).

*Description of experimental procedure*

In this paper, Evaluation for training motivation survey - EMI-2 (Markland & Ingledew, 1997; Vlašić et al., 2002) was conducted as an experimental procedure. Survey was distributed to both male and female students at the Civil Engineering and Geodesy Technical High School in Split and they were given about ten minutes to fill it in. Before start, they were given short instructions on the purpose and aim of the research and it was stressed the survey is anonymous and they should be sincere. The students took the survey voluntarily.

*Data processing methods*

All data were processed by "Statistica" software program. We calculated descriptive statistics to obtain basic information: arithmetic mean, standard deviation, minimal and maximal results, coefficient of kurtosis and asymmetry distribution coefficient, Kolmogorov- Smirnova test and so on. Further on, we did Mann-Whitney U test to establish in a non-parametrical way the differences between younger and older respondents in applied variables which assess motivation for physical exercise.

## RESULTS and DISCUSSION

Table 1 presents descriptive statistics results. We calculated basic statistic parameters: arithmetic mean, standard deviation, minimal and maximal results in addition to parameters which we use to assess distribution normality Skewness and Kurtosis and also Kolmogorov-Smirnova test. Data have shown that distribution in most variables is not normal which is expected since this was a survey with answers in form of marks from 0 to 5.
These results are important because of the forthcoming statistical methods since they revealed it is necessary to use non-parametrical statistic methods in processing them.

*Table 1. Basic statistic parameters (N=147)*

| *Variables* | *AM* | *MIN* | *MAX* | *SD* | *SKEW* | *KURT* | *MAXD* | *K-S* |
|---|---|---|---|---|---|---|---|---|
| *1 Weight management* | *3,34* | *0,25* | *5,00* | *1,26* | *-0,27* | *-0,91* | *0,10* | *p < ,10* |
| *2 Health avoidance* | *3,42* | *0,00* | *5,00* | *1,27* | *-0,82* | *0,26* | *0,12* | *p < ,05* |
| *3 Revitalization* | *4,12* | *0,67* | *5,00* | *0,98* | *-1,27* | *1,29* | *0,19* | *p < ,01* |
| *4 Appearance* | *3,59* | *0,75* | *5,00* | *1,03* | *-0,70* | *0,02* | *0,17* | *p < ,01* |
| *5 Social recognition* | *2,35* | *0,00* | *5,00* | *1,42* | *0,11* | *-0,89* | *0,07* | *p > .20* |
| *6 Stress management* | *3,31* | *0,00* | *5,00* | *1,41* | *-0,74* | *-0,38* | *0,13* | *p < ,05* |
| *7 Positive health* | *4,27* | *0,00* | *5,00* | *0,97* | *-1,88* | *4,05* | *0,23* | *p < ,01* |
| *8 Strength / endurance* | *4,40* | *1,75* | *5,00* | *0,78* | *-1,62* | *2,25* | *0,22* | *p < ,01* |
| *9 Enjoyment* | *3,51* | *0,00* | *5,00* | *1,37* | *-0,76* | *-0,34* | *0,15* | *p < ,01* |
| *10 Affiliation* | *2,34* | *0,00* | *5,00* | *1,52* | *0,04* | *-1,10* | *0,09* | *p < ,20* |
| *11Health pressure* | *1,46* | *0,00* | *5,00* | *1,36* | *0,80* | *-0,02* | *0,14* | *p < ,01* |
| *12 Competition* | *2,72* | *0,00* | *5,00* | *1,66* | *-0,12* | *-1,34* | *0,11* | *p < ,05* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *13 Nimbleness* | *3,74* | *0,33* | *5,00* | *1,15* | *-0,77* | *-0,20* | *0,15* | *p < ,01* |
| *14 Challenge* | *3,81* | *0,75* | *5,00* | *1,01* | *-0,63* | *-0,34* | *0,12* | *p < ,05* |

Additionally, observing the total sample of younger and older respondents in the previous table, where, on average, the highest marks were given to strength/endurance, positive health and revitalization variables. Such marked variables reveal that high school students, regardless of their age, recognize the importance of physical exercise when their health status is considered which is an essential information. However, the primary aim of the paper was to establish what motivation factors for exercise are recognized by high school students depending on their age, thus we can observe these data in table 2.

The mentioned table presents the analysed answers to questions on motivation for playing sports in a way we calculated differences between younger high school students compared to the older ones. It is evident that sample differentiates in six applied variables. These are all variables referring to disease prevention, revitalization, stress management, positive health, strength/endurance and nimbleness. By a more thorough insight into given variables, we may conclude that all six variables refer to the motives related to an individual's complete health status.

*Table 2. Analyses of differences between younger and older respondents in motivation for playing sports*

| ***Variables*** | ***AM*** | | ***Z*** | ***p*** |
|---|---|---|---|---|
| | ***Younger (N=74)*** | ***Older (N= 73)*** | | |
| *1 Weight management* | *3,19* | *3,49* | *-1,25* | *0,21* |
| *2 Health avoidance* | *3,02* | *3,83* | *-3,88* | *0,00* |
| *3 Revitalization* | *3,88* | *4,37* | *-3,50* | *0,00* |
| *4 Appearance* | *3,54* | *3,64* | *-0,63* | *0,53* |
| *5 Social recognition* | *2,49* | *2,20* | *1,24* | *0,22* |
| *6 Stress management* | *3,02* | *3,60* | *-2,25* | *0,02* |
| *7 Positive health* | *4,05* | *4,50* | *-2,90* | *0,00* |
| *8 Strength/endurance* | *4,32* | *4,49* | *-2,11* | *0,03* |
| *9 Enjoyment* | *3,31* | *3,72* | *-1,90* | *0,06* |
| *10 Affiliation* | *2,45* | *2,23* | *0,93* | *0,35* |
| *11 Health pressure* | *1,42* | *1,51* | *-0,91* | *0,36* |
| *12 Competition* | *2,93* | *2,52* | *1,48* | *0,14* |
| *13 Nimbleness* | *3,55* | *3,94* | *-2,02* | *0,04* |
| *14 Challenge* | *3,70* | *3,92* | *-1,27* | *0,20* |

Results reveal that in all six variables older respondents show more motivation than the younger ones which leads to a conclusion that older high school students show they care more about health than the younger ones. Previous researches revealed that as the respondents get older, the more their motivation for exercise is related to improving their health status. The assumption is, as we get older, we become more aware of the fact that by getting older one

loses his/her functionality and thus we need exercise to keep our abilities on a high level as long as possible, which eventually results in a better individual's health status. In high school students, it seems older respondents are becoming more mature and more aware of these facts, while younger respondents, mostly first graders in high school, give more attention to hanging out and do not consider the importance of physical exercise that much.

It is interesting that lowest results are evident from answers to the questions on health pressure in all of the respondents, regardless of their age. It reveals that young people at high school age do not prefer being engaged in a physical activity under some sort of guided exercises regime. We may assume that the young have a free spirit and do not like exercise in the aspect of someone controlling their training process and that such aspect of exercise evidently has a non-motivating impact.

## CONCLUSION

From all stated above we may conclude that high school students are generally well informed about the importance of physical exercise regarding health since factors with highest values of answers are exactly those relating to health, revitalization, disease prevention followed by strength and endurance. The purpose of paper was to determine if there are any differences between younger and older high school students in their choice of answers related to motivation factors in physical exercise. It has been established there are some differences in favour of older respondents, primarily in previously mentioned factors. Thus, the set hypothesis $H_1$ has been accepted and it says there is a significant difference in motivation for exercise between younger and older male or female high school students.

The obtained results reveal all high school students, regardless of their age, dislike health pressure meaning their motive is neither being engaged in a physical activity under certain supervision nor affiliation to an exercise group. Further on, it is evident older male and female students care more about their health than the younger ones since their motives for exercise are directed primarily towards that. Reasons may differ so future researches should involve more precise samples, study the relation according to sex and include in surveys additional circumstances that have impact on high school students at this age. For instance, we should study what the health status in high school students of both ages is and what they do in their free time, if they have been educated on the importance of physical exercise regarding their health, if they are obese and what their motor and functional abilities are like. Such information would help in understanding the established differences in motivation for physical exercise between two sub-samples of high school students of different ages. It is absolutely necessary to make younger high school students even more aware of the importance of physical exercise in health.

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# Difference in general nutrition and sports nutrition knowledge between Croatian and Swiss young water sports athletes

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## ABSTRACT

Nutrition knowledge is a key factor to establishing proper dietary habits which is closely connected to sports performance. The aim of this research was to assess the knowledge of Croatian and Swiss young athletes that practice water sports (sailing and water polo) and compare them. Total of 80 participants completed online survey about general nutrition knowledge and sports nutrition knowledge. The average age of the participants was 15 +/- 1,17 years, all adolescents who are still learning and shaping their dietary patterns. Knowledge of said athletes was insufficient with very low percentage of correct answers (59,5% for Croatian athletes and 45,1% for Swiss athletes). This low rate we can ascribe to their age and not enough experience with food. Overall Croatian athletes had better knowledge than Swiss athletes, male population had better scores as well as the recreative athletes, which was surprising considering they have been practicing said sports less than 3 years. A nutritional educational plan should be developed and implemented to teach young generation of athletes the importance of food selection and healthy diet on sports results.

**Keywords:** dietary habits, protein, carbohydrates, fats, adolescents.

## INTRODUCTION

Nutrition in sport is becoming more and more recognized as a big part of athlete's performance and success. Athletes need to understand and implement good nutrition habits in order to optimize health and sport results (Trabucco et al., 2013). Optimal nutrition is key to enhanced performance and recovery (ACSM, 2009). Nevertheless, there are numerous barriers to proper nutrition, and one of them is poor nutrition knowledge (Bonci et al., 2008). Dietary practices and knowledge of young elite Swiss athletes is badly researched (Colombani et al., 2001), as well as the knowledge of young Croatian athletes in water sports. The point of this research was to collect data in nutrition knowledge in Croatian and Swiss young (14-17) athletes practicing in water sports and to compare it based on national differences, sex differences and competitive level. Nutrition knowledge is tightly connected with dietary habits, and increases in overall knowledge should lead to improved dietary intake, better health for athletes, and enhanced sports performance (Spronk et al., 2015).

## METHODS

This research was carried out by 21 Croatian, and 39 Swiss water sport athletes. Participants completed a questionnaire in Google Forms. The questions used in this questionnaire were taken from the validated questionnaires of Parmenter and Wardle (1999) and Blennerhassett et al. (2018) with the modification according to Šatalić et al. (2016). In the questionnaire, we decided on a closed answer type. Data processing was carried out using a Microsoft Excel program. Descriptive statistics such as means, frequencies and

percentage values of individual variables were calculated. The questionnaire consisted of two parts. The first part comprised socio-demographic questions, and the second part of the questionnaire referred to general knowledge about nutrition and sports nutrition. Anthropometric measurements weren't performed with this group of subjects.

## RESULTS

A total of 60 athletes completed this questionnaire (n(Croatian)=21; n(Swiss)=39), and all of them practicing water sports (sailing and water polo). The respondents mean age was 15 +/- 1,17 years.

***Table 1.*** *Characteristics of the participants*

| | Total (n) | Female (n) | Male (n) | Recreative (n) | Competitive (n) |
|---|---|---|---|---|---|
| Croatian | 21 | 8 | 13 | 6 | 15 |
| Swiss | 39 | 18 | 21 | 5 | 39 |

Total percentage of correct answers of this survey (both for Croatian and Swiss population) is presented in Table 2.

Questions one, three and five relate to macronutrients in food, specifically are certain foods rich or low in protein, carbohydrates and fats. The participants could also mark „I don't know“ as an answer. From what we gathered, Croatian athletes had better knowledge in these topics and total of correct answers around 70%, while Swiss athletes had worse results (total amount of correct answers around 55%).

The second question, "Which fats are recommended to be taken in small amounts?" referred to the reduced intake of saturated fatty acids, and how a diet should highlight intake of monounsaturated and polyunsaturated fatty acids, and restrict intake of saturated fats. Croatian athletes had more correct answers (67%) with more correct answers from female (77%) and recreative (95%) population. Swiss athletes had very low percentage of correct answers, only 28% which were distributed almost equally through the populations.

Fourth question was related to the agreement with these statements: "Whole milk contains more protein than skim milk", "Whole milk contains more calcium than skim milk" and "Flax seeds, chia seeds, and walnuts are a good source of omega 3 fatty acids". Once again, Croatian athletes had higher percentage of correct answers (56%) in regard to Swiss athletes (27%). Surprisingly low amount of male and competitive Swiss athletes had correct answers in this question (21% and 26%).

In questions regarding sports nutrition overall percentages were a little bit better in Swiss athletes.

The statements in the next question were related to sports performance: "Negative impact on sports performance is observed when body mass is reduced by more than 2%", "Water is useful for quenching thirst, but sometimes it is not the most effective way of rehydration" and "Too high concentration of carbohydrates in sports drinks (8-10%) can cause gastrointestinal disturbances and slow down the emptying of the stomach". Overall Croatian athletes had better scores, but still percentages were lower than 60%, Croatian male athletes were the only ones with higher score (67% of correct answers).

In terms of questioning timeframe of their food intake after workout, next question read: „Postponing the intake of protein and carbohydrates for 1 h after the TA, instead of the intake at the end of the activity, can have negative effects on some immune parameters?“. In this question dominated the answers of recreative Croatian athletes, which was surprising considering they have

been practicing said sports less than 3 years. This was the first question where Swiss athletes had more correct answers in one subgroup (Swiss male athletes had more correct answers than Croatian male athletes).
Relaying on previous question we wanted to check how many of them knew that optimal timeframe for nutrient intake is within an hour after workout. Croatian athletes (especially male) had surprisingly high amount of correct answers, and once again Swiss athletes showed very poor knowledge in sports nutrition and the importance of food intake at specific time.
First question where Swiss athletes completely dominated Croatian athletes regarded the „snack“ if sugar levels drop during the workout. Croatian athletes had only 1 correct answer out of 21 whereas Swiss athletes had 19 correct answers (49%).
We examined the composition of sports drinks which are often consumed by young athletes thinking they have some superpower in them. Croatian athletes had more correct answers overall (81%) than Swiss athletes (59%).
Last question related to the amount of protein that should be ingested after workout. Most respondents chose "0.4 g of protein/kg of body weight" as the correct answer, which was a common confusion because protein intake in books is expressed as g protein/kg body fat. Here, we aimed at 20 g protein after a workout for optimal muscle hypertrophy. In Croatian athletes only 2 participants answered correctly, and in Swiss participants 4, which translates both to 10% of all correct answers. This wasn't a surprising result considering the formulation of the question.

## DISCUSSION

Young athletes' knowledge is not sufficient, at all, but general nutrition knowledge in athletes is lower than expected in other studies as well (Spronk et al., 2015; Heikkila et al., 2017). From what we can gather here is that knowledge about food composition (macronutrients and micronutrients) is very low, almost non-existing. Knowledge in proteins and carbohydrates is a little bit better in both groups but still not enough. Considering they are still young people who are shaping their eating habits and learning about nutrition, we can't say that we didn't expect this result. Croatian athletes showed better in almost all of the subjects in question, except for one: bigger percentage of Swiss athletes knew that milk is better for low sugar levels in workout instead of breakfast cookies. Milk is full of minerals and vitamins, as well as proteins. Low fat milk can actually help with glycogen repair, helps with muscle protein synthesis, and is effective as a rehydration drink (Shirreffs et al., 2007). What out athletes failed to recognize is the importance of food intake in a certain timeframe after a workout for muscle repair and recovery. Protein intake after workout helps with energy production and can easy muscle pain (Communications, 2016). The intake saturated fats should be <10% of total calorie intake (in some studies even <7%), and that percentage in modern diet is usually 12-18% kcal. In this research athletes failed to recognize that saturated fatty acids should be limited in our diet (Kaur et al., 2020). Unlike other studies (Heikkila et al., 2017) male population had higher percentage of correct answers overall, and to our surprise, recreative athletes had more correct answers than competitive ones. Nutrition knowledge is positivly associated with better diet quality (Spronk et. al., 2015), and therefore nutrition habits of our participants may not be adequate, but that wasn't the objective of this research.

| Table 2. Correct answers | % all answers (Croatia) | % all answers (Switzerland) | % Female (Croatia) | % Female (Swiss) | % Male (Croatia) | % Male (Swiss) | % Recreative (Croatia) | % Recreative (Swiss) | % Competitive (Croatia) | % Competitive (Swiss) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | **76** | **56** | **73** | **39** | **78** | **67** | **75** | **40** | **77** | **59** |
| 2. | **67** | **28** | **50** | **11** | **77** | **43** | **83** | **20** | **60** | **29** |
| 3. | **74** | **63** | **77** | **56** | **73** | **55** | **95** | **60** | **71** | **63** |
| 4. | **56** | **27** | **54** | **35** | **56** | **21** | **67** | **33** | **51** | **26** |
| 5. | **73** | **53** | **75** | **42** | **71** | **60** | **64** | **46** | **76** | **54** |
| 6. | **59** | **43** | **46** | **39** | **67** | **46** | **56** | **47** | **60** | **42** |
| 7. | **67** | **64** | **63** | **56** | **69** | **71** | **83** | **40** | **60** | **68** |
| 8. | **86** | **44** | **75** | **44** | **92** | **52** | **83** | **20** | **87** | **47** |
| 9. | **5** | **49** | **0** | **56** | **8** | **43** | **0** | **40** | **7** | **50** |
| 10. | **81** | **59** | **75** | **50** | **85** | **67** | **83** | **40** | **80** | **62** |
| 11. | **10** | **10** | **13** | **11** | **8** | **10** | **0** | **0** | **13** | **12** |
| Summary | 59,5 % | 45,1 % | 54,6 % | 39,9 % | 62,2 % | 48,6 % | 62,6 % | 35,1 % | 58,4 % | 46,5 % |

## CONCLUSION

This research demonstrated that young Croatian and Swiss athletes have inadequate knowledge in nutrition in general and sports nutrition. The understanding of nutritional issues might be lower due to participants age and educational level. Moving on, dietitians with an expertise in sport nutrition should be the primary source of information for this group. Lectures and educational classes should be held in basic topics, as well as the topics related to sport and not included in this research (such as supplements and doping).

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# Causes and mechanisms of occurrence most common injuries of kayakers

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## ABSTRACT

For the past few years, kayaking has been a sport in which interest is growing rapidly. Increasing number of athletes and recreational athletes engage in this activity, so does the percentage of injuries. The aim of this research was to show the most often injuries among paddlers, the mechanisms of their occurrence in order to better prepare and prevent. We searched through 3 databases. When searching the databases, the keywords "kayak", "kayaking", "injuries", "prevention" were used in different variants. Insight into previous research on the topic of injuries in kayakers, the emphasis is placed on the upper body, mostly on the shoulder. The cause of these injuries is attributed by most authors to improper rowing technique, muscle asymmetry, blows to various objects or objects on the water and excessive performance that leads to fatigue, and eventually to the possibility of injury. Chronic injuries, typically of the upper extremity, are quite common among rowers and are most often related to the shoulders, as evidenced by the largest number of studies. There are several external and internal factors that affect the potential injury of a kayaker. To reduce it, it is important to perform preventive actions such as better information, better warm-up, improvement of technique and dosing the amount of training, which is especially difficult for elite athletes.

**Keywords:** kayak injuries, shoulder, prevention, technique

## INTRODUCTION

Kayaking is a water sport that includes two basic disciplines - kayak and canoe. They differ primarily in the position of the body in the boat and the type of oars used. Kayaking equipment involves a two-bladed paddle, where the kayaker sits in the boat with their legs stretched out in front of the body, while canoeists use a single-bladed paddle and kneel. Kayaking is considered a cyclic monostructural activity that requires performing repetitive movements, which leads to a high possibility of injury. Performing these movements activates the back muscles to a greater extent than the front ones, which often results in an imbalance of the front and back muscle groups, thereby increasing the risk of injury (Costa, Herda, Herdai Cramer, 2013). In order to try to prevent this, the athlete should pay attention to performing exercises on dry land, in order to develop properly from an early age (Protić-Gava, 2014). Considering the positions of kayakers in the boat, in accordance with the requirements of the individual discipline, most of the mechanical work is focused on the upper part of the body, trunk and shoulder girdle of the arms, and therefore there is a high possibility of injury, which is also indicated by the largest number of studies. The authors include the shoulder, back and joints as the most frequently injured body parts (Papadas, MacLean and Stewart, 2018). Improving stroke technique can reduce shoulder injuries (Schoen and Stano, 2002). Facilitating trunk rotation, along with shoulder movements, is one way to improve technique for moving the boat. Using the trunk simultaneously with the shoulder reduces the amount of stress on the shoulder and allows for efficient energy transfer along the kinetic chain (Black, Jenkins, & Jones, 2003). The aim of this paper is to provide an

insight into the research so far on the most common injuries in kayaking, their causes and the mechanisms of their occurrence, in order to point out the possibilities of their prevention, and the emphasis is placed predominantly on shoulder injuries.

## METHODS

For the purposes of this research, a total of 4 databases were investigated. The search is focused on *Hrčak, PubMed* and *Scopus* databases. During the search, the terms "kayak", "kayaking", "injuries" and "prevention" were used, as well as variations of the mentioned terms using the capabilities of the search engine. A review of scientific and expert articles was performed.

## RESULTS and DISCUSION

All research that deals with the study of injuries in kayaking dominantly points out that shoulder injuries are one of the most common. During the Greek kayak championship on calm waters, information on injuries during the season was collected based on a questionnaire. Out of the total number, 56 rowers, or 39.4% of them, answered that they had one or more injuries during the season. The shoulder (21.1%) was the most frequently injured part of the body, followed by the joints (7.7%) and the lower back (7.7%). Regarding the types of injuries, tendinitis, i.e. tendon inflammation, was observed as the most common (41.9%), followed by sprains (25.8%) and joint strains (6.5%) (Papadas, MacLean and Stewart, 2018). Another recent study produced similar results. Griffin, Periman, Neemani & Smith (2020) sought to identify and compare the types of injuries sustained by professional rowers over the previous five years. Before each race, competitors filled out a questionnaire that investigated rowing-related injuries, athlete morphology, flexibility, equipment, training volume and environment. Of the 583 competitors examined, the largest number cited shoulder injury as the most common (31%), followed by lower back injury (23.5%) and wrist joint injury (16.5%). Among other injuries, neck (13.7%) and elbow injuries (11.0%) were mentioned. Stretching of the back muscles is most often the result of improper technique during paddling, improper positioning in the kayak, as well as hitting objects in the water (Sayer, 2017). Wrist sprains can also occur due to improper technique or excessive repetitive motions (Fisher, 2015). Powell (2009) attributed the answer to the questions regarding the most common kayaking injury and the most common site of injury to the difference depending on the type of boat used and the type of activity performed. He concluded that although there may be common demands, using different boats and participating in different activities, kayakers cannot be assumed to be a homogeneous group, further implying the development of injury prevention strategies. Earlier research on shoulder injuries was described by Edwards (1993) who tested thirty international elite sprint kayakers and found that 53% of the kayakers had a shoulder injury at the time of testing. Biceps tendonitis was attributed to 20% of shoulder injuries, followed by 20% to rotator cuff injuries, 14% to shoulder bursitis, while 46% of shoulder injuries were undiagnosed. A shoulder joint injury can be attributed to improper stroke technique, muscle imbalances, hitting various objects, or excessive repetitive motions. The most common types of injuries are luxations and rotator cuff injuries (Johansson, Svantesson, Tannerstedt & Alricsson, 2016). Intrinsic factors of these shoulder injuries include limited range of motion and imbalance in shoulder function (Donatelli et al., 2000). Specifically, low scapular positioning (Smith et al., 2002) and dyskinesia (Kibler, 2006), rotator cuff weakness (Escamilla, 2009), reduced glenohumeral internal rotation range (Burkhart et al., 2003), and a narrow posterior joint capsule (Kibler , 2006) may contribute to the risk of shoulder injury. Shoulders are designed for a wide range of motion, but kayakers often push them to their limits, causing injury. Shoulder injuries

usually occur when the shoulder is in an uncomfortable, i.e., risky position, which is characterized by the arm moved to the side, while the hand is above the head, in the so-called "high brace" position. Holland, Torrance and Funk (2017) say that paddlers' shoulder injuries most often occur while preventing the kayak from tipping over or during the tipping itself, and they believe that the "high brace" is one of the most common causes of more serious shoulder injuries for paddlers. The primary cause of shoulder injuries in kayaking can be attributed to improper technique. Rowers often perform external rotation of the shoulder during rowing, which results in luxation, i.e. dislocation of the shoulder joint (Piasechi, Meyer and Bach, 2008). It was Fiore and Houston (2001) who, in their research involving 392 kayakers, listed sprains as one of the most common types of injuries. The most common mechanism of injury was hitting an object, followed by excessive activity. Factors that influenced the likelihood of injury appeared to be related to exposure, that is, the number of days a year rowing was done. In his further research, Fiore (2003) says that, in an effort to prevent shoulder dislocation, most instructors should emphasize the importance of limiting shoulder exposure by keeping the arms tucked against the body. Interestingly, shoulder injuries are so common that paddlers fear them, and for this reason the American Rafting Safety Card (a plastic card that should be carried in the boat) contains information on how to deal with a dislocated shoulder while on the river (American Canoe Association, 2009). Cyclic and acyclic movements of the arms, accompanied by the movement of the trunk and the entire upper body, create the force necessary to propel the kayak. Bílý et al. (2013) found that rowers showed significant upper limb morphological asymmetry, which was associated with paddle grip in canoeists, while high levels of asymmetry were associated with injury risk. Excessive loading of anterior structures with poor scapular kinematics is a risk factor for shoulder injury that should be avoided (Kibler, 1991). Edwards (1993) attributed shoulder injuries in kayakers to weight training rather than water paddling. The author of this thesis, in his role as physiotherapist for the national sprint kayak team, together with the management team and coaches, similarly observed that the bench press was the exercise that caused more shoulder pain than rowing or other strength training modalities in the South African elite sprint kayak team. Hagemann, Rijke and Mars (2003) conducted a study on injuries in marathon kayakers. 52 of them filled out the questionnaire remotely, and their shoulders were scanned with magnetic resonance. MRI showed acromioclavicular hypertrophy, acromial or clavicular spur, inflammation of the supraspinatus tendon and its partial rupture as the most common abnormalities. They concluded that shoulder muscle injuries account for a large proportion of injuries seen in marathon rowers, about twice the number reported in sprint rowers. These injuries are the result of excessive practice of this sport. On the other hand, Toohey et al. (2019) analyzed the characteristics of injuries sustained by professional athletes in sprint rowing. Of these 63, 49 athletes sustained injuries to their upper limbs, and the shoulder was the most frequently injured part of the body. Injuries are common in sprint rowing and many athletes get injured more than once. Some of the subsequent injuries that appeared were related to the athlete's previous injury. Also, the frequency of injuries can be compared depending on whether the athlete races on calm or wild waters. A study published in Japan by Kasuyama, Tsuzuki, and Onoto (2020) investigated whether body composition and physical characteristics differed in junior calm-water kayakers with and without shoulder pain. It included 178 junior kayakers who assessed shoulder pain based on a questionnaire, interview and physical examination. 42.1% of them experienced shoulder pain. Using multivariate analysis, they found that lower trunk muscle mass per body mass was the most significant predictor of shoulder pain. This suggests that observation of body composition is necessary for the prevention of shoulder pain, and that appropriate lower body movements and trunk strengthening should become more important in kayakers. Sprains or

luxations are also one of the most common types of kayaker injuries. Anterior dislocation is cited as the most common, and the cause is mentioned as a fall on the arm that is in the position of extension and external rotation, a direct fall on the shoulder or the action of an external force (Beeson, 1999). In his paper, Romic (2016) says that the consequences of anterior traumatic dislocation of the shoulder depend on the severity of the injury and the age of the patient at the time of the first dislocation. The younger the patient, the greater the chances that he will dislocate his shoulder again. In athletes under the age of 20, the incidence of repeated dislocation of the shoulder joint is as high as 90%, and in the population aged 20 to 25, this incidence drops to 50-75%. In people over 40 years of age, anterior dislocation of the shoulder is associated with a lower chance of developing NRZ, but a higher chance of developing a rotator cuff injury (15%).

McKean and Burkett (2009) tested fifteen male and fourteen female kayakers and reported that they had a reduced range of shoulder rotation compared to what is considered the normal range for an optimally functioning shoulder joint. This study documented greater variation and limitation of internal rotation compared to external rotation. The strength and tightness of the pectoralis minor muscle is also likely to increase the slope of the front of the shoulder blade, so that it attaches to the coracoid process of the shoulder blade. This anterior tilting of the scapula decreases the distance of the acromion from the humerus and therefore increases the risk of rotator cuff injury (Kibler, 1991). It is necessary to coordinate the movements of the shoulder blade with the movements of the humerus to ensure that the axis of rotation of the glenohumeral joint is centered in all positions during all cases of movement. This is important for an optimal relationship between the strength and tension of the rotator cuff muscles, ensuring the best function and preventing uneven loading of the soft tissues. Moving the shoulder blade with the upper arm is also important to maintain the subacromial space to prevent impingement of the rotator cuff tendons (De Palmer and Johnson, 2003). To achieve optimal shoulder blade kinematics, as previously described, the shoulder blade must rotate upward (the inferior medial angle of the shoulder blade moves laterally upward) at the onset of the water phase and tilt against the drag of the water. The upward rotation of the shoulder blade is initiated by the fibers of the upper trapezius, performed by the activation of the lower fibers of the trapezius. The amount of upper arm abduction is determined by the preferred stroke width. The shoulder blade rotates upward with the humerus (Kibler, 1991), so it is concluded that stroke width can alter the kinematics of the shoulder blade. In order to increase the possibility of injury prevention, Wassinger (2007) states in his doctoral dissertation that it is important to analyze the movement performed during the stroke in order to gain knowledge about which potential mechanisms contribute to injuries. Knowing the cause and mechanics of injury is very important when planning prevention programs. Additional research is needed to determine the success of prevention programs for specific injuries in kayaking. As one of the most effective prevention programs, we can certainly mention the correct performance of the technique and the correct dosage of the load during the training process. Each body is unique in its own way and it is very important to recognize its characteristics and capabilities. The British Canoe Union (2002) states in their manual that there are a number of factors that affect overall performance in kayaking. It is important to understand which muscles are activated during rowing, which of them are agonists, which are antagonists, and which are synergists, so that the athlete can create a training plan that includes strengthening and stretching, not only of the muscles that perform the movement, but also of all the surrounding muscle groups. This is precisely what reduces the possibility of muscle imbalance where one muscle group dominates, which poses a great risk of injury for athletes. However, it is not only professional competitors who are at risk, the risk also applies to recreational rowers who often train like elite athletes, at least in terms of volume and

intensity of training, neglecting the quality of performance. Prevention will need to focus more on changing equipment and educating kayakers. Some potential equipment modifications that can reduce injuries include a bent shaft and reduced blades, as well as the use of face masks and helmets. A lot of time and effort should be invested in education because for a large number of kayakers, and boaters in general, river safety education could be very useful. Educational efforts to reduce injuries will likely need to be built on a better understanding of the risky behavior of elite athletes, who sometimes set unrealistic goals without considering the possibility of injury.

## CONCLUSION

Every athlete, by participating in an activity, exposes himself to the risk of potential injury. Chronic injuries, typically of the upper extremity, are quite common among rowers and are most often related to the shoulder, as evidenced by the largest number of studies. The shoulder is vulnerable when placed in a risky position due to incorrect execution technique, which most often leads to rotator cuff injuries or shoulder luxation. Professional kayakers further contribute to a greater risk of injury by pushing their limits, which sometimes forces them to make uncontrolled movements (arm overhead). It goes without saying that the well-developed muscles around the shoulder will largely hold the joint in place, but it is important that they work in a balanced way for the better functioning of the entire shoulder girdle. It is important to recognize that all of the aforementioned studies mainly refer to competitors as opposed to recreational athletes, because professional athletes spend much more time training and rowing, and are therefore more susceptible to more injuries. Also, it should be noted that rowers often have much stronger back muscles compared to front muscles, because these are the muscles that are primarily used for rowing forward. As most shoulders are dislocated by rowing forward, the front muscles should be as strong as the back muscles. This reduces the appearance of imbalance, caused by continuous forward rowing. In order for the main muscle groups needed for a proper stroke to function well, it is necessary that the surrounding muscles are well developed to help with stabilization. It is especially important to activate the trunk during the stroke in order to relieve part of the force from the shoulder. Due to the high incidence of shoulder injuries in kayaking and the repetitive nature of the sport, paddlers must employ injury prevention strategies if they are to prevent participation and performance limitation as well as long-term shoulder pathology. Strategies differ depending on the type of activity and group of rowers, which in most cases is heterogeneous and requires an individual approach. However, by combining prevention and factors that influence success, you can come up with a recipe that brings success.

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# Attitudes and interests of the citizens of the town of Našice and the surrounding area regarding the establishment of a water sports center on Lapovac lake

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## ABSTRACT

Developing sports recreation enables all citizens, regardless age, to actively use their free timeand thereby improve the quality of life. In the last few years, there has been a noticeable trendof increasing the popularity of water sports in continental Croatia.

The aim of the research was to examine the attitudes of citizens in the Town of Našice and its surrounding area in view of the establishment of a water sports center on Lapovac Lake. The sample of respondents consisted of 501 people (54% female, 46% male) between the ages of 16 and 70, residents of the Town of Našice and neighbouring towns. The sample of variables consisted of 8 questions. The first two questions related to general information about the respondents, and the third question to physical activity. The fourth and the fifth question analysepersonal experience in water sports. The aim of the next three questions was examining the interest in recreational water sports, the inclusion of children in water sports programs, and views of respondents regarding the construction of a water sports center.

Based on the results, the data were analysed using descriptive statistics and a particle frequency.The current state of infrastructure and natural conditions shows great potential for the establishment of a water sports center. The results show that 399 (79 %) respondents are interested in practicing water sports and that 450 (90 %) respondents are willing to try some ofthe water sports that will be conducted, and 487 (97 %) respondents support the establishmentof a water sports center on Lapovac Lake. Based on the results of the research, we can concludethat respondents are interested in establishing a water sports center and that the majority supports the establishment of the mentioned center.

**Keywords:** Attitudes and interests, water sports, continental tourism, Lapovac Lake, sports recreation

## INTRODUCTION

Developing sports recreation enables all citizens, regardless age, to actively use their free timeand thereby improve the quality of their lives (Andrijašević, 2010; Findak, Neljak, 2006). Physical activities that are carried out outdoors in nature are the best to meet the challenges thata modern way of life sets before mankind (Trkulja, Petković et al., 2016).

Water sports are a form of a physical activity that allows all participants to enjoy outdoor exercise (Gvozdić, 2019). Each of these sports can be practiced in groups or individually (Morar, Pop, 2016). The trend of water sports is becoming more and more popular in continental Croatia, and consequently the necessity for them is growing. Sports and recreation facilities are an indispensable part of the modern tourist offer and their number and quality undoubtedly

arouse the interest of potential users (Bartoluci, 2006). Našice is a town in Slavonia with great sports and tourism potential. One of the problems of the Town of Našice is the lack of sports and recreational facilities where middle-aged and elderly people could choose some type of

activity that is not competitive, but relaxing and recreational (Silađi, 2022). Lapovac Lake is an artificial lake whose function is retention and accumulation of water. The area around the lakeis landscaped and, in addition to tourism, it is also used for sports such as fishing, cycling, swimming, running, and various events (Knežević, 2020).

Improving sports and recreational facilities will improve the quality of life of citizens of all age groups (Jurakić, Heimer, 2012). One of the ways to improve sports and recreational facilities isthe establishment of a water sports center on Lapovac Lake. The research conducted by Lončar(2021) and Damjanović (2020) showed a great interest and support of citizens about the potential of a continental tourism as part of recreational activities, by providing water sports content. This alone leads to the goal of this research, which seeks to examine the attitudes of citizens of the Town of Našice and its surroundings regarding the establishment of a water sports center on Lapovac Lake.

## METHODS

The sample of respondents consisted of citizens of the Town of Našice and the surrounding places: Velimirovac, Markovac Našički, Zoljan, Martin, Brezik, Vukojevci and several smaller hamlets. A total of 501 respondents (271 female and 230 male), aged from 16 to 70, participated in the research.

The sample of variables consisted of 8 questions. The first two questions related to general information about the respondents, and the third question to physical activity. The third and the fourth question explore personal experience with water sports. The next three questions were aimed to investigate the interest in recreational water sports, the inclusion of children in water sports programs, and the views of respondents on the construction of a water sports center. An anonymous online survey was posted on social networks and groups. At the beginning of the survey, there was a short description defining the objectives of the research and certain criteria. The main note is that the survey refers exclusively to sports on water and does not include sportsin water. The survey consisted of 8 mandatory questions and was posted on social networks on April 23, 2021, and ended on June 13, 2021. For minors, parental consent was collected to be able to participate in the research.

Based on the results, using the Statistica 13 software package, the data were analysed with descriptive statistics and particle frequency

## RESULTS

The first group of questions is general data (gender and age). The total number of respondentsis 501, out of which 271 are women (54%) and 230 are men (46%).

According to age, the largest percentage of respondents, i.e. 208 respondents or 42%, belongs to the age group of 25 to 34 years. The next dominant group is 107 respondents, or 21%, who belong to the age group of 35 to 44 years, and 96 respondents, or 19%, belong to the age groupof 18 to 24 years (Table 1).

*Table 1: Sample of respondents by age*

| *Age* | *Number of persons* | *Response frequency* |
|---|---|---|
| *To 18 year* | *6* | *1 %* |
| *18 do 24* | *96* | *19 %* |
| *25 do 34* | *208* | *42 %* |
| *35 do 44* | *107* | *21 %* |
| *45 do 54* | *49* | *10 %* |
| *55 do 64* | *29* | *6 %* |
| *Stariji od 65* | *6* | *1 %* |

The second group of questions refers to physical activity, which will provide information about the respondent's involvement in some type of physical activity or sport. The results show that out of a total of 501 respondents, 322 (64 %) respondents are physically active, and 179 (35 %)are not physically active (Table 2).

*Table 2: Presentation of results according to physical activity*

| | *Female* | *Male* | *In total* |
|---|---|---|---|
| *Physically active* | *147* | *175* | *322* |
| *Physically inactive* | *124* | *55* | *179* |
| *In total* | *271* | *230* | *501* |

The next question was about water sports experience, which will provide information about therespondents' experience with different water sports. Respondents had the option of multiple answers. Out of the total number of the population, 353 (61%) respondents answered that theyhad no experience with water sports, 21 (4%) respondents declared that they had experience with sailing, 21 (4%) respondents had experience with windsurfing, 89 ( 15 %) of respondentshave experienced kayaking and 92 (16 %) of respondents have experienced rowing (Table 3).

*Table 3: Display of results for the question "Do you have experience with water sports?"*

| *Sports* | *Female* | *Male* | *In total* |
|---|---|---|---|
| *Without experience* | *197* | *156* | *353* |
| *Sailing* | *8* | *13* | *21* |
| *Windsurfing* | *5* | *16* | *21* |
| *Kayak* | *54* | *35* | *89* |
| *Rowing* | *31* | *61* | *92* |

Based on the following question, our goal was to find out what the experience of respondents who had the opportunity to try some of the water sports was like. To the question "If you have experienced water sports, was that experience positive or negative", 137 (94.5%) respondents confirmed that they had a positive experience with water sports, and 12 (5.5%) respondents declared that they had negative experience (Table 4).

*Table 4: Presentation of the results for the question "If you have experienced water sports, was the experiencepositive or negative?"*

| | *Number of persons* | *Response frequency* |
|---|---|---|
| *Positive* | *137* | *94%* |
| *Negative* | *12* | *6%* |
| *In total* | *149* | *100%* |

The next question was about interest in water sports. Out of the total number of respondents, 450 (90 %) respondents have a desire to try one of the water sports, and 51 (10 %) respondents do not want to try any of the water sports. (Table 5).

*Table 5: Presentation of the results for the question "If there was an opportunity to practice water sports recreationally, would you like to try them?"*

| | *Female* | *Male* | *In total* |
|---|---|---|---|
| *Yes* | *241* | *209* | *450* |
| *No* | *30* | *21* | *51* |
| *In total* | *271* | *230* | *501* |

The next question was about parents. The question was "Would you include your child/childrenin the Water Sports Center?". Out of the total number of respondents, we have 314 parents, of which 301 (60%) declared that they would like to include their child in the water sports center,13 (3%) parents declared that they would not want that, and 187 (37%) respondents were not parents (Table 6).

*Table 6: Presentation of the results for the question "Would you include your child/children in the Water Sports Center?"*

| | *Female* | *Male* | *In total* |
|---|---|---|---|
| *Yes* | *181* | *120* | *301* |
| *No* | *5* | *8* | *13* |
| *I'm not a parent* | *85* | *102* | *187* |
| *In total* | *271* | *230* | *501* |

By asking the question "Would you support the construction of a water sports center on LapovacLake?" we wanted to find out if the respondents support the construction of a water sports centeron Lapovac Lake. Out of the total number of respondents, as many as 487 (97 %) respondents support the construction of a water sports center, and 14 (3 %) respondents do not support it (Table 7).

*Table 7: Presentation of the results for the question "Would you support the construction of a water sportscenter on Lapovac Lake?"*

| | *Female* | *Male* | *In total* |
|---|---|---|---|
| *Yes* | *268* | *219* | *487* |
| *No* | *3* | *11* | *14* |
| *In total* | *271* | *230* | *501* |

## DISCUSSION

Based on the obtained results, it is concluded that the respondents are mostly interested in establishing a water sports center on Lapovac Lake. Out of the total number of respondents,450 (90%) declared that they were willing to try some of the potential sports. The results of theresearch can be linked to the research conducted by Cvitan (2022), where 90% of respondents support the idea of recreational sailing. One of the questions on the basis of which a clearerinsight into the level of physical activity could be obtained is "Do you engage in any activity orsport?". Based on the results, we see that 322 (64 %) respondents declared that they are engagedin some activity or sport, but this is not a realistic picture that describes the intensity of a weekly exercise. Regarding experience with water sports, the expected results were obtained where61% of the respondents have no experience, while 94% of the respondents with experience inwater sports saw this type of activity as a positive experience. One of the questions was aboutparents. The goal was to find out if they would include their children in the programs of thewater sports center. Of the total number of respondents, 314 were parents. The answers showthat 301 (96 %) parents want to include their child in the programs of the water sports center. The last question in the survey specifically shows us whether the respondents support theestablishment of a water sports center on Lapovac Lake. Out of the total number of respondents,as many as 487 (97 %) support the establishment of a water sports center on Lapovac Lake.

## CONCLUSION

The trend of increasing popularity of water sports is also visible from the results of this research. The largest part of the population of this study is between the ages of 18 and 44 (82%), who were found to be the most physically active. We can conclude that there is a positive atmospherefor the opening of such a center in the area of the Town of Našice. The respondents showed a desire to engage in recreational water sports, and most of the parents included in this research would include their children in water sports activities. Considering these two facts, the openingof a water sports center in the area of Našice would increase the number of people who have experience with this type of activity. In the end, out of the total number of respondents, 487 ofthem (97%) supported the construction of a water sports center. Since water sports are not thatpopular in continental Croatia, great interest is expected due to the attractiveness of this sport. For this reason, it is assumed that there is such a demand. The results coincide with research related to Karlovac County, where a high interest in water sports is also visible. One of the possible problems that complicates the process of establishing the mentioned center is the current legal and political relations that make it impossible or to a considerable extent difficultto start such a project and the non-existent infrastructure.

From the above results, it can be concluded that there is interest among the significant part

of the population, but it is necessary to consider the possibility of biased thinking, whichcould affect the results if the research was conducted by an unknown person who is not from their local area.

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# Positional differences in female water polo: Analysis on the sample of elite Chinese senior players

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## ABSTRACT

Water polo is characterized by high physical demands that include technical-tactical actions of high to moderate intensity as well as swimming tasks. Water polo players are divided in the game by playing positions, and some authors, based on the similarity of tasks, divide them into Perimeter and central players. The aim of this paper was to determine which factors differentiate the Center and the Perimeter of water polo. As their roles and tasks in the game are quite heterogeneous, it can be assumed that there will be significant differences in anthropometry, strength and endurance parameters. The sample of participants included 16 female water polo players (24.4 years old on average), all members of the China Olympic team. Goalkeepers were not included in this research, only field players divided into two groups. Set of variables consisted of (i) anthropometry parameters, (ii) strength features and (iii) measures of swimming, running and rowing sprinting and endurance capacities. Mann-Whitney test was used to investigate potential differences between the groups. The result show that a Center player are higher, more massive and have higher amount of both fat and muscle mass, but statistically significant differences were obtained only for the BM and BMI variables. The results of absolute maximum strength tests showed that Center player are stronger in both lower and upper extremities. However, this is one of the first studies that evaluated maximal strength levels in female players and evaluate it according to their playing positions. There were no differences in the swimming capacities between the groups. This can be considered as surprising as in general Perimeter players have higher swimming load during the game. These results indicate that the main differences between Center and Perimeter female players are in body dimensions and maximum strength results. Although a small number of respondents participated in the research, we consider the results extremely valuable because the observed water polo players belong to the circle of the world's best water polo players.

**Keywords:** Please provide 5 key words separated with comma, not included words from the title.

## INTRODUCTION

Water polo is team sport game played in the pool, in 8-minute quarters with two teams consisted of 6 field players and one goalkeeper confronting. Water polo belongs to the group of poly-structural complex activities, and is characterized by high physical demands that include both technical-tactical actions of high to moderate intensity and swimming tasks (Escalante, Saavedra, Mansilla, & Tella, 2011). It is a globally popular sport and has been a permanent participant in the Olympic Games since Paris in 1900. Although the first women's water polo match took place in 1906 in Harlem, Netherlands, women's water polo developed very late and has only been part of the Olympic program since Sydney 2000 (Lupo et al., 2011).

Water polo players are divided into different positions in the game. Apart from goalkeepers, players in the field are divided into two main categories, Center and Perimeter players. Among Center position are considered both Center and point player, while Perimeter positions include two wings and two drivers (Kondrič, Uljević, Gabrilo, Kontić, & Sekulić, 2012). Players in certain positions have specific roles in the game and different requirements regarding individual and team tactics (Kondrič et al., 2012). For example, Center players are usually placed approximately 2 meters from the goal and they are in constant battle for better position and the ball with the opposing point players (Martínez et al., 2015; Tan, Polglaze, Dawson, & Cox, 2009). On the other hand, wings and drivers have significantly higher swimming requirements, there are positioned slightly further from the goal and are in charge for ball circulation in the attack phase (Martínez et al., 2015; Tan et al., 2009). For these reasons, it can be assumed that certain differences in characteristics, skills and abilities will be present.

This is confirmed in several studies on adult male players (Idrizović, Uljević, Ban, Spasić, & Rausavljević, 2013; Kondrič et al., 2012; Lozovina, Đurović, & Katić, 2009). In particular, studies regularly report Center players as tallest and highest, while Perimeter players are considered lighter and with lower percentages of adipose tissue (Idrizović et al., 2013; Kondrič et al., 2012; Lozovina et al., 2009). Regarding physiological demands, studies found an average of 7.7±1.0 mmol of blood lactate in water polo players, but with large differences between Center and Perimeter players (11.2±1.0 and 5.3±0.9 mmol respectively) (Melchiorri, Castagna, Sorge, & Bonifazi, 2010). Finally, in terms of motor abilities, Center players are considered as stronger while Perimeter players are faster and more explosive (Botonis, Toubekis, & Platanou, 2018). However, although male water polo is very well explored, there is a lack of researches on female players. In general, there are only few studies that investigated positional differences. In particular, study on Australian players showed that Perimeter players had lower-body mass and body fat value and better swimming capacities, in both sprinting and endurance disciplines, compared with Center players (Tan et al., 2009). On the other side, authors of study on Spanish players concluded that only a small number of anthropometric differences exist between players of different positions in elite female water polo (Martínez et al., 2015). However, they suggested that shorter players with smaller arm spans suit better for the wings, and the ones with longer forearms should be considered to use as goalkeepers (Martínez et al., 2015).

Considering the obvious lack of research in female water polo, and given that only certain dimensions of motor and anthropometric areas were analysed in the mentioned studies, the aim of this paper was to explore which factors differentiates Center and Perimeter female water polo players. Considering their heterogeneous positional roles and in-game tasks, we hypothesized that significant differences will occur in anthropometry, strength and endurance parameters.

## METHODS

Participants in this study were 19 female senior players (24.4 years old on average), all member of China Olympic team. As inclusion criteria was their field position, we excluded three goalkeepers and final sample was consisted of 16 players. They were divided in two groups according to playing position, (i) Center (n=6, 23.5 years old on average) and (ii) Perimeter players (n=10, 25.6 years old on average). The testing was organized in the Olympic camp, by the Chinese Olympic federation, during the preparation for the 2020 Olympic Games in Tokio.

Set of variables consisted of (i) anthropometry parameters, (ii) strength features and (iii) measures of swimming, running and rowing sprinting and endurance capacities. In detail, body height (BH), body mass (BM), body mass index (BMI) and the body composition, including body fat percentage (BF) and muscle mass (MM) were measured as anthropometry indices. Tanita scales (TBF-300, Tanita, Tokyo, Japan) were used for body composition and BM measurement, and these data, along with BH measured with anthropometer scale, were used for BMI calculation. Strength measures included one maximal repetition on bench press (BP) and squat (SQ) exercise and hand grip strength measured with electronic hand dynamometer Camry (Model 124 EH101, Zhongshan Camry Electronic Co. Ltd. China). Swimming capacities were checked with freestyle swimming on 25, 50, 100, 200 and 400 meters. In addition to swimming, all participants conducted running test on 30 and 3000 meters along with the rowing test on 2000 meters on the Concept 2 ergometer.

All data were descriptively analysed (arithmetic mean and standard deviation), for whole sample and for the observed groups in particular and Kolmogorov-Smirnoff test was used to check normality of distribution. Considering small relatively small sample (i.e. only 6 players in Center players group) nonparametric Mann-Whitney test was used to investigate potential differences between the groups. Statistica ver. 13.5 (Tibco Inc., Palo Alto, CA, USA) was used for all calculations, with the significance level of $p < 0.05$.

## RESULTS and DISCUSION

Descriptive statistic parameters for the whole sample is presented in table 1. Result showed that all variables have normal distribution.

Table 1: Descriptive statistics

| *VARIABLES* | *AM* | *SD* | *K-s (p)* |
|---|---|---|---|
| *BH (cm)* | *177.75* | *4.06* | *p > .20* |
| *BM (kg)* | *77.23* | *7.21* | *p > .20* |
| *BF (%)* | *25.35* | *4.59* | *p > .20* |
| *MM (kg)* | *52.03* | *5.57* | *p > .20* |
| *BMI* | *24.75* | *1.93* | *p > .20* |
| *AS (cm)* | *180.06* | *4.97* | *p > .20* |
| *BP (kg)* | *94.44* | *9.65* | *p > .20* |
| *SQ (kg)* | *104.38* | *13.52* | *p > .20* |
| *DLH (Nm)* | *41.14* | *5.17* | *p > .20* |
| *DRH (Nm)* | *41.71* | *5.98* | *p > .20* |
| *R30 (sec)* | *4.92* | *0.36* | *p > .20* |
| *R3000 (sec)* | *819.06* | *76.01* | *p > .20* |
| *E2000 (sec)* | *498.56* | *24.74* | *p > .20* |
| *SF25 (sec)* | *13.00* | *0.31* | *p > .20* |
| *SF50 (sec)* | *30.04* | *0.91* | *p > .20* |
| *SF100 (sec)* | *62.48* | *1.40* | *p > .20* |
| *SF200 (sec)* | *136.29* | *5.19* | *p > .20* |
| *SF400 (sec)* | *287.02* | *13.08* | *p > .20* |

Legend: BH – body height, BM – body mass, BF - body fat, MM – muscle mass, BMI – body mass index, AS – arm span, BP – bench press, SQ – squat, DLH – dynamometer left hand, DRH – dynamometer right hand, R30 – running 30 meters, R3000 – running 3000 meters, SF25 – swimming freestyle 25 meters, SF50 - swimming freestyle 50 meters, SF100 - swimming freestyle 100 meters, SF200 - swimming freestyle 200 meters, SF400 - swimming freestyle 400 meters

Table 2: Descriptive statistics and Mann-Whitney test

| | *PERIMETER* | | *CENTER* | | *M-W test* | |
|---|---|---|---|---|---|---|
| *VARIABLES* | *AM* | *SD* | *AM* | *SD* | *Z* | *p* |
| *BH (cm)* | *177.20* | *4.29* | *178.67* | *3.83* | *0.49* | *0.63* |
| *BM (kg)* | *74.09* | *4.63* | *82.45* | *8.06* | *2.17* | *0.03** |
| *BF (%)* | *23.75* | *3.12* | *28.02* | *5.67* | *1.46* | *0.14* |
| *MM (kg)* | *49.90* | *4.36* | *55.58* | *5.90* | *1.79* | *0.07* |
| *BMI* | *23.84* | *1.04* | *26.27* | *2.20* | *2.44* | *0.01** |
| *AS (cm)* | *178.40* | *4.93* | *182.83* | *3.97* | *1.74* | *0.08* |
| *BP (kg)* | *90.10* | *8.57* | *101.67* | *6.83* | *2.33* | *0.02** |
| *SQ (kg)* | *97.00* | *7.89* | *116.67* | *12.11* | *2.71* | *0.01** |
| *DLF (Nm)* | *40.35* | *4.29* | *42.45* | *6.61* | *0.49* | *0.63* |
| *DRF (Nm)* | *41.29* | *4.32* | *42.40* | *8.52* | *0.60* | *0.55* |
| *R30 (sec)* | *4.86* | *0.43* | *5.03* | *0.19* | *1.79* | *0.07* |
| *R3000 (sec)* | *803.4* | *92.59* | *845.17* | *24.22* | *1,90* | *0,06* |
| *E2000 (sec)* | *498* | *29.29* | *499.5* | *17.05* | *-0,11* | *0,91* |
| *SF25 (sec)* | *12.98* | *0.25* | *13.02* | *0.43* | *0.11* | *0.91* |
| *SF50 (sec)* | *29.96* | *0.88* | *30.18* | *1.03* | *0.60* | *0.55* |
| *SF100 (sec)* | *62.22* | *0.96* | *62.91* | *1.97* | *0.54* | *0.59* |
| *SF200 (sec)* | *134.74* | *4.56* | *138.87* | *5.52* | *1.57* | *0.12* |
| *SF400 (sec)* | *284.47* | *12.82* | *291.29* | *13.51* | *1.08* | *0.28* |

Legend: BH – body height, BM – body mass, BF - body fat, MM – muscle mass, BMI – body mass index, AS – arm span, BP – bench press, SQ – squat, DLH – dynamometer left hand, DRH – dynamometer right hand, R30 – running 30 meters, R3000 – running 3000 meters, SF25 – swimming freestyle 25 meters, SF50 - swimming freestyle 50 meters, SF100 - swimming freestyle 100 meters, SF200 - swimming freestyle 200 meters, SF400 - swimming freestyle 400 meters

In table 2. positional descriptive parameters are presented along with the Mann Whitney test. Results showed that significant differences between Perimeter and Center players are found in BM (p=0.03), BMI (p=0.01), BP (p=0.02), SQ (p=0.01) and 2000m ERG (p=0.01) variables

According to these results we can highlight two most important findings. In detail, factors that contribute the most for positional differentiation in female water polo are anthropometry and maximal strength.

Center players in the observed sample are higher, more massive and have higher amount of both fat and muscle mass. Although they have higher values in all observed anthropometry indices, statistically significant differences are found for the BM and BMI. This finding is expected and in accordance with the previous studies conducted on both male and female players and even in the youth categories (Idrizovic, Uljevic, Spasic, Sekulic, & Kondric, 2014; Kondrič et al., 2012; Tan et al., 2009). It is clear that body dimensions are one of the most important factors that distinguish Center and Perimeter players. This finding has a clear background in the player duties during the game. In particular, Center players spend more time in direct contact with the opponents and in the fighting for the position. Majority of their playing time is consisted in wrestling in front of the goal and it is obvious that in these circumstances higher body mass represents an advantage (Tan et al., 2009).

The results of absolute maximum strength tests showed that Center player are stronger in both lower and upper extremities. As result showed higher values of muscle mass for Center players these differences are expected and can also be explained with the contact nature of the game for these playing positions. In short, stronger players will be able to generate greater forces which will assist them in wrestling with opponents and fighting for the best possible position in front of the goal. Similar findings were presented in the study on the Greek male senior players were Centers were significantly better in one maximum repetition on bench press and authors concluded that greater level of upper-body strength is required from Centers to cope with the physical demands of body contacts and wrestling (Botonis et al., 2018). However, this is one of the first studies that evaluated maximal strength levels in female players and evaluate it according to their playing positions.

Although authors expected, there was no differences in the swimming capacities between the groups. This can be considered as surprising as in general Perimeter players have higher swimming load during the game. As some previous studies showed different results (better sprinting and endurance capacities in Perimeter player), these findings can possible be result of sample specificity (Tan et al., 2009). In order to establish clearer picture of positional swimming requirements, in future study bigger and broader sample of players should be observed.

## CONCLUSION

This study aimed to identify differences between different playing positions in female water polo. Results in general highlighted body dimensions and maximal strength as most significant differential factors between Centers and Perimeter players. These results are consequence of specific game tasks as body mass and muscle strength is crucial factor for Centers playing efficacy.

One of the major limitations of the study was relatively small sample of the participants. However, considering that observed players represent highest senior level in female water polo, and that a large set of variables were measured, we can consider these results as applicable for the elite female water polo in general. In the future studies a larger sample of participants is required and potentially investigate the differences between a larger number of playing positions.

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# Shoulder Injuries in Water Polo Players During the Half-Season

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## ABSTRACT

This study aims to ascertain shoulder injury incidence in water polo players before and after half-season and provide educational insight to players to improve injury prevention and facilitate rehabilitation. This knowledge can empower water polo players and help them fully return to ongoing training and other professional activities. Thirty professional water polo players, ages ranging from 17 to 40, were chosen as a homogenous group of participants of this cohort study. Researchers collected the data on the 1st of February 2021. and on the 1st of June - at the beginning and after half a season. During the four months between measurements, the professional athletes participated in the training, tournaments, and other regular activities. The Constant-Murley score was used as a comprehensive and comparable assessment of shoulder function, grading the degree of injuries and pain of water polo players. The questionnaire examined the range of motion of the shoulder joint, joint strength, and pain affecting the quality of life of the study participants. Subjective findings of the participants were considered as well as objective measurements taken by the researchers. Following collection, the measurements were statistically processed. Statistical analysis with a confidence interval of 95% showed that a statistically relevant difference was measured in the shoulder internal rotation component ($p=0.0434$). Shoulder strength measurements showed a dramatic decrease ($p=0.0002$). Other parameters (pain within 24 hours, the effects of pain on daily life/activities, shoulder abduction, flexion and external rotation of the shoulder) did not show a statistically relevant difference when analyzed by the CMS questionnaire. Professional water polo players have limited internal rotation of the shoulder joint. This research elucidated the indicated deficiency and outlined its importance as one of the focus areas in injury prevention programs. By the end of the half-season, a decline in the shoulder strength of professional water polo players developed. As shoulder strength is one of the crucial indicators of shoulder damage and possible shoulder injury onset, this research sheds light on the effects training and competition have on an injury. We have outlined a prevention program that addresses the found issues. Shoulder measurements show the external rotation component as one of the focal points which need to be optimized in the future because a mild reduction in the range of motion is indicative of muscle imbalances of the shoulder girdle, especially scapular dyskinesis.

## INTRODUCTION

Shoulder is joint with greatest range of motion in human body, and because of it at the same time it is the most unstable one. It is most vulnerable to the overhead activities because that creates great stress to its stabilators which can be static (ligamento-labral complex) and dynamic (rotator cuff muscles). Extended exerted activity can damage static stabilization of the shoulder. That damage can disrupt balanced mechanism between rotators of the scapula and rotator cuff muscles. Extended exerted activity of the shoulder in some

overhead sports and professions can cause several overstrain syndromes such as subacromial impingement, suprachoroidal impingement, glenoidal impingement, frontal instability and SLAP lesions (1.)

Shoulder injuries are characteristic to overhead sports where primary hand motion is in a position of elevation overhead. According to the literature great number of shoulder injuries occurs in water polo players so it is important to address this issue.

Overhead throwing motion is very complex movement. During overhead throw great forces are generated and applied thru the shoulder joint. Thrower`s shoulder needs to be loose enough to allow extensive external rotation and yet stabile enough to prevent symptomatic subluxations of the humeral head, that is why that shoulder demands delicate balance between mobility and functional stability. This is also known as „thrower's paradox". (2.)

Some of the overhead sports include water polo, baseball, handball, discus throwing… Rehabilitation process of these athletes follows structured, multiphase process with emphasis on controlling the inflammatory response, restoring muscle balance, enhancing flexibility of the soft tissue, increasing proprioception and neuromuscular control all in order to help the athlete return to sport. (2)

## METHODS

In this research we observe water polo players and monitor their status and function of their shoulder joint at the beginning and at the end of half season. We monitor raise or fall in their performance as well as eventual injuries. This research is cohort study in which we formed a group of athletes at the beginning of the half season, did the initial measurements and monitored them until the end of half season and did the second and final measurements.

Primary method used in this research is Constant Murley score which consist of two segments. First is the questionnaire which is filled by the subject, and the second part are measurements of ROM as well as of the strength which are measured by the physician. Whit this method we observed pain (using VAS), functionality in daily activities, ROM of the joint and strength of the muscles in a shoulder position of 90 degrees abduction. Our tested group included 30 professionals male water polo players who were actively competing in highest rank. Their age was 17 to 40 years old.

Constant-Murley Score (CMS) was introduced in 1987. as an instrument of evaluating complete shoulder function and is independent of diagnostics of the injurie. It is recommended by the European society for surgery of the Shoulder and Elbow and as such has wide application in evaluating shoulder function around the world to this day. CMS score involves 4 aspects related to the shoulder pathology; 2 subjective ones: pain and influence on day to day activities as well as 2 objective ones: ROM and strength.

Subjective components are tested with a questionnaire and can accumulate 35 points, while objective ones are tested by a physician and can accumulate up to 65 points which gives a score of 100 in total (maximum result). (3.) Measurements of ROM were conducted using goniometer. Measurements of strength were conducted using dynamometer („PCE- FB" brand) which is designed to measure pressure or pull in laboratories or production and as such it was modified to address the needs of this research. The process of determining element of strength included three consecutive measurements of which the highest is used for score. Measurement were conducted in standing up position with shoulder abducted at a position of 90 degrees. Measurements were taken during practice, after warming up to prevent injuries during testing. All the data acquired using CMS tests were statistically

analyzed using t-test and p-values were calculated.

## RESULTS

| | Average 1. measurement | Average 2. measurement | p- value |
|---|---|---|---|
| Shoulder pain in the last 24 h (max 15) | 14.17 | 14.13 | P = 0.9495 |
| Shoulder pain influencing sleep (max 2) | 1.97 | 1.97 | / |
| Shoulder pain influencing daily activities (max 4) | 3.87 | 3.83 | P = 0.8389 |
| Shoulder pain influencing sport activities (max 4) | 3.8 | 3.7 | P = 0.4762 |
| Subjective painless ROM (max 10) | 9.6 | 9.3 | P = 0.5256 |
| Anteflexion ROM (max 10) | 9.53 | 9.53 | / |
| Abduction ROM (max 10) | 9.53 | 9.53 | / |
| External rotation ROM (max 10) | 9.27 | 9.4 | P = 0.7122 |
| Internal rotation ROM (max 10) | 8.93 | 9.2 | **P = 0.0434** |
| Strength (dynamometer measurement) | 15.17 | 13.55 | **P = 0.0002** |

Statistical analysis of the CMS score results is shown in the table. There was no statistically significant difference between results of CMS score at the beginning and at the end of the half season regarding pain in the past 24 h, influence of shoulder pain on sleep, influence of shoulder pain on daily activities, influence of shoulder pain on normal sports activities, subjective painless ROM as well as ROM for anteflexion, abduction and external rotation. It was concluded that the deficit of internal shoulder rotation was present in significant number of athletes in the first measurement and it continued to deteriorate during the half season and it resulted with poorer performance in the second measurement, observed difference was statistically relevant. Strength measurement showed statistically significant decrease of muscular strength between the two measurements which indicates loss in performance do to in competition training regime.

## DISCUSSION

Shoulder as a functional unit has a great potential for injuries in all overhead sports such as water polo, handball, tennis, etc... Research indicates that there are a few main factors that increase risk of injurie: glenohumeral deficit of internal rotation, lack of balance between internal and external muscle strength and scapular dyskinesia. (4.)

INTERNAL ROTATION DEFICIT

Internal rotation deficit is a well-known risk in developing chronical shoulder pain. It is recommended that difference between left and right shoulder internal rotation to be less than 18 degrees, and that the difference in complete shoulder ROM between left and right side should be less than 5 degrees.
Biomechanical studies show that cause for injuries are selective shortening of posterior shoulder structures such as posterior capsule of glenohumeral joint and posterior rotator cuff muscles. Some studies have shown bone adaptation to humeral torsion in overhead

athletes which only emphasizes the importance of addressing complete ROM which includes both internal and external rotation.

INTERNAL AND EXTERNAL MUSCLE DISBALANS

Overhead athletes often have sport specific adaptation which lead to relative decrease of strength of external rotators of the shoulder and consequently to disbalance in the strength of rotatory cuff muscles.

Isokinetic, isometric and excentric strength studies showed that such adaptation is present both in injured as well as in healthy athletes. External rotators of the shoulder decelerate the strong throwing movement with its excentric contraction and at the same time stabilize the joint, that is why it is important to include excentric contraction strength exercises in the training regime both for the healthy as well as for the injured athletes. Such training regime should focus on: emphasizing excentric phase while avoiding concentric phase of motion during exercises, slow exercises for strength and fast exercises for endurance and plyometric capacity (endurance and plyometric capacity can be exercised when athlete is instructed to catch the medicine ball) and exercises that put emphasis on the throwing cycles.

SCAPULAR DYSKINESIS

In the presence of scapular dyskinesis proper intervention training program should be implemented to return flexibility and establish proper muscular function. Main goals of the training program should include return of soft tissue flexibility especially m. pectoralis minor, m. levator scapulae, m. rhomboideus and all the posterior shoulder structures also the program should focus on increasing scapular muscle strength, muscle control, balance and coordination.

Exercises that increase scapular muscle balance showed positive results in isokinetic strength testing of the external rotators. (4.)

## CONCLUSION

Comparing the results in our research with those from the literature there is direct correlation regarding internal rotation deficit. Shortening of the internal rotators of the shoulder such as m. teres maior and m. subscapularis in combination of disbalance in strength of surrounding structures such as m. pectoralis minor and m. biceps is a direct consequence of sport specific motions that present in the training regime in all overhead sports. It is necessary to address the issue of external rotators and improve its excentric contractions to better stabilize the shoulder joint during throwing movement. Beside achieving balance between internal and external rotators of the shoulder there is a great need to address the scapular dyskinesis and increase the strength of m. rhoboideus, m. latisimus dorsi, m. serratus anterior et posterior as well as stretch m. levator scapulae to achieve the maximal effect in athletes throwing performance and prevent injuries.

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# Extracorporeal Shock Wave Therapy in acute lumbar syndrome

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## ABSTRACT

Acute lumbar syndrome is one of the most common painful syndromes. WHO estimates that every person experience acute lumbar syndrome in some part of his life, which can pass spontaneously with analgesics and rest, and sometimes requires medical intervention. The paper presents the case of a 45-year-old skipper with acute lumbar syndrome. After the initial examination, an Extracorporeal Shock Wave Therapy (ESWT) application was made. The application was 3 times during one week with fESWT on painful points, and then rESWT on the affected muscle groups. The patient was educated in performing core musculature exercises 3x a day, 3x 10 repetitions in examination we used VAS for pain, and Oswestry disability questionnaire. After 3 applications, reduced pain according to the VAS scale, reduced disability according to the Oswestry questionnaire, better mobility of the lumbar spine. Acute lumbar syndrome is common pain syndrome with great impact of daily activities. One of treatment modality is ESWT. We tried to reduce pain, improve lumbar mobility. In this case we used ESWT as preparation for exercise. Rest and analgesics are often prescribed in acute lumbar syndrome, but golden standard is exercise which should not be avoided in acute phase. Shock wave therapy is not a new method, but it certainly deserves further monitoring and evaluation of its application in acute lumbar syndromes with more precise procedures. We should determinate patient's condition, make precise protocol, and determine methods of evaluation.

**Keywords:** spine, pain, disability, exercise, focused, radial

## INTRODUCTION

Croatian health service yearbooks (2005-2014) published in the ten-year period, musculoskeletal disease was at the third place in the total score registered in Primary Health Care (PHC). The lowest incidence was recorded in 2005 with 798,358 diagnoses, or 8.6% of the total of the number of diagnoses made in PHC, the highest in 2011.years; 1,437,931 diagnoses, that in 2012 and 2013 that number would decrease. However, in 2014, an increase was recorded again; and it is recorded 1,196,445 diagnoses. If ignore oscillations, in a ten-year period monitoring, the number of diagnoses increased by 50%. The largest share was related to patients aged 20 to 64(60.6 - 61.1%), it is also the largest group in the total population. A large share of diseases applied to older people (34.6-35.4%), while negligibly few diseases affected children up to 7years, school children and young people. The most frequently registered diagnoses, with an increase from 47.5% to 52.6% were intervertebral diseases disc (MKB M50-M54)

Low back pain (lumbar back pain) is defined as pain in the back from the level of the lowest rib down to the gluteal fold, with or without radiation into the legs. Back pain is called nonspecific when there is no clear causal relationship between the symptoms, physical findings, and imaging findings.

| Mechanical Low Back or Leg Pain (97%)† | Nonmechanical Spinal Conditions (~1%) | Visceral Disease (2%) |
|---|---|---|
| Lumbar strain or sprain (70%)‡ | Neoplasia (0.7%) | Pelvic organ involveme |
| Degenerative processes of disc and facets (usually related to age) (10%) | Multiple myeloma | Prostatitis |
| *Herniated disc (4%)* | Metastatic carcinoma | Endometriosis |
| *Spinal stenosis (3%)* | Lymphoma and leukemia | Chronic pelvic inflan |
| Osteoporotic compression fracture (4%) | Spinal cord tumors | Renal involvement |
| Spondylolisthesis (2%) | Retroperitoneal tumors | Nephrolithiasis |
| Traumatic fractures (<1%) | Primary vertebral tumors | Pyelonephritis |
| Congenital disease (<1%) | Infection (0.01%) | Perinephric abscess |
| Severe kyphosis | Osteomyelitis | Aortic aneurysm |
| Severe scoliosis | Septic discitis | Gastrointestinal involv |
| Transitional vertebrae | Paraspinous abscess | Pancreatitis |
| Spondylolysis§ | Epidural abscess | Cholecystitis |
| Internal disc disruption or discogenic back pain‖ | *Shingles* | Penetrating ulcer |
| Presumed instability** | Inflammatory arthritis (often HLA-B27 associated) (0.3%) | |
| | Ankylosing spondylitis | |
| | Psoriatic spondylitis | |
| | Reiter syndrome | |
| | Inflammatory bowel disease | |
| | Scheuermann disease (osteochondrosis) | |
| | Paget disease | |

https://www.researchgate.net/figure/Differential-Diagnosis-of-Low-Back-Pain_tbl1_11103340

It is traditionally classified as acute (lasting up to 6 weeks), subacute (6–12 weeks), or chronic (more than 12 weeks). The overriding goal in the primary treatment of low back pain is symptomatic relief, i.e., acute reduction of the pain. You should pay attention to the exclusion of serious disease ("red flags"), the detection of clues that might suggest a specific diagnosis, and the early detection of psychosocial factors that promote chronification ("yellow flags").

## CASE REPORT

A 45-year man who works as a skipper on 12 m speed boat, presented with pain in the lumbar segment of the spine. Previous history without chronic diseases. This was first time of acute lumbar pain. The pain irradiated down the glutes across the front and back of both upper legs to the knees. the pain increased during physical activity, especially when bending over and lifting weights. He negates night pain, elevated body temperature, and the pain does not increase with coughing.

On examination, the patient is antalgic posture. He walks on his heels and toes. He wears a supportive load-relieving LS orthosis. Lumbar lordosis is straightened. Inclination of the LS spine initial, and painful with pain spreading in both gluteus and front and back of upper legs. Modified Schober test 3 cm.

Paravertebral musculature of the lumbar region is hypertonic and painful on palpation. Lateral flexion on both sides and retro flexion was terminally reduced. Rotations in the thoracic spine were terminally reduced. He denies sensory disorders. Lasegue sign was negative. N. femoralis stretch test was negative. Patellar and Achill tendon reflexes were normal.

VAS for pain was 7. Oswestry questionnaire was 31/50. For analgesia patient was taking ibuprofen 600mg 3 times per day, with paracetamol/tramadol 375/37,5 mg in evening.

X ray of LS spine describes the orderly height of the vertebral bodies. Narrowed

intervertebral spaces L5S1 with spondylophytes.

Considering the limited time for physical therapy, we decided on Extracorporeal Shock Wave Therapy (ESWT) with exercises. We applied ESWT 3 times per week (Monday, Wednesday, Friday). The shock wave was performed with a focused probe on painful points with energy 0,15 mJ/mm3, 1000 shocks, frequency 4 HZ.

We treated the paravertebral musculature, thoracolumbar fascia, gluteal musculature, adductors and iliotibial tract with a radial probe with pressure of 1,8 bar, 2000 pulses ad frequency of 15 HZ. The patient was educated for core musculature exercises, which he performed at home every day 3 times a day, lasting 3x 10 repetitions. He was advised to stop using the orthosis. After third application of ESWT and five days of intensive exercise the pain lessened. In analgesic therapy, the patient takes paracetamol/tramadol in the evening. VAS for pain was now 4. Oswestry questionnaire 18/50. We noted improvement in ROM: inclination of LS spine was 30 degrees, modified Schober test was 4 cm.

We explained the importance of doing the exercises at home and scheduled a check-up in a month. At that examination, he sometimes experiences pain during heavy lifting, didn't take any pain medications, had normal range of motion of LS spine. He was still preforming exercise 3 times per day, lasting 3x 10 repetitions. He was swimming 3 times per week. VAS pain was 2. Oswestry questionnaire was 10/50.

## DISCUSION

Shock wave therapy is not a new method. it has been used in urology since 1980. and its application in musculoskeletal diseases is primarily in calcifying tendinitis, plantar fasciitis and calcaneal exostosis. ESWT leads to the release of mRNA from the cell nuclei. This is followed by activation of cell organs such as the mitochondria and the endoplasmic reticulum and the cell vesicles, which release the specific proteins of the healing process. Wang's research group showed several working mechanisms which fit into this idea of mechano-transduction, as the cascade is called by ESWT users. In animal models it is observed, that ESWT induces free radicals and oxygen radicals, which induce the production of a number of growth factors. Cell regeneration is a complex process including cell activation, migration and interaction of different cell types. This leads to the expression of cell surface proteins (receptors), which are stimulated by cytokines and thus activate the interactions Wang reported that extracorporeal shock waves stimulate the expression of angiogenesis-related growth factors, including endothelial nitric oxide synthase (eNOS), vascular endothelial growth factor (VEGF), and proliferating cell nuclear antigen (PCNA), which induce neovascularization and improve blood flow in tissues, stimulating healing processes in inflammatory conditions in tendons, bones, and surrounding tissues, and resulting in pain relief . These growth factors increased as early as one week after the start of ESWT and lasted for about eight weeks, whereas neovascularization took place between four and twelve weeks after the start of ESWT [24]. The effects involved were mostly medium-term and long-term and may be of value in the treatment of chronic low back pain.

Lange and al in randomized controlled trial suggest that rESWT combined with physiotherapy and analgesia was not superior to analgesia and physiotherapy alone, in relation to pain intensity and physical function. Lee et al. also reported that a combination of ESWT and physiotherapy was more effective in relation to VAS scores and dynamic balance activity in comparison with an exercise program and physical therapy. Notarnicola et al. conducted a clinical trial including 30

patients suffering from chronic low back pain, who were randomly assigned to a shockwave therapy group or a rehabilitation exercise group. The authors reported a significant improvement in pain intensity and physical function after one and three months in the shockwave therapy group in comparison with the control group. The results of a review by Seco et al. did not support the use of shockwave therapy in patients with chronic low back pain and leg pain. They conclude that the available evidence does not support the effectiveness of shock wave therapy in low back pain,

Wang reported that extracorporeal shock waves stimulate the expression of angiogenesis-related growth factors, including endothelial nitric oxide synthase (eNOS), vascular endothelial growth factor (VEGF), and proliferating cell nuclear antigen (PCNA), which induce neovascularization and improve blood flow in tissues, stimulating healing processes in inflammatory conditions in tendons, bones, and surrounding tissues, and resulting in pain relief [23]. These growth factors increased as early as one week after the start of ESWT and lasted for about eight weeks, whereas neovascularization took place between four and twelve weeks after the start of ESWT.

## CONCLUSION

To our knowledge, so far, we have not found in the literature the use of radial and focused shock waves at same time for acute lumbar syndrome.

This case report certainly opens up further questions of shock wave application.

Certainly, this kind of application is not intended for all patients, so in the future they should investigate its effect with more precise application protocols.

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# Assessment of Psychological Characteristics of Perfectionism in Junior Swimmers

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## ABSTRACT

Today's sport competition is getting larger every day. Furthermore, It is well known that better performance determine success, but overthinking and burden of high performance can lead to negative consequences in terms of perfectionism. Therefore, aim of this study was to assess the psychological characteristics of perfectionism in junior category swimmers and to determine differences between gender groups. The sample of participants included 36 swimmers from swimming clubs in Croatia. Mean chronological age of participants was 15.28±1.26 years. For perfectionism revision the Sport Multidimensional Perfectionism Scale was used. Descriptive statistics parameters were calculated along with T-test that was applied to determine the differences in the psychological questionnaire between different groups of participants. It can be noted that participants perceived biggest results in Personal standards (AS=3.10±0.74) and Organization (AS=3.06±0.95). Furthermore, lowest results were measured in Perceived parental pressure (AS=2.17±1.07), on the whole sample. Analysis of variance of psychological characteristics and differences in both groups are showed significant difference between groups, and that is Concern about mistakes (p=0.04). Precisely, females perceived more concern in this category, than males. The found differences could be explained by maturation and sport category of participants. The aforementioned results showed that girls have significantly more Concern over mistakes than boys of this study Precisely, their maturation level implies that they are still in psychological development phase which leads to having more pressure. Future research should include more participants and differences among swimming disciplines.

**Keywords:** SMPS-2, questionnaire, youth swimmers, gender differences, concern over mistakes.

## INTRODUCTION

Swimming is one of the most popular sports in the world (Tanaka, 2009). Also, swimming is affordable to everyone, because of the fact it can be a professional, recreational and even rehabilitation activity. It is mainly individual, but it has team sport aspects mainly depending on disciplines (relays) and training environment. It fits in a monostructural cyclic activities, which is in accordance with developing of optimal length and frequency of stroke in regard of energy expenditure (Reić Rebov, 2016).

Today's sport competition is getting larger every day, whereas similar trend is visible in swimming. Therefore, the fact that young swimmers are in unfavorable psychological position, for example emotional burnout. This burnout leads to higher perfectionism levels in athletes (Jowett, Hill, Hall & Curran, 2016). Today's sport is requesting higher physiological and psychological demands from athletes. These demands are not only affecting senior athletes, but they are also noticeable in juniors. This environment could lead to series of negative affects that are influencing athlete's psychological health (Wright, 2017).

It is well known that better performance determine success, but overthinking and burden of high performance can lead to negative consequences in terms of perfectionism.
According to some authors perfectionism is defined as sort of obsessive-compulsive behavior (Frost, Novara & Rheaume, 2002). Perfectionism is also a multi-dimensional concept which could be divided into 3 aspects: directed towards yourself, directed towards others and socially prescribed perfectionism. It can encourage person to set certain goals and develop self-improvement (Goldner, Cockell i Srikameswaran, 2002), respectively it can stimulate better performance in task execution. Therefore, perfectionism is not always a negative term, but too much of it can lead towards emotional burnout and under achieving.

In the available literature there is a lack of psychology research in swimming, and especially in younger age groups. Furthermore, evaluation of psychological characteristics can lead to level of performance in individual sports. Therefore, aim of this study was to assess the psychological characteristics of perfectionism in junior category swimmers and to determine differences between gender groups.

## METHODS

### *Participants*

The sample of participants included 36 swimmers from swimming clubs in Croatia. Participants were divided into 2 groups, according to gender: Males (N=19) and Females (N=17). Mean chronological age of participants was 15.28±1.26 years Athletes were informed about the procedures and aims of the research and filled the anonymous on-line questionnaire.

### *Variables and procedure*

For perfectionism revision the Sport Multidimensional Perfectionism Scale (Dunn et al., 2006) was used. It was repurposed for this study by rejecting 9 questions about the parental pressure. After getting the answers, questions were divided into 5 categories, accordingly: Personal standards, Concern over mistakes, Perceived coach pressure, Perceived parental pressure, Doubts about actions and Organization. Which were processes according to Dunn et al. (2006).

### *Statistical analysis*

Descriptive statistics parameters were calculated: arithmetic mean and standard deviation for the 5-point Likert scales, and absolute and relative frequency values for all categories of perfectionism and optimism, on the whole sample of participants. Furthermore, T-test was applied to determine the differences in the psychological questionnaire between different groups of participants.
All of the data was analyzed in the software app. Statistica version 13.0.

## RESULTS

Table 1. Shows descriptive parameters in all measured variables for the whole sample of participants (N=36). Body mass (64.31±9.85) and body (175.75±9.87) are showed. Also, it includes optimism scale and 6 categories of perfectionism scale, accordingly: Personal standards, Concern over mistakes, Perceived coach pressure, perceived parental pressure, Doubts about actions and Organization. It can be noted that participants perceived biggest results in Personal standards (3.10±0.74) and Organization (3.06±0.95). Furthermore, lowest results were measured in Perceived parental pressure (2.17±1.07).

*Table 1: Descriptive indicators and sensitivity of the validated scales of the questionnaire used on a sample of swimmers (N=36)*

| Variables | AM± SD | Min | Max | Skew | Kurt |
|---|---|---|---|---|---|
| **Body mass (kg)** | 64.31±9.85 | 48.00 | 87.00 | 0.34 | -0.77 |
| **Body height (cm)** | 175.75±9.87 | 157.00 | 203.00 | 0.43 | 0.20 |
| **Personal standards** | 3.10±0.74 | 1.14 | 4.57 | -0.07 | 0.49 |
| **Concern over mistakes** | 2.49±0.79 | 1.13 | 4.63 | 0.73 | 0.07 |
| **Perceived parental pressure** | 2.17±1.07 | 1.00 | 4.89 | 0.88 | -0.18 |
| **Perceived coach pressure** | 2.39±0.96 | 1.17 | 5.00 | 0.97 | 0.29 |
| **Doubts about actions** | 2.39±1.05 | 1.00 | 5.00 | 0.81 | 0.29 |
| **Organization** | 3.06±0.95 | 1.29 | 4.86 | 0.08 | -0.59 |

**Legend: AM** – arithmetic mean, **Min** – minimum result, **Max** - maximum result, **SD** - standard deviation, **Skew** – coefficient of distribution asymmetry, **Kurt** – coefficient of distribution peak.

Analysis of variance of psychological characteristics and differences in both groups are showed in table 2. By analyzing the results only one category perceived significant difference between groups, and that is Concern about mistakes (p=0.04). Furthermore, in other variables (personal standards, and perceived coach pressure) males expelled better results than females. Moreover, in perceived parental pressure, doubts about actions and organization females got bigger scores.

*Table 2: Analysis of variance of psychological characteristics of swimmers in both groups (N=36)*

| Variables | Groups | | | | F | p |
|---|---|---|---|---|---|---|
| | Males (N=19) | | Females (N=17) | | | |
| | AM | SD | AM | SD | | |
| **Personal standards** | 3.19 | 0.64 | 3.01 | 0.84 | 1.75 | 0.47 |
| **Concern over mistakes*** | 2.23 | 0.67 | 2.77 | 0.84 | 1.60 | 0.04 |
| **Perceived parental pressure** | 1.99 | 0.88 | 2.37 | 1.24 | 1.97 | 0.29 |
| **Perceived coach pressure** | 2.57 | 1.03 | 2.20 | 0.86 | 1.44 | 0.25 |
| **Doubts about actions** | 2.18 | 0.81 | 2.64 | 1.25 | 2.39 | 0.20 |
| **Organization** | 2.93 | 0.89 | 3.20 | 1.02 | 1.30 | 0.40 |

**Legend**: **AM** – arithmetic mean; **SD** – standard deviation; **F** – coefficient of one-way analysis of variance; ***** – statistical significance of the F coefficient; **P** – level of statistical significance of the F coefficient.

## DISCUSSION

This study aimed to assess the psychological characteristics of perfectionism in junior category swimmers and to determine differences between gender groups. Results revealed that significant differences exist only in Concern over mistakes category of Perfectionism questionnaire. Moreover, boys and girls did not differ in other examined categories (Personal standards, Perceived parental pressure, Perceived coach pressure, Doubts about actions, Organization). However, even though they were not significant some differences have been perceived.

The found differences could be explained by maturation and sport category of participants. The aforementioned results showed that girls are have significantly more concern over mistakes than boys of this study. Maturation in girls come earlier than in boys, because of earlier puberty age in girls (Kaplowitz, et al., 2001). Furthermore, even if both groups do not differ in chronological age, they may have differences in psychological maturation.

Precisely, their maturation level implies that they are still in psychological development phase which leads to having more pressure. According to Trninić, Trninić, and Penezić (2016), this development phase leads to more worries about other peoples' opinion about their performance and mistakes in sport. Furthermore, swimmers of this study are in youth categories of swimming. According to Henriksen, Storm, Stambulova, Pyrdol, and Larsen (2019), most important results of youth athletes are in the future, this increases the fact that they are more worried about their mistakes. Similar trend was previously showed on youth skiers, where their worry about mistakes is higher than in senior skiers (Fawver, Cowan, DeCouto, et al., 2020).

Other results did not reveal significant differences in other variables, but they are existing. For example, boys perceived higher scores in Personal standards, and have better tolerance in Parental pressure. In perceived coach pressure category girls have better toleration for coach's pressure. According to Duda, Fox, Biddle & Armstrong (1992), boys that had higher score in personal standards were ultimately better than girls in sports. This finding is in accordance with previous study which showed that because of earlier maturation, in boys same age, some of them have easier toleration and process of critic and advice (Granito, 2002). Furthermore, boys have lower doubts about action but are less organized than girls. Which could be affected by more caution in performance than boys.

## CONCLUSION

The study results showed significant differences between boys and girls in perfectionism category of Concern over mistakes. Girls show much higher worry for mistakes in their sports performance than boys. This finding implies that sport today is psychological and physiological more demanding than before. Whereas, girls are less physically strong than boys at this age, because of they need to be more focused on avoiding mistakes in their performance. Furthermore, the fact that boys are more active in their free time could not be avoided.

Limitations of this study is participants honesty. Even do questionnaire is anonymous there is always possibility of giving socially acceptable answers. Future research should include bigger number of participants, but this topic in swimming is lacking and therefore should be more investigated.

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# Relations between Body Gold Ratios and Competition Degrees in Elite Monofin Swimmers

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## ABSTRACT

In the present study, the golden ratios were determined on the photographs from predetermined region that taken from 10 monofin swimmers who swim 200 meter in the final series of the country championship in Turkiye. The relationships between various golden ratios on body anthropometric measurements and real sportive performance achievement degrees was introduced. The golden ratio human model developed by Ernst Neufert was used to determine the golden ratios. The pixel counting feature of the line tool of the Photoshop CC software program was used in the analysis of the photographs. It was determined four body distances in two ratios, and the large distance was divided by the small distance. The ratios of each subject's measurements in the upper and lower body regions (floor to below the knee distance / below the knee to navel distance and navel to shoulder distance / shoulder to head distance) were ranked according to the approximation level to the golden ratio according to golden ratio that is accepted as 1,618. These determined golden ratio rankings were associated with the actual degrees of the athletes in the final competition. A higher correlation was found between the ranking degree of navel-to-shoulder distance / shoulder to head distance ratios (Mean: 1,718 ± 0,12) and competition degrees ($r$ =0,926) ($p < 0.05$). In the second region; there was also high correlation between the floor to below the knee distance / below the knee to navel distances (Mean: 1,586 ± 0,03) and competition degrees ($r$ = 0,896) ($p < 0.05$).

**Keywords:** Golden ratio, Monofin Swimmers, Success in sport.

## INTRODUCTION

There is one mathematical element with strong historical and philosophical background that exhibits remarkable properties and applications; the golden ratio (phi). Mathematically, the golden ratio equals approximately 1.61803.

The relationship between human body gold ratios and health has been the subject of scientific studies. However, to our knowledge, there is no literature examining the relationship between sports success and golden ratio of athletes up to now.

In this study, the golden ratios were determined on the photographs from predetermined region that taken from 10 monofin swimmers who swim 200 meter in the final series of the country championship. The relationships between various golden ratios on body anthropometric measurements and real sportive performance achievement degrees was introduced. The golden ratio human model developed by Ernst Neufert was used to determine the golden ratios. The pixel counting feature of the line tool of the Photoshop CC software program was used in the analysis of the photographs. It was determined four body distances in two ratios, and the large distance was divided by the small distance. The ratios

of each subject's measurements in the upper and lower body regions (floor to below the knee distance / below the knee to navel distance and navel to shoulder distance / shoulder to head distance) were ranked according to the approximation level to the golden ratio according to golden ratio that is accepted as 1,618. (Such as; Golden ratio 1., 2., 3., ... 10.). These determined golden ratio rankings were associated with the actual degrees of the athletes in the final competition. Thus, the present study aimed at exploring the relationship between the swimmer's approximation to the golden ratios and their degrees in the swimming competition.

## METHODS

In this study Ernst Neufert's golden ratio human model was used. The ratios of each subject's measurements in the upper and lower body regions (floor to below the knee distance / below the knee to navel distance and navel to shoulder distance / shoulder to head distance) were ranked according to the approximation level to the golden ratio according to golden ratio that is accepted as 1,618.

The proportions were determined by dividing the larger part into the smaller part on the lengths of the four body regions visible in the image. The pixel counting feature of the line tool of the Photoshop CC software program was used in the analysis of the photographs.

In this study, the golden ratios were determined on the photographs from predetermined region that taken from 10 monofin swimmers who swim 200 meter in the final series of the country championship. The relationships between various golden ratios on body anthropometric measurements and real sportive performance achievement degrees was introduced.

The statistical procedures employed in the present study are twofold. First, the descriptive statistics were determined by the means and standard deviations. Second, the relationship between gold ratio approximation ranking and swimming performance degree was explored by the Pearson correlation coefficient. All statistical tests were employed in the SPSS 21 package. For the statistical significance of the tests, the cut-off point was set as $p < .05$.

Prior to the study, the ethical approval letter was retrieved from the Non-Interventional Studies Ethical Board of Hitit University. For the participants, who were willing the participate in the study, a written informed consent was retrieved.

## RESULTS and DISCUSION

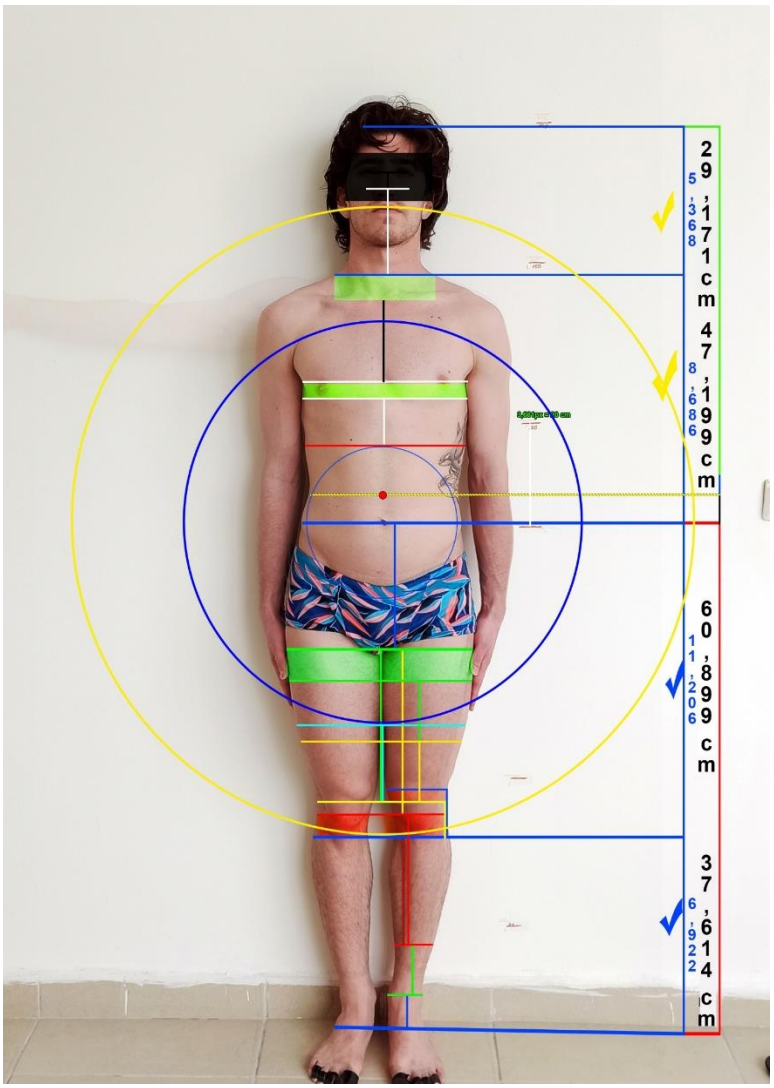
In the present study, the relationship between the golden ratio approximation of the swimmers and their sportive performance was examined. The relationship between human body gold ratios and health has been the subject of scientific studies recently (Henein, 2011; Kazankov, & Gubin, 2020; Yalta, Ozturk, & Yetkin, 2016). To our knowledge, this is the only and pioneering research study exploring this relationship. Therefore, there is no established literature supporting or contracting our results.

Determined golden ratio rankings in this study were associated with the actual degrees of the athletes in the final competition. A Higher correlation was found between the ranking degree of navel-to-shoulder distance / shoulder to head distance ratios (Mean: 1,718 ± 0,12) and competition degrees ($r$ =0,926) ($p < 0.05$).

The finswimmer shown in Figure 1 is Turkey's record holder and he came first in the races. At

the same time, he was determined as the closest athlete to the golden ratio.

Figure 1: Upper and Lower Body Distances and Golden Ratios in 200 Meters Monofin Champion Swimmer




In the second region; there was also high correlation between the floor to below the knee distance / below the knee to navel distances (Mean: 1,586 ± 0,03) and competition degrees (r = 0,896) ($p < 0.05$). Detailed findings related to this study shown in the Table 1.

Table 1: Upper and Lower Body Distances and Golden Ratios in 200 Meters Monofin Swimmers

| *Floor to below the knee* | *Below the knee to navel (cm)* | *Floor to below the knee / Below the knee to navel* | *Navel to shoulder (cm)* | *Shoulder to head (cm)* | *Navel to shoulder / Shoulder to head* | *Competition Degree* | *Golden Ratio Rankings Region 1* | *Golden Ratio Rankings Region 2* |
|---|---|---|---|---|---|---|---|---|
| *37,614* | *60,899* | *1,619* | *47,199* | *29,171* | *1,618* | *1:22.99* | *1* | *1* |
| *36,754* | *59,691* | *1,624* | *49,172* | *30,453* | *1,614* | *1:31.77* | *2* | *2* |
| *40,665* | *65,812* | *1,618* | *42,189* | *29,033* | *1,453* | *1:33.56* | *1* | *4* |
| *36,846* | *59,065* | *1,603* | *49,605* | *29,749* | *1,667* | *1:36.67* | *3* | *3* |
| *35,840* | *56,345* | *1,572* | *49,677* | *27,597* | *1,800* | *1:37.67* | *5* | *6* |
| *36,646* | *57,790* | *1,577* | *49.552* | *27,620* | *1,794* | *1:40.30* | *4* | *5* |
| *37,110* | *58,262* | *1,570* | *48,198* | *26,658* | *1,808* | *1:41.93* | *6* | *8* |
| *36,808* | *57,714* | *1,568* | *48,958* | *27,108* | *1,806* | *1:42.76* | *7* | *7* |
| *37,296* | *57,846* | *1,551* | *47,019* | *25,963* | *1,811* | *1:45.17* | *9* | *10* |
| *37,606* | *58,439* | *1,554* | *47,201* | *26,092* | *1,809* | *1:49.24* | *8* | *9* |

## CONCLUSION

High relations have been found between sportive success and golden ratio for this subject group show that human body golden ratios are effective to sports performance.

In this study, it was determined that body anthropometry and golden ratio were highly effective in the success of sportive performance in monofin swimmers; therefore, it is considered important to include the human body golden ratio in the evaluation of talent selection.

Are these statistical findings a matter of impression (alchemy), a statistical “illusion” or the results of real biological and physical principles? Further evidence-based researches especially on all sports branches with large samples will give us the answer.

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# Perception and knowledge about proper nutrition in general and sports nutrition in water sports athletes

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**Abstract:** Proper nutrition, in general, is a key to a healthy life and in sports means the difference between 1st and 2nd place. Sailing is a water sport that is very popular in Croatia and it is enrolled mostly by younger athletes. This paper is focusing on exploring the knowledge of said young sailing athletes in Split, Croatia. The questions in this survey were taken from validated questionnaires and modified to match the group of respondents. We examined their knowledge of nutrition in general (foods rich in proteins, carbohydrates, and fats) with a few general questions regarding sports nutrition. The results weren't as promising as we thought, but the sample was too small and the age of the respondents was a contributing factor. What we can conclude is that sports clubs in Split should educate their competitors on food science in a way of presentations by nutritionists or workshops so they could improve their diet and maximize their sports results.

**Keywords: sailing, diet, sports results, carbohydrates, protein, fats**

## Introduction

Nutrition is the basis of success, especially for competitors in strength and power sports (Slater and Phillips, 2011). When preparing for a competition, the nutritional status of food, the time of consumption, and the amount of food are extremely important. In addition to helping to improve performance, proper nutrition has three extremely important roles in sports: fuelling the body during training, helping athletes recover after training, and acting as a promoter of individual adaptations to training (e.g. muscle hypertrophy) (Ihatsu, 2018)). In the research conducted by Bernardi et al. the sailors of America's Cup team had been evaluated by their nutrition habits. The results indicated the lack of knowledge and eating by intuition instead of the general recommendations for athletes. The sailors had a higher protein intake than needed and a lower carbohydrate intake (they were consuming less than 50% of recommended carbohydrates to replenish glycogen storage, and 70% more protein then needed) (Bernardi et al., 2010). The recommendations for sailing athletes in particular are very tight and the researches of nutrition knowledge in sailors are almost non-existing. Jeni Pearce, a sports dietitian, was involved in sailing and gave 3 key points regarding nutrition in sailors: 1. reducing the loss of lean mass that is needed for strength; 2. maintaining muscle glycogen and blood glucose levels for endurance, concentration and coordination; 3. maintaining fluid balance (big nutrition concern) where she encouraged the use of sports drinks (Burke, 2003). One study followed elite sailor's and their change in knowledge after the adoption of „sports science support (SSS) programme "where they were educated about sports nutrition. Their fluid intake improved, as well as the increase in performance, volume and intensity of physical training. The results concurred that their knowledge, psychology, and physical conditioning improved (Mackie and Legg, 1999). The main goal of this research was to assess nutrition knowledge of younger sailors in Split and compare it between genders and competitive level.

## Methods

This research was carried out with 21 members of Split sailing clubs. Sailors were mostly male (13 respondents), and mostly competitive sailors (15 respondents). The research was conducted as a questionnaire in Google Forms, and is divided into two parts. The first set of questions referred to socio-demographic questions: 13 respondents were male, 8 respondents were female; the age of the respondents is between 14-16 years, with few older respondents (20, and 21 years). Most of the respondents have been practicing that sport for over 3 years (17 respondents) and the rest have been in the sport for less than a year. A bigger number of the respondents are actively participating in competitions (15 respondents). We assumed that people in top sports, i.e. competitors, have better knowledge about proper nutrition and the nutrition of athletes, considering the impact of nutrition on sports performance. The second part of the questionnaire referred to general knowledge about nutrition and sports nutrition.

The questions used in this questionnaire were taken from the validated questionnaires of Parmenter and Wardle (1999) and Blennerhassett et al. (2018) with the modification according to Šatalić et al. (2016). In the questionnaire, we decided on a closed answer type. Data processing was carried out using an Excel programme and the frequencies and percentage values of individual variables were calculated. The questionnaire did not cover anthropometric values of said sailors, so no comparisment was made with their status or body composition.

## Results and Discussion

To assess the knowledge of our respondents, 11 questions related to proper nutrition were asked.

The first, third and fifth question referred to respondents' knowledge about food composition; whether the certain foods are rich or low in protein, carbohydrates and fats. Also, respondents could mark the answer "I'm not sure".

**Table 1.** Results of correct answers for Questions number 1,3 and 5

| **1. Question: Are the following food rich or low in proteins?** | | | | | | |
|---|---|---|---|---|---|---|
| | Correct answer | **All** | **Male** | **Female** | **Recreationists** | **Competitors** |
| | | **%** | **%** | **%** | **%** | **%** |
| Tukey | Rich | 90% | 92% | 88% | 83% | 93% |
| Banana | Low | 67% | 69% | 63% | 67% | 67% |
| Cheese | Rich | 71% | 85% | 50% | 67% | 73% |
| Margarine | Low | 81% | 69% | 100% | 100% | 73% |
| Peanuts | Rich | 67% | 69% | 63% | 67% | 67% |
| Potato | Low | 81% | 85% | 75% | 67% | 87% |

| **3. Question: Select if the food is rich or low in fats:** | | | | | | |
|---|---|---|---|---|---|---|
| | Correct | **All** | **Male** | **Female** | **Recreationists** | **Competitors** |
| Pasta | Low | 90% | 88% | 81% | 83% | 93% |
| Honey | Low | 67% | 63% | 71% | 83% | 60% |
| Nuts | Rich | 62% | 88% | 90% | 50% | 67% |
| Eggs | Rich | 81**%** | 100% | 52% | 83% | 80% |
| Margarine | Rich | 52% | 38% | 86% | 83% | 40% |
| Butter | Rich | 100% | 100% | 95% | 100% | 100% |
| Bread | Low | 67% | 63% | 67% | 83% | 60% |

| 5. Question: Select if the food is rich or low in carbohydrates: | | | | | | |
|---|---|---|---|---|---|---|
| | **Correct answer** | **All** | **Male** | **Female** | **Recreationists** | **Competitors** |
| Sardines | Low | 86% | 85% | 88% | 83% | 87% |
| Popcorn | Rich | 67% | 62% | 75% | 33% | 80% |
| Chicken | Low | 86% | 85% | 88% | 83% | 87% |
| Oatmeal | Rich | 76% | 77% | 75% | 67% | 80% |
| Butter | Low | 67% | 69% | 63% | 67% | 67% |
| Spaghetti | Rich | 95% | 92% | 100% | 83% | 100% |
| Cedevita | Rich | 33% | 31% | 38% | 33% | 33% |

As per Table 1. we can see that their knowledge of protein foods is adequate. The female population had a lower percentage of correct answers regarding „cheese" and „peanuts" being rich in protein. In general, competitors had more correct answers regarding protein, which wasn't suprising. The third question regarding the fats in food had some expected correct answers (pasta, eggs, butter), but what surprised us was that only 52% of the female, and 100% of male population knew that eggs are rich in fats. Also, what was unexpected was the lack of knowledge that margarine is rich in fats: 52% of all respondents knew this statement. Competitors had a lower percentage of correct answers (71%) in comparison to recreative athletes (80%). The fifth question concerned the carbohydrates in food. Recreative athletes failed to recognize that popcorn (a whole grain cereal) is rich in carbs (33% correct asnwers). Other foods had a higher percentage of recognition except for „Cedevita" where the percentage of correct answers was very low. Here we can see the younger athletes don't know what is in their beverages.

The second question, "Which fats are recommended to be taken in small amounts?" referred to the reduced intake of saturated fatty acids and their sources, that is, how a proper diet should emphasize monounsaturated and polyunsaturated fatty acids.

**Table 2.** Results for correct answers for Question number 2

| 2. Question: Which fatty acids should we consume in smaller quantities? | | | | | | |
|---|---|---|---|---|---|---|
| | **Correct answer** | **All** | **Male** | **Female** | **Recreationists** | **Competitors** |
| | | **%** | **%** | **%** | **%** | **%** |
| Monounsaturated fats | | 5 | 13 | 0 | 0 | 7 |
| Polyunsaturated fats | | 5 | 13 | 0 | 17 | 0 |
| Saturated fats | Saturated fats | 67 | 50 | 77 | 83 | 60 |
| I don't know | | 24 | 25 | 23 | 0 | 33 |

Not enough respondents answered this question correctly (67%). The female population had more correct answers (77%) than the male (50%). Also, surprisingly a group of recreational athletes had more correct answers than competitors even though they do not compete as professional sailors. In the male population, some thought the monounsaturated and polyunsaturated fats need to be taken in smaller quantities which is a lack of knowledge in essential fats, while the rest of the females decided to answer with „I don't know".

Next question is related to the agreement with certain statements. The stated claims were "Whole milk contains more protein than skim milk", "Whole milk contains more calcium than skim milk" and "Flax seeds, chia seeds, and walnuts are a good source of omega 3 fatty acids".

**Table 4.** Results for correct answers for Question number 4

| 4. Question: Do you agree with the following? | | | | | | |
|---|---|---|---|---|---|---|
| | **Correct** | **All** | **Male** | **Female** | **Recreationists** | **Competitors** |
| Whole milk contains more protein than skim milk. | NO | 57% | 62% | 50% | 67% | 53% |
| Whole milk contains more calcium than skim milk. | NO | 48% | 46% | 50% | 50% | 47% |
| Flax seeds, chia seeds, and walnuts are good sources of omega-3 fatty acids. | YES | 62% | 62% | 62% | 83% | 53% |

In this question, the rate of correct answers was low in all categories which indicates a lack of knowledge of the composition of food and the ingredients in it. The lowest percentage was in question regarding minerals in food (calcium).

The next question is related to the agreement with certain statements. The statements were related to sports performance, and read "Negative impact on sports performance is observed when body mass is reduced by more than 2%", "Water is useful for quenching thirst, but sometimes it is not the most effective way of rehydration" and "Too high concentration of carbohydrates in sports drinks (8-10%) can cause gastrointestinal disturbances and slow down the emptying of the stomach".

**Table 6.** Results for correct answers for Question number 6

| 6. Question: Do you agree with the following? | | | | | | |
|---|---|---|---|---|---|---|
| | **Correct** | **All** | **Male** | **Female** | **Recreationists** | **Competitors** |
| A negative impact on sports performance is observed when body mass is reduced by more than 2% | YES | 62% | 85% | 25% | 67% | 60% |
| Water is useful for quenching thirst, but sometimes it is not the most effective way to rehydrate | YES | 62% | 69% | 50% | 67% | 60% |
| Too high a concentration of carbohydrates in sports drinks (8-10%) can cause gastrointestinal disturbances and slow down the emptying of the stomach | YES | 59% | 46% | 63% | 33% | 60% |

Females had a lower percentage of correct answers to questions regarding hydration (25% of correct answers in 1$^{st}$ statement and 50% of correct answers in 2$^{nd}$ statement). Recreative sailors had a low rate of correct answers for the statement regarding sports drinks (only 33%).

The seventh question asked if our respondents knew that delaying the intake of protein and carbohydrates for 1 hour after physical activity, instead of taking it at the end, can have negative effects on some immune parameters.

**Table 7.** Results for correct answers for Question number 7

| **7. Question: Postponing the intake of protein and carbohydrates for 1 h after the TA, instead of the intake at the end of the activity, can have negative effects on some immune parameters?** | | | | | |
|---|---|---|---|---|---|
| **Correct answer** | **All** | **Male** | **Female** | **Recreationists** | **Competitors** |
| | % | % | % | % | % |
| Correct | 67 | 69 | 63 | 83 | 60 |

More than half of the respondents (66.7%) knew that delaying the intake of protein and carbohydrates can have negative effects on recovery after physical activity, muscle protein synthesis, and the filling of glycogen stores that were depleted during activity. A very low percentage of competitors (60%) managed to recognize that postponing the intake of food could hinder their progress.

The eighth question complemented the previous one, and we were interested in the optimal time frame for food intake after training. Probably prompted by the previous question, most respondents chose “within 1 hour of training” as the optimal time frame in which to ingest nutrients after training. All groups answered correctly (in high percentage rates) as to take the food within an hour after workout for optimal utilization.

**Table 8.** Results for correct answers for Question number 8

| **8. Question: When an athlete trains daily, the optimal time for food intake after training is?** | | | | | | |
|---|---|---|---|---|---|---|
| | **Correct answer** | **All** | **Male** | **Female** | **Recreationists** | **Competitors** |
| | | **%** | **%** | **%** | **%** | **%** |
| Within 1 hour | Within 1 hour | 86 | 92 | 75 | 83 | 87 |
| Between 2-3 hours | | 14 | 8 | 25 | 17 | 13 |

The next question asked the respondents to choose a "snack" they would take during training/match when their sugar "crashes". The majority of respondents chose "breakfast biscuit" as the correct answer (81% of respondents). Considering that the correct answer to this question was "milk", only 1 respondent answered correctly.

**Table 9**. Results for correct answers for Question number 9

| **9. Question: If the athlete has a low sugar during training/match, will he compensate for it better by consuming:** | | | | | | |
|---|---|---|---|---|---|---|
| | **Correct answer** | **All** | **Male** | **Female** | **Recreationists** | **Competitors** |
| | | **%** | **%** | **%** | **%** | **%** |
| Breakfast biscuit | | 95 | 92 | 100 | 100 | 93 |
| Milk | Milk | 5 | 8 | 0 | 0 | 7 |

Even though the correct answer here was „milk" only one respondent answered correctly. From the statistic, we can see that the respondent was male and an active competitor in sailing. Low-fat chocolate milk contains B group vitamins, calcium, vitamin D, sodium, proteins, and carbohydrates, which makes it desirable for consumption during physical activity. Its benefits for replenishing glycogen stores, restoring and growing muscles, rehydration, and replenishing electrolytes have been proven (Karfonta i sur., 2010).

We also examined the knowledge of the composition of sports drinks, which are often consumed in the sports world, either by

recreational players or by competitors. The results are not disappointing, given that most respondents answered correctly.

**Table 10.** Results for correct answers for Question number 10

| 10. Questions: What are the ingredients of sorts drinks to replace lost body fluids during training: | | | | | | |
|---|---|---|---|---|---|---|
| | **Correct** | **All** | **Male** | **Female** | **Recreationists** | **Competitors** |
| | | **%** | **%** | **%** | **%** | **%** |
| Water, electrolytes, sugar | Water, electrolytes, sugar | 81 | 85 | 75 | 83 | 80 |
| Water, caffeine, electrolytes, sugar | | 19 | 15 | 25 | 17 | 20 |

The last question examined the knowledge of protein intake in athletes after training. Most respondents chose "0.4 g of protein/kg of body weight" as the correct answer. Although protein intake is expressed as g protein/kg body weight and this could potentially be confusing for our subjects, the correct answer is "20 g protein". Namely, protein intake in the amount of 20 g several times a day (5-6 times) enables optimal muscle hypertrophy. Only 2 respondents answered correctly.

**Table 11.** Results for correct answers for Question number 11

| 11. Question: Recommended dose of protein after workout is: | | | | | | |
|---|---|---|---|---|---|---|
| | **Correct answer** | **All** | **Male** | **Female** | **Recreationists** | **Competitors** |
| | | **%** | **%** | **%** | **%** | **%** |
| 10 g | | 29 | 23 | 38 | 17 | 33 |
| 0,4 g protein/BM | | 62 | 69 | 50 | 83 | 53 |
| 20 g | 20 g | 10 | 8 | 13 | 0 | 13 |

## Conclusion

With this questionnaire we examined the knowledge of younger athletes that are practicing or competing in sailing. There were few deficiencies: the number of respondents is too low to make greater assumptions, and the formulation of questions should be open type to extend the range of possible answers. There were possibly some doubts regarding the question related to protein intake, because the answer of 0.4 g/kg body weight could lead respondents to believe that the intake depends on the weight of the athlete, which is common for proteins. Protein intake may depend on the type of sport, and the recommendation of 20 g is a general recommendation, which could be indicated in the question. We can conclude that this subject group did not have much knowledge of the food's rich in protein, carbohydrates, or fats (surprisingly the respondents didn't know that Cedevita is rich in carbohydrates or that eggs are rich in fats). What surprised us is the fact that the female population as well as the competitive sailors had less correct answers in some aspects where we thought they would dominate (such as delaying of the food intake, hydration and sports drinks, and the macro- and micronutrients in food). We can ascribe that to the age of the respondents as well as their level of education. The respondents are younger athletes who are still shaping their eating habits, with a very big influence of society and media. As they are growing as people and in their sport, they need quality leadership and adequate knowledge in sports nutrition. It's

necessary to have nutrition educational classes as a part of their training session if they want to achieve better sports results.

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# Reliability and Validity of a New Agility Test and Skill for Young Water polo Players

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## ABSTRACT

As in every team sport, the importance of agility is very well recognized. There are few previous studies which test in-water water polo agility but there is an evident lack of their applicability. Creating a new test that is simple to use, with quick and reliable extraction of data could be of big use for water polo coaches when testing and training specific agility. The aim of this study was to evaluate reliability and validity of newly developed test for pre-planned water polo agility. 23 elite junior male water polo players from two Croatian water polo clubs were evaluated using a newly developed in-water pre-planned agility test. The test was performed using Blazepod flash reflex training system mounted on the water polo goal. In each trial players' task was to touch the pod that lights up with the closer hand to the pod with the other hand performing a block. There were 6 light reaction during each and every trial with the same lighting up protocol. Each participant performed the test three times with a pre-test familiarization. The reliability analyses included calculation of intra-session Cronbach Alpha (CA) and Inter-Item-Correlation (IIR), as well as analysis (ANOVA) for repeated measurements. All the light reactions except for PPAPN4, PPAPN1, and PPAPN3 had sufficient internal consistency. Results of ANOVA had shown statistically significant differences between the testing units except for the first light reaction. We assumed that it can be a matter of familiarization. Main problem of familiarization can be solved by more testing trials which would result in stabilization of the results or pre-testing familiarization process should be more clearly explained and executed. New pre-planned agility test is reliable but its stability is insufficient. Larger number of participants, better and longer familiarization process should be important to consider when creating future studies. Due to lack of these type of tests, this study has scientific and practical value.

**Keywords:** in-water test, specific agility, change of direction speed, light reaction, test familiarization

## INTRODUCTION

Water polo is a team sport that featured in the second modern Olympics in 1900 in Paris while the women's water polo tournament was introduced in 2000 Summer Olympics in Sydney. Water polo belongs in the category of polistructural complex motions (Lozovina et al., 2010). It is considered as a highly-demanding physical activity where the players swim, wrestle, pass and shoot the ball as well as doing other complex tasks within the full 4 x 8 min match. There are many factors affecting the game of water polo. Takagi et al. (2005) gathered the data from 108 matches of the world water polo championship in 2001 (60 men matches and 48 women matches) to determine the factorial structure of the game performance. They have concluded that there are two key areas that determine the game outcome. First, the realization of counterattacks

and the second being the ability to defend with player less. Better teams were more successful with blocking and saving shots from the opponent team. Like in every team sport the outcome of every match is determined by the score. Meaning, the winning team is the one with most goals. In order to gain scoring opportunities opposing teams are attempting to invade their opponent's territory to enhance scoring opportunities (Young, Dawson, & Henry, 2015). Since quick changes of direction are common in water polo, agility could play a key role in those attempts and thus so influence the final outcome of the game. Agility is defined as a rapid whole-body movement with changes of velocity or direction in response to a stimulus (Shepard & Young, 2006) and it has two manifestations (Young, Dawson, & Henry, 2015). The first one is non-planned or reactive agility, where players perform a change in direction while reacting to an external stimulus. The second agility manifestation is called pre-planned or non-reactive agility where players have an advanced knowledge of the directional change. The pre-planned agility is commonly referred to as the change of direction speed (Sheppard & Young, 2006). The lack of research working on agility is evident. Small number of papers were published but they clearly had limitations. Mainly, these papers (Tucher et al., 2014, Tucher et al., 2015, Tucher et al., 2016) using the same test (Functional Test for Agility Performance – FTAP) had problems with: insufficiently determined criteria for starting and ending the time measurement, the participation of an additional players in the testing of one subject that potentially represent an additional variable, the creation of the test field that limits wide use and the most important thing - game conditions that are much more complex than swimming for the ball. With more recent study (Dong et al., 2021) authors had an aim to create an easily implementable sport-specific water polo in-water agility test. They have created a more reliable test when compared to the FTAP test. TV screen was used poolside which might not be an ideal scenario for every pool. With new sport testing equipment being developed each year they are becoming each more available to much larger number of coaches and athletes. That equipment as reflex training light-reaction system with the corresponding mobile phone app could be much more practical in everyday use today. Creating the new tests and testing protocols is getting simpler where the athletes and coaches might get great benefits. The aim of this paper was to evaluate the reliability and validity of newly developed test for pre-planned water polo agility.

## METHODS

### *Participants*

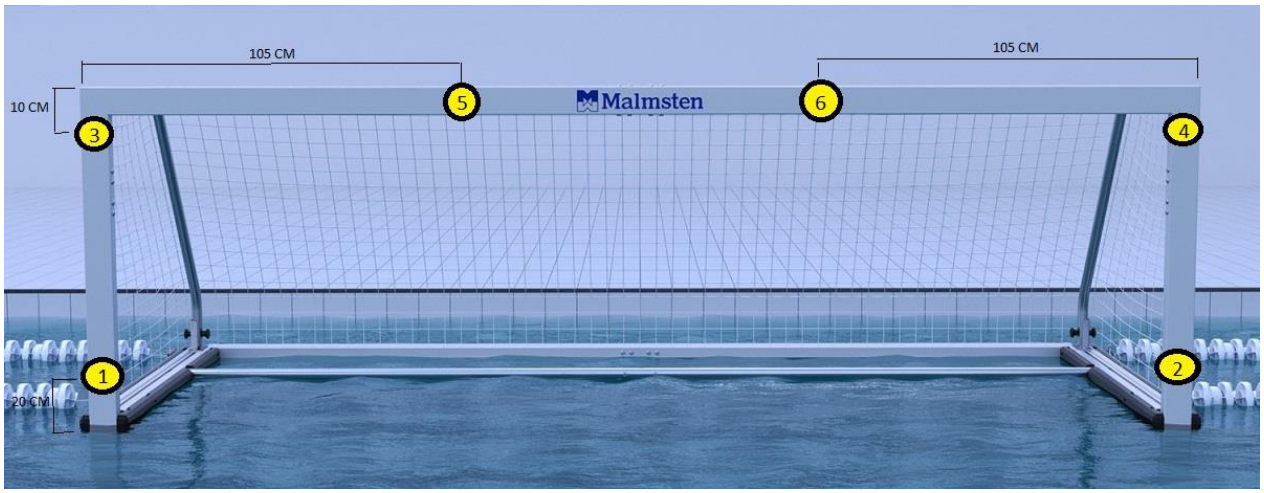
Twenty-three young men elite junior athletes from two Croatian water polo clubs from two different cities were included in the study. Both teams are competing at the national level. At the time of collecting the measures all the players were healthy with no injuries.

### *Variables and procedure*

Testing was performed during the second half of the competitive season during team training sessions. Innovative system of reflex training called Blazepod was used and the lighting up protocol was created in the Blazepod mobile phone application. For the pre-planned agility test we used six light pods that were set up on the water polo goal (see Fig. 1). Additionally, all the pods were protected from water with transparent plastic bags. The lighting up protocol was as follows: 6-2-4-5-1-3 with a one second delay after touching the previous pod. The pods would turn off on hit and the start of the test was given by the examiner after the

three second countdown. The participants performed three repetitions of the test with a familiarization trial before the start. The players were verbally motivated during the test. Starting position was set in front of the goal in the middle so the participant could have every pod in their eyesight. Each player started the test with left arm raised in the air simulating the block in the game. After the start of the test each players had to hit the lit-up pod with corresponding hand (pods 2,4 and 6 with the right hand and pods 1, 3 and 5 with the left hand). Rest in between repetitions was larger than one minute. Blazepod mobile application provided the results of total test time of each repetition (PPAT), average reaction time for each repetition (PPAAVG), and time of each reaction individually.

Figure 1: *Pods setup for pre-planned agility test*




## RESULTS and DISCUSSION

The indicators of reliability of the newly developed test of water polo specific PPA are presented in Table 1. ANOVA revealed significant differences among testing trails. There is a trend of improvement in the testing results.

Table 1: *Descriptive statistics and reliability analysis (CA – Cronbach Alpha, IIR – inter-itemcorrelation, F-test among trials) for water polo pre-planned agility test*

| | Mean | SD | CA | IIR | F test | p |
|---|---|---|---|---|---|---|
| PPA1PN6 | 776.83 | 192.05 | | | | |
| PPA2PN6 | 710.65 | 269.65 | | | | |
| PPA3PN6 | 697.04 | 215.97 | 0.74 | 0.52 | 1.63 | 0.2 |
| | | | | | | |
| PPA1PN2 | 711.00 | 236.07 | | | | |
| PPA2PN2 | 608.52 | 123.76 | | | | |
| PPA3PN2 | 602.35 | 151.51 | 0.72 | 0.57 | 172 | 0.001 |
| | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| PPA1PN4 | 906.17 | 932.92 | | | | |
| PPA2PN4 | 641.96 | 147.70 | | | | |
| PPA3PN4 | 645.70 | 125.45 | 0.41 | 0.19 | 223 | 0.001 |
| | | | | | | |
| PPA1PN5 | 1358.70 | 455.68 | | | | |
| PPA2PN5 | 1329.91 | 483.58 | | | | |
| PPA3PN5 | 1181.48 | 339.00 | 0.82 | 0.66 | 89 | 0.001 |
| | | | | | | |
| PPA1PN1 | 937.87 | 1059.35 | | | | |
| PPA2PN1 | 632.87 | 180.78 | | | | |
| PPA3PN1 | 601.48 | 131.00 | 0.52 | 0.31 | 151 | 0.001 |
| | | | | | | |
| PPA1PN3 | 911.83 | 823.62 | | | | |
| PPA2PN3 | 646.39 | 203.96 | | | | |
| PPA3PN3 | 574.35 | 183.72 | 0.6 | 0.4 | 82 | 0.001 |
| | | | | | | |
| PPA1AVG | 888.83 | 316.90 | | | | |
| PPA2AVG | 762.74 | 166.27 | | | | |
| PPA3AVG | 716.70 | 132.53 | 0.88 | 0.72 | 211 | 0.001 |
| | | | | | | |
| PPI1T | 10.43 | 1.90 | | | | |
| PPI2T | 9.64 | 1.07 | | | | |
| PPI3T | 9.35 | 0.86 | 0.88 | 0.74 | 847 | 0.001 |

The findings of this study have shown that the pre-planned agility test is of appropriate reliability but not of sufficient stability (the results are improving in following repetitions). Results of ANOVA had shown statistically significant differences between the testing units except for the first light reaction. All the light reactions except for pods PPAPN4, PPAPN1, and PPAPN3 had sufficient internal consistency. In this study we performed 3 trials after the familiarization trial. Larger number of testing trials or much clearer familiarization of the test could help with the improvement of the result stability. Additionally, the players performed three light reactions in a sequence with one hand followed by the three reactions with the other hand. Setting up the protocol in a way where the participants would need to change the hand which is performing the reaction to the light (pod hit) could help with the familiarization problem.

## CONCLUSION

Results of the new pre-planned agility test had shown that it is reliable when testing specific water polo agility but the stability of the results is insufficient. When creating future studies, it should be important to consider using larger number of participants and performing a better and longer familiarization process. When taking into the consideration the lack of these types of tests, this research paper has scientific and practical value.

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