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# Assessment of the impact of injuries on basic movement patterns in amateur swimmers

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## Abstract

**Introduction:** Swimming is a sport that often involves various injuries, which can cause pain that can last for a lifetime. The aim of the study was to assess the impact of past injuries on basic movement patterns in amateur swimmers.

**Material and methods:** Sixty amateur swimmers (32 women and 28 men) completed the Functional Movement Screen (FMS) test and a questionnaire on past injuries. The mean age of the respondents was 37 years (SD = 12.7), body weight 72 kg (SD = 13.7) and body height 175 cm (SD = 10). All subjects were adults, practicing amateur swimming for at least two hours a week. Any participant with injuries that had occurred in the previous four weeks was excluded from the study.

**Results:** Among the respondents, 62% reported suffering injury: 78% being a traumatic injury, 35% an overload injury and 14% both types. The FMS test indicated an increased risk of injury in 20% of respondents, based on a result lower than or equal to 14 points. The mean score in the FMS test was 16 points. Additionally, 5% reported pain in the lumbar spine in the trunk stability push-up test. All other tests were passed by all study participants. No significant difference in global FMS score was found between injured and non-injured swimmers.

**Conclusions:** The FMS score obtained by amateur swimmers does not appear to be influenced by previously experienced injuries. Most of the respondents had suffered injuries in their lives, and these were mainly traumatic injuries.

Keywords: pain, swimming, injury, FMS

## Introduction

Irrespective of the sports discipline, hours of training per week and the level of training, injuries are a daily occurrence for athletes [1]. However, there is a difference between competitive and amateur sport. When doing sport professionally, the athlete is usually guided by a coach to achieve the best results and thus reap the financial benefits. Studies show that due to pressure from coaches and the influence of public opinion, athletes often hide their injuries [2]. Despite the fact that professional sportsmen and women are much better prepared motorically and usually receive better medical care than amateurs, 70% of them suffer serious injuries to the musculoskeletal system [3]. In turn, in people engaged in recreational sports, injuries are caused by inadequate preparation for training, poor quality or incorrect equipment, and also poorer skills [4].

Previously experienced injuries affect the entire body. For example, long-term immobilization of body parts, a change in gait or even pain during which our body compensates in various ways can affect basic movement patterns [5]. The Functional Movement Screen (FMS) test is used to assess the functional level of basic movement patterns consists of seven movement tests [6]. It allows for the analysis of basic movement patterns, requiring a combination of stability, mobility and coordination of muscle groups. The results can be used to indicate asymmetries and functional limitations. Studies show that a total score of 14 points or below indicates an increased risk of injury from 15% to 51% during a soccer season [7]. On the basis of the FMS test, it is possible to identify the weakest link in the entire biokinematic chain and thus select appropriate activities that will complement sports training [6].

One of the most common injuries that occur while swimming is an injury around the shoulder joint [8], occurring in 40% to 91% of swimmers [9], followed by the knee joint, reported by 34% of professional swimmers [9]. The third area most commonly prone to injury is the spine. Breaststroke and butterfly cause hyperextension in the lower back [10]; when performed at high intensity and repetitions, these movements strain the structures of the lumbar spine, which can cause pain. Studies have found 68% of professional swimmers and 29% of recreational swimmers to show degeneration of the intervertebral discs at different levels of the spine [11].

The FMS test is used in various sports disciplines. Although most analyses are carried out on competitive athletes, many people do recreational sport and are also at risk of injury or have problems with basic movement patterns. Research conducted on students suggests that the FMS test works well in evaluating amateur athletes, but a division into specific disciplines is needed [12]. The aim of the study was to assess the impact of past injuries on basic movement patterns in amateur swimmers.

## Material and methods

### Study design and settings

The research was carried out at a swimming pool in Warsaw in the period from October to December 2021. All subjects were adults and filled in a voluntary written consent form to participate in the study. All completed the FMS test and a questionnaire on past injuries. The research was approved by the Senate Research Ethics Committee No. SKE 01-32/2021.

### Participants

The research group included 60 adults (32 women and 28 men). The criterion for inclusion was practicing amateur swimming for at least two hours a week. Those who had suffered fresh injuries, i.e. in the previous four weeks, were excluded.

### Procedures

The FMS test is a non-invasive test intended to assess the functional state of an individual [6] based on an assessment of coordination, stabilization, balance, muscle flexibility and joint mobility. A maximum of 21 points can be obtained. If the subject scores 14 points or less, there is a likelihood of an increased risk of injury. The test was carried out before evening training (approx. 18:00–20:00) in comfortable clothes that did not restrict movement and without shoes.

Past injuries were assessed by a questionnaire. The subject wrote down a maximum of five previous (in the last 5 years) traumatic and overload injuries. The following supplemental information was added for each injury: the year, the area covered by the injury, the type of injury, how it occurred, whether there was a break in training and whether the injury recurred.

### Statistical analysis

The research results were compiled using the SPSS Statistics 21.0 statistical package. Arithmetic means, standard deviations and minimum and maximum values were calculated for all the parameters studied and the result of the global FMS test. Due to the nature of the variables (ordinal), the size of the groups and the distribution of variables, non-parametric tests were used for the analysis. The significance of any differences in general characteristics or the global FMS test score between injured and uninjured players and between overloaded and non-overloaded players was tested with the Mann-Whitney test. In the entire study group, simple Spearman's correlation coefficients (r) were calculated between the global FMS test result and age, body height and body weight. A level of $p \leq 0.05$ was considered statistically significant.

## Results

Sociodemographic characteristics (age, weight, height, BMI) are presented in Table 1.

In the FMS test, 20% of participants scored less than or equal to 14 points, indicating an increased risk of injury. The mean results were 16.2 points among women and 16.3 points among men (Fig. 1).

The best results were obtained by the subjects in the shoulder mobility test, with as many as 83% obtaining three points. Nobody resigned from the test due to pain. The only aborted trial was the trunk stability push-up test, where 5% of people reported pain in the lumbar spine.

**Tab. 1.** Characteristics of the study group

| | | Women | Men | Total |
|---|---|---|---|---|
| Age [years] | min | 22 | 23 | 22 |
| | max | 72 | 68 | 72 |
| | mean | 37 | 37 | 37 |
| | SD | 13 | 13 | 13 |
| Body weight [kg] | min | 50 | 64 | 50 |
| | max | 85 | 102 | 102 |
| | mean | 63.2 | 82 | 72 |
| | SD | 8.9 | 11 | 13.7 |
| Body height [m] | min | 1.57 | 1.71 | 1.57 |
| | max | 1.83 | 1.95 | 1.95 |
| | mean | 1.69 | 1.82 | 1.75 |
| | SD | 0.1 | 0.1 | 0.1 |
| BMI [kg/m$^2$] | min | 17 | 19 | 17 |
| | max | 29 | 31 | 31 |
| | mean | 22 | 25 | 23.4 |
| | SD | 2.6 | 3.5 | 3.3 |

BMI – body mass index, max − maximum value, mean – mean value, min – minimum value, SD − standard deviation.

It can be seen that women obtained better results in the hurdle step attempt and active straight leg raise (Fig. 2), while men performed the trunk stability push-up test better (Fig. 3). The women in this sample were also more likely to report pain, scoring 0 points.

Among the respondents, 62% indicated not suffering any injury in their life; of these, 78% reported a traumatic injury, 35% an overload injury, and 14% both types of injuries.

Regarding past injuries, the most common area of traumatic injury was reported to be the ankle joint (28%), followed by the knee joint (28%; Fig. 4), and the shoulder joint (58%; Fig. 5).

The most common recurring traumatic injuries were joint sprains (24%) and ligament tears (14%), and the most common overload injuries were tissue overload (42%), myositis (17%) and bursitis (17%). The most common causes of traumatic injury were falling (41%) or training (32%). The most common causes for overload injury were training (75%), unknown (17%) and overtraining (8%).

Breaks in training usually lasted one to three months after suffering traumatic injury or overloading. However, 3% suffering a traumatic injury and 17% an overload injury reported no break. Traumatic injury recurred in 28% of cases and overuse injury in 67%.

No significant differences in overall performance or global FMS score were found between injured and non-injured swimmers (Mann-Whitney test). Higher age and BMI were significantly correlated with a lower overall FMS score ($rS = 0.45$, $p < 0.001$ for age and $rS = 0.32$, $p = 0.013$ for BMI).

## Discussion

All athletes, including amateurs, are at risk of injury. This study evaluated the impact of past injuries on basic movement patterns in amateur swimmers.

The risk of injury increases with poor movement patterns, low levels of tissue flexibility in the body, and

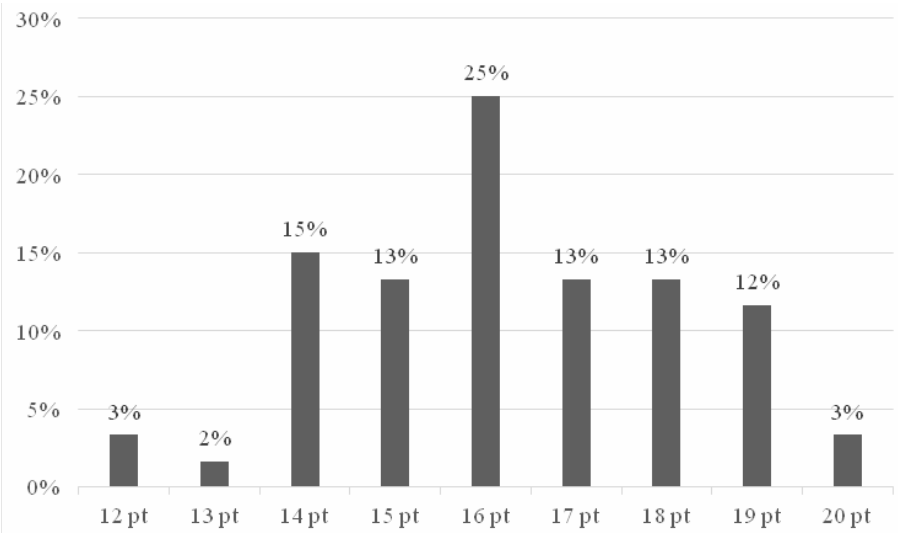
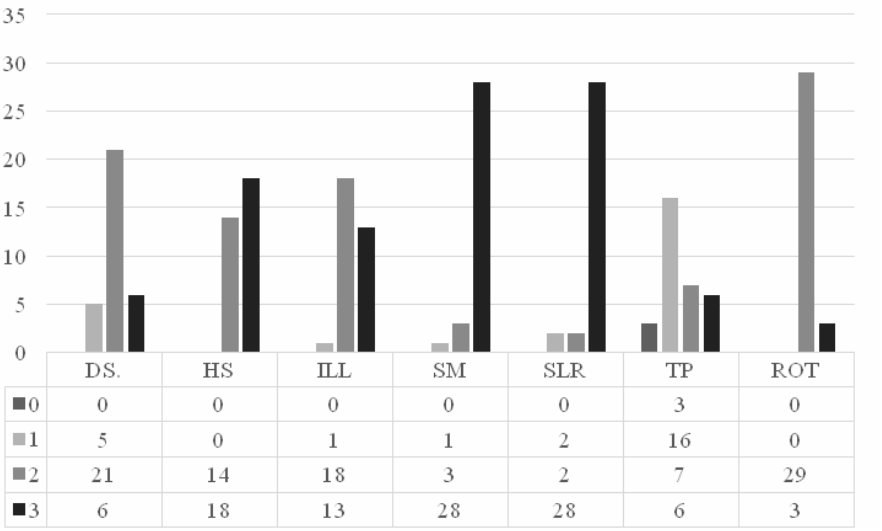


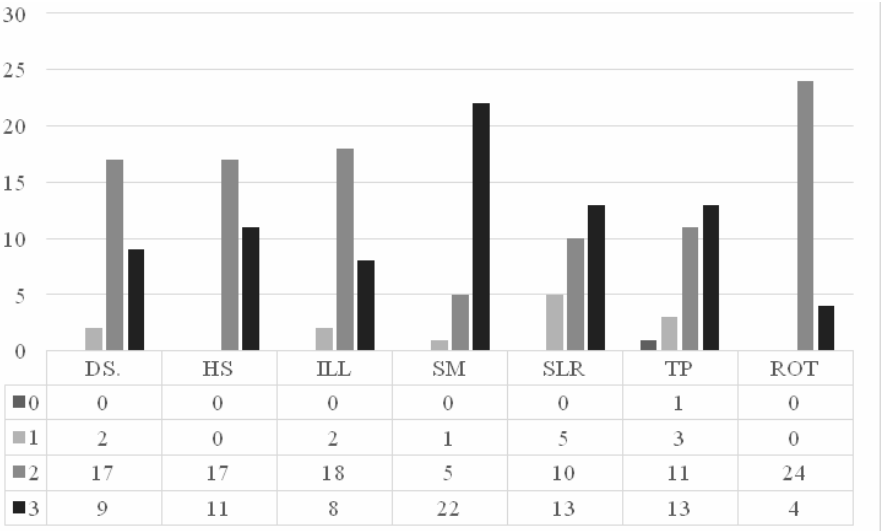

**Fig. 1.** Final result of the FMS test




| | DS. | HS | ILL | SM | SLR | TP | ROT |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| 1 | 5 | 0 | 1 | 1 | 2 | 16 | 0 |
| 2 | 21 | 14 | 18 | 3 | 2 | 7 | 29 |
| 3 | 6 | 18 | 13 | 28 | 28 | 6 | 3 |

**Fig. 2.** Individual FMS score values in women

DS − deep squat, HS − hurdle step, ILL − in-line lunge, ROT − rotational stability, SLR − active straight leg raise, SM − shoulder mobility, TP − trunk stability push-up.




| | DS. | HS | ILL | SM | SLR | TP | ROT |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1 | 2 | 0 | 2 | 1 | 5 | 3 | 0 |
| 2 | 17 | 17 | 18 | 5 | 10 | 11 | 24 |
| 3 | 9 | 11 | 8 | 22 | 13 | 13 | 4 |

**Fig. 3.** Individual FMS score values in men

DS − deep squat, HS − hurdle step, ILL − in-line lunge, ROT − rotational stability, SLR − active straight leg raise, SM − shoulder mobility, TP − trunk stability push-up.

previous injuries [13]. It has been found that injuries experienced in the previous 12 months can affect the FMS test result in handball players [16]. Similarly, in professional soccer players, the mean total FMS score was 14.3 for players who had been previously injured, and 17.4 for those who had not [7]. In addition, a study of 160 athletes training at least three hours a week recorded a mean total FMS score of 13.6 points for the injured group and 15.5 for the uninjured group [17]. Our study did not show this relationship. Similar results were obtained in a study of 209 physically-active people aged 18 to 40 [15]. It might indicate that the impact of previous injuries on the FMS test exist in the professional and not amateur sport.

In our research, women performed better in the active straight leg raise attempt, and men in the trunk stability push-up test. Indeed, previous studies on 93 swimmers also found that women are much better at performing the active straight leg raise test and rotational stability than men [18]. Similarly, a study of 140 professional swimmers found that in addition to a better active straight leg raise score, women also had a better result on the in-line lunge test; the men were better at the trunk stability push-up test [19]. Another study

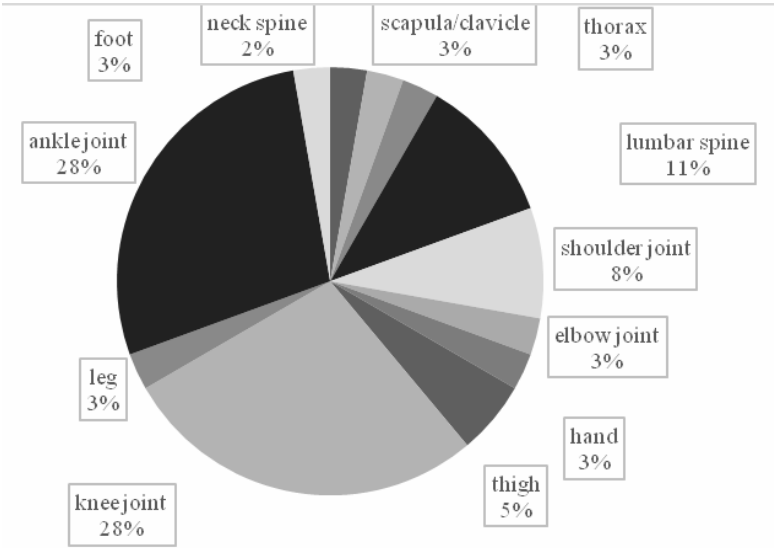



**Fig. 4.** Traumatic injury area

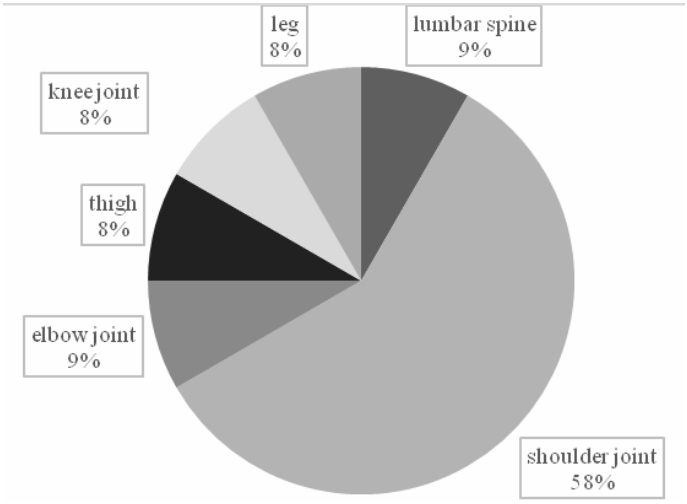



**Fig. 5.** Overload injury area

found women to be better at the shoulder mobility test, and men the trunk stability push-up test [15]. Both our own and previous studies found the trunk stability push-up test was the best one performed by men, and the active straight leg raise by women.

In the present study, pain was most commonly reported in the trunk stability push-up test, during the preliminary lumbar spine extension test (5% of participants). In a study of 140 professional swimmers, pain was most commonly caused by the shoulder mobility test, with 6.4% of the respondents failing, followed by the trunk stability push-up test, with 5.7% failing [19].

The most common type of injury in the present study was traumatic injury, particularly those affecting the ankle joint (28%), the knee joint (28%) and the lumbar spine (11%). The majority of amateur swimmers indicated that the cause of this injury was a fall, and 32% that it was caused by training in various sports disciplines. This is confirmed by the literature, which indicates that traumatic injuries mainly affect these three joints, with the most common causes of traumatic injuries being muscle tear and contusion [20].

Overuse injuries occur in about 25-50% of athletes in general, and in 40% to 91% of swimmers; in the latter, these most commonly affect the shoulder joint [3]. The prevalence of shoulder pain in competitive swimmers has been found to range from 27% to 87% [21]. Similarly, the shoulder was also found to be the most common site of overload injury in the present study, being indicated by more than half of participants. This was followed by injuries to the lumbar spine (9%) and the elbow joint (9%). Due to the biomechanics of swimming and the movement of the upper limbs, the humerus continually circles the shoulder joint using several movement patterns.

A review of 850 articles analyzing the incidence of overuse injuries in adult swimmers found the most common to occur around the shoulder joint, knee and lumbar spine, and that overuse injuries are more common than traumatic ones. One article found traumatic injuries to be repeated more often than those due to overuse [20]. Most of the participants in our study reported the occurrence of a previous traumatic injury, and the most common type of overload injury was tissue overload and overload changes in the spine.

Our findings indicate that older people and those with a higher BMI achieved worse results on the FMS test. This is reflected in previous studies of non-overweight and obese soccer players, which found that a higher BMI correlated with a worse total score on the FMS test [22]. Overall fitness declines with age due to changes in balance, cognitive function, and musculoskeletal changes [23], with these parameters deteriorating after 40 years of age [15]. This may be the reason for the lower FMS test result.

It is not clear whether the FMS test can be used to accurately assess the risk of injury. A systematic review of studies evaluating the relationship between FMS test score and subsequent risk of injury found the test to be unreliable in predicting future injury [24]. Only among male military personnel was evidence found of a small association between FMS score and injury. According to Garrison et al. [17], injury history alone can identify individuals at higher risk of future injury. In contrast, another review of studies found that participants scoring 14 or less on the FMS were more likely to be injured than those with higher scores [25], and other research indicates that the optimal point cutoff may vary by gender [26].

**Study limitations**

The present study has limitations. Firstly, the group of participants demonstrated considerable variation in age, and hence, their efficiency, quality of movement skills and the number of injuries they have experienced. An additional limitation was the unequal level of training and advancement of the participants. Moreover, many people practiced other sports in addition to swimming, which is common in amateur sport but could have influenced the results. More research is needed to refine and validate the FMS test and target it to specific amateur sports [15].

## Conclusions

The FMS score obtained by amateur swimmers does not appear to be influenced by previously experienced injuries. Most participants obtained an FMS score, which did not show an increased risk of injury. Most of the swimmers had suffered injuries in their lives, and these were mainly traumatic injuries.

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