



Predictive Models for Musculoskeletal injuries for swimmers in Jordan

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Abstract

This study is the first of its kind to investigate musculoskeletal injuries in Jordanian swimmers. It aimed to identify common sports injuries in male and female swimmers aged 18 to 25 in Jordan. The research involved 173 participants affiliated with the Jordanian Swimming Federation, using correlation and regression analysis. The study explored the intricate relationship between the age of starting swimming, training routines, and competitive involvement. It revealed negative correlations between the age of initiation and various performance measures, indicating that starting swimming at a younger age is associated with increased competition participation, more training time, and longer training distances. Furthermore, a strong negative correlation was observed between the number of competitions and weekly training time, suggesting that more competitions require more training. Conversely, a positive correlation was found between weekly training distance and training time, indicating that longer training sessions cover greater distances. It's important to note that these correlations do not imply causation, and other factors may contribute. Regression analysis revealed that the selected independent variables significantly influenced the prediction of swimming injuries, explaining around 37.3% of the variability. The number of competitions emerged as the most influential factor, negatively impacting injury prediction, meaning that more competitions were associated with fewer injuries. Additionally, variables like weekly training time, weekly training distance, and the age of starting swimming positively affected injury prediction. The study presented a predictive equation for estimating swimmers' injuries, providing valuable insights for injury prevention and athlete well-being.

Keywords: (Injury ,Correlation analysis ,Regression Analysis, Swimmers, Jordan).

Introduction:

The world has undergone a remarkable transformation, experiencing significant advancements across various disciplines including sports and sport related fields. For many years, the interest in sports has increased dramatically and it has become a special feature for many societies, because of the many benefits of sports on the individual's physical and psychological health, and how sport enhances the strength and solidity of society. Swimming is considered one of the most important sports activities that gain great support and attention, especially in countries bordering the seas (Al-Hawamdeh, 2021) and Trikha, et al., 2022).

Swimming sport is an important water sport that has gained tremendous popularity, where its pioneers receive remarkable accolades for their achievements. This is because swimming contributes to the integration of the individual's personality in various ways. Swimming provides an excellent non-weight-bearing alternative to exercise for people of all age groups. It also has the ability to enhance cardiovascular fitness, muscular strength, and overall well-being without subjecting the body to the same level of strain as high-impact sports (Gračanin, et al.,2023). However, despite its seemingly gentle nature, swimming is not without risks, and swimmers are susceptible to

musculoskeletal injuries that impact on swimmers affecting their performance, training routines, and overall enjoyment of the sport. The repetitive nature of swimming strokes, combined with improper technique and inadequate warm-up practices, can lead to a range of musculoskeletal issues, including shoulder impingement, rotator cuff injuries, knee pain, and lower back problems. The prevalence of these injuries highlights the need for a comprehensive understanding of their underlying factors and the development of effective preventive measures (Al-Tani, Taha Ghafil 2021).

This study conducted an in-depth investigation into musculoskeletal injuries among Jordanian swimmers, a previously unexplored topic in the region. The research aimed to bridge the knowledge gap by identifying the most common musculoskeletal injuries in Jordanian swimmers and understanding the contributing factors, considering variables like gender, age, swimming techniques, training intensity, and competitive involvement. It also examined the impact of these injuries on athletic performance. The research is crucial in the context of competitive swimming, an area where sports injuries have been relatively underexplored. The study focused on aspects with a direct impact on swimmers, distinguishing it from more generalized scientific investigations. The findings provide

insights into sports injuries among swimmers, informing policy and practice for the Jordanian Swimming Federation. The research leveraged participant insights and empirical evidence to develop effective injury prevention strategies, ultimately aiming to improve swimmers' well-being and athletic performance while fostering a deeper appreciation for the sport.

Methodology

A comprehensive mixed-methods approach was employed, utilizing an internet-based survey distributed through Qualtrics to gather data from 173 swimmers who are affiliated with the Jordanian Swimming Federation (JSF). The survey, comprising 33 inquiries, incorporated diverse question formats aimed at capturing information concerning demographics, musculoskeletal injuries, training practices, injury prevention strategies, and other relevant aspects. Subsequently, the amassed data underwent meticulous and rigorous descriptive statistical analysis to elucidate trends and disparities between theoretical research findings and practical experiences. While the initial target sample size was originally intended to encompass 200 adult swimmers within the age range of 18-25, the final number settled at 173 questionnaires, which were considered suitable for thorough statistical analysis after eliminating responses that did not meet the required criteria for

inclusion. Diverse online channels were employed for data collection, including social media platforms, direct communication with JSF, and online interviews. The collected data underwent careful processing using statistical software tailored for social sciences (SPSS), involving the calculation of correlation coefficients, as well as regression analysis, with a significance level established at $p < 0.05$ to ensure statistical validity.

RESULTS

Demographics

Demographic data include age, age at which swimming started, number of competitions, gender, weekly training time (WTT), weekly training distance (WTD) and swimming styles have been calculated with the frequency and percentage demonstrated in tables (1) and Figures (1 – 7). This exercise was carried out to gain insight into variables which may be related to injury, and to investigate the average demographics of swimming population.

Table 1: Demographics, Categories, Frequencies and Percent of data variables.

Table (1)
Demographics, Categories, Frequencies and Percent of data variables.

Demographics	Categories	Frequency	Percentage %
Age	18 -20	124	71.7
	21 -23	46	26.6
	24 -26	3	1.7
Age started swimming	5 -10	107	62.2
	11 -15	22	12.8
	16 -20	38	22.1
	21 -25	5	2.9
Number of competitions	0	70	40
	1 - 5	10	6
	6 -10	5	3
	> 10	88	51
Gender	Male	101	58
	Female	72	42
WTT	< 5	79	45.7
	5 - 10	11	6.4
	> 10	83	48
WTD	< 5	77	44
	5 - 10	13	8
	> 10	83	48
Swimming Styles	Freestyle	121	49
	Breaststroke	52	21.1
	Backstroke	42	17
	Butterfly	32	13

Figure No. (1)
Age of Participants.



Figure No. (2)
Age at which Participants started swimming.

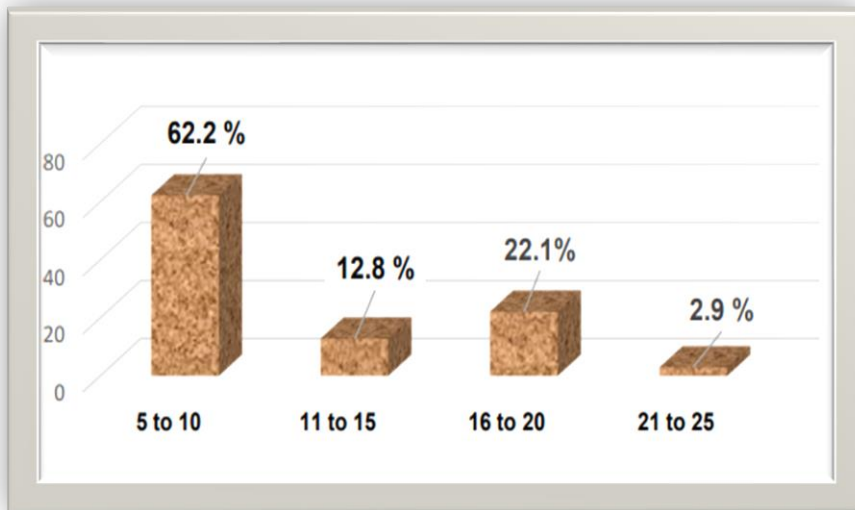


Figure No. (3)
Number of competitions swimmers have Participated in

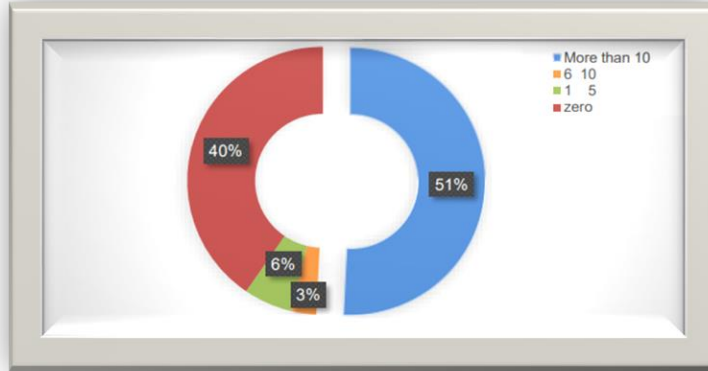


Figure No. (4)
Gender distribution of Participants

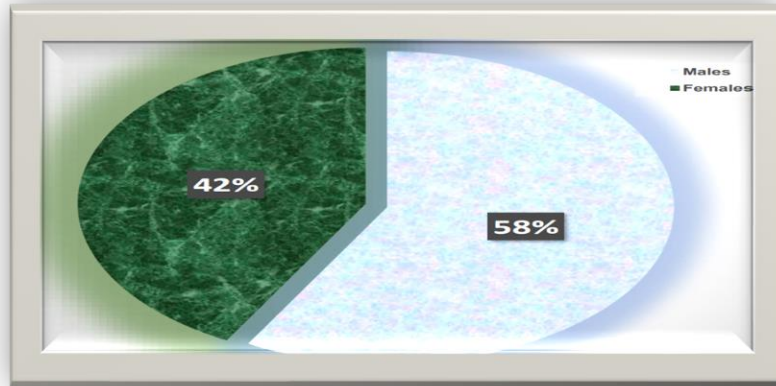


Figure No. (5)
Weekly training time (hours) that Participants have used.

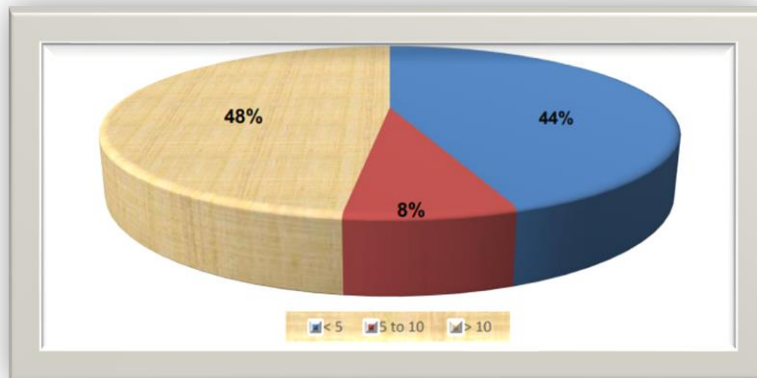


Figure No. (6)
Weekly training time (hours) that Participants have used.

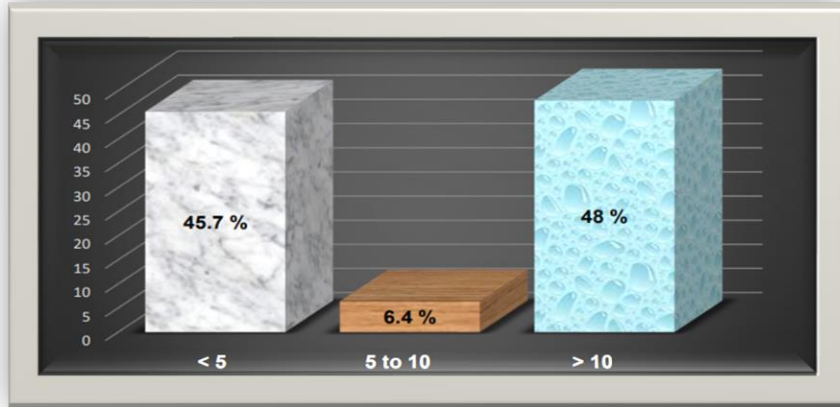


Figure No. (7)
Swimming styles that Participants have practiced.

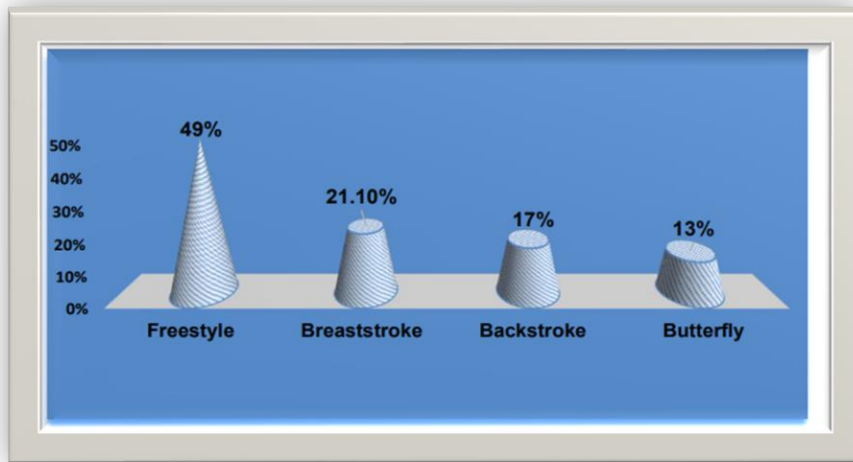


Table 1 and figures (1 – 7) show that there were 173 swimming participants. Almost 71.7% of the participants noted their age to be underlying within 18 to 20 years. Nearly 26.6% of them stated they were between the ages of 21 to 23 years. The rest, 1.7% of the survey candidates, highlighted their age to be within 24 to 26 years. The age ranges at which the participants have started swimming have been grouped as follows: 5 -10 ,11 -15 ,16 -20 and 21 -25; 62.2%,12.8 % , 22.1% and 2.9% respectively. The percent number of competitions were as follows: (zero; 40%), (1-5; 6%), (6-10; 3%) and (> 10; 51%). For gender, percentage was distributed as 58% for male and 42% for female. The percentage WTT of participants was conducted for the following categories: less than 5, 5 -10, more than 10, distributed as follows: 45.7 % , 6.4 % , and 48 % respectively. The percentage of the WTD of the participants

was carried out for the following categories: less than 5 , 5 -10 , more than 10, distributed as follows 44%, 8% , 48%, respectively. Since participants competed with more than one swimming style, the total of the 173 participants' styles have been reported, including freestyle (49%), breaststroke (21.1%), backstroke (17%), and butterfly style (13%).

Correlation analysis

Correlation analysis is a method of measuring the correlation of two data sets. The correlation method is used to measure the movement of two data ranges, that is, the similarity between the large values of one set and the high values of the other set (+R), the correlations between the small values of one set and the large values of the other set (- R), or the values of both sets that are unrelated (zero

correlation). Correlation coefficient method in the SPSS was used and analysis results are shown in table 2. As shown in table 2 a negative correlation was found between age at which the participant started swimming on one hand, and the number of competitions, weekly training time and weekly training distance on other hand, where (r = - 0.714 , -0.701 and -0.661, respectively, p < 0.001).

Negative correlation also shown between number of competitions and (weekly training time; 0.948), (age at which started; - 0.714) and (weekly training distance; 0.890) at (p<0.001). A strong correlation is also shown between weekly training distance and weekly training time (r = 0.944) at (p<0.001).

Table (2)
:Pearson’s correlation coefficients between variables.

Correlations					
		Age at which you started swimming	Number of competitions	Weekly training time	Weekly training distance
Age at which you started swimming	Pearson Correlation	1	-.714**	-.701**	-.661**
	Sig. (2-tailed)		<.001	<.001	<.001
	N	172	172	172	172
Number of competitions	Pearson Correlation	-.714**	1	.948**	.890**
	Sig. (2-tailed)	<.001		<.001	<.001
	N	172	173	173	173
Weekly training time	Pearson Correlation	-.701**	.948**	1	.944**
	Sig. (2-tailed)	<.001	<.001		<.001
	N	172	173	173	173
Weekly training distance	Pearson Correlation	-.661**	.890**	.944**	1
	Sig. (2-tailed)	<.001	<.001	<.001	
	N	172	173	173	173

** . Correlation is significant at the 0.01 level (2-tailed).

Multiple Linear Regression (MLR):

Multiple linear regression method has been carried out to predict swimming injuries (dependent variable) as a result of several independent variables. The selected independent variables used in this study were the number of competition, swimming age start (SAS), weekly training time (WTT), and weekly training distance (WTD).

According to results, the sum of what independent variables explain in terms of the variance in swimming injuries was 0.373 table (3) were R² equals 623 and adjusted R² equals 0.373, at statically significant level less than 0.05 table (4).

According to Beta value shown in table (5) the number of competitions has the highest effect with Beta = -0.377, then WTT, WTD and SAS with Beta value equal 0.185, 0.405 and 0.488, respectively. Based on these results the equation of prediction for swimming injuries is as follow

$$\text{Swimmers' Injuries} = - 0.377 * \text{Number of competitions} + 0.185 * \text{WTT} + 0.405 * \text{WTD} + 0.488 * \text{SAS} .$$

Table (3)
Model summary of regression analysis.

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.623 ^a	.388	.373	.370	.388	26.478	4	167	<.001

a. Predictors: (Constant), • Number of competitions • SAS • WTD •WTT
b. Dependent Variable : INJURY

Table (4)
ANOVA of regression analysis.

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14.519	4	3.630	26.478	<.001 ^b
	Residual	22.894	167	.137		
	Total	37.413	171			

a. Dependent Variable: • INJURY
b. Predictors: (Constant), • Number of competitions •SAS •WTD • WTT

Table (5)
Coefficients of regression analysis.

Coefficients ^a								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	2.486	.445		5.584	<.001	1.607	3.365
	SAS	.031	.044	.060	.695	.488	-.057	.118
	WTT	-.169	.127	-.350	-1.332	.185	-.419	.081
	WTD	.074	.089	.153	.835	.405	-.101	.250
	Number of competitions	-.123	.063	-.377	-1.944	.054	-.247	.002

a. Dependent Variable: • INJURY

Discussion:

The findings presented in Table 2 highlight significant correlations among various factors related to swimming performance. These correlations shed light on the complex interplay between the age at which individuals start swimming, their training regimen, and their competitive involvement.

Firstly, a negative correlation was observed between the age at which individuals began swimming and several performance metrics. Specifically, a negative correlation coefficient (r) of -0.714, -0.701, and -0.661 was determined between the age of swimming initiation and the number of competitions, weekly training time, and weekly training distance, respectively. This suggests that individuals who commenced swimming at an earlier age tended to

participate in more competitions, allocate more time to weekly training, and cover greater distances during their training sessions. Moreover, the negative correlation between the number of competitions and various other factors was also evident. Notably, a strong negative correlation of -0.948 was detected between the number of competitions and weekly training time, as well as a negative correlation of -0.714 with the age at which swimming commenced, and -0.890 with weekly training distance. These findings imply that participants engaging in a higher number of swimming competitions typically devoted more time to weekly training, commenced swimming at a younger age, and covered greater training distances. Furthermore, a robust positive correlation was identified between weekly training distance and weekly training time,

with a correlation coefficient of 0.944. This implies that individuals who trained over longer distances during their weekly sessions also tended to allocate more time to training overall.

In a scientific context, these correlations can be attributed to several factors. The negative correlation between the age of swimming initiation and performance metrics could be linked to the notion that starting training at a younger age allows for more years of skill development and practice, leading to enhanced performance. The negative correlation between the number of competitions and training time might suggest that athletes engaging in more competitions require more training to maintain their competitive edge. The positive correlation between weekly training distance and training time might be indicative of a comprehensive training approach where longer sessions facilitate covering greater distances. It's important to note that these correlations do not necessarily imply causation; other unaccounted factors could also influence the observed relationships. Nevertheless, the scientific significance of these findings underscores the intricate relationships between the timing of skill acquisition, training intensity, and competitive involvement in the realm of swimming performance.

The results of the regression analysis, as presented in Table 3, reveal that the combined influence of independent variables on explaining the variance in swimming injuries is approximately 37.3%. This assessment is corroborated by the R-squared value of 0.623 and the adjusted R-squared value of 0.373, both of which are consistent with a statistically significant level below 0.05 (as indicated in Table 4). These metrics collectively suggest that the selected independent variables have a substantial impact on the prediction of swimming injuries.

Upon closer examination of the Beta values provided in Table 5, it becomes evident that the number of competitions emerges as the most influential factor. With a Beta value of -0.377, it exerts a negative effect on the prediction of injuries, implying that an increase in the number of competitions is associated with a decrease in the incidence of injuries. On the other hand, variables such as WTT (with a Beta value of 0.185), WTD (with a Beta value of 0.405), and SAS (with a Beta value of 0.488) also exhibit noteworthy effects on predicting swimming injuries, though in a positive manner.

Taken together, the outcomes of the analysis furnish us with a predictive equation for estimating swimmers' injuries: $\text{Swimmers' Injuries} = -0.377 * \text{Number of Competitions} + 0.185 * \text{WTT} + 0.405 * \text{WTD} + 0.488 * \text{SAS}$. This equation encapsulates the interplay between the key factors contributing to swimming injuries, elucidating the relative importance of each independent variable. It is evident that while the number of competitions appears to act as a protective factor, the other variables - WTT, WTD, and SAS - seem to correlate with an increased likelihood of injuries. These findings provide valuable insights for practitioners and researchers in the field of swimming sports, aiding in the development of targeted injury prevention strategies and training protocols to enhance athletes' well-being and performance. However, it's

important to acknowledge the limitations of the model. While the explanatory power is significant, it doesn't encompass all the factors that might contribute to injury variability in swimming. This suggests the possibility of unaccounted variables that could also influence injury occurrences. Future research could delve into these additional factors to create a more comprehensive understanding of swimming injuries. Overall, the analysis provides a robust foundation for advancing the knowledge surrounding swimming injuries and lays the groundwork for informed decision-making in the field.

Conclusion:

This study delved into the realm of swimming performance and injury prevention among Jordanian swimmers. The research uncovered significant correlations between the age at which individuals commence swimming, their training habits, and their participation in competitions. Notably, starting swimming at a younger age correlated with increased involvement in competitions, more extensive weekly training, and greater training distances. These findings suggest that early exposure to swimming fosters skill development and performance improvement over the years, highlighting the importance of an early start. Moreover, the study revealed that a higher number of competitions was associated with increased training time and more extensive training distances. Athletes participating in more competitions seemed to dedicate additional time to training to maintain their competitive edge. This underscores the demand for comprehensive training routines to support the demands of competitive swimming. The regression analysis further demonstrated that the number of competitions played a pivotal role in predicting swimming injuries. Surprisingly, a higher number of competitions was linked to a lower incidence of injuries, suggesting that competitive swimmers might have injury-preventive advantages. However, other factors like weekly training time, weekly training distance, and the starting age of swimming also had notable effects on predicting swimming injuries. The study provides a predictive equation for estimating swimmers' injuries. While the number of competitions acts as a protective factor, other variables, including weekly training time, weekly training distance, and the starting age of swimming, appear to correlate with an increased likelihood of injuries. These findings offer valuable insights for practitioners and researchers in the field of swimming sports, aiding in the development of targeted injury prevention strategies and training protocols to enhance athletes' well-being and performance.

Recommendations:

Based on the findings of this study on musculoskeletal injuries among Jordanian swimmers, several recommendations can be made. First, early initiation of swimming is encouraged to promote skill development and performance. Sports programs and schools should incorporate swimming into curricula. Second, swimmers should balance the number of competitions with adequate training and coaches should provide guidelines for competition frequency. Third, comprehensive training programs emphasizing proper techniques, warm-up

exercises, and longer training sessions should be developed. Regular health assessments and access to sports medicine professionals are crucial. Lastly, age-appropriate training programs should be tailored to swimmers' developmental

stages, focusing on physical development and skill acquisition. Implementing these recommendations can enhance the well-being and performance of swimmers in Jordan while fostering a deeper appreciation for the sport.

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