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Comprehensive Study on Musculoskeletal Injuries among Swimmers in Jordan: Causes, Effects, and Prevention Strategies

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ABSTRACT

No prior investigations have evaluated the musculoskeletal (MSK) injuries characteristic to swimming sport in Jordan. This study aimed to identify the most common sports injuries among male and female swimmers in Jordan. Through a survey distributed to the Jordanian Swimming Federation's registered swimmers, 173 participants (72 female, 101 male) aged 18 to 25 completed the questionnaire. The results of the study showed that the most common injuries were arranged as follows: muscle spasm, muscle cramps and sprains; 29.8%, 28.6% and 17.7%, respectively. The most vulnerable areas were Shoulder 35.3%, followed by the back 14.4 %, knee 10.7% and neck 10.2%. The most common cause of injuries were Inadequate warm up where his percentage reached 34% followed by Overtraining with a percentage of 27%. Reduced training intensity or frequency, impaired stroke technique , limited range of motion or flexibility and required complete cessation of swimming had the main effectiveness the swimming performance and training ,were the percent was 34.9%, 20.8%,10.3% and 4.3% , respectively.

Keywords: Jordanian Swimming Federation (JSF), Musculoskeletal (MSK), Shoulder, Injury, and Jordan.

INTRODUCTION:

Swimming is an exercise that engages most of the body's muscles, promoting physical efficiency and improving physiological aspects. It enhances resistance to diseases, boosts self-confidence, and aids in leisure time management while enhancing mental capabilities. Swimming is a comprehensive exercise that carries both physical benefits and injury risks. The study focuses on understanding and preventing musculoskeletal injuries in Jordanian swimmers, considering various factors that influence injury occurrence and their impact on performance. The research aims to enhance knowledge of swimming-related injuries and contribute to the development of injury prevention strategies (Trikha, 2022).

The science of sports injuries plays a vital role in sports medicine, focusing on the diagnosis and prevention of injuries. It enhances athletes' awareness of injury causes and preventive measures, highlighting the need for specialized training and first aid. Fatigue, stress, and excessive training pressure contribute to sports injuries (Struck *et al.,* 2020; Croteau *et al.,* 2021). Swimming, a low-impact exercise, is popular in coastal regions, emphasizing the importance of understanding swimming-related injuries and their prevention. This research explores musculoskeletal injuries among Jordanian swimmers, aiming to identify injury types, causes, and their impact on performance. The study utilizes mixed methods, incorporating quanti-

tative and qualitative data from surveys, interviews, and physical examinations, with a focus on gender, age, swimming styles, starting age, training time, distance, and competitiveness (McLean *et al.,* 2020).

MATERIALS AND METHODS:

The data collection method chosen for this study involved conducting an internet-based survey, specifically utilizing Qualtrics survey software due to its accessibility and the availability of diverse question formats. The survey was directed at 195 swimmers who were affiliated with the Jordanian Swimming Federation. Data was collected through an extensive survey distributed to adult swimmers aged 18 and older. Statistical analysis, including calculations of frequencies, percentages, mean sand standard deviations was performed using SPSS. Various statistical techniques were applied during the analysis, and ethical considerations played a central role in the rese-arch process, ultimately enhancing the reliability of the findings regarding musculoskeletal injuries in Jordanian swimmers.

RESULTS:

Answers of study questions:

To answer the study questions and achieve the research objectives, the researcher has used frequencies and percentages. Data collected in this section is represented in tables and graphs as follow:

Question One: What is the most common position of musculoskeletal Injuries for the Swimmers in Jordan?

To address this question, the researcher used frequencies and percentages values for each of the variables as shown in **Table 1** and **Fig. 1**.

Table 1: Frequency and Percentages of the most common position of musculoskeletal injuries for swimmers in Jordan.

Injury	Frequency	Percentage %
Shoulder	76	35.3
Back	31	14.4
Knee	23	10.7
Neck	22	10.2
Foot	18	8.4
Ankle	13	6.0
Hand	11	5.1
Elbow	9	4.2
Wrist	6	2.8
Hip	4	1.9
Head	2	0.9
Sum	215	100

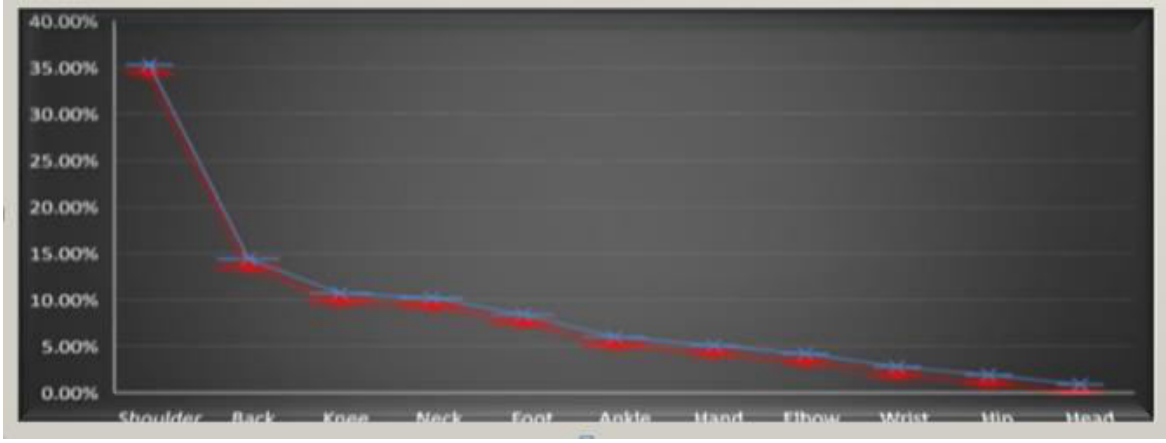

Fig. 1: The most common position of musculoskeletal injuries for swimmers in Jordan.

Table 1 and **Fig. 1** show the values of frequency and percentages of the most common positions of musculoskeletal Injuries of Swimmers in Jordan, where the results indicate that Shoulder has the highest frequency of 67, and a percentage of 35.3%, followed by the back injuries with a frequency of 31 and a percentage of 14.4 %. Next was the knee injuries with a frequency of 23 and a percentage of 10.7. Finally, and as presented in the table, the least susceptible site of injury was the neck with a frequency of 22 and a

percentage of 10.2%. The total number of injuries was 215, with a rate of 100%.

Questions Two: These questions were to be answered in yes or no?

To address the questions and to achieve the objectives, the researcher used frequencies and percentages values for each of the variables as shown in **Table 2** and **Fig. 2**.

Table 2: Frequency and Percentages of questions to be answered in yes or no.

Questions	Answer	Frequency	Percentage %
Do you do strength training ?	Yes	119	68.8
	No	54	31.2
Have you received any guidance or education on preventing swimming-related injuries ?	Yes	147	86
	No	24	14
Have you received medical treatment for swimming injuries ?	Yes	117	68.8
	No	53	31.2
Have you made any modifications to your swimming technique or training routine to reduce injuries in the future ?	Yes	122	72.2
	No	47	27.8
Are you aware of any exercises or specific stretches that can help prevent swimming injuries ?	Yes	107	63.3
	No	62	36.7
Do you use any equipment or aids for swimming (such as swim fins, swimming paws, swimming rafts, etc.) during your training ?	Yes	130	76.9
	No	39	23.1
Do you adhere to proper warm-up sessions before start swimming or cool-down exercises after the sessions ?	Yes	85	50.3
	No	84	49.7
Are you currently experiencing any swimming-related injury ?	Yes	52	30.8
	No	117	69.2
Have you ever undergone any surgical procedure related to musculoskeletal injuries, ligaments, tendons, cartilage ?	Yes	20	11.8
	No	149	88.2
Have you ever received a confirmed diagnosis of a musculoskeletal injuries by a doctor ?	Yes	42	24.9
	No	127	75.1
Do you agree on the importance of implementing clear, scientifically based training programs to reduce sports injuries ?	Yes	161	95.3
	No	8	4.7

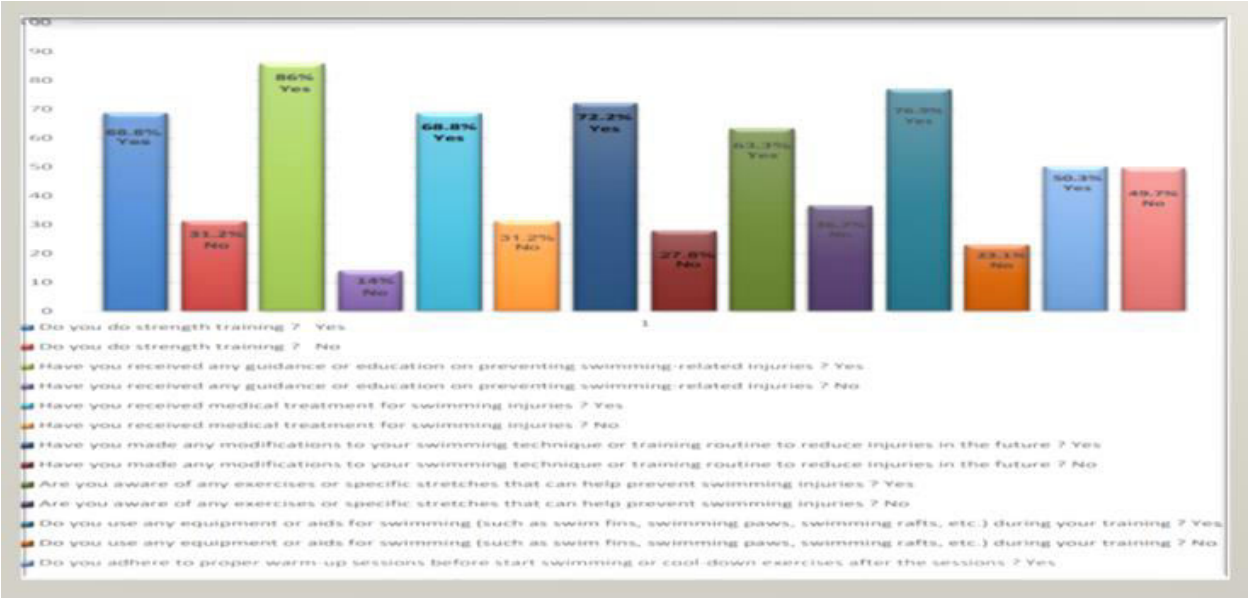

Fig. 2: Question to be answered in yes or no.

Table 2 and **Fig. 2** present the values of frequencies and percentages for the questions that have been answered as yes or no. Concerning using strength training, most of the participants (68.8%) answered yes, while 31.2 % answered no. Whereas with respect of receiving guidance or education on preventing swimming-related injuries, 86% answered yes and 14% answered, **Fig. 3**, **Fig. 4** shows the main sources through which the participants received their guidance or education. Swimming coaches are the main source with 77% followed by healthcare specialists with 5% and 18% from other sources. When asked if they have received medical treatment for swimming injuries, the most frequent answer was yes, with a percent of

68.8%, while 31.2% answered no. **Fig. 5** presents the main types of medical treatment that participants have received. Physical therapy was the main type with 86% followed by the surgery of 3% and medication treatment of 26 %. With respect to applying modifications to swimming technique or training routine in order to reduce their injuries in the future 72.2% of them said yes and of 27.8% said no. Participants were also asked if they were aware of any exercises or specific stretches that can help prevent swimming injuries, 63.3% answered yes and 36.7% said no. **Fig. 6** demonstrates how critical is to perform warming up and stretching exercises for injury prevention, where according to Likert scale, 62% strongly agreed, 26% agreed 7% were neutral, and those who disagreed were only 0.5%.and those who strongly disagreed made 5%. with respect to equipment or aids use for swimming (such as swim fins, swimming paws, swimming rafts, etc.) during training, 76.9% answered with yes and 23.1% said no answer. With regard to adhering to proper warm-up sessions before starting swimming, or cool-down exercises after the sessions, 50.3% answered yes and 49.7% said no. The participants have been also asked if they were currently experiencing any swimming-related injury. 30.8% of them actually answered yes and 69.2% answered no. Concerning undergoing a surgical procedure related to musculoskeletal injuries (Roy *et al.,* 2020), ligaments, tendons, or cartilage, 11.8% answers were positive and 88.2% answers were negative. Then they were asked if they had received a confirmed diagnosis of a musculoskeletal injuries by a doctor, the majority with 75.1% answered negative. Finally, the answer was yes with a percentage of 95.3% for a question about if they agree on the importance of implementing clear, scientifically based training programs to reduce sports injuries. **Fig. 7** show that the injuries occurrence whiles the participants were either inside or outside the water, of 86% and 14% percentages, respectively.

Question Three: What are the most common Swimming Injuries you experienced?

To answer the question and achieve the objective, the researcher used the frequencies and percentages value for each of the variables as shown in **Table 3** and **Fig. 8**.

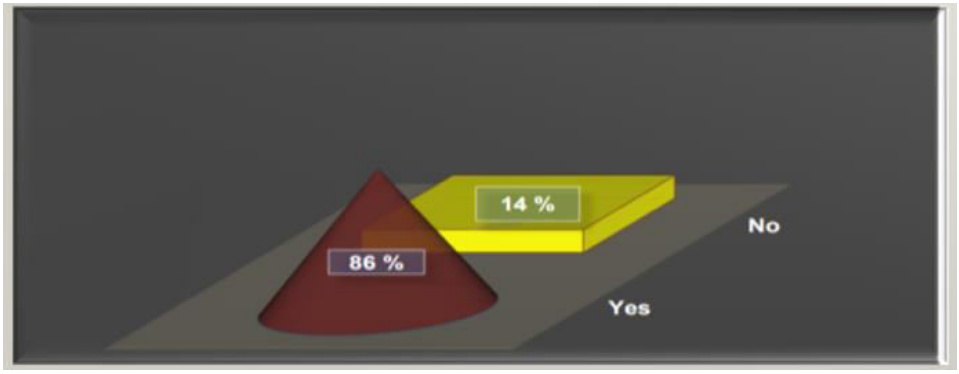

Fig. 3: Answer the question if the participants have received any guidance or education on preventing swimming – related injuries.

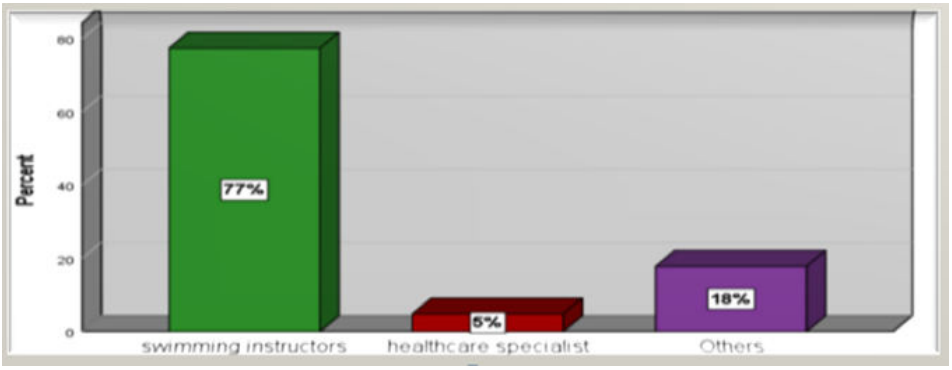

Fig. 4: The main sources from where participants received the guidance or education.

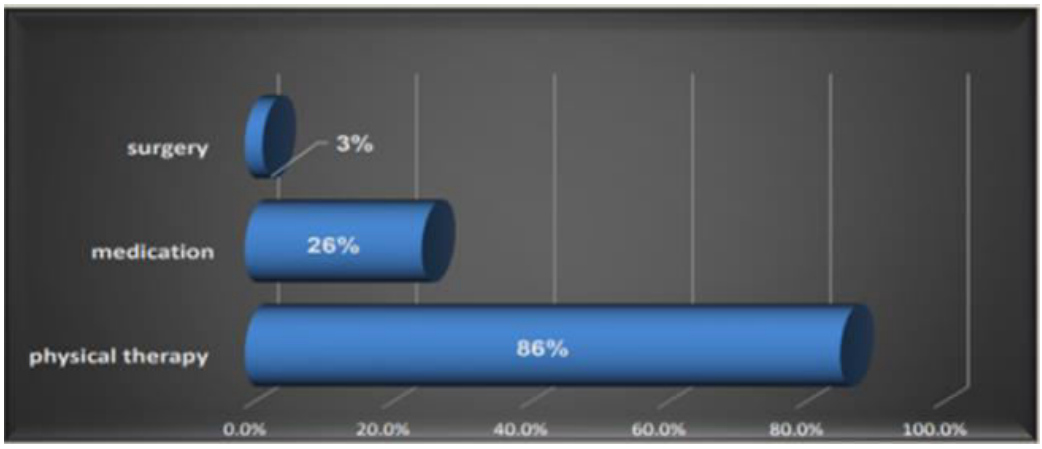

Fig. 5: Types of medical treatment that participants were received.

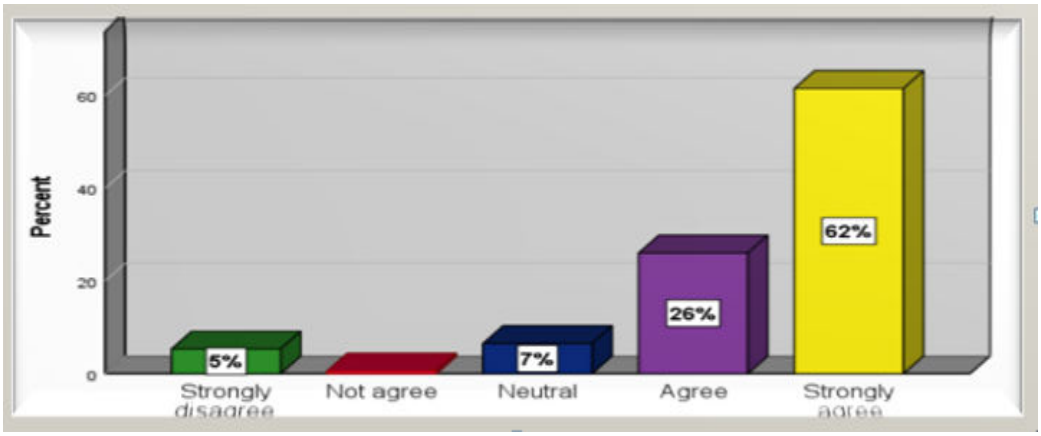

Fig. 6: How important are warm up and stretching exercises for injury prevention during swimming according Likert scale.

Fig. 7: Percentage of injuries occurrence either in or out of the water.

Table 3: Frequency and Percentages of the most common musculoskeletal injuries for swimmers in Jordan.

Injury	Frequency	Percentage %
Muscle cramps	71	28.6
Sprains	44	17.7
Muscle spasm	74	29.8
Ligament or tendon tears	25	10.1
No injury	34	13.7

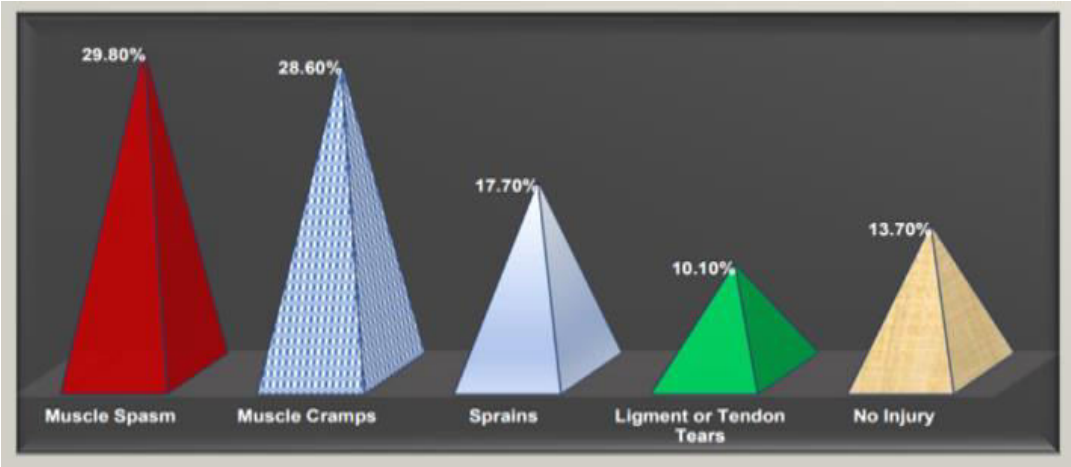

Fig. 8: The most common musculoskeletal of swimmers in Jordan.

Table 3 and **Fig. 8** show that muscle spasm was the injury most frequently reported by swimmer practitioners (29.8%) followed by muscle cramps (28.6%) and in the third place was sprain (17.7%). However, the injury with the least frequently reporting was ligament or tendon tears (10.1%). The majorities of these injuries were reported as sudden and not chronic injuries.

Question Four: What causes injuries among swimmers practitioners in Jordan?

To address the question and achieve the objective, the researcher used frequencies and percentages value for each of the variables as shown in **Table 4** and **Fig. 9**.

Table 4: Frequency and Percentages of causes of sport injuries for swimmers in Jordan.

Injury	Frequency	Percentage %
Overtraining	90	27.0
Inadequate warm up	112	33.6
Mistakes during the exercise	54	16.2
Poor technique	45	13.5
Other reasons	32	9.6
Sum	333	100

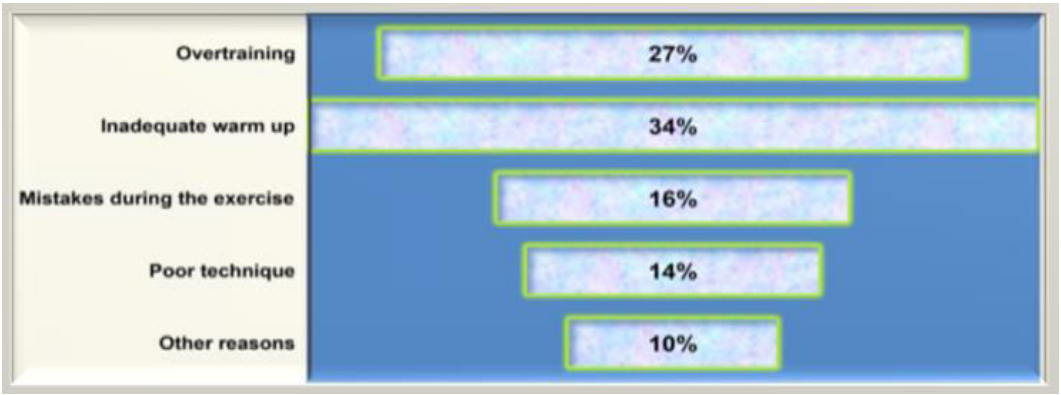

Fig. 9: Causes of sports injuries among swimming practitioners in Jordan.

Table 4 and **Fig. 9** demonstrate the recurrence causes of sport injuries among swimming practitioners in Jordan, where the most common reason of injury occurrence has been a result of Inadequate warm up of a percentage of 34%, followed by overtraining with a percentage of 27%, then mistakes during exercising with a percent of 16%, poor technique with a percent of 14% and finally other reason with a percent of 10%. Participants suggest to add the following reasons:÷ the lack of good behavior of the athlete, lack of attention,

haste, violation of the laws of the game, lack of gradual increase in the exercise load and continuity in training when an injury occurred. In addition to the invalidity of sportswear, non-adherence to a clear training program, absence of the coach's guidance, bad weather, lack of compliance with security and safety rules, allowing the player to return to training before full recovery, non-adherence to diet program and lack of knowledge about swimming injuries, causes and ways to prevent them.

Question Five: How have swimming injuries affected swimming performance and training?

To address the question and achieve the objective, the researcher used frequencies and percentages value for each of the variables as shown in **Table 5** and **Fig. 10**.

Table 5: Frequency and Percentages of the effected injuries on swimmer's performance.

Effectiveness	Frequency	Percentage %
Decreased swimming speed or endurance	129	34.9
Limited range of motion or flexibility	38	10.3
Impaired stroke technique	75	20.3
Reduced training intensity or frequency	77	20.8
Required complete cessation of swimming	16	4.3
Others	35	9.5
Sum	370	100

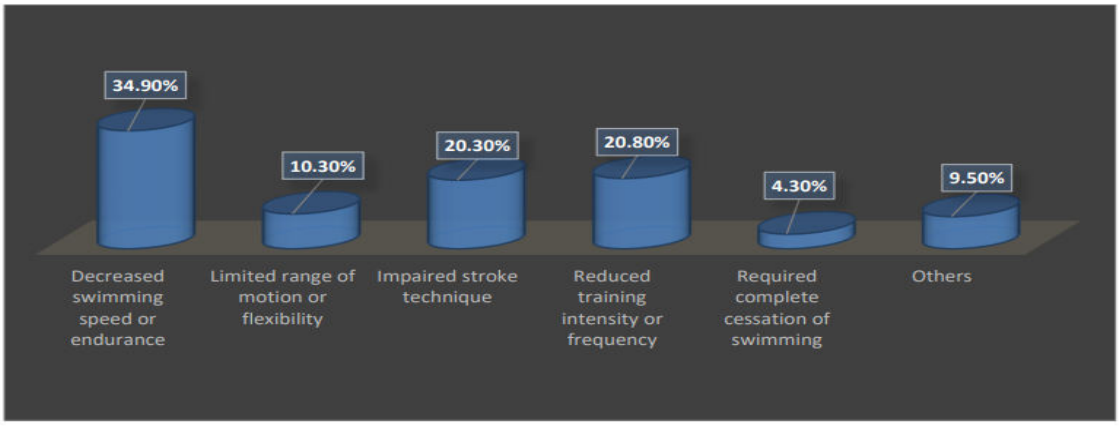

Fig. 10: Injuries effect on swimmer's performance.

As presented in **Table 5** and **Fig. 10**, decreased swimming speed or endurance, reduced training intensity or frequency, impaired stroke technique, limited range of motion or flexibility and requiring complete cessation of swimming cause the main effects on the swimming performance and training, with the following weights respectively: 34.9% , 20.8% ,20.3%,10.3% and 4.3%.

Question Sex: if the swimmer adhered to warming up before or cooling down after sessions?

To address the question and achieve the objective, the researcher used the frequencies and percentages value for each of the variables as shown in **Table 6**.

Table 6: Percents if the swimmer adhered to warming up before or cooling down after sessions.

			a					
			Muscle Cramps	Sprains	Muscle spasm	Ligament or tendon tears.	No sports injury.	Total
Do you adhere to proper warm-up sessions before start swimming or cool-down exercises after the sessions ?	Yes	Count	40	12	41	9	20	85
		% of Total	23.7%	7.1%	24.3%	5.3%	11.8%	50.3%
	No	Count	30	32	33	16	13	84
		% of Total	17.8%	18.9%	19.5%	9.5%	7.7%	49.7%
Total		Count	70	44	74	25	33	169
		% of Total	41.4%	26.0%	43.8%	14.8%	19.5%	100.0%

According to the results in the current study, the most causes of injuries were inadequate warm up. Participants were asked if they have been adhering to proper warming up before and cooling down after sessions, the result in table 4.8 shown that participants who answered yes made 50.3%. These have reported the following injuries percentages: (the muscle spasm; 24.3%), (muscle cramps; 23.7%), (no injuries; 11.8%), (sprains; 7.1%) and (ligament or tendon tears; 5.3%). Whereas those who answered no made 49.7%, and, reported the following injuries: (muscle spasm; 19.5%), (sprains; 18.9%) (muscle cramps; 17.8%), (ligament or tendon tears; 9.5%), and (no injuries; 7.7%). According to these results, we found that the despite 50.3% of the participants have been warming up, there are still injuries present among them. This leads us to question the adequacy and nature of the exercises they perform and their duration.

DISCUSSION:

The study revealed that shoulder injuries were the most common musculoskeletal injuries among swimmers in Jordan, followed by back, knee, and neck injuries. These findings align with the biomechanics of swimming, where shoulder involvement is integral to propulsion. Rotator cuff impingement and tendinitis were prevalent shoulder injuries, consistent with elite swimmers. Interestingly, these results diverge from some previous studies, underlining the importance of recognizing sport-specific injury risks. Question two explored participants' engagement in strength training and their receipt of injury prevention guidance. The majority (68.8%) acknowledged participating in strength training, emphasizing its perceived importance for swimmers. Swimming coaches played a pivotal role in providing injury prevention guidance, reinforcing their influence in fostering injury prevention awareness. Furthermore, the prevalence of swimmers seeking medical treatment (68.8%) emphasizes the need for enhanced preventive measures. The diverse treatment methods used reflect the multifaceted nature of these injuries, with physical therapy being prominent for musculoskeletal imbalances. Surgical intervention was necessary for severe cases. Many swimmers (72.2%) adapting their training routines demonstrated a proactive approach to injury prevention. The awareness of exercises and stretches for injury prevention (63.3%) indicates an informed cohort. The use of equipment and aids (76.9%) underlines their role in optimizing training and potentially mitigating injuries. However, variations in warm-up and cool-down practices suggest the need for enhanced awareness campaigns. Question three examined common musculoskeletal injuries among Jordanian swimmers, revealing muscle spasm, muscle cramps, sprains, and other injuries such as ligament or tendon tears. This aligns with some literature, although variations in findings can be attributed to sample differences, capacities, interests, injury causes, and circumstances. The diverse injury patterns emphasize the complexity of injuries among swimmers. Question four addressed the causes of sports injuries, with inadequate warm-up emerging as a leading cause. Proper preparation through warm-up routines readies the body and optimizes joint performance. Nevertheless, these results contrast with some studies in the literature, highlighting the impact of overtraining, especially in swimmers with multiple commitments and varied coaching methods. These findings underscore the significance of understanding sport-specific injury risks. Swimming injuries have multifaceted effects on performance, involving physiological and biomechanical changes. They lead to the reduced swimming speed or endurance, decreased training intensity, compromised stroke technique, limited range of motion, and even complete cessation of swimming. These effects are attributed to the complex nature of injuries, causing pain and discomfort and altering movement patterns and muscle tension. Reduced training intensity results in detraining effects, compromising cardiovascular fitness, muscle strength, and neuromuscular coordination. Additionally, stroke technique is compromised due to compensatory movements, and the joint flexibility is reduced. Even a brief hiatus from swimming leads to performance decline, with muscle atrophy, weakened neural pathways, and diminished cardiovascular fitness. These multifaceted effects encompass pain-related changes, biomechanical alterations, detraining consequences, muscle loss, and neuromuscular adaptations, with several factors determining the extent of performance impact. In question five and six, inadequate warm-up practices significantly contributed to injuries. Approximately 50.3% of participants followed warm-up protocols, experiencing injuries like muscle spasms

and cramps. Interestingly, even some of those who adhered to warm-up routines experienced injuries, prompting questions about the efficacy and nature of these exercises. These findings underscore the intricate relationship between warm-up practices and injury prevention, emphasizing the need for a more nuanced and comprehensive approach to exercise prescription and injury mitigation. A scientifically informed warm-up is a pivotal component of any physical activity regimen, offering multifaceted physiological and neurological benefits, enhancing circulation, improving muscle elasticity, and reducing injury risks.

CONCLUSION AND RECOMMENDATIONS:

The study investigated prevalent the musculoskeletal injuries among swimmers in Jordan, revealing that muscle spasm (29.8%), muscle cramps (28.6%), and sprains (17.7%) were the most common injuries, primarily of abrupt nature. These injuries were often attributed to factors like insufficient warm-up (34%), overtraining (27%), the exercise errors (16%), poor technique (14%), and other causes (10%). These injuries had various impacts on swimmers' performance and training, such as reduced speed or endurance (34.9%) and compromised stroke technique (10.3%). Specific body positions were identified as more prone to injuries, with the shoulder (35.3%), back (14.4%), knee (10.7%), and neck (10.2%) areas being particularly susceptible. The study underscores the significance of injury prevention, proper technique, and gradual training in swimming, offering valuable insights for swimmers, coaches, and professionals seeking to enhance training practices and prioritize swimmers' well-being. The recommendations provided encompass various aspects of swimming, including training, coaching, and injury prevention. They emphasize the importance of incorporating scientifically designed warm-up programs to reduce the risk of injuries, the necessity of imparting precise guidance on swimming techniques to ensure correct form, the inclusion of supplementary dryland training, and the significance of refraining from training until a full recovery from injury. Education on injury theory is deemed crucial for both coaches and swimmers, along with the cultivation of a holistic coach-athlete relationship. Swimmers should also embrace personal responsibility, while administrative officials are responsible for providing adequate training facilities. The regular maintenance of training equipment is pivotal, and the sharing of injury study findings with trainers is encouraged to enhance the safety of training programs. Collectively, these recommendations serve as a comprehensive framework for injury prevention and the overall well-being of swimmers in the field of swimming.

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CONFLICTS OF INTEREST:

The authors declare no conflicts of interest in conducting and presenting this study.

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