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Measuring shoulder range of motion to diagnose shoulder injury among weightlifters: a study in athletes with and without shoulder injury

Medidas del rango de movimiento del hombro como indicación de lesión en el hombro en levantadores de pesas: un estudio en atletas con y sin lesión en el hombre

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Abstract. Background: Weightlifting is one of the sports that contribute to Olympic medals for Indonesia. With the demand to contribute medals at the Olympics, a thorough screening is needed to evaluate athletes for possible risks of injury. Moreover, the lifting movements involve the joints, muscles, and skeleton. Therefore, the sport poses a very high risk of injury, especially to the shoulders. Knowing the athlete's Range of Motion (ROM) is important to see a good range of motion. This study aimed to observe ROM differences between injured and non-injured weightlifters. Method: An observational study was conducted on 16 athletes (10 male and 6 female) with the following characteristics for male (24.1 ± 6.7 years, 168.2 ± 2.5 cm, 83.0 ± 11.9 kg, 29.2 ± 4.0 kg/m^2) and female (18.8 ± 1.6 years, 158.6 ± 3.8 cm, 65.2 ± 7.9 kg, 27.2 ± 4.5 kg/m^2) participants. In data analysis, all athletes went through the screening stage. After that, the body composition and ROM of both arms were measured using InBody 270 and Humantrak 3D Human Movement Analysis, with statistical significance determined at a value <0.05 using the Mann-Whitney test in Minitab. Result: The study found a significant difference in the range of motion of the shoulder between athletes who had injuries and those who did not have injuries. Conclusion: This research revealed a decreased range of motion in weightlifting athletes with injuries.
Keywords: Weightlifter, Injury, Range of Motion, Shoulder

Resumen. Antecedentes: el levantamiento de pesas es uno de los deportes que contribuyen a las medallas olímpicas de Indonesia. Con la demanda de contribuir con medallas en los Juegos Olímpicos, se necesita un examen exhaustivo para evaluar a los atletas en busca de posibles riesgos de lesiones. Además, los movimientos de elevación involucran las articulaciones, los músculos y el esqueleto. Por tanto, el deporte presenta un riesgo muy alto de lesiones, especialmente en los hombros. Conocer el rango de movimiento (ROM) del atleta es importante para ver un buen rango de movimiento. Este estudio tuvo como objetivo observar las diferencias de ROM entre levantadores de pesas lesionados y no lesionados. Método: Se realizó un estudio observacional en 16 deportistas (10 masculinos y 6 femeninos) con las siguientes características masculinas (24,1 ± 6,7 años, 168,2 ± 2,5 cm, 83,0 ± 11,9 kg, 29,2 ± 4,0 kg/m2) y femeninas (18,8 ± 1,6 años, 158,6 ± 3,8 cm, 65,2 ± 7,9 kg, 27,2 ± 4,5 kg/m2) participantes. En el análisis de los datos, todos los deportistas pasaron por la etapa de selección. Después de eso, se midieron la composición corporal y el ROM de ambos brazos utilizando InBody 270 y Humantrak 3D Human Movement Analysis, con significación estadística determinada en un valor <0,05 utilizando la prueba de Mann-Whitney en Minitab. Resultado: El estudio encontró una diferencia significativa en el rango de movimiento del hombro entre los atletas que tuvieron lesiones y los que no las tuvieron. Conclusión: Esta investigación reveló una disminución del rango de movimiento en atletas de levantamiento de pesas con lesiones.
Palabras clave: Levantador de pesas, Lesión, Rango de movimiento, Hombro

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Introduction

Weightlifting is a type of sport that develops the strength and size of skeletal muscles through training (Fares et al., 2020). It involves muscle and skeletal performance to increase the weight of the maximum load (Rumbach et al., 2020). Weightlifting athletes normally compete by lifting the highest total weight to be the best. In the Olympics, the primary lifts competed in this sport are the “snatch” and the “clean and jerk” (Technical and Competition Rules, 2023). Indonesian weightlifters have started making history in this sport since they successfully contributed medals at the Olympics in Beijing 2008 (Himawan et al., 2018) to the 2020 Tokyo Olympics. Indonesian athletes even broke the world record at the 2023 Asian Games, making weightlifting one of the most popular sports in the world (Aasa et al., 2017).

Since then, interest in weightlifting in Indonesia has been increasing and becoming more popular every year. Unfortunately, the increasing popularity is also followed by an increase in injuries among athletes (Ampat et al., 2022). Although some scholars argue that the highest risk of athlete injury occurs in contact sports and team sports (Parkkari et al., 2004; Pons-Villanueva et al., 2010), others believe that injuries are more likely to occur in sports activities with high-intensity demands compared to activities with light intensity (Choe et al., 2021). Meanwhile, weightlifting is a sport with high-intensity demands both during training and competition (Mangine et al., 2018; Samsudin et al., 2022). Therefore, this sport also has a very high risk of injury. In elite weightlifters, the most frequent injuries are to the back (especially the lower back), knees, and shoulders (Calhoon & Fry, 1999). Meanwhile, according to the research by Strömbäck et al. (2018), the parts of the body that often suffer injuries include the lumbopelvic, shoulders, and hips. In particular, the types of injuries most experienced are from muscle strains to tendinitis.

The incidence of injury in this sport is calculated at 2.4-3.3 injuries / 1000 hours of practice (Aasa et al., 2017).

Weightlifting sport has two primary lifts, the snatch and the clean and jerk. They have different movements and phases even though the weight support remains the same. Explosive movements during training or competitions with heavy-weight resistance are a big challenge for weightlifters. According to Brett Baker, athletes have a long-term involvement in the particular sport they take up, and thus, repetitive stress or overuse injuries can occur at any time (Baker et al., 2019). Meanwhile, ongoing injuries have been proven to interfere with an athlete's performance (Pardiwala et al., 2020). The movements when weightlifters lift weights always involve joints, muscles, and the skeleton, which are identical to the abduction and adduction movements of the shoulder from the frontal plane.

Range of motion refers to the full movement potential of a joint, usually its range of flexion and extension. The greater the ROM, the better the range of motion can be said to be. This is crucial for performing training and competition phases effectively, as a good ROM can prevent issues such as shoulder problems. Therefore, maintaining optimal ROM is essential for weightlifters to maximize performance and minimize the risk of injury. Given this importance, understanding the differences in ROM between injured and non-injured weightlifters can provide valuable insights. Thus, this study aims to observe ROM and determine whether there are differences in shoulder ROM results between injured and non-injured weightlifters based on gender.

Method

This research used the observational study to obtain a range of motion data for athletes with and without shoulder injuries. Prior to data collection, the research received an ethical permission number 25/KEPK/EC/X/2022 and was approved by the Declaration of Helsinki.

Population and Sample

The subject population of this study was male weightlifters in Indonesia (N=20). Using a purposive sampling technique, the study determined research samples based on the inclusion criteria that the researchers had determined, such as (1) having at least experience competing at the national level and (2) having or not having shoulder injuries. Meanwhile, the exclusion criteria are (1) athletes who have not been involved in systematic weightlifting training in the last 2 months. With these criteria, the researcher found 16 participants who met the inclusion criteria in this study. The participants in this research were athletes preparing for the national championship as provincial representatives.

Data Collection

Data in this research were collected by having participants complete a questionnaire. The questionnaire consisted of items regarding the characteristics of the presence or absence of previous weightlifting-related injuries form (Fuller et al., 2006) and has been modified to adjust the present research needs. Anthropometric and body composition measurements were carried out using the BIA. Meanwhile, the Range of Motion of the shoulder when performing abduction and adduction movements has been tested for reliability (McCarthy et al., 2023). The ROM protocol included several steps. First, the athlete stood at a predetermined camera position, 1.5m from the center point of the tripod, to ensure the SOPs required by Humantrak were met. After that, they were asked to stand up straight with their hands at their sides. The tester then operated and gave a signal to move alternately with shoulder abduction/adduction as wide/as far as possible. This was done 3 times. Finally, the results displayed were taken from the highest of three trials and were immediately processed using an algorithm by Humantrak software in real-time.

Statistical Analysis

After data collection, the data were processed using the Minitab version 21 application (USA). The Anderson-Darling normality test method was employed because the sample was less than 50. The results indicated that the data were normally distributed. Thus, the Mann-Whitney non-parametric method was applied to determine the differences between the two groups with a significance value <0.05. All data are presented as mean ± standard deviation (SD).

Results

The first part of this section reveals the anthropometric results of 10 male and 6 female weightlifter athletes, as presented in Table 1. The results indicated the following characteristics of the male athletes, covering their mean age (24.1 ± 6.7 years), height (168.2 ± 2.5 cm), weight (83.0 ± 11.9 kg), BMI (29.2 ± 4.0 kg/m^2), skeletal muscle (36.1 ± 3.0 kg), body fat (19.9 ± 7.6 kg), arm length (74.6 ± 1.8 cm), and leg length (105.3 ± 8.4 cm). Meanwhile, the characteristics of the female athletes included the mean age (18.8 ± 1.6 years), height (158.6 ± 3.8 cm), weight (65.2 ± 7.9 kg), BMI (27.2 ± 4.5 kg/m^2), skeletal muscle (21.7 ± 9.0 kg), body fat (25.8 ± 1.1 kg), arm length (70.8 ± 1.1 cm), and leg length (94.2 ± 3.4 cm).

Subsequent analysis was then performed to see the differences between the injured and uninjured athletes based on gender. The anthropometric statistics for male athletes showed that there were significant differences between injured and uninjured athletes, except for the BMI results shown in Table 2. However, the results of anthropometric

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statistics for female athletes did not show any significant difference, as shown in Table 3.

Following that, this study measured shoulder adduction and abduction. The results indicated that injured male athletes had shoulder adduction Left (6.9° ± 2.7°), shoulder adduction Right (11.8° ± 7.9°), shoulder abduction Left (166.0° ± 2.6°), and shoulder abduction Right (166.7° ± 1.6°). On the other hand, male athletes who were not injured showed shoulder adduction Left (31.3° ± 3.5°), shoulder adduction Right (34.7° ± 6.1°), shoulder abduction Left (174.0° ± 4.5°), dan shoulder abduction Right (174.0° ± 2.1°). This research also reported the female athletes who experienced injuries. Based on the analysis, they had shoulder adduction Left (21.0° ± 15.3°), shoulder adduction Right (15.1° ± 10.0°), shoulder abduction Left (176.0 ± 8.6), and shoulder abduction Right (173.5° ± 4.8°). Meanwhile, female athletes who were not injured showed shoulder adduction Left (38.4° ± 6.2°), shoulder adduction Right (28.0° ± 4.1°), shoulder abduction Left (183.3° ± 2.1°), and shoulder abduction Right (184.0° ± 5.0°). From the range of motion of the shoulder, the results of athletes who had injuries and those who did not have injuries had a significant difference with a p-value <0.05. The limitations of the athlete's range of motion in Table 4 and Table 5 show no significant difference between athletes who are injured and those who are not injured. However, it can be seen that athletes who have shoulder injuries experience limited range of motion in abduction movements.

Table 1.
Anthropometry Test

Variable	Male (n=10)	Female (n=6)	P-Value
	Mean ± SD		
Age	24.1 ± 6.7	18.8 ± 1.6	0.033*
Height (cm)	168.2 ± 2.5	158.6 ± 3.8	0.001*
Weight (Kg)	83.0 ± 11.9	65.2 ± 7.9	0.001*
BMI (Kg/m^2)	29.2 ± 4.0	27.2 ± 4.5	0.126
Skeletal Muscle (Kg)	36.1 ± 3.0	26.5 ± 0.4	0.012*
Body Fat Mass (Kg)	19.9 ± 7.6	25.8 ± 1.1	0.005*
Arm length (cm)	74.6 ± 1.8	70.8 ± 1.1	0.040*
Leg length (cm)	105.3 ± 8.4	94.2 ± 3.4	0.010*

Table 2.
Statistical anthropometry test on male participants

Variable	Male (n=10)		p-value
	Injury Shoulder	Uninjury Shoulder	
	(n=5)	(n=5)	
	Mean ± SD		
Age	22.6 ± 4.8	26.2 ± 7.1	0.539*
Height (cm)	170.0 ± 2.3	166.8 ± 1.1	0.017*
Weight (Kg)	91.1 ± 9.6	76.2 ± 9.8	0.023*
BMI (Kg/m^2)	31.7 ± 3.1	27.6 ± 3.4	0.044*
Skeletal Muscle (Kg)	38.0 ± 2.6	33.9 ± 2.4	0.017*
Body Fat Mass (Kg)	22.8 ± 6.0	16.3 ± 5.3	0.095
Arm length (cm)	70.8 ± 1.5	74.0 ± 2.1	0.016*
Leg length (cm)	92.0 ± 1.9	99.7 ± 5.5	0.018*

Table 3.
Statistical anthropometry test on female participants

Variable	Female (n=6)		p-value
	Injury Shoulder	Uninjury Shoulder	
	(n=3)	(n=3)	
	Mean ± SD		
Age	20.5 ± 0.7	17.0 ± 2.8	0.063
Height (cm)	162.5 ± 6.4	160.0 ± 7.1	0.672
Weight (Kg)	70.6 ± 14.9	64.4 ± 7.9	0.283
BMI (Kg/m^2)	27.0 ± 7.8	25.4 ± 5.3	0.482
Skeletal Muscle (Kg)	26.7 ± 0.3	26.2 ± 0.3	0.388
Body Fat Mass (Kg)	27.9 ± 6.6	16.8 ± 8.2	0.073
Arm length (cm)	71.0 ± 1.0	69.7 ± 1.5	0.295
Leg length (cm)	90.3 ± 0.6	94.7 ± 2.5	0.101

Table 4.
Statistical analysis of male participants

Variable	Male (n=10)		p-value
	Injury Shoulder (°)	Uninjury Shoulder (°)	
	(n=5)	(n=5)	
	Mean ± SD		
Left Shoulder Add	6.9 ± 2.7	31.3 ± 3.5	0.023*
Right Shoulder Add	11.8 ± 7.9	34.7 ± 6.1	0.023*
Left Shoulder Abd	166.0 ± 2.6	174.0 ± 4.5	0.022*
Right Shoulder Abd	166.7 ± 1.6	174.0 ± 2.1	0.021*

Table 5.
Statistical analysis of female participants

Variable	Female (n=6)		p-value
	Injury Shoulder (°)	Uninjury Shoulder (°)	
	(n=3)	(n=3)	
	Mean ± SD		
Left Shoulder Add	21.0 ± 15.3	38.4 ± 6.2	0.020*
Right Shoulder Add	15.1 ± 10.0	28.0 ± 4.1	0.019*
Left Shoulder Abd	176.0 ± 8.6	183.3 ± 2.1	0.025*
Right Shoulder Abd	173.5 ± 4.8	184.0 ± 5.0	0.012*

Discussion

The first results of this study showed that athletes who had no injuries had a normal range of motion, while athletes with injuries to the shoulder area experienced a decreased range of motion in all protocols. This is similar to what research has found, in which weightlifters who experience shoulder injuries have a 4 to 5 times greater risk of experiencing re-injury than athletes who do not experience injuries to the upper extremities (Shanley et al., 2011). For a weightlifter, this injury is classified as a chronic injury. Chronic injuries in weightlifting are caused by excessive exercise, in contrast to acute injuries caused by muscle fatigue and overload, which can cause dislocations and even bone fractures (Golshani et al., 2018).

The incidence of injury to weightlifters occurs at 2.4 - 3.3/1000 hours of training (Gimigliano et al., 2021). Interestingly, in this study, the results shown in anthropometric statistics show that athletes who have injuries and those who do not have injuries have differences. However, in contrast to the results of female athletes, there were no differences between athletes who had injuries and those who were not injured. This may occur due to different nutrition given to athletes or injury due to excessive training. Such differences were also found in other sports, such as baseball, where differences were found in the range of motion for athletes with and without shoulder injuries (Bullock et al., 2018). Range of motion disorders can occur due to medical conditions, such as fractures, pain, stroke, or other neuromuscular diseases (Oosterwijk et al., 2018).

Another interesting finding in this study was that males' overall ROM scores were worse than females both with and without injuries (see Table 2 and Table 3). These findings are in line with (Mauntel et al., 2015; Weisenthal et al., 2014), who mentioned that males tend to get injured more often compared to females during training. One of the possible reasons might be the large number of repetitions that male athletes do. The impact of more repetitions causes worse changes in technique, thereby increasing the risk of injury (Neto et al., 2023).

Furthermore, this study emphasizes that athletes who have a history of injury and are currently experiencing injury should undertake more substantial strengthening training programs. If the injury is not treated, it will result in more severe injury, which can have a wider impact on the body due to the interconnected nature of the musculoskeletal system. Moreover, a limited range of motion can make athlete's performance less optimal because the human musculoskeletal system is a complex and closely interconnected network. Both muscles and bones do not function as independent entities (Murphy et al., 2018).

Conclusion

In conclusion, this research reveals that a decrease in range of motion occurs most often in athletes who have a history of injuries or are currently experiencing injury. In addition, men have a higher range of motion limitations when compared to women and the joints that are most disturbed during movement abduction. This research is hoped to help describe the characteristics of a range of motion in injured and uninjured weightlifters. Thus, athletes and coaches have strategies to prevent injuries. Nevertheless, it should be noted that there are several limitations in this research. For instance, the researcher only studies the limited range of motion of the shoulder. Thus, it is important to analyze and conduct further research on injury data that occurs in each sport. The data can be processed as a basis to create an injury revention program that suits the characteristics of injuries in Indonesia. The aim is to reduce the risk of sports injuries and enable all athletes to participate optimally in each training program or competition.

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