

## Some Biomechanical Variables And Their Relationship To Leg Pain In Gymnastics On The Floor Movement Mat

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### Abstract

The research problem lies in studying the relationship between some biomechanical variables and the degree of pain in the leg area, specifically at the moment the foot hits the ground on the floor movement mat in gymnastics, due to its significant impact on the player's performance and achieving a high level. This type of injury occurs frequently due to the body's forces not being proportional to the reaction of the tool or the ground. The main objective of this research is to study the relationship between some biomechanical variables and the degree of pain in the leg area among gymnastics players from university students. The research sample included the university gymnastics team, which included (8) players who suffer from leg pain at the moment of hitting the ground, especially in the final stage of performance and achieving balance. After conducting the tests and measurements, the data were collected and processed statistically to reach the most important conclusions:

- 1. The results showed that increasing the rotation angle and angular velocity increases the likelihood of injury.*
- 2. The results showed that there is a strong correlation between the rotation angle and angular velocity with the degree of pain.*

**Keywords:** Biomechanical variables pain and gymnastics.

### 1-Introduction

The body, with its various parts, whether tissues, muscles or bones, is subject to the influence of different forces that require study according to what is known as biomechanics. This type of study is of great importance in the field of sports and movement sciences, as it helps researchers to know the effect of different forces on athletic performance and various movements in performance.

Analyzing different forces and understanding the nature of the effect of forces is important for coaches to understand the nature of performance, which affects the improvement of different techniques that play an important role in improving performance and reducing the risk of injury. Therefore, understanding biomechanics gives a deep vision of the mechanism of performance and a broader understanding of the kinetic properties, which prevents the player and student from the possibility of

injury or reduces its risks by understanding the pressures and forces affecting performance and different parts of the body.

Biomechanics, according to it, is concerned with studying the movement of the human body and analyzing the mechanical properties according to the physical concept of movement. What distinguishes the concept of physics here is centered on knowing what the effect of forces, whether internal or external, is on the movement of different parts of the body related to performance, especially in gymnastic movements on the floor movement mat. Biomechanics is defined as an analytical study from the perspective of the human body of the external and internal influences of different forces that affect the occurrence of different movements and improve performance and reduce the risk of injury, especially in gymnastics due to its special requirements in performance.<sup>1</sup>

Leg pain is one of the problems facing many players and students in various sports, especially in gymnastics, specifically the mat of ground movements, as a result of the reaction of forces on the body, especially the lower extremity in the leg area. Leg pain results from several reasons, the most important of which is excessive stress on the muscles, ligaments and bones in the leg area, which generates inflammation and micro-injuries that worsen until the injury occurs significantly. Leg injury may result from excessive force on the legs at the moment of repeated landing and the imbalance of the body's forces represented by the muscles with the force of the ground's reaction.<sup>2</sup>

Studying the causes that lead to leg injury from a mechanical point of view plays an important role in understanding the aspects of weakness that result in injury, so reducing the risk of continuing to perform in a way that may exacerbate the injury, specifically recurring leg pain. Studying the relationship between mechanical indicators and pain in the leg is very important in the field of ground movements, as it gives a clear idea of the effect of force on the leg area, especially at the moment of contact of the foot with the ground, which is the subject of the study.

### **1-1 The research problem**

The research problem lies in the fact that the weakness of the structural composition of the body is affected by the amount of external forces affecting it, especially when performing movements that require resistance to the ground's reaction to the body. Here, the researchers noticed that performing movements on the ground movement mat results in generating continuous reactions on different parts of the body, especially the leg area. Therefore, the imbalance of muscle strength in the leg part results in pain in the leg area as a result of the ground's reaction when landing and the foot's contact with the ground in the skill of the ground movement mat in gymnastics.

### **1-2 Research objectives**

- Study the relationship between some biomechanical variables and leg pain in gymnastics on the floor exercise mat.

### **1-3 Research hypotheses**

- There is a statistically significant relationship between some biomechanical variables under study and leg pain in gymnastics on the floor exercise mat.

#### 1-4 Research field

- Human field: University team gymnastics players for the academic year 2023-2024.
- Time field: For the period from 3/2/2024 to 8/5/2024.
- Spatial field: Gymnastics Hall in the College of Physical Education and Sports Sciences / University of Babylon.

#### 2- Research Methodology

The researchers used the descriptive approach with a correlational design to suit the nature of the research procedures.

##### 2-1 Research community and sample

The research community included the players of the University of Babylon gymnastics team, numbering (10) players. (8) players were selected as a sample for the research who suffer from leg pain at the moment of hitting the ground after (2) player who underwent the exploratory experiment was excluded. Also, homogeneity was performed for the individuals of the research sample in the variables of height, age and weight as in Table 1.

**Table 1.** Shows the homogeneity of the research sample.

Statistics		Length	Weight	Age
N	Valid	8	8	8
	Missing	0	0	0
Mean		167.38	67.75	20.62
Median		166.5	67.5	20.5
Std. Deviation		1.99	6.251	0.926
Skewness		0.46	0.074	0.045

From the table (1) it is clear that the value of the skewness coefficient ranges between ( $\pm 1$ ) and this indicates the homogeneity of the research method.

##### 2-2 Devices and tools used in the research

- Ground motion carpet.
- Video camera.
- Tripod.
- Length drawing scale (1 meter).
- Laptop type (DELL).
- Motion analysis program.

##### 2-3 Exploratory experiment

The exploratory experiment was conducted on (5/2/2024) in order to identify the most important obstacles that may affect the implementation of the experiment, as well as to familiarize the support team with the mechanism for implementing the tests and how to collect information.

## 2-4 Tests used in the research:

### 1. Test of the biomechanical variables under study<sup>3</sup>

- The aim of the test: to measure the biomechanical variables under study at the moment of contact of the foot with the ground during the landing phase.
- Tools used in the research:
  - Ground motion carpet.
  - Video camera.
  - Tripod.
  - Length drawing scale (1 meter).
  - Laptop type (DELL).
  - Motion analysis program.
- Test Description: The players' movements were analyzed on the ground movement mat by installing the camera at a distance of (6) meters and perpendicular to the performance and at a height of (1.5) meters after the drawing scale was placed at the performance level to obtain the most important measurements that require speed in performance.

### 2. Numeric pain rating scales<sup>4</sup>

- This scale is commonly used to measure pain intensity, where a person rates their pain on a scale from 0 to 10. Zero means “no pain” and 10 means “the worst pain possible”. These pain intensity levels can be assessed at the initial treatment, or periodically after treatment.

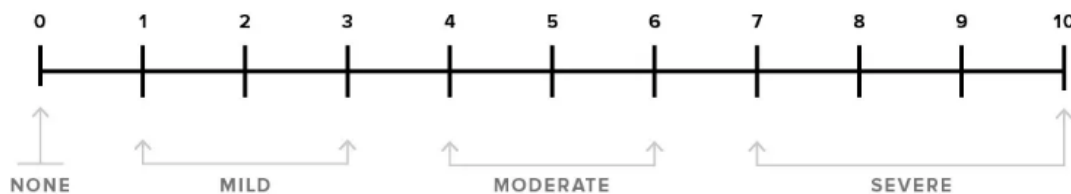


Figure 1. Pain scale shows the degree of pain in numbers.

## 3- Results and Discussions

- **Presentation and analysis of the results of biomechanical variables and pain level according to statistical analysis**

Table 2. Show statistics show the variables under study

Variables	Mean	Std. Deviation	N
Velocity angle	73	1.75	8
Rotation Angle	26.813	1.61	8
Angular velocity	115	2.66	8
Kinetic energy	1038.94	12.45	8
Pain	5.19	0.75	8

- **Presentation and analysis of the results of the relationship between biomechanical variables and the degree of pain according to the Pearson test**

**Table 3.** Show correlation coefficient between the biomechanical variables under study and the degree of pain

	<b>Variables</b>	<b>Velocity angle</b>	<b>Rotation Angle</b>	<b>Angular velocity</b>	<b>Kinetic energy</b>
<b>Pain</b>	Pearson Correlation	0.102	0.90	0.85	0.29
	Sig. (2-tailed)	0.71	0.000	0.001	0.28
	N	8	8	8	8

From the table (2 and 3) it is clear that there is a strong correlation between the angle of rotation and the angular velocity with the degree of pain, as the higher the angular velocity and the angle of rotation, the greater the probability of injury due to the increase in the amount of momentum that increases the amount of body weight in relation to the reaction of the forces affecting the body.<sup>5</sup>

This type of correlation is important for therapists and researchers to understand the reasons that affect the occurrence of pain in the part of the body concerned with performance, especially pain in the leg area in gymnastics, specifically the floor movement mat. Determining the correct mechanism of movement enables the coach and teacher to employ the performance in a way that prevents the student or player from injury.<sup>6</sup>

This type of study adds advanced aspects in the field of innovating exercises and tools that contribute greatly to improving performance and protecting against injury, as the degree of pain in gymnastics, especially at the moment the foot hits the ground when landing,<sup>7</sup> is determined by the angle of the player's landing, as the angle of landing and the speed of rotation are linked to each other, and the more it increases, the more weight is placed on the different parts of the body, especially the leg area.<sup>8</sup> Gymnastics requires increasing muscle strength to achieve relative strength for each part of the body to increase its ability to resist various pressures, ensuring protection from the large amount of resistance imposed upon it at the moment of collision with the ground.<sup>9</sup>

While there was no clear correlation between kinetic energy and the angle of velocity at the moment of collision with the ground,<sup>10</sup> this only indicates that the amount of energy was transferred to the ground in a large way,<sup>11</sup> which generated a large reaction

against the various parts of the body due to the body not retaining the energy necessary to maintain the body's balance.<sup>12</sup>

#### 4- Conclusions

3. The results showed that increasing the rotation angle and angular velocity increases the likelihood of injury.
4. The results showed that there is a strong correlation between the rotation angle and angular velocity with the degree of pain.
5. The results did not show a correlation between the velocity angle and kinetic energy with the degree of pain in the leg area.

#### 5- Recommendations

1. The necessity of conducting similar studies on other biomechanical variables to study the relationship with the degree of pain in the leg area.
2. The necessity of developing performance using angle exercises related to the performance of each skill to increase the body's resistance strength against the various reactions of the tool with the body.
3. The necessity of continuous evaluation by the coach and teacher for players and students to know the degree of proportion between physical strength and the reaction of the devices on the body.

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