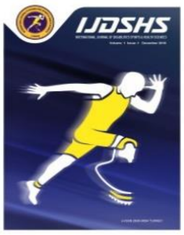

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RESEARCH ARTICLE

# Extent of Knowledge and Application the Basics of Biomechanics Among Paralympic Games Coaches

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**Abstract**
This study aimed to identify the extent to which the bio-mechanical principles of human movement are known and applied in training the skill aspects of Paralympic coaches where the sample of the study consisted of 35 Paralympic coaches from several countries, all of whom are males. The average age of 42 ± 3.4 years. Their average training age was 7.5 ± 2.6 years. In order to achieve the study's objectives, the researchers designed a cognitive test that its validity, reliability, difficulty index were confirmed, and composed of 51 questions distributed to 6 axes. They also designed a questionnaire that its validity and reliability were confirmed and consistent and made up of (38) A paragraph distributed to (6) axes. The study results showed a low level of knowledge and low degree of application of the basics of biomechanics among Paralympic coaches. According to the results of our study, The responsible authorities of the Paralympic Committees should provide their coaches with special courses in biomechanical analysis and enhance their capabilities in this field, given its practical importance.. Academic agencies that issue training certificates in the field of sports training for persons with disabilities should focus on the field of biomechanical analysis and its related matters in their teaching programs.

**Keywords**
Paralympics, Biomechanics, Application, Coaches, Knowledge Range

## INTRODUCTION

Since the 1940s, persons with disabilities have used sport as a therapeutic tool to overcome health complications, prevent secondary disabilities and survive. Then after several fluctuations, especially after the large number of physically disabled people due to World War I and World War II, the sport of the disabled began to develop until the appearance of the Paralympics corresponding to the Olympic Games, where it debuted in 1960 in Rome (Mauerberg-deCastro et al.,2016) When focusing this, we find that all matters related to the disabled in rehabilitative therapeutic terms are conducive to high-level sports competitions associated with achievement. also related to biomechanical aspects, whether for treatment, motor rehabilitation or physical and skillful sports training. The rehabilitation and physiotherapy for persons with disabilities is based on the biomechanical aspects and thus their athletic training is based on these biomechanical aspects (Maly, 2009).

Biomechanics is a quantitative and qualitative study to perform sports. It is the physics of sport in which physical laws applied to sports movements and skills in order to achieve a

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deeper, better and more accurate understanding of the sports movement through modeling of skill performance based on a range of mechanical elements for all athletes (Watkins, 2014). Biomechanical analysis is an important factor for the development of the skill performance of athletes in all sports, especially among athletes with injuries or physical and sensory disabilities. Understanding and applying biomechanical work to provide scientific and practical data to coaches that help them to develop the sporting plans of their players and commensurate with them in terms of the nature of their disability and their specialized sport, which helps them adapt to the correct skill form and apply it with the least time and effort and in the best possible way (Lopes et al., 2023).

Motor analysis based on biometric principles increases the awareness of athletic coaches of the mechanical performance specifications, helping them to develop the required skill development plans of their players with disabilities (Trowell et al., 2020) so that this disability requires a full mechanical understanding of it in terms of its impact on the mechanics of movement in general and the skills associated with sport in particular. Also understand the mechanical nature of the remaining motor capacity after disability and thus build the skill performance in a mechanical manner commensurate with this ability and with the type of motor mechanical loss because of disability. The biometric principles of sports movements provide continuous information to coaches to evaluate skill performance first and thus progressively develop it based on the strengths and weaknesses that characterize the player. The coach works to modify weaknesses and enhance strengths through targeted training programmers that take into account aspects and biomechanical variables such as strength, speed and other variables and the relationship between these variables in order to the best possible skill performance according to biomechanical models that are consistent with the type and severity of disability and the requirements of the sport practiced by the disabled person (O'Riordan and Frossard, 2006) .

By examining the Biomechanics analysis, we find that he studies linear and angular dynamics and statics through two groups. First, the kinematic variables that describe movement externally, such as speed. acceleration, displacement, joint angles, angular speeds, peripheral speeds and other variables, And the Kinetic variables that show the amount of internal work and internal forces such as strength, speed, work, torque, work, joints momentum and other dynamic variables 139-4.The athletic coach must know and apply all this to optimize the skill performance, which consists of the result of movements based on Biomechanical variables. Each skill performance has a biomechanics shape with certain values that control the success of this performance if not (Özkaya et al., 2016). Thus, in the current era, coaches must know and apply biometric principles and develop their quantitative and qualitative motor analysis capabilities according to them and use the tools and equipment needed for such analysis to identify many variables of their players' skill performance such as their inertia, freedom of their movements, their ability to move, coordinate movements, and the appropriate Kinetic rhythm(Higgs et al., 1990).

Players trained according to the principles and rules of biometrics have achieved better results than others compared to those who have not been trained according to these principles and rules, especially in the field of continuity of development and progress in the skill performance of (Dutt, 2018). Therefore, biomechanical motor analysis is important, necessary and useful for all athletes at all ages and levels whether local or international for the normal people or disabled, as it gives the coach a unique opportunity to develop the skill of his players more in terms of motor efficiency (Chawla, 2017). In fact, the need to apply biomechanical aspects to disabled athletes is more important than applying these aspects to normal people, especially with the differences in anthropometric measurements of disabled players, as a result of the disability that imposes different forms of performance in terms of mechanical terms, which means the importance of identifying the special mechanical variables for each sports skill in disabled sports (İSLAMOGLU., et al, 2023). So When we talking about Paralympic sports of a highly competitive nature, we find them to be diverse and multiple and characterized by their skillful form and nature from the sport of the normal people. Each game has a professional medical classification to which the player is subject according to his or her abilities and type of disability, giving him a degree that determines his or her sensory or motor ability after disability. This means that each player has a degree and severity of disability and ability to move remaining after the disability, this requires the coach to know the biomechanical aspects that the player possesses according to the remaining capabilities and capabilities he has to avoid losing any performance aspect that the player can perform in order to increase competitiveness and the opportunity to achieve success and win (Reina et al., 2019). So from the foregoing, if the need for the coaches of normal players to know and apply the biomechanical principles when developing their athletic performance is urgent and necessary and is an important requirement that distinguishes the modern trainer, that need seems more pronounced in the coach of the Paralympics, the average person has preceded anatomically and functionally identifying his biometric variables based on the nature of the usual human movement. As for the person who is anatomically disabled, and because of the sensory or motor defect, he has an impact on the nature of the motor mechanics in his movements. Therefore, there is an increased need for his trainers to know and apply the appropriate biomechanical bases for his situation and try to develop them for his skill performance.

**This study therefore addressed the answer to the following questions:**

1. How well do Paralympic coaches know the principles and biometric laws of human movement?
2. How far do Paralympic coaches apply the biometric principles and laws of human movement when developing skilled training plans?

## MATERIALS AND METHODS

### *Study Design*

This study used the descriptive curriculum of all its scientific procedures and tools to achieve its objectives.

### *Study sample*

The study respondents consisted of 35 Paralympian trainers from several countries, all of whom were males. The average age was 42 ± 3.4 years, while their average training age was 7.5 ± 2.6 years.

This study was approved by the Scientific Research Ethics Committee of the College of Pharmacy at Mutah University - Jordan (approval code: 295/2023-SREC-7/ May. 29,2023)

### *Study Tools*

Researchers used a test in addition to a questionnaire to measure the knowledge and application of the biometric principles of human movement in Paralympic coaches and below detailed the study tools:

### *Cognitive Test*

The test consisted of 51 multiple-choice questions, with each question having 4 answer options, with a time of 60 minutes. The test questions were divided into six axes:

1- Concepts related to biomechanics (9 questions)
2- Divisions of Sports Skill Movements as Described in Biomechanics (11 questions)
3- Newton's Laws of Motion (8 questions)
4- Mechanical aspects of sports movements (9 questions)
5- Human kinetic levers (7 questions)
6- Applied biomechanical analysis procedures (7 questions),

These questions measure Paralympic coaches' knowledge of the biomechanical principles and laws of human movement.To ensure the validity of the test, it was presented to (10) arbitrators who specialize in kinesiology, biomechanical analysis, and measurement and evaluation in sports training. They indicated the comprehensiveness and gradation of the questions, and that they actually measure the extent of Paralympic coaches' knowledge of the biomechanical foundations and laws of human movement, the lowest average acceptance rate for questions was 78%, while the highest acceptance rate for questions was 96%, which are acceptable percentages. The specialists also agreed that the time allotted for the test is sufficient. As for the reliability of the cognitive test, it was calculated by applying the test and re-applying it after two weeks on (10) coaches are not included in the study respondents. After calculating the internal consistency through the Cronbach alpha test, the results showed the reliability coefficients for the study test is 0.912 for stability and 0.84 for for reliability.

***Difficulty and Discrimination Coefficient of the Test***

The difficulty and ease coefficient was calculated as the difficulty and ease rate ranged from 0.32 to 0.71. The discrimination coefficient was 0.31. Therefore, 3 questions were excluded. Their transactions came outside the established ratios. The test settled on 40 cognitive questions.

The following ratios have been adopted by researchers to determine the level of knowledge

1. Concepts related to biomechanics (7 paragraphs)
2.Divisions of Sports Skill Movements as Described in Biomechanics (7 paragraphs)
3. Newton's Laws of Motion (6 paragraphs)
4. Mechanical aspects of sports movements (6 paragraphs)
5. Human kinetic levers (6 paragraphs)
6. Applied biomechanical analysis procedures (6 paragraphs), which is based on the five-point Likert scale.

The answers were identified as follows:
Radically Agreed - 5 Marks
Mildly Agreed - 4 Marks
Agree - 3 Marks
Slightly Agreed - Two Marks
Very Slightly Agreed - One Mark

The scale did not contain any negative paragraphs requiring reversal of grades.

In order to ensure the validity of the test, it was presented to (11) specialists and academics in kinesiology, sports training science, training for persons with disabilities, measurement and sports evaluation, where they made some amendments to the texts of some paragraphs, and the agreement of the specialists was approved by 75% for the approval of the paragraph and the field. The percentages of agreement ranged On fields and paragraphs, with a minimum score of 78% and a maximum score of 97%.

As for the reliability of the cognitive test, it was calculated by applying the test and re-applying it after two weeks on (13) coaches are not included in the study respondents. After calculating the internal consistency through the Cronbach alpha test, the results showed that the cognitive test obtained a stability coefficient with a value of 0.80.

The researchers adopted the following percentages to judge the extent to which Paralympic Games coaches applied the principles of Paralympic coaches in the biometric principles of human movement:
≥ 0.75, high level
0.60 - .074 average level
≤ 0.59, low level

***Study Questionnaire***

The study questionnaire, which determines the extent to which Paralympic coaches apply the principles and biometric rules of human movement when developing skilled training plans, is based on 38 paragraphs spread over (6) areas.

and biomechanical rules of human movement when developing skill training plans:
1- If the arithmetic mean (1-1.8) is a very low degree of application
2- If the arithmetic mean (1.81-2.6) is a low degree of application
3- If the arithmetic mean is (2.61-3.4), the degree of application is medium
4- If the arithmetic mean (3.41-4.2) is a high degree of application
5- If the arithmetic mean is greater than or equal to (4.21), a very large application score.

***Statistical Analysis***

In this study all analyses were performed by using the Statistical Package for the Social Sciences (SPSS) software version 15, The following statistical treatments were used: internal consistency coefficient Cronbach's Alpha, means and standard deviations, frequency, percentage, and median.

## RESULTS

**The following are the results of the study according to the questions posed**

***First***

As a result of the first question: How well do Paralympic coaches know the principles and biometric laws of human movement?

The table 1 indicates the percentages of the Paralympic Games coaches' knowledge of the biomechanical principles and rules of human movement in the biomechanics-related concepts axis, where the average correct answers were 14 out of 35 answers, while the percentage of correct answers for the axis as a whole was 39.66%.

**Table 1.** Percentages of the extent to which Paralympic Games coaches know the basics and laws of biomechanics of human movement in the axis of concepts related to biomechanics.

| No. | The question | The integer (N) | Percentage for each question % | The average number of correct answers $\bar{x}$ | The total percentile of the axis % |
|---|---|---|---|---|---|
| 1 | What is the ultimate goal of biomechanics? | 16 | 0.45 | 14 | 39.66% |
| 2 | What does the kinetic refer to? | 14 | 0.40 | | |
| 3 | What is kinematics? | 14 | 0.40 | | |
| 4 | What does quantitative kinetic analysis mean? | 12 | 0.34 | | |
| 5 | Which of the following refers to qualitative kinetic analysis? | 14 | 0.40 | | |
| 6 | What does angular kinematic analysis relate to? | 12 | 0.34 | | |
| 7 | What is linear analysis? | 14 | 0.40 | | |
| 8 | Which of the following is static work? | 15 | 0.42 | | |
| 9 | Which of the following does not indicate dynamic motion? | 15 | 0.42 | | |

The table 2 indicates the percentages of the extent to which the Paralympic Games coaches know the principles and biomechanical rules of human movement in the axis of the divisions of sports skill movements according to biomechanics, where the average of correct answers was 13.90 out of 35 answers, while the percentage of correct answers for the axis as a whole was 39.36%.

**Table 2.** Percentages of the extent to which Paralympic Games coaches know the basics and biomechanical laws of human movement in the axis of sports skill movement divisions according to biomechanics.

| No. | The question | The integer (N) | Percentage for each question % | The average number of correct answers $\bar{x}$ | The total percentile of the axis % |
|---|---|---|---|---|---|
| 1 | What does variable speed mean? | 18 | 0.51 | 13.90 | 39.36% |
| 2 | What is positive acceleration? | 16 | 0.45 | | |
| 3 | Which of the following is a kinetic example of a general motion? | 11 | 0.13 | | |
| 4 | What does linear motion refer to? | 13 | 0.37 | | |
| 5 | Which of the following indicates a difference between curvilinear motion and circular motion? | 12 | 0.34 | | |
| 6 | What is the difference between a closed skill and an open skill? | 15 | 0.42 | | |
| 7 | What is the center of gravity of a stationary body? | 18 | 0.51 | | |
| 8 | Which of the following is a movement performed on the longitudinal axis of the body? | 11 | 0.31 | | |
| 9 | Which of the axes is perpendicular to the frontal plane? | 13 | 0.37 | | |
| 10 | Which of the following movements is performed on the deep axis of the body? | 12 | 0.34 | | |
| 11 | At what point do all the axes and physical levels meet? | 14 | 0.40 | | |

The table 3 indicates the percentages of the Paralympic Games coaches' knowledge of the biomechanical principles and rules of human movement in the Newton's Laws of Movement axis, where the average correct answers were 13.37 out of 35 answers, while the percentage of correct answers for the axis as a whole was 37.75%.

**Table 3.** Percentages of Paralympic Games coaches' knowledge of the biomechanical principles and rules of human motion in the axis of Newton's laws of motion.

| No. | The question | The integer (N) | Percentage for each question % | The average number of correct answers $\bar{x}$ | The total percentile of the axis % |
|---|---|---|---|---|---|
| 1 | What does force equal to? | 17 | 0.48 | 13.37 | 37.75% |
| 2 | What is acceleration? | 16 | 0.45 | | |
| 3 | Does controlling training tool blocks help development? | 10 | 0.28 | | |
| 4 | What is inertia totally related to? | 11 | 0.31 | | |
| 5 | Inertia is useful in all of the following movements, except ? | 11 | 0.31 | | |
| 6 | Which of the following is an example of action and reaction in athletic movements? | 14 | 0.40 | | |
| 7 | What does speed equal to? | 19 | 0.54 | | |
| 8 | Does increasing power by stabilizing mass and increasing acceleration lead to performance improvement? | 9 | 0.25 | | |

The table 4 indicates the percentages of the extent to which Paralympic Games coaches know the principles and biomechanical rules of human movement in the axis of mechanical manifestations of sports movements, where the average of correct answers was 12 out of 35 answers, while the percentage of correct answers for the axis as a whole was 33.77%.

**Table 4.** Percentages of Paralympic Games coaches' knowledge of the principles and biomechanical rules of human movement in the field of mechanical manifestations of sports movements.

| No. | The question | The integer (N) | Percentage for each question % | The average number of correct answers $\bar{x}$ | The total percentile of the axis % |
|---|---|---|---|---|---|
| 1 | What does Kinetic rhythm refer to? | 19 | 0.54 | 12 | 33.77% |
| 2 | Can the freedom of movement be inferred through? | 14 | 0.40 | | |
| 3 | What shape appears on the motion athletic movements chart as a result of a proper change in the directions of movement in the joints? | 8 | 0.22 | | |
| 4 | What is the purpose resulting from the occurrence of kinetic transfer? | 9 | 0.25 | | |
| 5 | Which of the following is a transfer of motion from the foot to the torso? | 16 | 0.45 | | |
| 6 | What is the ratio of torso mass to body mass? | 9 | 0.25 | | |
| 7 | Does proper kinetic absorption begin with the joints? | 11 | 0.31 | | |
| 8 | What does dynamic movement mean? | 10 | 0.28 | | |
| 9 | What does collision mean? | 12 | 0.34 | | |

The table 5 indicates the percentages of the Paralympic Games coaches' knowledge of the biomechanical principles and laws of human movement in the leversaxes, as the average of correct answers was 11.14 out of 35 answers, while the percentage of correct answers for the axes as a whole was 31.28%.

**Table 5.** Percentages of Paralympic Games coaches' knowledge of the biomechanical principles and laws of human movement in the leversaxes

| No. | Question | The integer (N) | Percentage for each question % | Average number of correct answers $\bar{x}$ | Total percentage of the axes % |
|---|---|---|---|---|---|
| 1 | Which of the following is not an anatomical lever that does not provide effort? | 10 | 28.0 | 11.14 | 31.28% |
| 2 | The PUSH UP exercise is an example of leversthat? | 8 | 22.0 | | |
| 3 | Which of the following is a point of resistance in levers? | 9 | 25.0 | | |
| 4 | What is the point of power in levers? | 13 | 37.0 | | |
| 5 | The more the resistance line in the lever it becomes? | 15 | 42.0 | | |
| 6 | Equal to the lines of resistance and power in the levers occurs in the movements that need? | 12 | 34.0 | | |
| 7 | Examples of levers that provide effort? | 11 | 31.0 | | |

The table 6 indicates the percentages of the Paralympic Games coaches' knowledge of the biomechanical principles and laws of human movement in the axes of movement analysis procedures, where the average of correct answers was 10.14 out of 35 answers, while the percentage of correct answers for the axes as a whole was 28.42%.

**Table 6.** Percentages of Paralympic Games coaches' knowledge of the biomechanical principles and laws of human movement in the axes of applied biomechanical analysis procedures

| No. | Question | The integer (N) | Percentage for each question % | Average number of correct answers $\bar{x}$ | Total percentage of the axes % |
|---|---|---|---|---|---|
| 1 | Is drawing scale used in mechanical motion analysis for purposes? | 8 | 22.0 | 10.14 | 28.42% |
| 2 | Cameras are placed to portray the movement to be analyzed according to ? | 8 | 22.0 | | |
| 3 | The distance between the camera and performance relates inherently with? | 10 | 28.0 | | |
| 4 | Body joints identification points must be in colors that distinguish them? | 9 | 25.0 | | |
| 5 | The number of cameras used in photography increases as it is? | 14 | 40.0 | | |
| 6 | Which of the following is a program designed to analyze sports movements? | 9 | 25.0 | | |
| 7 | The faster the athletic performance, the cameras must be distinguished by? | 13 | 37.0 | | |

The table 7 indicates the averages of the correct answers and the total percentages for each of the axes of the Paralympic Games coaches' knowledge test of the biomechanical principles and laws of human movement, the results show that the highest axis was the axis of concepts related to biomechanics with an average of 39.66%, while the axis of applied biomechanical analysis principles came as the lowest axis with an average of 28.42%. While the results also indicated that the total range of knowledge according to the axes of the Paralympic Games coaches of the biomechanical principles and laws of human movement was low, with an average of correct answers reaching 12.42 out of 35, with a percentage of 35.04%, which is classified as low according to the levels that were chosen to judge the results of this question.

**Table 7.** The arithmetic average of the correct answers and the total percentage of the Paralympic Games' knowledge test of the biomechanical principles and laws of human movement according to the test axes

| No. | Axes | Average of correct answers x̄ | Total percentage of axes % | Axis knowledge level | Average of the total number of correct answers for the axes x̄ | Total percentage of axes % | Axis overall knowledge level |
|---|---|---|---|---|---|---|---|
| 1 | Concepts related to biomechanics. | 14 | 39.66% | low | 12.42 | 35.04% | low |
| 2 | Divisions of athletic skill movements from the point of view of biomechanics | 13.90 | 39.66% | low | | | |
| 3 | Newton's Laws Of Motion | 13.37 | 37.75% | low | | | |
| 4 | Mechanical manifestations of athletic movements | 12 | 33.77% | low | | | |
| 5 | The levers | 11.14 | 31.28% | low | | | |
| 6 | Applied biomechanical analysis procedures | 10.14 | 28.42% | low | | | |

**The result of the second question: To what extent do Paralympic Games coaches apply the biomechanical principles and laws of human movement when developing skill training plans?**

***Second***

The table 8 shows the arithmetic averages and standard deviations for the field of concepts related to biomechanics, where the paragraph "the final mechanical goal of the skill training plans for players to reach the motor efficiency" came in the first rank with an arithmetic average of 3.88 and a large degree of application, while the paragraph "Work on applying power, resolve and work equations when calculating training intensity in skill plans" came in the last rank with an arithmetic average of 2.14 and a low degree of application, while the level of application of the field as a whole came with an arithmetic average of 2.62 and a medium degree of application

**Table 8.** Arithmetic averages, standard deviations, and the degree of applied of the field of concepts related to biomechanics

| No. | Rank | Paragraph | x̄ | SD | Application Degree |
|---|---|---|---|---|---|
| 1 | 1 | The final mechanical goal of skill training plans is to reach players efficiency of the movement | 3.88 | 2.17 | Great |
| 2 | 7 | Work on applying power, resolve and work equations when calculating training intensity in skill plans | 2.14 | 1.94 | Low |
| 3 | 3 | Put skillful plans based on a clear perception related to the speed and acceleration of performance and the angles of motor work | 3.64 | 2.03 | Great |
| 4 | 6 | Interested in collecting raw data on mechanical | 2.39 | 1.45 | Low |

| | | | | | |
|---|---|---|---|---|---|
| | | players' performance variables to use as feedback? | | | |
| 5 | 4 | Realize that each skillful motor performance has mechanical variables that are more influential than others? | 3.21 | 1.16 | Medium |
| 6 | 5 | Realize that calculating variables such as speed and acceleration differs between linear and circular work? | 2.89 | 1.32 | Medium |
| 7 | 2 | Distinguish between static and dynamic movements when developing skill exercises | 3.41 | 1.56 | Medium |
| Field of concepts related to biomechanics | | | 2.62 | 1.09 | Medium |

The table 9 shows the arithmetic averages and standard deviations for the field of athletic skill movement divisions from the point of view of biomechanics, where the paragraph “Taking into account when developing skill training plans the difference in speeds when performing” came in the first rank with an arithmetic average of 4.22 and a large degree of application, while the paragraph “Taking into account the nature of closed and open skills when developing my skills training program” came in the last rank with an arithmetic average of 1.74 and a low degree of application, while the level of application of the field as a whole came with an arithmetic average of 2.44 and a medium degree of application.

**Table 9.** Arithmetic averages, standard deviations, and the application degree of the field of athletic skill movement divisions from the point of view of biomechanics

| No. | Rank | Paragraph | x̄ | SD | Application Degree |
|---|---|---|---|---|---|
| 1 | 1 | When developing skill training plans, take into account the difference in performance speeds | 4.22 | 2.56 | Great |
| 2 | 2 | Work on putting exercises with different speeds | 3.02 | 1.77 | Medium |
| 3 | 6 | When developing training plans, I put exercises that take into account the forms of engineering movements | 1.77 | 23.0 | Low |
| 4 | 3 | Distinguish between the speeds of my players by moving straight, curved or circular | 2.74 | 1.44 | Medium |
| 5 | 5 | Aware of the axes and levels on which most of the skills that I am training are based | 1.78 | 63.0 | Low |
| 6 | 7 | Taking into account the nature of closed and open skills when developing my skills training program | 1.74 | 78.0 | Low |
| 7 | 4 | Aware of how the body's center of gravity shifts in most of the exercises I include in my training plans | 1.82 | 1.09 | Low |
| Field of divisions of athletic skill movements from the point of view of biomechanics | | | 2.44 | 1.32 | Medium |

The table 10 shows the arithmetic averages and standard deviations for the field of Newton’s laws of motion, where the paragraph “Benefit from the law of motor reflex response when developing technical plans” came in the first rank, with an arithmetic average of 2.94 and with a medium degree of application, while the paragraph “Putting my training plans to work on modifying some of the mechanical variables associated with skillful performance using Movement laws” came in the last rank, with an arithmetic average of 1.82 and a low degree of application, while the level of application of the field as a whole came with an arithmetic average of 2.17 and a low degree of application.

**Table 10.** Arithmetic averages, standard deviations, and the degree of application of Newton's laws of motion

| No. | Rank | Paragraph | x̄ | SD | Application Degree |
|---|---|---|---|---|---|
| 1 | 4 | Taking into account the laws of power calculation when developing training plans | 1.89 | 72.0 | Low |
| 2 | 2 | Taking into account the issue of the player's body mass and its relationship to his inertia when making plans | 2.66 | 1.05 | Medium |
| 3 | 5 | Use the methods of controlling mass, acceleration, or both as the primary control for power | 1.84 | 1.02 | Low |
| 4 | 3 | Use the law of inertia when developing training programs | 1.90 | 97.0 | Low |
| 5 | 1 | Benefit from the law of motor reflex response when developing technical plans | 2.94 | 1.25 | Medium |
| 6 | 6 | Putting my training plans to work on modifying some of the mechanical variables associated with skillful performance using Movement laws | 1.82 | 51.0 | Low |
| Newton's Laws of Motion field | | | 2.17 | 1.06 | Low |

The table 11 shows the arithmetic averages and standard deviations for the field of mechanical manifestations of athletic movements, where the paragraph “Work during the training plans to take into account the distribution of performance power ideally on the parts of the movement” came in the first rank, with an arithmetic average of 3.74, and with a great degree of application. With an arithmetic average of 2.51, with a great degree of application, while the paragraph “In developing my skill training program, I make sure that the point of the body's center of gravity is in the most appropriate place for performance” camein the last rank, with an arithmetic average of 2.51 and a low degree of application, while the level of application of the field as a whole came with an arithmetic average of 2.92 and a medium degree of application.

**Table 11.** Arithmetic average, standard deviations, and the degree of application to the field of mechanical manifestations of athletic movements

| No. | Rank | Paragraph | x̄ | SD | Application Degree |
|---|---|---|---|---|---|
| 1 | 3 | Putting the motor rhythm for all the skills that I work on training | 2.74 | 1.33 | Medium |
| 2 | 4 | Make sure to draw a dynamic flow chart for all the skills that I put itstraining plans | 2.54 | 1.20 | Low |
| 3 | 1 | Work during the training plans to take into account the distribution of performance power ideally on the parts of the movement | 3.74 | 1.89 | Great |
| 4 | 5 | Clearly, I put the directions of motor transfer in the training plans | 2.69 | 1.32 | Medium |
| 5 | 2 | Putting part of my schematic program to train a special skill in how to finish the skill perfectly | 3.34 | 2.87 | Medium |
| 6 | 6 | In developing my skill training program, I make sure that the point of the body's center of gravity is in the most appropriate place for performance | 2.51 | 1.02 | Low |
| Field of mechanical manifestations of athletic movements | | | 2.92 | 2.11 | Medium |

The table 12 shows the arithmetic averages and standard deviations for the field of levers, where the paragraph “I realize power and resistance points in the exercises that I put in my training plan” came in the first rank, with an arithmetic average of 2.41 and a low degree of application, while the paragraph came “Use anatomical levers as a mechanical basis when developing skill training plans” in the last place with an arithmetic average 1.71, with a low degree of application, while the level of application of the field as a whole came with an arithmetic average of 1.90, with a low degree of application

**Table 12.** Arithmetic average, standard deviations, and degree of application for the field of levers

| No. | Rank | Paragraph | x̄ | SD | Application Degree |
|---|---|---|---|---|---|
| 1 | 5 | I distinguish the motor levers and their types for most of the exercises that I put in my skill training plan | 1.77 | 2.30 | Very low |
| 2 | 3 | I have the ability to vary the difficulty of the movements performed by changing the lever on which the exercise works | 1.90 | 1.65 | Low |
| 3 | 1 | I realize power and resistance points of the exercises that I put in my training plan | 2.41 | 1.95 | Low |
| 4 | 4 | I distinguish the line of resistance and the line of power in the exercises that I put for the players | 1.82 | 1.02 | Low |
| 5 | 6 | Use anatomical levers as a mechanical basis when developing skill training plans | 1.71 | 36.0 | Very low |
| 6 | 2 | Distinguish clearly the changes that occur as a result of the difference in power and resistance | 2.01 | 1.32 | Low |
| Field of levers | | | 1.90 | 1.01 | Low |

The table13 shows the arithmetic averages and standard deviations for the field of applied biomechanical analysis procedures, where the paragraph “Know where to place the cameras to get the best viewing angles for the players' performance” came in the first rank, with an arithmetic average of 2.55 and a low degree of application, while the paragraph “Use the drawing scale to determine the distances across the screen relative to reality” came in the last place With an arithmetic average of 1.55, with a low degree of application, while the level of application of the field as a whole came with an arithmetic average of 1.87, with a low degree of application.

**Table 13.** Arithmetic averages, standard deviations, and degree of application for the field of applied biomechanical analysis procedures

| No. | Rank | Paragraph | x̄ | SD | Application Degree |
|---|---|---|---|---|---|
| 1 | 4 | Work on photographing the performance of the tactical and skillful players for the purposes of biomechanical analysis | 1.70 | 98.0 | Very low |
| 2 | 1 | Know where to place the cameras to get the best viewing angles for the players' performance | 2.55 | 1.20 | Low |
| 3 | 2 | I am good at determining the ideal distances between the performance analysis cameras and the location of the actual performance of the players | 2.03 | 1.33 | Low |
| 4 | 5 | Use the flowchart drawing of the players to judge a player's skillful performance | 1.66 | 69.0 | Very low |
| 5 | 6 | Use the drawing scale to determine the distances across the screen relative to reality | 1.55 | 1.03 | Very low |
| 6 | 3 | I am good at using at least one mechanical analysis software, and I use that in my training work | 1.77 | 1.32 | Very low |
| Field of applied biomechanical analysis procedures | | | 1.87 | 1.04 | Low |

The table 14 shows the arithmetic average and standard deviations of the fields of application of the Paralympic Games trainers to the principles and laws of biomechanics of human movement when developing skill training plans. Where the field of mechanical manifestations of athletic movements came in the first rank with an arithmetic average of 2.92 and a medium degree of application, while the field of applied biomechanical analysis procedures came in the last place with an arithmetic average of 1.87 and a low degree of application, while the total level of the Paralympic Games trainers' application of the biomechanical principles and laws of human movement when developing skill training plans came with an arithmetic average of 2.32, with a low overall application degree.

**Table 14.** Arithmetic average, standard deviations, order of fields, and the degree of application of the Paralympic Games trainers to the principles and biomechanical laws of human movement when developing skill training plans according to the fields of study?

| No | Rank | Field | x̄ | SD | application degree | overall arithmetic average of fields x̄ | overall standard deviation of fields SD | Overall application degree |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | Concepts related to biomechanics | 2.62 | 1.09 | Medium | 2.32 | 1.55 | Low |
| 2 | 3 | Divisions of athletic skill movements from the point of view of biomechanics | 2.44 | 1.32 | Medium | | | |
| 3 | 4 | Newton's laws of motion | 2.17 | 1.06 | Low | | | |
| 4 | 1 | Mechanical manifestations of athletic movements | 2.92 | 2.11 | Medium | | | |
| 5 | 5 | levers | 1.90 | 1.01 | Low | | | |
| 6 | 6 | Applied biomechanical analysis procedures | 1.87 | 1.04 | Low | | | |

**From the above, the answer to the study questions is as follows:**

1- The result of the first question: To what extent do Paralympic Games coaches know the basics and biomechanical laws of human movement?

Low

2- To what extent do Paralympic Games coaches apply the biomechanical principles and laws of human movement when developing skill training plans?

Low

## DISCUSSION

According to the results of the study, it is clear that the Paralympic Games coaches who are represented by the study respondent do not have sufficient knowledge nor sufficient ability to apply the principles and biomechanical laws of human movement when developing skill training plans, where the results were low, whether for the extent of their knowledge or their application of these principles. Returning to the results, we find that the knowledge of the trainers about biomechanics in all aspects was low. This can be explained by the fact that the trainers may not have received an academic education related to the subject of their profession, such as being former players and becoming coaches as a result of their previous experiences. They would not have given the mechanical side an important space when they received the courses for training their various games, although the biomechanical analysis is an important aspect and cannot be separated from sports training because of its benefits related to the perfect skillful performance that is free from motor errors, as it makes the performance acquire a streamlined and economical nature in The effort exerted in addition to avoiding injuries, which increases the chances of success for athletes (Perrin, 2021).

The need for athletes from healthy people to be trained according to the rules of kinesiology and biomechanical analysis due to the imbalances of movement that are associated with their disability, which generally affect the directions of movement, its performance line, the power needed by each part of the movement, as well as the general shape of the movement, and all these variables are related to the mechanics of movement different from the disabled person. This means that the mechanical and kinetic requirements are different for normal people, especially when performing skillful movements in competitive sports activity. Indeed, they differ from one disabled person to another and in the same sport, depending on the functional medical

classification and the degree of disability of the player, which gives additional importance to the extent to which trainers know the rules of biomechanical analysis and use them not only when developing Skill training plans, but when evaluating performance, kinesiology in general can be used as a tool for measuring and adjusting at one time (Romanov and Medjedovic, 2022).
As for when returning to the results of the second question related to the extent to which the trainers apply the principles and biomechanical laws of human movement when they develop the skill training plans, we find that it is low and this is consistent with their low knowledge in this field. Certainly, knowing something helps to apply it, but in another look at the fields that measure the extent of application, we find some field such as the field of concepts related to biomechanics, the divisions of sports skill movements from the point of view of biomechanics and mechanical manifestations and athletic movements have come in medium levels of application, which the researchers attribute to the fact that trainers may apply some of the principles of biomechanical analysis in their plans acquired through expertise and experience without knowing that it is part of biomechanics or kinesiology and therefore we find that all knowledge axes are low, but the fields of application appear to have medium degrees of application. The experiences give the trainers additional capabilities that they may not have received during the courses (Silva and Fonseca, 2019) which means that the trainer, as a result of his acquisition of training experiences, realized some mechanical variables without knowing that they are related to this side.

## Conclusion

The trainers of the Paralympic Games for the sport of persons with disabilities show a cognitive and practical weakness in the biomechanical principles and laws of human movement when developing skill training plans, which is something that those in charge of these games must take into account by providing their coaches with special courses in biomechanical analysis and raising their capabilities in this field in view of its applied importance. It should also be noted that the academic institutions that issue training certificates in the field of athletic training for persons with disabilities should focus on the field of biomechanical analysis and related fields such as kinesiology in their teaching programs.

Conflict of interest : The authors confirm that there are no conflicts of interest associated with this study, and that it was self-funded by the authors.

**Conflict of interest**

No conflict of interest is declared by the authors. In addition, no financial support was received.

**Ethics Committee**

This study was approved by the Scientific Research Ethics Committee of the College of Pharmacy at Mutah University - Jordan (approval code: 295/2023-SREC-7/ May. 29,2023).

**Author Contributions**

Study Design, Literature Search Data Collection and Statistical Analysis (Ibtehal Alkhawaldeh), Data Interpretation, Manuscript Preparation and Application of study procedures (Ibtehal Alkhawaldeh and Mohnnad Alzughialat)

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