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The relationship between neuromuscular coordination and motor performance of some basic handball skills in middle school students

A Field Study on Selected Middle Schools in Biskra Province

علاقة التوافق العصبي العضلي والأداء الحركي لبعض المهارات الأساسية في كرة اليد لدى تلاميذ المرحلة المتوسطة

دراسة ميدانية على بعض متوسطات ولاية بسكرة

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Abstract: The aim of the study was to reveal the relationship between neuromuscular coordination and motor performance of some basic skills of middle school handball students. The school team of Bzeit Mohammed Middle School is a model. The researcher used a set of tests represented by handball skill tests in addition to neuromuscular coordination tests. The study sample consisted of fourteen (14) players representing the school handball team of Bezit Mohamed Middle School in the Ouled Djellal district of Biskra province. The descriptive approach was adopted using the correlational method, and the results of the study showed the existence of a correlational relationship between neuromuscular harmony and the motor performance of passing, receiving, dribbling and shooting skills in handball.

Keywords: compatibility, performance, skill, handball, intermediate stage.

الملخص : هدف الدراسة الكشف عن العلاقة الموجودة بين التوافق العصبي العضلي والأداء الحركي لبعض المهارات الأساسية لتلاميذ المرحلة المتوسطة في كرة اليدّ الفريق المدرسي لمتوسطة بزيط محمد نموذجا حيث استخدم الباحث مجموعة من الاختبارات تمثلت في اختبارات مهارية في كرة اليدّ إلى جانب اختبارات التوافق العصبي العضلي .وتكونت عيّنة الدراسة من أربعة عشر(14) لاعبا الممثّل لفريق كرة اليد المدرسي لمتوسطة بزيط محمد بدائرة أولاد جلاّل ولاية بسكرة .وقد اعتمد المنهج الوصفي بالطريقة الارتباطية وأظهرت نتائج الدراسة إلى وجود علاقة ارتباطية بين التواف العصبي العضلي والأداء الحركي لمهارة التمرير ولاستقبال ، التنطيط والتصويب في كرة اليدّ .

- **الكلمات المفتاحية :** التوافق ، الأداء، المهارة، كرة اليدّ، المرحلة المتوسطة .

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*** Introduction and problematic of the study**:

Over the past years, most studies have addressed teaching and training methods for sports skills, in addition to examining their biomechanical indicators and exploring certain functional aspects among practitioners of handball. As a result, specialization in this field has begun to build on these foundations. This includes selection processes that are based on certain anthropometric variables, although this alone is insufficient. Physiological variables must also be considered, such as tests of the nervous and muscular systems, given that most handball skills rely on elements of speed, accuracy, and concentration. These skills cannot be performed effectively unless there is coordination in the motor performance of the body segments involved, which depends on the interaction between the nervous and muscular systems, as well as the integrity of the nervous system and the speed at which information is transmitted to the motor-muscular parts of the body. Training and practicing neuromuscular coordination must continue without stopping, especially when learning new skills and movements, because they affect the advancement of physical fitness qualities

Sports charge the brain and develop cognitive abilities in learning and performance. **(Zari, Sahar ,2023, p. 136)**

Motor development varies, interrelates, and integrates throughout the different age stages. During adolescence, this development becomes particularly evident, as movements are often characterized by instability, imbalance, and lack of harmony and coordination. This makes it difficult for individuals at this stage to control and direct their movements toward a specific objective. This is clearly observed during training, where younger players face great difficulty controlling the ball, for example, or performing various basic skills.

Handball requires the practicing student to use maximum physical and psychological strength, especially when competing with peers. It is one of the

sports that heavily relies on mastery of basic and complex motor skills. It is also distinguished by its unique nature, as it is played by hand at high speed during passing, receiving, and other movements, with ball direction needing to be quick and accurate at the same time. This demands a high level of focus and precision, depending on the number of muscles involved in the performance and the ability to control them. All voluntary actions performed by an individual are the result of the work of one muscle or a group of muscles.

This is supported by the study of Hatem Flaym Hafidh Hassan on neuromuscular coordination and the accuracy of certain offensive spiking techniques and their relationship to ranking in the Premier League of the Middle Euphrates region for a master's degree in Iraq (2004–2005). The aim of the study was to identify the accuracy of certain offensive spiking techniques among volleyball players in the Premier League of the Middle Euphrates region and their relationship to league ranking. The sample included 56 players from seven clubs participating in the 2004–2005 season. The researcher used the descriptive method with survey and correlational approaches.

In this context, learners need this coordinative ability to acquire basic handball skills, and this depends on the type of task, the amount of force required, and the speed demanded. Additionally, the participation of more than one muscle in a given task does not mean that all these muscles work in the same direction or contribute equally. Rather, their roles differ according to their relative importance and responsibility in performing the movement **(Mouslat, 1999, p. 60).** Such performance requires a degree of coordination between the nervous and muscular systems and an understanding of how this coordination relates to skillful execution.

The study of Luay Ghanem Al-Sumaida'i further emphasizes the importance of neuromuscular coordination. He conducted research on this

concept and its relationship to the accuracy of tennis serves in volleyball for a master's degree at the University of Diyala, College of Physical Education, Iraq, in 2008. The aim was to identify the correlation between neuromuscular coordination and the accuracy of tennis serves in volleyball. The sample consisted of 15 players from the College of Physical Education team at the University of Mosul during the 1998–1999 academic year who participated in the volleyball league. The researcher used the descriptive method with a survey design due to its suitability for the research nature.

Neuromuscular coordination plays a significant and essential role in achieving victory. In handball, it is considered the foundation of playing technique, as high psychological and motor demands are reflected in the level of technical performance. The importance of neuromuscular coordination lies in the player's ability to maintain balance, stability, agility, and the organization of motor actions on the court, as well as determining the appropriate position of the player within the playing area.

Researchers believe that many coaches focus primarily on basic skills and attributes such as speed and strength, while giving insufficient attention to other physical qualities that greatly influence skill performance and acquisition, such as neuromuscular coordination, which is fundamental to technical execution.

Through the researcher's interaction with several teachers and field visits to secondary schools in the Biskra province, a noticeable problem was observed regarding students' acquisition of basic handball skills. This led to the following main research question: **Is there a relationship between neuromuscular coordination and the motor performance of certain basic skills in handball?** From this, the following sub-questions emerge:

1. Is there a relationship between neuromuscular coordination and the motor performance of the shooting skill in handball?

2. Is there a relationship between neuromuscular coordination and the motor performance of the passing and receiving skills in handball?
3. Is there a relationship between neuromuscular coordination and the motor performance of the dribbling skill in handball?

2. Research Hypotheses

2.1 General Hypothesis: There is a relationship between neuromuscular coordination and the motor performance of certain basic skills in handball.

2.2 Sub-Hypotheses

- There is a relationship between neuromuscular coordination and the motor performance of the shooting skill in handball.
- There is a relationship between neuromuscular coordination and the motor performance of the passing and receiving skills in handball.
- There is a relationship between neuromuscular coordination and the motor performance of the dribbling skill in handball.

3. Research Objectives

- To identify the relationship between neuromuscular coordination and the motor performance of the shooting skill in handball.
- To identify the relationship between neuromuscular coordination and the motor performance of the passing and receiving skills in handball.
- To identify the relationship between neuromuscular coordination and the motor performance of the dribbling skill in handball.

4. Research Significance

This study contributes to enriching the scientific field, as it examines the relationship between neuromuscular coordination and the motor performance of certain basic handball skills among individuals aged 12 to 15. This stage requires a high level of neuromuscular coordination to acquire accurate and

well-performed motor skills. Through this study, an attempt will be made to reach sufficient indicators that confirm the relationship and the considerable importance of neuromuscular coordination in the performance and proper acquisition of handball skills. Furthermore, this research builds upon previous studies and serves as a foundation for future investigations that may raise new questions in this domain.

Applied Aspect

1. Methodological Procedures of the Study

1.1 Exploratory Study

The exploratory study represents the first step that helps the researcher gain a general overview of the various aspects of the field study. To conduct this study, the following steps were taken:

1.1.1 First Stage: Field contact was made with the responsible authority, namely Abi Dhar Al-Ghafari Middle School, located in the administrative district of Ouled Djellal, Biskra Province. Contact involved the school principal and the physical education teacher to arrange an appointment to discuss the research, as well as to determine the timing and location for conducting the tests and coordinating with the physical education teacher.

1.1.2 Second Stage: I prepared the tests and presented them to a panel of experts consisting of professors specialized in physical education and sports, specifically in the field of handball.

1.1.3 Third Stage: This final stage involved rewriting the tests in their final form, incorporating the modifications and clarifications provided by the expert professors.

To develop the test package, which included skill tests in handball and neuromuscular coordination tests approved by a panel of physical education

specialists, and to ensure their validity, reliability, and objectivity, an exploratory application was carried out on a sample different from the main sample.

1.2 Study Methodology: A methodology is the approach followed by the researcher when determining the steps of the study through which the research problem can be solved (**Hassan, 2007, p. 83**). Accordingly, the researcher used the experimental method, as it is appropriate for the nature of this study.

1.3 Study Population: Terminologically, the study population is "the original group from which the sample is taken, and this group may consist of schools, teams, students, residents, or any other units" (**Nasreddine, 2003, p. 14**). It is also defined as "a group of elements that share one or several common characteristics that distinguish them from other elements and upon which the research or investigation is conducted."

The statistical population refers to the entire set of objects possessing observable and measurable characteristics or attributes suitable for statistical analysis (**Morris, 2004, p. 67**).

The population of this study consists of male school handball teams from middle schools in the administrative district of Ouled Djellal, Biskra Province, who were registered during the 2015–2016 school sports season. Their number is seven (07) teams, as follows:

1. Bezit Mohamed Middle School
2. Chahid Rouina Middle School
3. Muneeb Abdelkader Middle School
4. Ibn Tufail Middle School
5. Abi Dhar Al-Ghafari Middle School
6. Sheikh Al-Naami Middle School
7. Shaabani Mohamed Middle School

1.4 Study Sample

The study sample is defined as "a part or subset of the population" (**Allaoui, 1999, p. 143**). The sample of this study was a purposive sample, consisting of the male school handball team of Bezit Mohamed Middle School, totaling 14 players. Dr. Ali Gharbi states that a purposive sample is selected according to the nature of the topic and the objectives of the research, and based on predetermined criteria (**Zerouani, 2007, p. 334**).

1.5 Study Tools: it was necessary to rely on more than one tool, the main ones being:

1.5.1 Tests

1.5.1.1 Handball Skill Tests

First Test: Passing and Receiving Test (**Al-Sayeh, 2000, p. 81**)

Second Test: Accurate Shooting Test (**Al-Sayeh, 2000, p. 81**)

Third Test: Dribbling Test (**Al-Sayeh, 2000, p. 81**)

2.1.5.1. Neuromuscular Coordination Tests:

1. First Test: Throwing and Catching Balls Test **(Al-Arbi, 2004, p.151) (Hand-Eye Coordination)**

2. Second Test: Numbered Circles Test (Eye-Foot Coordination) **(Sobhi Hassanein, 2004, p 329)**

6.1. Validity and Reliability of the Study Tool:

6.1.1. Validity of the Study Tool: Querten defines validity as an estimate of the correlation between the raw test scores and the true score (**Sobhi, 2000, p.183**). To ensure the appropriateness of the test design relative to the study objectives, the researchers employed expert validity. The tests were presented to a group of experts, all holding doctorates and specializing in the field of physical education and sports. The researchers benefited from their feedback, implemented several adjustments and clarifications, and finalized the test form.

6.1.2. Reliability of the Study Tool: The researchers used the test-retest method, applying the test to a pilot sample and recording each participant's scores. The test was then repeated on the same group under identical conditions. An essential criterion for a reliable test is objectivity, meaning freedom from bias, prejudice, or the personal opinions and preferences of the examiner. Objectivity ensures that the test measures the participant's actual abilities as they exist, not as desired (**Sobhi, 2000, p.183**).

7.1. Main Study:

The researcher conducted the main experiment, which included the tests relevant to the study (shooting, dribbling, passing and catching tests in handball, as well as neuromuscular coordination tests: hand-eye coordination and eye-foot coordination) on the study sample, which consisted of 15 players from the school team at **Bezit Mohamed Middle School** as follows:

1. **Tuesday, 2016/04/11:** Handball skill tests were conducted. The study sample had been previously informed about these tests. The tests took place on the school's sports field at 14:30. Upon arrival, the test procedures were explained, followed by a simple warm-up. After the warm-up, the players performed the **shooting test**, then the **dribbling test**, and finally the **passing and catching test**.
2. **Tuesday, 2016/04/18:** At the same time (14:30), the participants performed the **hand-eye coordination test** (throwing and catching the ball) and the **eye-foot coordination test** (numbered circles test).

(Shooting, passing and catching, dribbling, hand-eye coordination, and eye-foot coordination tests data were recorded in specially prepared forms to collect the raw data for statistical processing and results extraction).

Foundations of the Tests: The following principles were considered when designing the set of tests used to study the relationship between neuromuscular

coordination and certain handball skills in the school male team at Bezit Mohamed:

1. The selected sports tests were appropriate to the players' skill level and compatible with the available facilities at the school.
2. Safety and security factors were observed.
3. Emphasis was placed on the correct execution of the tests, given its significant impact on the validity and credibility of the results.

8.1. Statistical Methods: The purpose of this research is to study the relationship between neuromuscular coordination and the motor performance of some fundamental handball skills at the middle school level (ages 12–15). This relationship was assessed by examining the correlation between neuromuscular coordination and performance in key handball skills (shooting, dribbling, passing, and catching) using the following statistical methods:

1. Arithmetic mean
2. Standard deviation
3. Simple correlation (Spearman)

These analyses were performed using the SPSS statistical package. After tabulating the obtained results, they were interpreted and analyzed to draw conclusions and explanations regarding the findings.

2. Presentation and Analysis of Results:

1.1. Presentation and Analysis of the Passing and Catching Skill Test with the Throwing and Catching Ball Test (Hand-Eye Coordination):

Table 1: Shows the Spearman correlation coefficient between the passing and catching test and the throwing and catching ball test (hand-eye coordination).

Group	N	Mean	Std Deviation	Spearman Corr Coe	Sig
Passing and Catching Test	15	5.47	1.72	0.93	Significant at 0.01
Throwing and Catching Ball Test		11.87	2.56		

From the table, it is observed that the Spearman correlation coefficient between the passing and catching test and the throwing and catching ball test equals 0.93, which is statistically significant at 0.01. This indicates a statistically significant positive correlation between passing and catching and throwing and catching (hand-eye coordination). Since the correlation coefficient is positive, the relationship is direct: as the passing and catching score increases, the throwing and catching ball score also increases, and vice versa.

2.1 Presentation and Analysis of the Dribbling Skill Test with the Throwing and Catching Ball Test (Hand-Eye Coordination):

Table 2: Shows the Spearman correlation coefficient between the dribbling test and the throwing and catching ball test (hand-eye coordination).

Group	N	Mean	Std Deviation	Spearman Corr Coe	Sig
Dribbling Test	15	6.47	1.72	0.85	Significant at 0.01
Throwing and Catching Ball Test		11.87	2.56		

From the table, it is observed that the Spearman correlation coefficient between the dribbling test and the throwing and catching ball test equals **0.85**, which is statistically significant at **0.01**. This indicates a statistically significant

positive correlation between dribbling and throwing and catching (hand-eye coordination). Since the correlation coefficient is positive, the relationship is direct: as the dribbling score increases, the throwing and catching ball score also increases, and vice versa.

3.1 Presentation and Analysis of the Shooting Skill Test with the Throwing and Catching Ball Test (Hand-Eye Coordination):

Table 3: Shows the Spearman correlation coefficient between the shooting test and the throwing and catching ball test (hand-eye coordination).

Group	N	Mean	Std Deviation	Spearman Corr Coe	Sig
Shooting Test	15	3.47	1.55	0.69	Significant at 0.01
Throwing and Catching Ball Test		11.87	2.56		

From the table, it is observed that the Spearman correlation coefficient between the shooting test and the throwing and catching ball test equals 0.69, which is statistically significant at 0.01. This indicates a statistically significant positive correlation between shooting and throwing and catching (hand-eye coordination). Since the correlation coefficient is positive, the relationship is direct: as the shooting score increases, the throwing and catching ball score also increases, and vice versa.

4.1 Presentation and Analysis of the Passing and Catching Skill Test with the Numbered Circles Test (Eye-Foot Coordination):

Table 4: Shows the Spearman correlation coefficient between the passing and catching test and the numbered circles test (eye-foot coordination).

Group	N	Mean	Std Deviation	Spearman Corr Coe	Sig
Passing and Catching Test	15	5.47	1.72	-0.71	Significant at 0.01
Numbered Circles Test		6.73	1.49		

From the table, it is observed that the Spearman correlation coefficient between the passing and catching score and the numbered circles score equals -0.71, which is statistically significant at 0.01. This indicates a statistically significant inverse correlation between passing and catching and performance in the numbered circles test (eye-foot coordination). Since the correlation coefficient is negative, the relationship is inverse: as the passing and catching score increases, the numbered circles score decreases, and vice versa.

5.1 Presentation and Analysis of the Dribbling Skill Test with the Numbered Circles Test (Eye-Foot Coordination):

Table 5: Shows the Spearman correlation coefficient between the dribbling test and the numbered circles test (eye-foot coordination).

Group	N	Mean	Std Deviation	Spearman Corr Coe	Sig
Dribbling Test	15	6.47	1.72	-0.82	Significant at 0.01
Numbered Circles Test		6.73	1.49		

From the table, it is observed that the Spearman correlation coefficient between the dribbling score and the numbered circles score equals -0.82, which is statistically significant at 0.01. This indicates a statistically significant inverse correlation between dribbling and performance in the numbered circles test

(eye-foot coordination). Since the correlation coefficient is negative, the relationship is inverse: as the dribbling score increases, the numbered circles score decreases, and vice versa.

6.1 Presentation and Analysis of the Shooting Skill Test with the Numbered Circles Test (Eye-Foot Coordination):

Table 6: Shows the Spearman correlation coefficient between the shooting test and the numbered circles test (eye-foot coordination).

Group	N	Mean	Std Deviation	Spearman Corr Coe	Sig
Shooting Test	15	3.47	1.55	-0.56	Significant at 0.01
Numbered Circles Test		6.73	1.49		

From the table, it is observed that the Spearman correlation coefficient between the shooting score and the numbered circles score equals -0.56, which is statistically significant at 0.01. This indicates a statistically significant inverse correlation between shooting and performance in the numbered circles test (eye-foot coordination). Since the correlation coefficient is negative, the relationship is inverse: as the shooting score increases, the numbered circles score decreases, and vice versa.

3. Discussion of Hypotheses:

3.1 Discussion of the First Hypothesis:

The first hypothesis states that there is a relationship between neuromuscular coordination and the shooting skill in handball among middle school males (ages 12–15).

Based on the analysis of the results, it can be concluded that neuromuscular coordination is indeed related to the motor performance of the shooting skill in handball. This is evident from the shooting and throwing-catch

test (hand-eye coordination) shown in Table 3, as well as the shooting and numbered circles test (eye-foot coordination) shown in Table 6.

In the first test, a positive correlation is observed between hand-eye coordination and the shooting skill: the better the shooting performance, the better the hand-eye coordination, and vice versa. Similarly, in the numbered circles test, an inverse correlation is observed: the shorter the time achieved in the eye-foot coordination test, the better the shooting performance, and vice versa. This is because the eye-foot coordination test (numbered circles) is measured by time—less time indicates higher eye-foot coordination.

This finding is supported by previous studies, which suggest that the coordination reflected by the numbered circles test is a complex ability linked to multiple factors. Improvement occurs due to both increased speed and enhanced efficiency of the nervous system in coordinating hand movements with shooting simultaneously. Therefore, development in coordination is accompanied by an improvement in handball skill performance.

This aligns with the observations of **Bastaouisi Ahmed (1999, p. 151)**, who stated that coordination is a complex and essential ability related both to speed and to the integrity of the neuromuscular system.

Based on the above, it can be concluded that the first hypothesis is confirmed, indicating the existence of a significant correlation between neuromuscular coordination and the motor performance of the shooting skill in handball at the middle school level.

3.2 Discussion of the Second Hypothesis:

The second hypothesis states that there is a relationship between neuromuscular coordination and the motor performance of the passing and catching skill in handball among middle school males (ages 12–15).

Based on the analysis of the results, it can be concluded that neuromuscular coordination is indeed related to the passing and catching skill in handball. This is evident from the passing and catching test with the throwing and catching ball (hand-eye coordination) shown in Table 1, as well as the passing and catching test with the numbered circles (eye-foot coordination) shown in Table 4.

In the first test, a positive correlation is observed between hand-eye coordination and the passing and catching skill: the better the passing and catching performance, the better the hand-eye coordination, and vice versa. Similarly, in the numbered circles test, an inverse correlation is observed: the shorter the time achieved in the eye-foot coordination test, the better the passing and catching performance, and vice versa. This is because the eye-foot coordination test (numbered circles) is measured by time—less time indicates higher eye-foot coordination.

Previous studies support this finding, showing that achieving automaticity in certain skills is a key factor influencing control over brainwave activity. This aligns with the findings of **Abdelwahab Kamel (1994, p. 122)**, who noted that the nervous system can be controlled through muscular activity manifested in visuomotor performance, via the biological feedback system that regulates individual behavior. Additionally, **Mohamed Al-Arabi Shamoun (1996, p. 30)** emphasized that repetition in skill performance contributes to skill development, particularly when training is performed correctly, as it strengthens the neural pathways that facilitate correct performance in subsequent attempts.

Based on the above, it can be concluded that the second hypothesis is confirmed, indicating the existence of a significant correlation between neuromuscular coordination and the motor performance of the passing and catching skill in handball for middle school males.

3.3 Discussion of the Third Hypothesis:

The third hypothesis states that there is a relationship between neuromuscular coordination and the motor performance of the dribbling skill in handball among middle school males (ages 12–15).

Based on the analysis of the results, it can be concluded that neuromuscular coordination is indeed related to the dribbling skill in handball. This is evident from the **dribbling test with the throwing and catching ball (hand-eye coordination)** shown in Table 2, as well as the **dribbling test with the numbered circles (eye-foot coordination)** shown in Table 5.

In the first test, a positive correlation is observed between hand-eye coordination and dribbling: the better the dribbling performance, the better the hand-eye coordination, and vice versa. Similarly, in the numbered circles test, an inverse correlation is observed: the shorter the time achieved in the eye-foot coordination test, the better the dribbling performance, and vice versa. This is because the eye-foot coordination test (numbered circles) is measured by time—less time indicates higher eye-foot coordination.

Previous studies support this finding, indicating that one of the most important indicators of the functional state of the nervous system is the athlete's ability to master motor skills characterized by speed and motor coordination. Furthermore, the athlete's ability to maintain their performance level for as long as possible is also an important indicator reflecting nervous system efficiency. When learning new motor skills, new neural formations and temporal relationships are created in the cerebral cortex, and with continued training, the individual develops the ability to perform the motor skill automatically **(Abou Al-Alaa, 1997, p. 162).**

Additionally, **Jean Carper** citing **Kautman et al.** noted that engaging in sports stimulates brain cells to produce a chemical growth factor, which in turn

promotes the growth of neural extensions, enhancing the brain's communication network, including areas that control motor functions **(Jiyad, 2008, p. 115).**

Based on the above, it can be concluded that the third hypothesis is confirmed, indicating the existence of a significant correlation between neuromuscular coordination and the motor performance of the dribbling skill in handball for middle school males.

4. Conclusions:

- There is a relationship between neuromuscular coordination and the motor performance of the shooting skill in handball at the middle school level.
- There is no relationship between neuromuscular coordination and the motor performance of the passing and catching skill in handball at the middle school level.
- There is a relationship between neuromuscular coordination and the motor performance of the dribbling skill in handball at the middle school level.

Finally, it is recommended to seriously and effectively incorporate exercises and tests that help develop and enhance this motor ability (coordination), specifically neuromuscular coordination.

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