Movement quality as a core determinant of gymnastics skill proficiency in adolescents

La calidad del movimiento como determinante central de la competencia técnica en gimnasia en adolescentes

Authors

Musab Turkman [1]
Maryam Hethnawi [2]
Aseel Qady [3]
Masod Halawa [4]
Ahmad Nassar [5]
Mohanad Omar [6]
Samer AbuEid [7]
Abderraouf Ben Abderrahman [8]

[1] Manouba University (Tunisia)
[2] Jenin Directorate of Education Educational Supervisor (Palestine)
[3]Al-Istiqlal University (Plaestine)
[4] An-Najah University (Plaestine)
[5] Palestine Technical University-Kadoorie (Plaestine)
[6] Palestine Technical University-Kadoorie (Plaestine)
[7] Arab American University (Plaestine)
[8] Manouba University (Tunisia)

Corresponding author:
Maryam Hethnawi
mmhathnawi@gmail.com

Received: 20-04-26
Accepted: 12-05-26

How to cite in APA

Turkman, M., Hethnawi, M., Qady, A., Abohalawa, M., Nassar, A., Omar, M., AbuEid, S., & Ben Abderrahman, A. (2026). Movement quality as a core determinant of gymnastics skill proficiency in adolescents. *Retos, 80,* 993-1007. https://doi.org/10.47197/retos.v80.119288

Abstract

Introduction: Existing evidence on the relationship between functional movement quality and technical performance in adolescent gymnasts remains limited, particularly within school-based contexts. While FMS is commonly used as a measure of functional movement quality and the risks of injuries, the relationship between FMS and gymnastics performance has not yet been established.
Objective: The study investigates the relationship between Functional Movement Screen (FMS) scores and performance in floor exercise among adolescent male students Jenin City.
Methodology: A descriptive cross-sectional study using a simple random sample of 200 subjects was conducted. The data were gathered using the FMS test and the evaluation of floor exercise skills. Descriptive statistics, Pearson correlation, and simple linear regression analyses were performed.
Results: The average total FMS score was 15.45 ± 2.38, which accounted for 73.57%, indicating a satisfactory movement quality level and a lower risk of injury. Scores for floor exercise performance varied between 6.30 and 6.96. The Pearson correlation coefficient test showed a very strong positive correlation between FMS and performance variables (r = 0.78–0.87). Results from regression analysis demonstrated the predictive value of FMS for performance indicators, accounting for 61.2% to 75.4% of the variation.
Discussion: From the perspective of motor control theory, this indicates that movement quality factors such as stability, balance, and mobility are essential components of gymnastics performance.
Conclusions: This research provides insights into how schools should incorporate the use of the Functional Movement Screen in their training programs.

Keywords

Functional Movement Screen (FMS); floor exercise; functional movement; skill performance; adolescents.

Resumen

Introducción: La evidencia existente sobre la relación entre la calidad del movimiento funcional y las habilidades técnicas en gimnastas adolescentes es limitada. Aunque el FMS se utiliza comúnmente como medida de la calidad del movimiento funcional y del riesgo de lesiones, la relación entre el FMS y el rendimiento en gimnasia aún no se ha establecido.
Objetivo: El estudio investiga la relación entre las puntuaciones del Functional Movement Screen (FMS) y el rendimiento en gimnasia de suelo en atletas adolescentes de la ciudad de Jenin.
Metodología: Se realizó un estudio descriptivo transversal con una muestra aleatoria de 200 sujetos. Los datos se recopilaron mediante el test FMS y la evaluación de las habilidades gimnásticas en el suelo. Se aplicaron estadísticas descriptivas, correlación de Pearson y análisis de regresión lineal simple.
Resultados: La puntuación media total del FMS fue de 15.45 ± 2.38, lo que representó el 73.57%, indicando un nivel satisfactorio de calidad del movimiento y un menor riesgo de lesión. Las puntuaciones del rendimiento en gimnasia de suelo variaron entre 6.30 y 6.96. El coeficiente de correlación de Pearson mostró una correlación positiva muy fuerte entre el FMS y las variables de rendimiento (r = 0.78–0.87). Los resultados del análisis de regresión demostraron el efecto predictivo del FMS sobre los indicadores de rendimiento, explicando entre el 61.2% y el 75.4% de la variación.
Discusión: Desde la perspectiva de la teoría del control motor, esto indica que los factores de calidad del movimiento, como la estabilidad, el equilibrio y la movilidad, son componentes esenciales del rendimiento en gimnasia.
Conclusiones: Esta investigación ofrece una visión sobre cómo las escuelas deberían incorporar el uso del Functional Movement Screen en sus programas de entrenamiento.

Palabras clave

Test FMS; gimnasia de suelo; movimiento funcional; rendimiento de habilidades.

Introduction

Due to the rapid development of physical education and youth sports training, the use of assessment tools has increased to better evaluate movement quality and individualize athletic training programs. Among the widely utilized movement analysis techniques is the Functional Movement Screen (FMS). The technique is used to assess an individual's movement capacity in terms of mobility, stability, balance, and neuromuscular control. The FMS has been extensively used to evaluate any deficiencies in movement ability that would negatively affect an athlete's sporting activities and predispose him or her to injuries (Kamal et al., 2021). Several studies have found that movement assessment tools are essential in enhancing both the physical and technical abilities of athletes and guiding the development of their training programs (Vernetta-Santana et al., 2020; Pullen et al., 2022).

Of the various sports where coordination and movement control play an important role, floor exercise is recognized as one of the most physically demanding gymnastics disciplines since it involves a combination of strength, flexibility, balance, stability, and technical skillfulness. Recent research emphasizes the significance of movement quality in skill-oriented sports like gymnastics since effective motor movement influences technique and body control (Anderson et al., 2022; İribalcı et al., 2024). With respect to this point, movement analysis can be instrumental in identifying any deficits which affect technique performance and can prove useful for training programs for young adults.

The theoretical foundations of the present study are grounded in Dynamic Systems Theory, Motor Control Theory, and Long-Term Athletic Development (LTAD) theory. According to Dynamic Systems Theory, movement performance is determined by the integration of several physiological and biomechanical systems, such as balance, coordination, and stability as well as external limitations imposed on the system (Davids et al., 2008; Yudho et al., 2025). In addition, Motor Control Theory argues that successful skill performance is determined not by individual physical capacities but by the proper organization and regulation of effective movement patterns (Schmidt & Lee, 2011; Stergiou & Decker, 2011). LTAD theory underscores the importance of the acquisition of basic movement skills in the process of adolescent development for subsequent sports-related skills and performance (Logan et al., 2012; Lloyd & Oliver, 2012). From the perspective of the above theories, FMS can be considered as an indirect marker of movement organization and neuromuscular effectiveness in relation to gymnastics performance.

Positive correlations have previously been observed between the results of the FMS test and the performance metrics, including balance, agility, muscular strength, jumping ability, and coordination of athletes (Smith et al., 2017; Sommerfield et al., 2022; Davies et al., 2022; Alexe et al., 2024; Wang et al., 2024; Perdomo Trujillo et al., 2025). It has similarly been proven by studies conducted on adolescent populations that FMS results are positively related to greater movement efficiency and proficiency in performing complicated motor tasks (O'Brien et al., 2022; Pan, 2024). Furthermore, functional exercises based on FMS results have been linked to enhanced dynamic balance, muscular strength, and gymnastic skills (Kamal et al., 2021; Zhang, 2024). In the same vein, Gözlükaya Girginer (2024) noted that athletes with high FMS scores exhibited better agility and coordination.

Moreover, the issue of movement quality has been shown to be crucial in postural control and gymnastics techniques. According to Anderson et al. (2022), educational gymnastics programs play a positive role in postural control in youth, whereas the connection between the quality of movements and the probability of injuries in gymnastics was discussed by Armstrong and Relph (2021). Moreover, Vernetta-Santana et al. (2020) found significant differences in the quality of movements between adolescent acrobatic gymnasts and non-gymnastic subjects using the FMS protocol. However, some studies raise doubts about the predictive ability of FMS tests conducted independently of their application in certain sports as some of the components of the protocol are connected with general physical fitness but not sport skills (Bonazza et al., 2017; Łyp et al., 2022).

Even though the previous literature shows the significance of the FMS test for athletic evaluations, very few studies were carried out regarding the specific relationship between FMS and performance in gymnastics among adolescents, particularly in school-based physical education settings. In other words, most of the available literature concentrated on evaluating injuries or performance in general and not the technical aspect of gymnastics performance. This indicates the need for further investigation to explore the extent to which movement quality is connected with technical performance in adolescent gymnastics-related tasks.

Therefore, the current research attempts to investigate the correlation between Functional Movement Screen (FMS) scores and floor exercise performance among adolescent male students in Jenin City. The study aims to assess the level of functional movement and floor exercise performance, explore the relationship between them, and determine the predictive value of FMS for gymnastics skill performance within a school-based setting.

Literature Review

Recent literature stresses the significance of high functional movement competency in optimizing athletic performances and reducing movement-related weaknesses in adolescents. The use of functional movement training techniques based on FMS outcomes is known to foster improved strength, better vertical jump capabilities, greater balancing and flexibility skills, and effective movement actions, which are highly associated with floor exercise activities (Smith et al., 2017; Wang et al., 2024). Additionally, Davies et al. (2022) noted that high scorers on the FMS assessment tend to outperform their counterparts in different athletic disciplines. Therefore, FMS can be deemed an appropriate indicator of movement competency and physical preparedness. Moreover, Sommerfield et al. (2022) discovered a positive link between skilled movements and performance abilities in adolescents.

Further evidence supporting these findings has been provided through systematic reviews and meta-analyses. O'Brien et al. (2022) reported a significant association between Functional Movement Screen (FMS) scores and motor competence as well as physical performance among children and adolescents. Similarly, Davies et al. (2022) found that the relationship between FMS scores and athletic performance indicators ranged from moderate to strong. However, these relationships seem to vary depending on sport specificity, athletes' training background, and the physical demands of each activity, indicating that FMS may not have the same level of effectiveness across all sporting contexts.

The Functional Movement Screen (FMS) has been found to be an established tool used by professionals to evaluate how well athletes can move with their bodies in relation to how well they can perform basic movement patterns that are associated with mobility, stability, and balance. Squatting and lunge movements show how mobility and stability work together in the body when performing rotational and stabilizing exercises, according to İribalcı et al. (2024). In addition to this, Hawamdeh et al. (2024) also stated that coaches use the FMS to assess whether a player has limited or uneven movement that will either reduce athletic performance or potentially lead to injury.

The inclusion of a Functional Movement Assessment (FMA), within sport-specific training programs, has been associated with enhanced movement efficiency and increased technical skill, for athletes. Anderson et al. (2022) identified that poor motor control and instability resulted in an adverse impact upon gymnastic technique when performing cartwheels, hand stands, and rotational skills. Kamal et al. (2021) concluded that the introduction of a series of functional training sessions significantly improved the adolescents' FMS scores, balance, dynamic ability, and explosive power when involved in gymnastics related activities. Additionally, Kamal et al. (2021) stated that the application of functional movement training had a positive effect on the technical ability of gymnasts. Zhang (2024) also supported this by stating that; an individually tailored program, designed using the results from the FMS assessments would result in improved muscular strength, stability and balance within the adolescent population.

The authors also report that higher scores on the Functional Movement Screening (FMS) were significantly related to better movement efficiency for adolescents participating in a variety of complex motor activities (Mamani-Ramos et al., 2025). The results from O'Brien et al. (2022), Pan (2024) indicated that adolescent athletes who had higher movement quality scores performed better than their peers when they engaged in running, jumping and coordination-based physical activity. Gözlükaya Girginer (2024) has identified similar findings as well; she reported that youth soccer players who scored higher on the FMS had faster, stronger, more agile and longer lasting performances at sprinting, jumping, and shuttle runs.

Movement quality is especially important within gymnastics-specific environments due to the Technical Requirements for Body Control/Posture/Stability/Flexibility/Coordination. Šćepanović et al. (2020), determined that a Core Strengthening Program lasting 8 weeks resulted in statistically significant im-

provements in Functional Movement Screen (FMS) Scores relative to Balance, Control & Flexibility. Similarly, Armstrong & Relph (2021), stated the Gymnasts with lower movement-quality FMS scores were more susceptible to Recurrent Injuries as well as Displayed Poorer Technical Precision when Competing. Further still, Vernetta-Santana et al. (2020), showed Statistically Significant Differences in movement quality Between adolescent acrobatic gymnast's and Non-Practitioner's Using the FMS Battery; thus, further emphasizing the importance of functional movement assessment in gymnastics populations.

Although many studies emphasize the importance of Functional Movement Screening (FMS) as a method of assessing an athlete's performance and athletic abilities, some research has also raised concerns regarding the use of FMS alone as a predictor of athletic performance. Some examples include, but are limited to, Bonazza et al. (2017), who stated that at least some of the relationships found between FMS and athletic performance may be due to shared commonalities with other physical fitness factors (e.g., general athleticism or fitness level) instead of being directly related to the specific sport/position they play. Likewise, Łyp et al. (2022) expressed their belief that the usefulness/predictive potential of FMS may be dependent upon the particular types of movements required by an individual's sport. In this way, both of these studies illustrate the need to examine the utility of FMS within different sports/different athletic positions, rather than continuing to interpret it in a generalized manner.

Although a considerable amount of research has supported the need for Functional Movement Screens (FMS) as an important tool to help assess athletes during assessments and provide valuable information during training; however, there are many fewer studies that explore the relationship between FMS scores and specific technical gymnastic performances, specifically in regards to the youth population. In addition to this limitation, most previous research has focused on the use of FMS for injury prevention purposes or to evaluate overall athletic performance in comparison to evaluating the technical proficiency of gymnasts on their floor exercises. Therefore, further investigation is required to establish how well the quality of movement relates to gymnast's performance while participating in gymnastics at the high school level.

Method

Research Design

The researchers employed the descriptive survey technique, the correlational technique in particular, because of its appropriateness in regard to the nature and aims of the investigation. The correlational design provides an opportunity to investigate and analyses variable relationships.

Study Population

The sample used in this study includes all the students enrolled in governmental secondary schools in Jenin city, which totaled 1,308 students based on the documents from the Directorate of Education in Jenin - Palestine for the academic year (2024–2025).

Study Sample

The study sample comprised 200 high school students in Jenin City, who were randomly chosen from the study population. A simple random sampling method was used to select the participants from governmental secondary schools in Jenin City. The sample represented approximately 15% of the entire population. The term “students” was consistently adopted throughout the study because the participants were school students enrolled in physical education classes rather than registered competitive gymnasts, although they regularly participated in school-based sports and gymnastics-related physical activities. Table (1) below depicts the study sample characteristics in terms of body mass index, height, and age.

Only male students were included in the study to maintain sample homogeneity and minimize possible physiological and anthropometric differences associated with sex during adolescence. In addition, the available schools participating in the study during the data collection period included male student groups only.

Table 1. Characteristics and homogeneity of the study sample according to body mass, height, and age variables (N = 200).

Variables	Mean	Standard Deviation	Skewness Coefficient
Body Mass (kg)	63.84	5.93	0.64
Height (m)	1.74	0.06	0.45
Age (years)	16.71	0.78	0.56

Descriptive statistics for body mass, height, and age are presented in Table (1). The mean and standard deviation values were (63.84 ± 5.93 kg), (1.74 ± 0.06 m), and (16.71 ± 0.78 years), respectively. Skewness coefficients for these variables ranged within ±1, indicating approximate normal distribution of the data.

Normality tests showed that the skewness coefficients were within acceptable ranges, indicating suitability for parametric tests. Anthropometric variables (age, height, body mass) were considered to ensure sample homogeneity and control for potential confounding effects.

The study instruments included the Functional Movement Screen (FMS), comprising seven tests (Deep Squat, Hurdle Step, In-Line Lunge, Shoulder Mobility, Straight-Leg Raise, Trunk Stability Push-Up, Rotary Stability), and floor exercise skills (Dive Roll, Cartwheel, Handstand, Forward Roll with Legs Extended, Front Scale) to assess performance.

Validity

To ensure the validity of the functional movement and skill tests, the instruments were presented to (8) experts specialized in the field of the study. Discriminant validity was also used by applying the Functional Movement Screen (FMS) to a pilot sample of (14) students distinguished and non-distinguished in gymnastics, who were not included in the original study sample. To determine the differences between the two groups, the Independent Samples t-test was applied. Table (2) shows the results.

Table 2. Results of the Independent Samples t-test for differences between distinguished and non-distinguished groups in FMS and floor exercise skills (N = 14).

Variables	Distinguished Group Mean ± SD	Non-Distinguished Group Mean ± SD	T Value	Significance Level
FMS	15.86 ± 0.90	12.71 ± 2.06	3.70	0.003*
Dive Roll	7.57 ± 0.98	5.57 ± 1.51	2.94	0.012*
Cartwheel	7.29 ± 1.11	5.43 ± 1.27	2.91	0.013*
Handstand	6.71 ± 0.95	5.29 ± 1.10	2.58	0.024*
Arabesque	6.72 ± 1.11	5.14 ± 0.91	2.91	0.013*
Front Scale	7.14 ± 0.69	5.14 ± 0.90	4.67	0.001*

* Statistically significant differences at (α ≤ 0.05).

Table (2) presents the results of the independent samples t-test used to assess discriminant validity.

Reliability

To ensure the reliability of the FMS and floor exercise skills tests, the Test-Retest method was used with the same pilot sample. The time interval between the two applications was one week. Pearson correlation coefficients were then calculated to indicate the relationship between the two administrations and to extract self-validity values. Table (3) illustrates the results.

Table 3. Reliability and self-validity coefficients of the FMS and floor exercise skills tests under study (N = 14).

Variables	R Value	Self-Validity	Sig.
FMS	0.92	0.959	0.000**
Dive Roll	0.85	0.921	0.000**
Cartwheel	0.81	0.900	0.000**
Handstand	0.87	0.932	0.000**
Arabesque	0.88	0.938	0.000**
Front Scale	0.90	0.948	0.000**

** Statistically significant correlation at (α ≤ 0.01)

Table (3) presents the reliability and self-validity coefficients of the Functional Movement Screen (FMS) and floor exercise skills tests. The reliability coefficient for the overall FMS was (0.92), while the reliability coefficients for the floor exercise skills ranged between (0.81–0.90). The self-validity coefficients ranged between (0.90–0.959), with all values statistically significant at ($\alpha \leq 0.01$)

Study Variables

The present study included both independent and dependent variables. The independent variable was the Functional Movement Screen (FMS), while the dependent variables comprised the level of skill performance on the floor exercise mat, as measured by students' scores in the floor exercise skill tests, including the Dive Roll, Cartwheel, Handstand, Arabian flip, and Front Scale.

Study Procedures

This study followed a systematic series of processes. There was a thorough investigation of literature regarding the FMS and floor exercise skills to identify the variables of the study. The population of the study was determined, the sample was chosen, and the process was officially approved to be implemented in public high schools in Jenin city. Data collection instruments were prepared, and validity was confirmed in a pilot test using a separate pilot sample not included in the actual study.

The study was conducted in two phases during the second semester of the 2024–2025 academic year. The first phase involved conducting the pilot study and validating the instruments, whereas the second phase involved implementing the main data collection procedures in participating schools.

In order to have standardized test administration, a meeting was arranged with the assisting team. This was done by grouping students into 8 groups of 25, providing them with instructions, and allowing each student to perform three tries on the test with the highest score being recorded.

The floor exercise skill tests were conducted under the supervision of the assisting team after providing standardized instructions to all students. Each student was allowed three attempts, and the best performance was recorded for analysis.

Coding, entry, and data analysis were done using the Statistical Package for the Social Sciences (SPSS). Mean, standard deviation, and coefficient of skewness for descriptive statistics were computed. The relationship among variables was determined using the Pearson correlation test, while the predictive power of the FMS score on gymnastics performance was determined using simple and multiple regressions. Level of significance was set at ($\alpha \leq 0.05$) and ($\alpha \leq 0.01$).

In order to strengthen the analysis, some regression assumptions were evaluated. The assumption of normality was tested by means of skewness values, which suggest normality. Even though the analysis of multicollinearity through Variance Inflation Factor (VIF) and homoscedasticity tests was not performed, the employment of only one independent variable (FMS) prevents multicollinearity problems.

Ethical Considerations

This study was carried out in accordance with the ethical principles governing research involving human participants. Ethical approval was obtained prior to data collection from the Research Ethics Committee at Palestine Technical University – Kadoorie. Each participant, and their legal guardian when required, voluntarily provided written informed consent before participating in the study. All collected data were treated with strict confidentiality and used solely for scientific research purposes, ensuring full protection of participants' rights and privacy.

Results

First Question: What is the level of functional movement (FMS) among adolescent male students

To answer this question, the mean, standard deviation, and relative weight were calculated for each element of functional movement and for the overall FMS score, as shown in Table 4. The interpretation of the results was based on the following criterion:

- (14 points or less) with a relative weight of (66.66%) indicates no quality in movement and a higher possibility of sports injuries.
- (More than 14 points) with a relative weight greater than (66.66%) indicates quality in movement and a lower possibility of sports injuries.

Table 4 shows that the overall FMS score and all functional movement components exceeded the established threshold value (66.66%), indicating satisfactory movement quality among the participants.

Table 4. Mean, Standard Deviation, and Relative Weight of Functional Movement Screen (FMS) Scores and Its Components among adolescent male students in Jenin City (N = 200)

Functional Movement Components	Maximum Score	Mean	Standard Deviation	Relative Weight (%)
Balance	9	6.43	1.15	71.44
Motor Stability	6	4.36	1.04	72.66
Range of Motion	6	4.71	1.05	78.50
Overall FMS	21	15.45	2.38	73.57

Second Question: What is the level of floor exercise performance among adolescent male students in Jenin City?

To answer this question, the mean, standard deviation, and skewness coefficient were calculated for the floor exercise skills under study, as shown in Table (5)

Table 5. Mean, Standard Deviation, and Skewness Coefficient of Floor exercise Performance among adolescent male students in Jenin City (N = 200)

Floor exercise Skills	Maximum Score	Mean	Standard Deviation	Skewness Coefficient
Dive Roll	10	6.94	1.73	-0.41
Cartwheel	10	6.63	1.78	-0.15
Handstand	10	6.30	1.77	0.24
Arabesque	10	6.51	1.67	0.01
Front Scale	10	6.96	1.80	-0.29

The results in Table (5) indicate moderate performance levels across the evaluated floor exercise skills, while the skewness coefficients suggest approximate normal distribution of the data.

Third Question: What is the relationship between Functional Movement Screen (FMS) results and floor exercise performance among adolescent male students in Jenin City?

To answer this question, the Pearson Correlation Coefficient was used to determine the relationship between functional movement and skill performance, as shown in Table (6).

Table 6. Results of the Pearson Correlation Coefficient between Functional Movement Screen (FMS) and Floor exercise Performance among adolescent male students in Jenin City (N = 200)

Functional Movement Elements	Floor exercise Skills				
	Dive Roll	Cartwheel	Handstand	Arabesque	Front Scale
Balance	0.61**	0.64**	0.70**	0.70**	0.73**
Motor Stability	0.63**	0.70**	0.68**	0.76**	0.56**
Range of Motion	0.49**	0.49**	0.49**	0.46**	0.47**
Overall FMS	0.78**	0.82**	0.84**	0.87**	0.81**

** Statistically significant correlation at ($\alpha \leq 0.01$).

Table (6) demonstrates statistically significant positive correlations between FMS scores and all evaluated floor exercise skills. The strongest relationships were observed between the overall FMS score and the performance variables.

Fourth Question: To what extent does the Functional Movement Screen (FMS) contribute to predicting the level of floor exercise performance among adolescent male students in Jenin City?

To answer this question, the first step involved using the Pearson Correlation Coefficient to determine the relationship between functional movement and performance level, as shown in Table (7).

In the second step, to answer the first part of the question, Simple Linear Regression was used to determine the contribution of the overall average of functional movement to the level of skill performance on the floor exercise mat, as shown in Table (8).

As for the second part of the question, Multiple regression analysis was used to determine which elements of functional movement (balance, motor stability, range of motion) contribute most as independent variables to the level of skill performance in floor exercise skills as dependent variables, as presented in Tables (9–18). The results of this question are presented below:

Table 7. Summary of Pearson Correlation between Functional Movement Screen (FMS) and Floor exercise Performance among adolescent male students in Jenin City (n = 200)

Functional Movement Elements	Flying Roll	Cartwheel	Handstand	Arabian Flip	Front Balance
Balance	0.61**	0.64**	0.70**	0.70**	0.73**
Motor Stability	0.63**	0.70**	0.68**	0.76**	0.56**
Range of motion	0.49**	0.49**	0.49**	0.46**	0.47**
Overall Average of FMS	0.78**	0.82**	0.84**	0.87**	0.81**

Significant correlation at the level ($\alpha \leq 0.01$).

The results in Table (7) indicate strong positive correlations between the overall FMS score and all floor exercise performance variables, supporting the suitability of conducting regression analyses., as follows:

A. Results related to the first part of the question concerning the contribution of the overall average of functional movement (FMS) to the level of skill performance on the floor exercise mat:

Table 8. Summary of Simple Linear Regression between Functional Movement Screen (FMS) and Floor exercise Performance among adolescent male students in Jenin City (n = 200)

Gymnastics Skills	Sum of Squares	Degrees of Freedom	Mean Squares	F Value	Sig. Level	B Value	Beta	R^2
Flying Roll	365.88	1	365.88	311.88	0.000*	-1.86	0.57	0.612
	232.28	198	1.17					
	598.16	199						
Cartwheel	426.78	1	426.78	418.67	0.000*	-2.87	0.62	0.679
	201.84	198	1.02					
	628.62	199						
Handstand	440.60	1	440.60	482	0.000*	-3.36	0.63	0.709
	180.99	198	0.91					
	621.59	199						
Arabian Flip	416.10	1	416.10	606.22	0.000*	-2.87	0.61	0.754
	135.90	198	0.69					
	552	199						
Front Balance	422.25	1	422.25	370.86	0.000*	-2.49	0.61	0.652
	225.43	198	1.14					
	647.68	199						

Significant at the level ($\alpha \leq 0.01$).

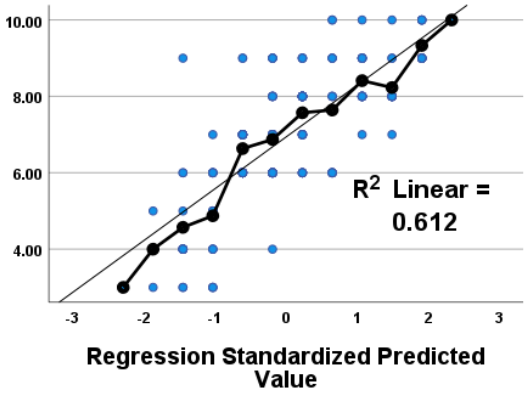
The regression results presented in Table (8) indicate that the overall FMS score significantly predicts performance in all evaluated floor exercise skills. The coefficients of determination (R^2) demonstrate that FMS accounts for a substantial proportion of variance in performance outcomes.

To avoid redundancy, the detailed interpretation of each regression equation and figure was minimized because the statistical results are already clearly presented in Table (8) and accompanying figures.

1. The proposed predictive equation for the contribution of the overall average of functional movement in explaining (61.20%) of the Flying Roll skill is:

Flying Roll (score) = (Overall FMS × 0.57) – 1.86, as shown in Figure (1).

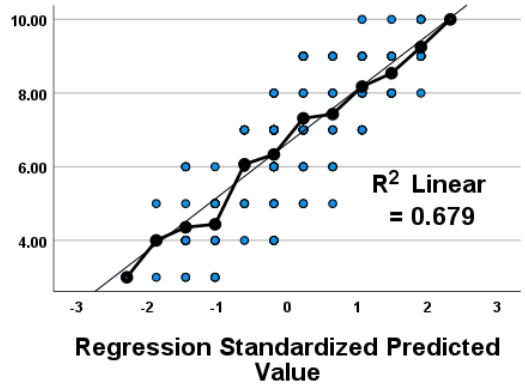
Figure 1. Regression line of the contribution of overall functional movement to the Flying Roll skill among high school players in Jenin City.



2. The proposed predictive equation for the contribution of the overall average of functional movement in explaining (67.90%) of the Cartwheel skill is:

Cartwheel (score) = (Overall Functional Movement FMS score × 0.62) – 2.87, as shown in Figure (2).

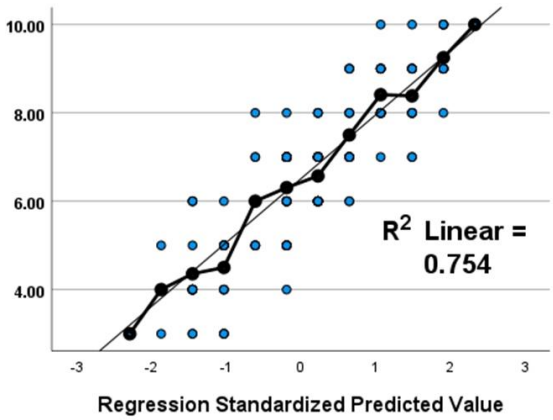
Figure 2. Regression line of the contribution of overall functional movement to the Cartwheel skill among high school players in Jenin City.



3. The proposed predictive equation for the contribution of the overall average of functional movement in explaining (70.90%) of the Handstand skill is:

Handstand (score) = (Overall Functional Movement FMS score × 0.63) – 3.36, as shown in Figure (3).

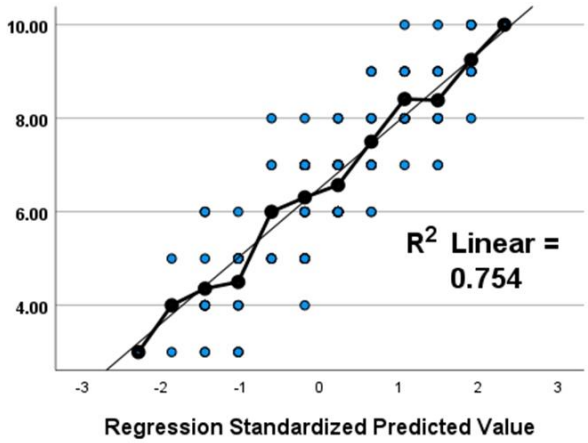
Figure 3. Regression line of the contribution of overall functional movement to the Handstand skill among high school players in Jenin City.



4. The proposed predictive equation for the contribution of the overall average of functional movement in explaining (75.40%) of the Arabian Flip skill is:

Arabian Flip (score) = (Overall Functional Movement FMS score × 0.61) – 2.87, as shown in Figure (4).

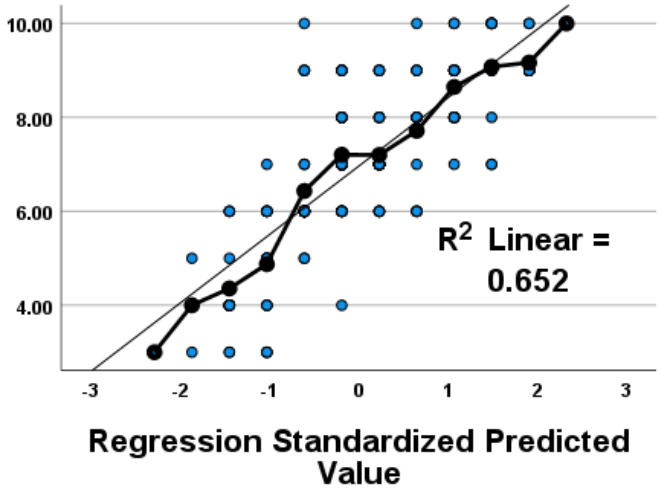
Figure 4. Regression line of the contribution of overall functional movement to the Arabian Flip skill among high school players in Jenin City.



5. The proposed predictive equation for the contribution of the overall average of functional movement in explaining (65.20%) of the Front Balance skill is:

Front Balance (score) = (Overall Functional Movement FMS score × 0.61) – 2.49, as shown in Figure (5).

Figure 5. Regression line of the contribution of overall functional movement to the Front Balance skill among high school players in Jenin City



Discussion

Theoretical Interpretation

The results obtained in the study can be interpreted within the framework of Dynamic Systems Theory and the concepts related to motor control. According to these theories, a successful performance is the result of the interplay between several physiological and biomechanical subsystems working together. There is a significant correlation between the Functional Movement Screen (FMS) score and gymnastics performance, which indicates that movement competency is indicative of the efficiency of these physiological systems. Particularly, the efficiency of the balance and stability subsystems as well as neuromuscular coordination seems to be at the forefront of such processes. Therefore, the concept that the

athletes who have an integrated and organized movement pattern are more likely to perform gymnastics skills successfully holds true.

Interpretation of Findings

Notably, the rather high degree of functional movement performance can be attributed to several factors. For example, active involvement of students in sport-related activities such as playing football and basketball has been found to help in achieving better performance when it comes to the major functional movement components such as balance, motor stability, and range of motion. In this way, various types of exercises, including stability training, squats, and these movements contribute to developing motor skills and coordinating body parts. Besides, the inclusion of stretching exercises in the process of training helps to achieve better range of motion results. The favorable atmosphere of schools that ensures sufficient facilities and a wide range of sports contributes to better results when performing functional movements. The obtained results are consistent with some previous studies which showed the correlation between movement proficiency and athletes' performance (Gözlükaya Girginer, 2024; O'Brien et al., 2022; Šćepanović et al., 2020).

In a similar vein, the degree of floor exercise skills is indicative of the well-structured and progressive training process that takes place in school settings. The acquisition of gymnastics skills usually takes place in physical education classes, where learners receive guided training intended to foster strength, flexibility, and balance. The progressive aspect of training coupled with proper equipment and guidance leads to better performance in terms of skill execution. This conclusion is corroborated by the results from various studies that have established the effectiveness of well-structured training processes in enhancing gymnastics skills (Anderson et al., 2022).

Functional Movement–Performance Relationship

Given the positive relationships found between FMS scores and floor exercise performance, it can be concluded that functional movement components such as balance, motor stability, and flexibility are crucial for the effective execution of gymnastics movements. These findings can be interpreted using Motor Control Theory, which states that movement patterns emerge when the body uses many different systems efficiently. Functional movement assessments such as FMS can be seen as indirect measures of the efficiency of these motor processes. The connections between the factors could be because functional movements help in coordinating muscles and movements, increasing movement effectiveness, and regulating posture control. These findings are in line with previous literature about the positive relationship between the FMS score and athletic ability (Gözlükaya Girginer, 2024; O'Brien et al., 2022; Šćepanović et al., 2020).

However, it should be pointed out that certain studies raise questions about the ability of FMS to predict outcomes on its own because of its limited capability, which might be related to the correlation between general physical fitness factors and the variability in sports-specific settings (Bonazza et al., 2017). In this regard, the current research results are significant for the discussion because there have been identified high correlations in a specific setting, when movement quality is associated with performance conditions (Łyp et al., 2022).

Predictive Role and Implications

According to the regression output, the regression analysis demonstrated that movement efficiency

significantly predicts floor exercise performance, given that the coefficients of determination indicated substantial explained variance across the evaluated skills. In addition, the stability of variance across various performance measures confirms this finding. Most importantly, this finding suggests that functional movement quality contributes meaningfully to performance variation beyond simple descriptive association.

This finding is in agreement with previous research findings that indicate that high FMS score is associated with increased athletic ability in adolescent populations, especially in tasks that involve coordination and balance (Davies et al., 2022). Likewise, Kamal et al. (2021) found that functional movements are positively associated with technical performance of gymnasts, while İribalcı et al. (2024) discovered a significant relationship between FMS scores and balance as well as muscular strength. In addition,

Gözlükaya Girginer (2024) found that athletes with high FMS scores display superior agility and coordination skills.

However, the correlation values found in the current research might be attributed in some way to the presence of similarity concepts among functional movement factors and the physical demands of gymnastics practice, which involve similar features, such as balance and motor coordination. In spite of this consideration, the stability of these associations in various skills, along with the characteristics of the test sample, suggests that there is a significant contribution of functional movements into performance results apart from simple anthropometric factors, the impact of which seems to be limited.

From a practical perspective, incorporating FMS testing into training programs may be useful for identifying movement deficiencies and developing intervention strategies that enhance performance while reducing the risk of injury. This study emphasizes the importance of integrating functional movement assessment into physical education and training systems.

Conclusions

The overall objective of this study was to investigate the relationship between the Functional Movement Quality, which is measured by the Functional Movement Screen (FMS), and Gymnastics Performance of Adolescent Gymnast's in Jenin city. The results from this investigation supported the objective. There exists a significant relationship between the Functional Movement Quality and Gymnastics Performance. Thus, it appears that Functional Movement Quality could serve as an indicator for predicting performance.

These results are consistent with both Dynamic Systems Theory (and) Motor Control Theory. Both of those theories are based on the idea that when many different parts of the body work together to produce a high level of performance, they will form one highly organized system. Thus, the quality of a person's movements during gymnastics would include their ability to coordinate muscle contractions, maintain posture and exhibit sufficient mobility to effectively execute gymnastics skills. Additionally, this research has expanded upon the applications of those theories by including adolescent populations performing gymnastic skills within educational environments.

The research for this study adds to the body of knowledge about Physical Education through highlighting the connection between assessing the quality of movements and the performance of the floor exercises amongst adolescents. Academically, this study provides empirical data on the influence of the FMS in adolescents' performance in a particular locale.

In addition, it supports the theoretical understanding of FMS as an indicator of movement organization and neuromuscular coordination.

The results are likely to have practical implications in that assessing students and athletes using FMS may provide coaches with an opportunity to identify poor movement patterns and develop interventions to improve function and reduce the potential for injury. Because this was a cross-sectional study and therefore did not use advanced statistical techniques to account for potentially confounding variables, the association found should be viewed as only associative (i.e., it does not necessarily imply causality).

Longitudinal and experimental design studies in the future will be useful to understand causal relationships between functional movement pattern assessments of athletic performance. Also, by using multivariate regression analyses to examine the individual contributions of the sub-components of a functional movement assessment, and with larger sample sizes that include both males and females, different age groups and various sport disciplines, may enhance the generalizability of these findings. Also important for future research is to explore the responses of FMS to training programs and how they are specifically adapted to particular sports disciplines in order to strengthen the role of FMS as both an assessment tool and training tool.

Acknowledgements

The authors would like to express their sincere appreciation to their respective universities and institutions for the continuous support provided throughout the course of this research. Our gratitude extends to Manouba University – Higher Institute of Sport and Physical Education, Al-Quds University, and Palestine Technical University – Kadoorie for offering the academic environment, facilities, and motivation that enabled the successful completion of this work.

Financing

The authors declare that no financial support was received for the research.

References

Alexe, D. I., Čaušević, D., Čović, N., Rani, B., Tohănean, D. I., Abazović, E., Setiawan, E., & Alexe, C. I. (2024). The relationship between functional movement quality and speed, agility, and jump performance in elite female youth football players. Sports, 12(8), 214. https://doi.org/10.3390/sports12080214

Anderson, N., Button, C., & Lamb, P. (2022). The effect of educational gymnastics on postural control of young children. *Frontiers in Psychology, 13*, 936680. https://doi.org/10.3389/fpsyg.2022.936680

Armstrong, R., & Relph, N. (2021). Screening tools as a predictor of injury in gymnastics: Systematic literature review. *Sports Medicine–Open, 7*, 73. https://doi.org/10.1186/s40798-021-00361-3

Bonazza, N. A., Smuin, D., Onks, C. A., Silvis, M. L., & Dhawan, A. (2017). Reliability, validity, and injury predictive value of the Functional Movement Screen: A systematic review and meta-analysis. *American Journal of Sports Medicine, 45*(3), 725–732. https://doi.org/10.1177/0363546516641937

Davids, K., Button, C., & Bennett, S. (2008). *Dynamics of skill acquisition: A constraints-led approach*. Human Kinetics. https://psycnet.apa.org/record/2008-04551-000

Davies, K. F., Sacko, R. S., Lyons, M. A., & Duncan, M. J. (2022). Association between Functional Movement Screen scores and athletic performance in adolescents: A systematic review. *Sports, 10*(3), 28. https://doi.org/10.3390/sports10030028

Gözlükaya Girginer, F. (2024). The relationship between Functional Movement Test (FMS) results and athletic performance of young football players. *Gaziantep Üniversitesi Spor Bilimleri Dergisi, 9*(1), 1–12. https://doi.org/10.31680/gaunjss.1401885

Hawamdeh, Y., Mohammed, Y., & Samer, M. (2024). Functional movement screen as a tool for predicting and detecting the risk of injury among senior youth football players of Al-Ayoun Municipality. *Journal of Excellence in Sciences and Techniques of Physical and Sports Activities, 9*(2), 521–541. https://asjp.cerist.dz/en/article/260000

İribalcı, Ş., Aydoğmuş, M., Revan, S., & Genç, H. (2024). Relationship between functional movement screening (FMS) scores and balance and strength performance in young male athletes. *Journal of Men's Health, 20*(12), 130–137. https://doi.org/10.22514/jomh.2024.208

Kamal, A. M., Gomaa, M. M., & Abu Zeid, A. M. H. (2021). Evaluation of the technical performance of some floor exercise skills in artistic gymnastics for students of the Faculty of Physical Education. *Scientific Journal of Physical Education and Sports Sciences, 10*(6), 29–48. https://doi.org/10.21608/pemas.2021.193320

Logan, S. W., Robinson, L. E., Wilson, A. E., & Lucas, W. A. (2012). Getting the fundamentals of movement: A meta-analysis of motor skill interventions in children. *Child: Care, Health and Development, 38*(3), 305–315. https://doi.org/10.1111/j.1365-2214.2011.01307.x

Łyp, M., Rosiński, M., Chmielewski, J. P., Czarny-Działak, M. A., Osuch, M., Urbańska, D., Wójcik, T., Florek-Łuszczki, M., & Stanisławska, I. A. (2022). Effectiveness of the Functional Movement Screen for assessment of injury risk occurrence in football players. *Biology of Sport, 39*(4), 889–894. https://doi.org/10.5114/biolsport.2022.107482

Mamani-Ramos, A. A., Damian-Nuñez, E. F., Carpio-Vargas, E. E., Mujica-Bermúdez, I., Pérez-Reátegui, C. M., Botton-Estrada, L. M., Quisocala-Ramos, J. A., Quispe-Cruz, H., Cutimbo-Quispe, C. V., Rodriguez-Mamani, J. R., Palomino-Crisóstomo, R. P., Cutipa-Salluca, W. R., Tuero-Chirinos, K. F., Villanueva-Alvaro, N. S., & Lava-Gálvez, J. J. (2025). Main variables predicting motor skills: analysis with classification trees. *Retos*, *68*, 318-330. https://doi.org/10.47197/retos.v68.113239

O'Brien, W., Khodaverdi, Z., Bolger, L., Tarantino, G., Philpott, C., & Neville, R. D. (2022). The assessment of functional movement in children and adolescents: A systematic review and meta-analysis. *Sports Medicine, 52*(1), 37–53. https://doi.org/10.1007/s40279-021-01529-3

Pan, J. (2024). Evaluation on the level of Functional Movement Screen (FMS) and functional training vis-à-vis sprint performance of college track and field athletes. *Journal of Education and Educational Research, 8*(2), 380–389. https://doi.org/10.54097/7e04qt58

Perdomo Trujillo, J. J., Quijano Duarte, S. A., Rodríguez Laiseca, Y. A., & Ocampo Gonzalez, C. F. (2025). Factores asociados a la Calidad del Movimiento funcional en Futbolistas de las categorías sub 15 y sub-17. *Retos*, *68*, 1-12. https://doi.org/10.47197/retos.v68.110995

Pullen, B. J., Oliver, J. L., Lloyd, R. S., & Knight, C. J. (2022). Relationships between athletic motor skill competencies and physical performance in youth. *Children, 9*(3), 375. https://doi.org/10.3390/children9030375

Lloyd, R. S., & Oliver, J. L. (2012). The youth physical development model: A new approach to long-term athletic development. *Strength and Conditioning Journal, 34*(3), 61–72. https://doi.org/10.1519/SSC.0b013e31825760ea

Šćepanović, T., Protić-Gava, B., Sporiš, G., Rupčić, T., Miljković, Z., Liapikos, K., Mačak, D., Madić, D. M., & Trajković, N. (2020). Short-term core strengthening program improves Functional Movement Score in untrained college students. *International Journal of Environmental Research and Public Health, 17*(22), 8669. https://doi.org/10.3390/ijerph17228669

Schmidt, R. A., & Lee, T. D. (2011). *Motor control and learning: A behavioral emphasis* (5th ed.). Human Kinetics. https://psycnet.apa.org/record/2011-15560-000

Smith, L. J., Creps, J. R., Bean, R., Rodda, B., & Alsalaheen, B. (2017). Performance of high school male athletes on the Functional Movement Screen™. *Physical Therapy in Sport, 27*, 17–23. https://doi.org/10.1016/j.ptsp.2017.07.001

Sommerfield, L. M., Harrison, C. B., Whatman, C. S., & Maulder, P. S. (2022). Relationship between strength, athletic performance, and movement skill in adolescent girls. *Journal of Strength and Conditioning Research, 36*(3), 674–679. https://doi.org/10.1519/JSC.0000000000003512

Stergiou, N., & Decker, L. M. (2011). Human movement variability, nonlinear dynamics, and pathology: Is there a connection? *Human Movement Science, 30*(5), 869–888. https://doi.org/10.1016/j.humov.2011.06.002

Vernetta-Santana, M., de Orbe-Moreno, M., Peláez-Barrios, E. M., & López-Bedoya, J. (2020). Movement quality evaluation through the Functional Movement Screen in adolescents. *Journal of Human Sport and Exercise, 15*(4), 918–931. https://doi.org/10.14198/jhse.2020.154.18

Wang, X., Soh, K. G., Deng, N., Zhang, D., Cao, S., & Samsudin, S. (2024). Effects of functional training on muscle strength, jumping, and Functional Movement Screen in Wushu athletes: A systematic review. *Heliyon, 10*(2). https://doi.org/10.1016/j.heliyon.2024.e24087

Yudho, F. H. P., Fachrezzy, F., & Dlis, F. (2025). Unravelling the Impact of Physical Activity on Postural Stability: An Experimental Study of University Students : Desentrañar el impacto de la actividad física en la estabilidad postural: un estudio experimental de estudiantes universitarios. *Retos*, *68*, 13-23. https://doi.org/10.47197/retos.v68.113330

Zhang, R. (2024). Study on the application of Functional Movement Screen in individualized physical training programs for adolescents. *International Journal of Education and Humanities, 13*(2), 200–203. https://doi.org/10.54097/r39c0e46.

Authors and translators' details:

Musab Turkman	Mosab.turkman@yahoo.com	Author
Maryam Hethnawi	mmhathnawi@gmail.com	Author and Translator
Aseel Qady	Aseelqady2@gmail.com	Author
Masod abohalawa	masodabohalawa90@gmail.com	Author
Ahmad Nassar	a.nassar@ptuk.edu.ps	Author
Mohanad omar	muhanad.ibrahim@ptuk.edu.ps	Author
Samer AbuEid	samer.abueid@aaup.edu	Author
Abderraouf Ben Abderrahman	abderraouf.benabderrah-man@issep.uma.tn	Author