

Inclusion rates of motor abilities in artistic gymnastics apparatus: A content analysis of FIG Technical Manuals

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ABSTRACT

As the inclusion rate of motor abilities in artistic gymnastics apparatus is crucial for the determination of the training program and the learning process of each ability in this branch, the study aims to analyse and determine the representation frequency of motor abilities in each apparatus of artistic gymnastics based on the updated content of techniques given by FIG. This research employs a descriptive quantitative approach to investigate the current state of motor abilities in 239 techniques outlined in the FIG Technical Manual across both genders. Each technique was analysed to identify and highlight specific motor abilities, including coordination, strength, speed, mobility, flexibility, balance, endurance, and agility. The findings are presented using descriptive and frequency statistics, organized into charts for clarity. When the results were examined, it appears that, although there are similarities in motor skills across artistic gymnastics disciplines, each discipline has its own specific requirements. The requirements also vary depending on the difficulty level of the movements. Therefore, as the discipline evolves, the apparatus requirements need to be constantly updated. The study concludes that as the difficulty of techniques changes and new skills are introduced into the Code of Points, along with advancements in gymnastics-related technology, the representation frequency of motor abilities may shift, requiring updates to training programs.

Keywords: performance analysis; motor skills; artistic gymnastics apparatus; representation frequency of motor abilities; training programs; physical conditioning.

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INTRODUCTION

Artistic gymnastics is a sport that encompasses many disciplines and therefore places high demands on motor skills. The wide variety of disciplines further complicates the motor skill requirements. In addition, because the techniques used depend on multiple motor skills, involve varying difficulty levels, and are applied along different axes of the body, the sport's complexity increases further. As a result, it is challenging to determine which motor skills are required for each apparatus and to what extent. However, to achieve success, it is necessary to determine the dominant motor skills for each apparatus. Several authors have raised concerns regarding strength and motor skill requirements in artistic gymnastics (Gasparetto et al., 2022).

Although books and research studies indirectly assess motor skill representation frequency, these studies may not be fully up to date for several reasons. In the past, the difficulty of techniques in artistic gymnastics was lower than it is today, and the motor skill representation frequency, determined by the sport's earlier structure, may not accurately reflect the demands of modern gymnastics. Fifty or sixty years ago, gymnastics was characterised primarily by positions that required flexibility. Nowadays, due to advancements in technology and medical sciences, the difficulty of movement has increased significantly, with a greater emphasis on the mechanical structure of techniques rather than flexibility (Fédération Internationale de Gymnastique, 2017a, 2017b). For example, at the 2019 Artistic Gymnastics World Championship in Stuttgart, several new techniques were added to the Code of Points. These techniques, such as The Petz (Uneven Bars), The Biles (Uneven Bars), The Biles (Balance Beam), The Sanne Wevers 2 (Balance Beam), The Biles 2 (Floor), The Volleman 2 (Floor), The Lieke Wevers (Floor), The Volleman-Lieke Wevers (Floor), The Brooklyn Moors (Floor), and The Laney Madsen (Floor), are not defined solely by flexibility. They also require high levels of mobility, coordination, strength, and other motor abilities. Consequently, the inclusion of motor abilities in movement execution is more complex than treating each ability in isolation. During the execution of gymnastics techniques, motor abilities interact, giving rise to complex capabilities such as coordination and mobility.

Based on this, it appears that the representation frequency of motor skills reported in the literature does not reflect the difficulty levels of modern artistic gymnastics techniques. Therefore, prioritising motor skills that do not represent the sport's current demands may lead to errors in applied training programs. Since all studies and training programs are developed based on the sport's requirements and the representation frequency of motor skills, it is essential to update the representation frequency ratios of motor skills for each apparatus, taking into account the evolving difficulty levels and demands of artistic gymnastics techniques.

The emergence of revolutionary techniques such as 'The Biles' (on Vault, Balance Beam, and Floor) or 'The Petz' (on Uneven Bars) demonstrates that modern gymnastics is no longer defined solely by flexibility, but rather by a complex interaction of mobility, coordination, and explosive strength. However, despite this technical advancement, the current scientific literature lacks a precise quantification of how these innovations have reconfigured motor demands across each apparatus.

In this context, it is hypothesised that the technical evolution of the FIG Code of Points has shifted traditional motor representation frequency, positioning coordination and strength as the most critical transversal abilities in current performance, surpassing the passive flexibility parameters prevalent in previous decades.

Consequently, the objective of this research is to systematically determine and analyse the inclusion rates of motor abilities across different artistic gymnastics apparatus by examining 239 techniques from the FIG

Technical Manual. By developing percentage representation frequency indicators, this study seeks to provide an updated empirical basis for optimising the design of training programs in the contemporary sporting cycle.

METHODS

Study model

This research is a descriptive study using quantitative content analysis to systematically evaluate the current technical requirements and motor demands in artistic gymnastics. This study involves the analysis of publicly available technical manuals and did not involve human participants or animals; therefore, institutional ethical approval was not required.

Analysed content

The analysed Technical Manuals and Code of Points have been updated for the years 2022-2024 and include all evaluation procedures in artistic gymnastics, the mechanical understanding of each technique, prerequisite elements, related skills, physical qualities, physical preparation, teaching methodology, and more.

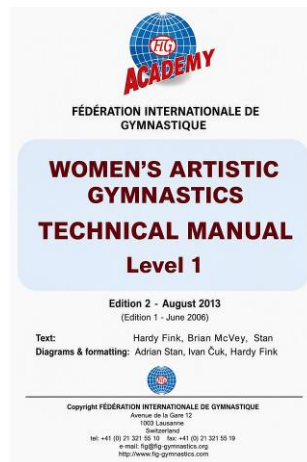


Figure 1. Women's artistic gymnastics technical manual analysed (Level 1).

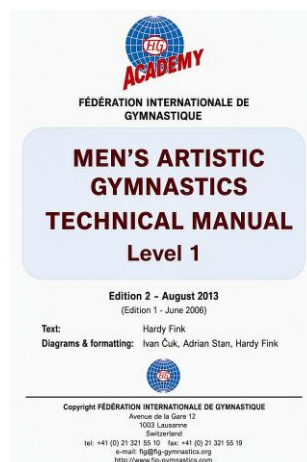


Figure 2. Men's artistic gymnastics technical manual analysed (Level 1).



Figure 3. Analysed 2022-2024 Code of Points (Women's Artistic Gymnastics).



Figure 4. Analysed 2022-2024 Code of Points (Men's Artistic Gymnastics).

This comprehensive information enabled the classification of each motor skill and the determination of the inclusion ratio for each motor quality.

Method of determining dominant motor abilities

The artistic gymnastics techniques presented in the technical manuals mentioned above require a wide range of motor abilities for proper performance. These manuals specify the physical qualities needed to execute each technique. Based on this, we identified the required motor abilities for each technique and apparatus in order to determine the representation frequency ratio of motor abilities in artistic gymnastics.

To examine the representation frequency of specific motor abilities for each apparatus, an extensive analysis was conducted using 239 techniques (Floor: MAG 30, WAG 45; Vault: MAG 17, WAG 17; Pommel Horse: MAG 5; Rings: MAG 27; Parallel Bars: MAG 17; Horizontal Bar: MAG 28; Asymmetric Bars: WAG 22; Beam: WAG 31) described in the *Women's Artistic Gymnastics Technical Manual (Level 1)* and the *Men's Artistic Gymnastics Technical Manual (Level 1)*. These manuals provide a detailed list of techniques and clearly indicate the motor abilities required to execute them. Motor abilities are categorised as physical qualities such as strength, coordination, flexibility, balance, and endurance. This classification, illustrated in Example 1, provides a clear basis for understanding the physical preparation required for each technique.

The analysis involved extracting and summarising data for each technique to identify how frequently specific motor abilities were required. In particular, the techniques were evaluated according to their demands for strength, coordination, flexibility, and other relevant motor abilities. This quantitative approach enabled the determination of the extent to which each motor ability is represented across different techniques.

As a result, percentages were calculated to show the prevalence of each motor ability within the analysed techniques. These findings were used to define the dominant motor abilities for each apparatus. The results provide a strong basis for developing training programs that reflect the technical demands of artistic gymnastics and help ensure alignment with the most important motor ability requirements.

This detailed understanding of the demands of motor ability can help coaches and athletes design more targeted and scientifically supported training strategies, which may contribute to improved performance in artistic gymnastics. To achieve a more complete understanding of these demands, a detailed analysis of the technical manuals is essential.

Lastly, the motor ability classifications were derived directly from the FIG Academy Technical Manuals, where the required physical qualities for each technique had already been established by FIG expert working groups. Therefore, motor abilities were not interpreted by the researchers; coding involved transferring these stated abilities into a structured table and calculating their frequency of occurrence across the 239 techniques analysed. The extraction was completed by the first author and then checked entry by entry by a second author against the source manuals, with any differences corrected by referring back to the original documents. Since the ability categories were already defined by the FIG source rather than created by the researchers, the values reported here can still be directly checked against the published manuals.

Table 1. Example of motor abilities representation frequency: Swing to handstand technique.

Physical qualities
Strength
Speed
Endurance
Mobility
Coordination

Note. Included motor abilities are highlighted in orange.

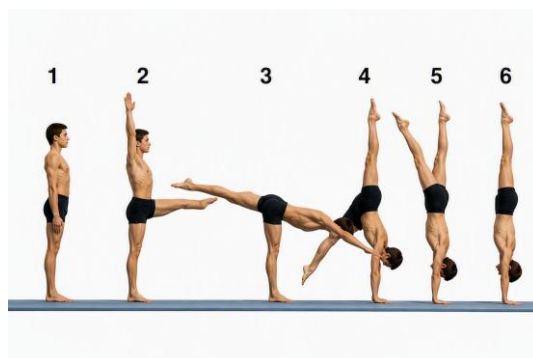


Figure 5. Swing to handstand technique.

Table 1 and Figure 5 illustrate an example from the 239 gymnastics techniques included in the study. The motor qualities highlighted in orange represent the abilities required to perform the Swing-to-Handstand

technique. Each technique is accompanied by a unique table detailing the necessary motor abilities. These tables and figures, presented in the Findings section, show the inclusion ratio for each motor ability across specific techniques.

Analysis of the results

The data were analysed using SPSS version 26.0. Descriptive statistics were performed in SPSS, while the percentages of motor ability inclusion for each apparatus and technique were calculated in Excel. Figures were also created using Excel. The analysis of the results is based on the percentage of inclusion of each motor ability across all techniques.

RESULTS

To determine the inclusion ratio of each motor quality across various gymnastics techniques, all techniques were classified according to the Technical Manuals described in the Methods section (FIG Academy MAG and WAG Level 1 Technical Manuals). For each apparatus, each technique was assessed for its involvement of each motor quality, and a single technique could involve more than one motor quality. “Nr.” indicates the number of techniques requiring that motor quality, out of the total number of techniques for that apparatus (shown in the column heading). “%” is calculated as Nr. divided by the total number of techniques for that apparatus. Because a technique can require multiple motor qualities, the percentages within a given apparatus column do not sum to 100%. Table 2 presents data for the apparatus specific to women’s gymnastics (Beam and Asymmetric Bars), together with Floor and Vault, where the analysed techniques combine the men’s and women’s programmes for shared apparatus. Table 3 presents data for the apparatus specific to men’s gymnastics (Rings, Parallel Bars, Horizontal Bar, Pommel Horse), together with Vault. The “General” column is the average percentage for each motor quality across the eight distinct apparatus (Floor, Vault, Beam, Asymmetric Bars, Rings, Parallel Bars, Horizontal Bar, Pommel Horse), with Vault counted once.

Table 2. Motor quality inclusion ratios by women's gymnastics apparatus.

Physical qualities	Floor		Vault		Beam		Asymmetric Bars		General Avg %
	Nr.	%	Nr.	%	Nr.	%	Nr.	%	
Coordination	34	76	17	100	21	68	20	91	88.57
Strength	12	27	14	82	11	35	16	73	73.07
Speed	16	36	14	82	5	16	18	82	62.83
Mobility	10	22	7	41	12	39	8	36	46.5
Flexibility	32	71	6	35	15	48	4	18	42.71
Balance	25	56	5	29	22	71	5	23	34.19
Endurance	0	0	1	6	2	6	0	0	3.92
Agility	3	7	0	0	0	0	0	0	0.83

Note. The Floor column includes the floor exercise techniques of both the men's and women's programmes (MAG 30, WAG 45), as the apparatus is common to both.

Table 2 shows that coordination dominates across all apparatus, peaking at 100% in Vault and averaging 88.57%, confirming it as the universal prerequisite for technique execution. Strength and speed form a secondary cluster, with both reaching 82% in Vault and Asymmetric Bars, reflecting the explosive demands of these apparatuses. Flexibility and balance instead follow apparatus-specific patterns: flexibility peaks on Floor (71%) due to acrobatic and dance content, while balance peaks on Beam (71%) due to its narrow base of support. Mobility remains moderate throughout (22-41%), whereas endurance and agility are minimally represented, indicating they are not structurally embedded in women's gymnastics technique.

Table 3. Motor quality inclusion ratios by men's gymnastics apparatus.

Physical Qualities	Vault		Rings		Parallel Bars		Horizontal Bar		Pommel Horse		General Avg %
	Nr.	%	Nr.	%	Nr.	%	Nr.	%	Nr.	%	
Coordination	17	100	22	81	17	100	26	93	5	100	88.57
Strength	14	82	23	85	17	100	23	82	5	100	73.07
Speed	14	82	13	48	9	53	24	86	5	100	62.83
Mobility	7	41	14	52	14	82	11	39	3	60	46.5
Flexibility	6	35	7	26	8	47	10	36	3	60	42.71
Balance	5	29	2	7	2	12	10	36	2	40	34.19
Endurance	1	6	1	4	2	12	1	4	0	0	3.92
Agility	0	0	0	0	0	0	0	0	0	0	0.83

Table 3 shows that coordination and strength are the leading qualities across the men's apparatuses. Both reach 100% on the Parallel Bars, while coordination, strength, and speed each reach 100% on the Pommel Horse, highlighting the strong integration of strength, coordination, and speed required for this apparatus. Speed varies by apparatus, peaking at 100% on Pommel Horse and 86% on Horizontal Bar but dropping to 48-53% on Rings and Parallel Bars, where strength-based elements dominate. Mobility and flexibility play secondary roles (39-82% and 26-60%, respectively), while balance is comparatively low (7-40%), suggesting men's apparatus rely more on dynamic strength-speed combinations than static equilibrium. As in the women's data, endurance is minor, and agility is entirely absent, confirming both as peripheral qualities in men's artistic gymnastics. The graphs show the inclusion ratios (%) of motor abilities in artistic gymnastics techniques for each apparatus.

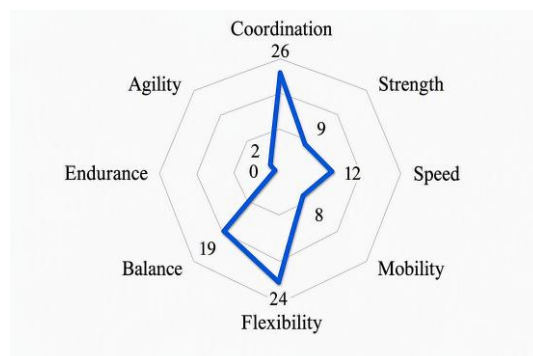


Figure 6. Representation frequency of motor abilities on the floor apparatus. Coordination, followed by flexibility, balance, speed, strength, and mobility, plays the most important role in floor techniques.

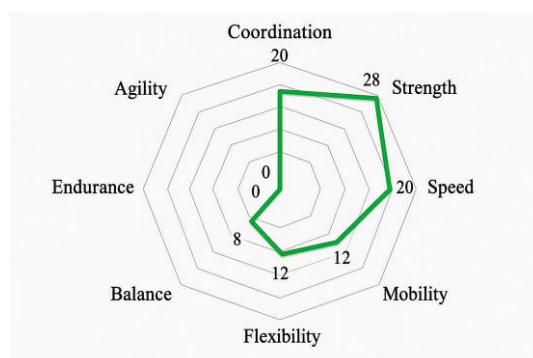


Figure 7. Representation frequency of motor abilities on the Pommel Horse apparatus. Strength is the dominant ability on the pommel horse, followed by coordination, speed, mobility, and flexibility.

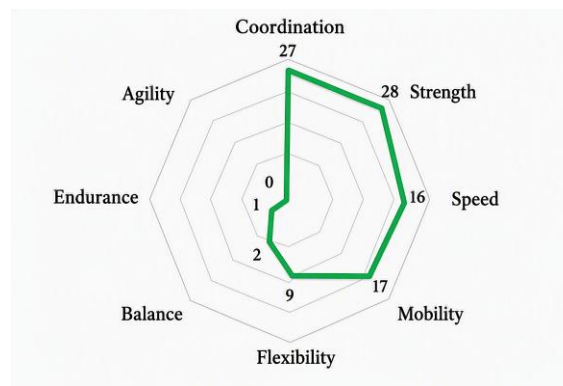


Figure 8. Representation frequency of motor abilities on Rings. Strength appears to be the dominant ability on the rings, followed by coordination, mobility, and speed.

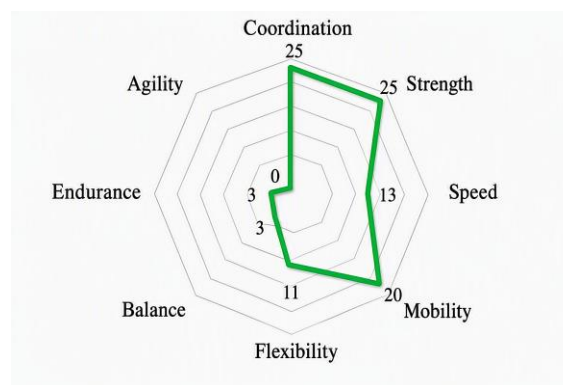


Figure 9. Representation frequency of motor abilities on Parallel Bars. The parallel bars rely on both strength and coordination, followed by mobility, speed, and flexibility.

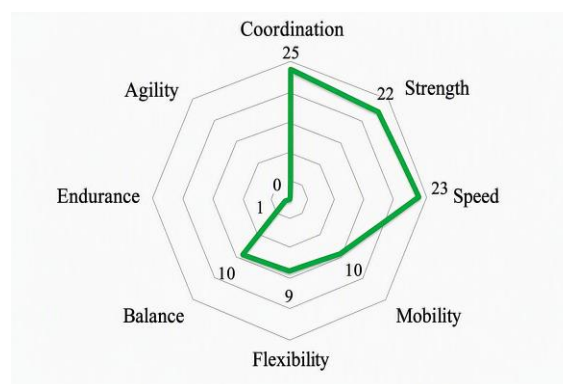


Figure 10. Representation frequency of motor abilities on the Horizontal Bar. The horizontal bar appears to be primarily characterised by coordination, speed, and strength. Balance and mobility, followed by flexibility, also play important roles.

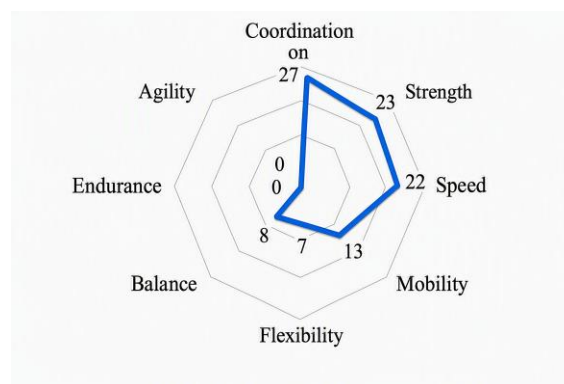


Figure 11. Representation frequency of motor abilities on Vault. The vault appears to involve a broad range of motor abilities, with coordination being the most dominant, followed by strength, speed, and mobility.

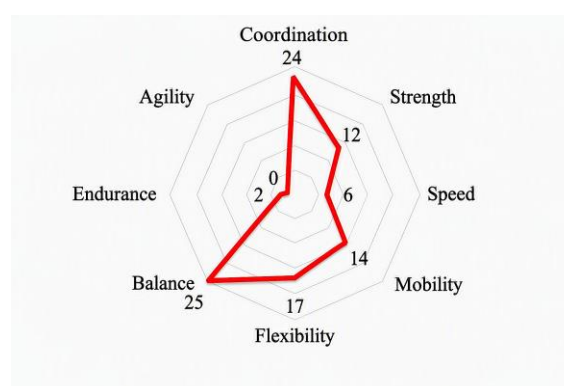


Figure 12. Representation frequency of motor abilities on the Balance Beam. Although the apparatus is characterised by balance, coordination is the most represented ability on the balance beam, followed by balance, flexibility, mobility, and strength.

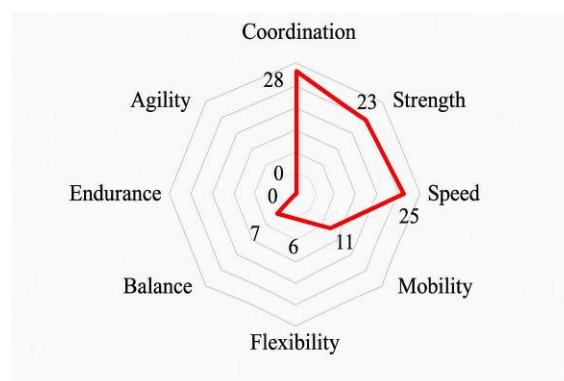


Figure 13. Representation frequency of motor abilities on Asymmetric Bars. Similar to the vault, the asymmetric bars are dominated by coordination, followed by speed, strength and mobility.

As Figures 14 and 15 show, the inclusion ratio of motor abilities in artistic gymnastics is presented as percentages. Coordination appears to be the most important ability, followed by strength and speed. As discussed in the Discussion section, coordination is a complex motor ability that includes multiple motor skills,

which is why it emerges as the most critical skill. These three motor abilities are also accompanied by mobility, flexibility, and balance, which play important roles in artistic gymnastics. However, endurance and agility do not appear to be significantly involved in the sport, even though factors such as force endurance and reaction time are relevant. These aspects are analysed as components of strength and speed.

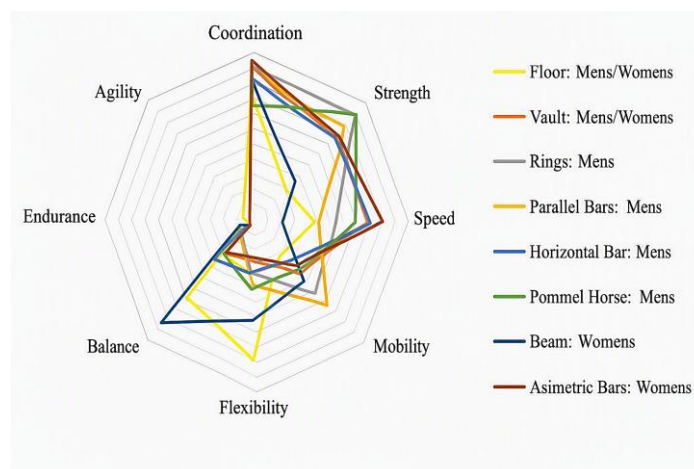


Figure 14. Representation frequency of motor abilities across artistic gymnastics apparatus.

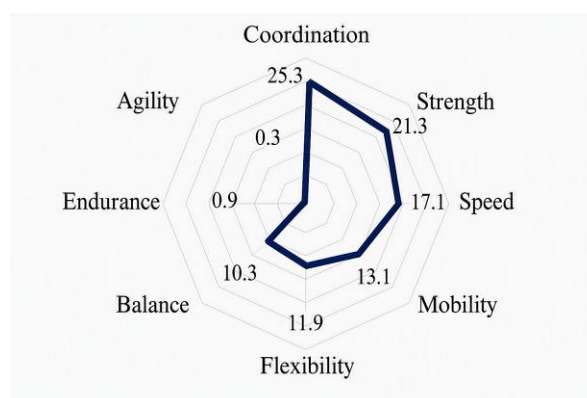


Figure 15. Generalised representation frequency of motor abilities across artistic gymnastics apparatus.

DISCUSSION

As the study aimed to determine the inclusion rate of motor abilities in each apparatus, the results suggest that coordination plays a more significant role in artistic gymnastics than previously believed, particularly in mastering techniques outlined by the FIG (Fink & Hofmann, 2015; Fink et al., 2015). In the past, the demands on flexibility in artistic gymnastics were lower, with simpler movements focusing on poses and stretches. This can be seen in the earlier editions of the Code of Points, which recognised only three difficulty categories in men's gymnastics and two in women's, described the beam exercise mainly as an exercise of balance, allowed a maximum of three stops, and instructed gymnasts only to avoid too many lying and sitting positions (Fédération Internationale de Gymnastique, 1968, 1970). In the current editions, both disciplines use ten difficulty values from A to J, and handstands and holds may no longer be used to meet the composition requirements, which instead require dance connections with a 180° split, turns, an acrobatic series containing a jump, and acrobatic elements performed in different directions (Fédération Internationale de Gymnastique,

2025a, 2025b). Accordingly, advancements in technology and medicine have contributed to major progress in the sport, leading to increasingly complex movements that require greater mobility, coordination, strength, and speed (Fink & Hofmann, 2015; Fink et al., 2015; Fédération Internationale de Gymnastique, 2017a, 2017b). Although the literature sometimes confuses flexibility with mobility, flexibility remains an important component, even if it is usually ranked fourth after coordination, strength, and speed. Flexibility is essential for achieving the required joint range of motion, particularly in techniques such as splits and floor bridges (Fink et al., 2013; Fink, 2013). Flexibility can be measured both statically and dynamically: static flexibility involves external forces, such as gravity or partner assistance, while dynamic flexibility is actively controlled by the muscles (McGuigan, 2016). The relationship between static and dynamic flexibility is still being researched (Jeffreys, 2016; Cook, 2010). Passive flexibility provides the basis for active flexibility, which in turn supports overall mobility (Jeffreys, 2016; Cook, 2010).

Coordination involves combining motor skills and activating multiple muscles simultaneously, which is essential for performing synchronised movements (Foran, 2000; Çetin & Flock, 2014). Therefore, optimal coordination between body parts and equipment is crucial; for example, the parallel bars require high levels of hand and spatial coordination. In artistic gymnastics, the three main facets of coordination (difficulty level, accuracy, and acquisition time) are closely interconnected with various motor skills. Additionally, coordination is influenced by factors such as body weight, height, timing, sensory perception, balance, movement direction and distance, and visual targeting (Karabina & Pirselimoglu, 2017). On the parallel bars, coordination between the body and space must be at the highest level to successfully link close-bar techniques, long-hanging elements, and flying movements. Similarly, on the balance beam, coordination among the extremities, the body, the apparatus, and the surrounding space is critical. In floor exercise, demonstrating coordination is essential to ensure fluency, adequate speed, and continuous execution of high-difficulty techniques without pause. In vaulting, maximum running, jumping, body coordination, and aerial orientation are all important components. Therefore, the development of coordination skills should be prioritised, as their inclusion rate on each apparatus highlights their significant importance in gymnastics training.

In artistic gymnastics, athletes must maintain control of their body weight throughout routines, with relative strength playing a pivotal role, as it reflects an individual's strength relative to their body size or lean mass (Fleck & Kraemer, 2014; Bompa, 2015; Ratamess, 2012). This ability is fundamental across all gymnastics disciplines (Bompa, 2015), and performance on apparatus such as the rings is highly dependent on adequate relative strength (Bompa, 2015). Studies suggest that women tend to develop greater relative strength than men under similar training regimes (Kell, 2011), emphasising the importance of this difference, particularly in artistic gymnastics. In disciplines like the parallel bars, where gravity significantly influences technique, both relative and absolute strength are crucial, with some research indicating that improvements in relative strength can contribute to gains in absolute strength (Kell, 2011).

In analysing movements on the rings, a sequence of concentric, eccentric, and isometric contractions occurs, highlighting the significance of these types of strength (Fédération Internationale de Gymnastique, 2017a). The stretch-shortening cycle (SSC) is also pivotal, as it involves muscles contracting, shortening, then immediately lengthening, which is crucial for performing movements such as holding positions on the rings for at least two seconds (Fédération Internationale de Gymnastique, 2017a). The SSC is also vital in floor jumps, impacting performance during rapid ground contacts such as round-off Tsukahara, double jump, Deferr, and Morandi, which occur in less than 250 milliseconds (Potach & Chu, 2016). It contributes to performance through the elastic properties of muscles and tendons, the amortisation phase, and the storage and release of energy, enhancing the efficiency of the eccentric phase. In artistic gymnastics, especially on apparatuses such as the balance beam, techniques are closely interconnected, with coordination playing a

crucial role; however, the physiological basis of force is equally important. Speed, following coordination and strength, facilitates both movement execution and the connection of elements.

Techniques on apparatuses such as the high bar, parallel bars, asymmetric bars, balance beam, and vault rely on achieving height through rapid and powerful swings. Speed, which follows coordination and strength in importance, is crucial in artistic gymnastics and directly impacts performance (McGuigan, 2016). Explosive power, which depends on speed, must be highly developed (Fink et al., 2013). Maximal speed is essential for successful vault jumps, as horizontal velocity significantly influences the vertical flight phases (Potach & Chu, 2016). The stretch-shortening cycle (SSC), which is vital in movements such as the round-off Tsukahara, improves performance by reducing ground contact times to less than 250 milliseconds. Speed also plays a key role in initiating each technique and is essential for executing skills such as somersaults on the vault and balance beam, as well as bar changes on asymmetric bars (Fédération Internationale de Gymnastique, 2017b).

Mobility in artistic gymnastics refers to the freedom of movement within a joint's range of motion (DeWeese & Nimphius, 2016). It encompasses the functional balance between active and passive flexibility. Demonstrating mobility requires applying flexibility during movements that demand strength, motor control, and dynamic joint balance (Karabina & Pirselimoglu, 2017). Mobility, which integrates flexibility, strength, and motor skills, is a key component in artistic gymnastics and is particularly prominent in parallel apparatus techniques due to their demand for a wide range of motion (Fink & Hofmann, 2015). Functional flexibility is crucial for dynamic movements on the balance apparatus, indicating the importance of mobility skills in these techniques (Fink et al., 2015). Although mobility is typically ranked fourth, following coordination, strength, and speed, its comprehensive nature indirectly enhances the application of techniques that require these skills. Since mobility encompasses flexibility, it is also addressed within the flexibility section below.

Balance is the ability to maintain static and dynamic equilibrium or to support the body's centre of gravity over its base of support (Miller, 2012; Reilly & Waterhouse, 2009; McGuigan, 2016). Balance skills are particularly prominent on the balance beam, where the centre of gravity must be carefully maintained above the narrow support base, and they are also crucial in floor exercises. Although balance is important on apparatus such as the horizontal bar, parallel bars, and pommel horse, these exercises rely less on maintaining balance, as most movements occur with the centre of gravity below the support base. Instead, the focus shifts to adjusting the direction, tempo, and other characteristics, using swings and oscillations to transition from the bar to elevated positions rather than solely maintaining balance. Static balance, which involves keeping the centre of gravity above the support point, is commonly involved in floor exercises, the balance beam, and other apparatus events. Dynamic balance, on the other hand, is required when transitioning between balance positions, such as Alvirano or Menichelli, and regaining the same position. In particular, achieving different positions in the fourth movement group demands a high level of dynamic balance (Fink & Hofmann, 2015; Fink et al., 2015). Successfully performing movements in other groups and regaining lost positions, whether consciously or unconsciously, also depends on advanced dynamic balance. Although balance is typically ranked fifth in artistic gymnastics, its importance increases when considering its direct relationship with second-ranked static strength in dynamic balance. Similarly, the close relationship between dynamic balance and coordination, ranked first in importance, further highlights the significance of this characteristic.

Endurance in artistic gymnastics is primarily associated with the aerobic energy system, which depends on aerobic capacity, the maximum rate of energy production through the oxidation of energy sources (McArdle et al., 2015; McGuigan, 2016). However, because routines are relatively short, endurance is generally less critical. Instead, the sustained application of strength over periods of approximately 30 to 90 seconds

emphasises the importance of anaerobic capacity (McArdle et al., 2015; McGuigan, 2016). Endurance becomes significant in competition settings that involve multiple series, despite the dominant role of the phosphagen system and anaerobic capacity in gymnastics performance (McArdle et al., 2015; McGuigan, 2016). It is particularly relevant for apparatus such as the parallel bars and balance beam, although it is considered less important than other motor skills (Fink & Hofmann, 2015; Fink et al., 2015).

Agility is generally considered more important in collective sports, which involve manoeuvring ability, deceleration, acceleration, and changes of direction (Sheppard & Young, 2006; Stewart et al., 2014; McGuigan, 2016). When the components and underlying principles of agility are examined, it becomes clear that it plays a limited role in gymnastics apparatus performance. Similarly, as shown in Figure 14, agility does not appear to have a significant level of representation frequency in any apparatus, except for the floor. Compared to other apparatuses, agility is more involved in floor exercise; however, it has a relatively low impact compared to other motor skills (Fink & Hofmann, 2015; Fink et al., 2015).

From a conditioning perspective, the frequency of different motor abilities in artistic gymnastics techniques provides an apparatus-specific guide for program design rather than one general gymnastics profile. Since coordination is the most represented ability, conditioning should stay closely linked to skill performance, focusing on the rate of force development and inter-muscular coordination over general muscle hypertrophy training. Strength should be trained according to the type of muscle contraction rather than treated as one general category, with greater focus on isometric and eccentric-concentric strength on the rings and on relative strength wherever body mass must be controlled. On vault and floor, where the stretch-shortening cycle occurs during ground contacts of less than 250 ms, short-contact plyometrics exercises are more suitable than slow strength work. Mobility and flexibility should be trained through active range of motion under load, while balance work is most relevant on the beam and floor and can be combined with static strength work. Endurance training should mainly focus on anaerobic capacity during efforts lasting 30 to 90 seconds, while agility requires less attention beyond floor preparation.

Limitations

This study contains limitations. Since coordination is a broad, multi-component ability encompassing spatial orientation, timing, and inter-limb coordination, its high representation frequency percentage (25.3%) may not be directly comparable to more narrowly defined abilities such as balance or endurance. Future research could subdivide coordination into specific sub-components for a finer-grained analysis. The study is based on FIG Level 1 Technical Manuals, which predominantly cover foundational and intermediate techniques. The motor ability profiles of elite-level D–G difficulty elements may differ substantially, limiting generalisability to top-level competitive gymnastics. All techniques were assigned equal analytical weight regardless of their FIG difficulty value, meaning that an A-difficulty element and an F-difficulty element contribute equally to the representation frequency, which may underrepresent the true demands of modern high-difficulty gymnastics. The findings represent a static snapshot of the 2022–2024 Code of Points. As the FIG continues to introduce new techniques and revise its Code, the motor-ability representation frequency reported here will require periodic updates to remain applicable to contemporary gymnastics training.

CONCLUSION

An examination of the graphs reveals that, despite certain similarities in motor skill requirements across artistic gymnastics disciplines, each apparatus presents its own distinct demands. These demands appear to be shaped by the structural characteristics of the apparatus, the techniques performed on it, and the FIG regulations governing its execution, and they also vary with the difficulty of the movements involved.

Consequently, as the discipline continues to evolve, the motor skill requirements for each apparatus must be periodically reassessed and updated.

When considered overall, taking into account the importance of all apparatuses in artistic gymnastics, the most dominant motor skill is coordination, followed by strength, speed, mobility, flexibility, balance, and, finally, endurance and agility. Since the representation frequency of motor skills evolves alongside the sport's development, older sources may present outdated or overlapping information. Therefore, it is necessary to update these findings in parallel with the discipline's ongoing development.

As a result, it has been found that the representation frequency of motor skills in artistic gymnastics has changed due to the sport's ongoing development. This study was conducted based on current literature from FIG, NSCA, and other sources. When the representation frequency percentages of motor skills across each apparatus were generalised, coordination emerged as the dominant skill with 25.3%, followed by strength (21.3%), speed (17.1%), mobility (13.1%), flexibility (11.8%), balance (10.2%), endurance (0.9%), and agility (0.3%). The primary motor skills were identified as coordination, strength, speed, mobility, flexibility, and balance. Additionally, due to interrelationships among motor skills, abilities ranked fourth or fifth in representation frequency can also contribute to those ranked first. For instance, relationships such as mobility-flexibility, mobility-strength, dynamic balance-coordination, and static balance-static strength can increase the difficulty of certain techniques.

Currently, training programs in artistic gymnastics are often designed around motor skill representation frequency established when the sport was less developed than it is today. Therefore, outdated information about skill representation frequency can undermine the effectiveness of these programs. In this regard, it is recommended that training programs be designed in line with the updated representation frequency of motor skills identified in this study. Gymnasts' performance can be improved by focusing on motor skills such as intramuscular and intermuscular coordination, spatial orientation, the stretch-shortening cycle (SSC), elastic force, relative strength, pre-activation, mobility, and flexibility.

Finally, future analyses should include weighted scores based on the difficulty values of the analysed techniques. Since techniques with different difficulty values do not place the same motor demands on gymnasts, giving them equal weight may hide the actual importance of certain motor abilities. A difficulty-weighted approach would therefore provide a more realistic determination of which motor abilities are most important in contemporary artistic gymnastics.

AUTHOR CONTRIBUTIONS

All authors meet the criteria for authorship in accordance with established ethical guidelines. Contributions are specified according to the CRediT (Contributor Roles Taxonomy) as follows:

Conceptualisation: Milaim Berisha. Methodology: Milaim Berisha, Pablo Prieto Gonzalez. Formal analysis: Milaim Berisha. Investigation: Milaim Berisha, Pablo Prieto Gonzalez. Data curation: Milaim Berisha. Writing – original draft: Milaim Berisha, Pablo Prieto Gonzalez. Writing – review & editing: Milaim Berisha, Pablo Prieto Gonzalez. Supervision: Pablo Prieto Gonzalez.

All authors have critically reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

AI USE DISCLOSURE

In accordance with current publishing ethics and transparency recommendations, artificial intelligence (AI) tools were used solely to assist with translation and language editing, with the aim of improving clarity and readability. No AI tools were used in the generation of scientific content, including the study design, data collection, analysis, interpretation of results, or the formulation of conclusions. The authors retain full responsibility for the content of the manuscript and confirm its originality, integrity, and accuracy.

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