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Sport-Specific Neuromuscular Adaptations in Basketball and Netball Athletes: A Comparative Analysis of Strength, Sprint Speed, and Change-of-Direction Performance

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ABSTRACT

In this study, the sport-specific neuromuscular adaptations of basketball and netball players were investigated for the following parameters: maximal strength, sprint speed, change of direction (COD) performance and explosive strength. The design of the study was cross-sectional comparative with 60 athletes (30 basketball players and 30 netball players). Maximal strength was determined with front squat and deadlift 1RM, isometric mid-thigh pull, handgrip strength and rate of force development. Sprint performance was tested on 5 m, 10 m and 20 m and COD ability was tested with the deceleration measures, 505 test and 5-10-5 test. The basketball athletes exhibited higher absolute strength, higher sprint performance and higher countermovement jump height. Basketball players had significantly greater front squat strength ($p = .003$); the 20 m sprint time ($p = .004$) and the CMJ height ($p = .005$) were also favored in basketball players. Netball athletes, on the other hand, showed better performance in deceleration and COD, with superior deceleration time ($p = .004$) and 505 test performance ($p = .022$). The MANOVA results confirmed that there was a significant sport effect in all the performance domains, with the largest effect in COD/deceleration performance (partial $\eta^2 = .320$). In general, the results suggest unique neuromuscular characteristics among basketball and netball players and the benefits of sport-specific strength and conditioning programmes.

Keywords: Neuromuscular Adaptations; Basketball; Netball; Sprint performance; Change-of-Direction Speed.

1. Background of the Study

Intermittent team invasion sports (e.g. basketball, netball) have a high level of multidirectional activities at high intensity levels mixed with lower intensity or rest periods. These sports place a high demand on the use of both the aerobic and anaerobic energy systems, with sprinting, jumping and quick changes of direction occurring in a repetitive fashion. These sports are dynamic, requiring more than just physical qualities including strength, sprint speed and agility, they also demand, optimized neuromuscular coordination, to allow the efficient and effective execution of sport specific movements (Arede et al., 2025).

For example, in basketball, there are quick movements, constant positions, and high intensity that can be similar to sprinting for short distances. Aerobic capacity is important for players to sustain their endurance in the game, while anaerobic power is crucial for repeated sprints and jumps (Chumvangvapee et al., 2025). Neuromuscular adaptations, in particular, strength and power in muscle architecture, have been proven to play a significant role in improving sprint performance and preventing injuries in the context of team sports, such as basketball (Docampo-Blanco et al., 2026). Concurrently high-intensity strength training along with sprint-specific stimuli are consistently associated with improvements in maximal strength, muscle fascicle properties and sprint velocity needed to fulfill the intermittent high-intensity demand of the sport (Docampo-Blanco et al., 2026). Additionally, agility and change of direction (COD) abilities are essential in basketball, and enhancing these skills through targeted training strategies might be more difficult given the multidirectional and unpredictable nature of the game (Shiraz et al., 2024).

The netball is thus presented in this context and the sport has many of the physiological and biomechanical requirements of basketball but also unique movement patterns and positions that will impact the type of neuromuscular adaptations that are developed by the athlete. Both sports have quick interspersed sprints, a lot of jumping and changing direction but there's also differences in what the players are doing, the court and the rules which may account for differences in strength, speed and agility profiles. As an example, in both basketball and netball, the literature provides evidence that small-sided games training enhances intermittent high-intensity endurance, sprint acceleration, explosive power of the lower limbs and change of direction ability, demonstrating similarities in the physical attributes demanded of athletes in these invasion games (Liu et al., 2026).

Comparative analyses also reveal that in basketball, resistance training and high-intensity interventions produce beneficial effects on sprinting performance, which is important for training intensity and neuromuscular conditioning for accelerating and changing movement velocity (Murphy et al., 2023). These results are also applicable to youth basketball players who showed improved aerobic and anaerobic performance with speed endurance training, which positively affected sprint speed and lactate clearance needed for multiple sprints (Chumvangvapee et al., 2025). In a team sport, however, specific training adaptations for COD and functional ability could vary among athletes, as basketball has been found to have different correlations between sprint speed and COD relative to other sports (Czyznielewska et al., 2024). In summary, the physical characteristics of athletes in the literature of sport performance suggest the need for a well-rounded strength and conditioning regimen to improve maximal strength, sprint speed and change of direction agility to meet the demands of the complex and intermittent demands of basketball and netball. This comparison offers a solid base to explore sport-specific neuro-muscular adaptations and further enhance the knowledge of how customised training may improve performance and minimise injury risk for basketball and netball players.

2. Literature Review

Strength, sprint and change of direction (COD) performance in basketball and netball players have attracted a considerable amount of research interest because the ability of these attributes is important in optimizing sport-specific performance. Although basketball and netball share many common physiological and biomechanical requirements of the sport including acceleration, deceleration, multidirectional movement and power output, subtle ways in which their sports-specific neuromuscular adaptations may distinguish athletes. This review brings together the latest up-to-date literature that highlights the comparisons of the neuromuscular

mechanisms that influence strength, sprint speed and agility in basketball and netball athletes, focusing on training considerations, assessment of performance and implications of sport-specific adaptations.

2.1 Strength and Its Influence on Performance

Maximum strength in common compound movements like front squat and deadlift seems to be a good predictor and correlate with increase in basketball-specific sprint and jump movement. Strong positive correlation between maximal strength level and vertical jump height ($r = 0.85-0.91$), and strong inverse correlation between sprint times (5-20 m) and maximal strength level ($r = -0.71- -0.85$), have been obtained for male youth elite basketball players, indicating the importance of prioritizing strength training in these exercises to elicit higher scores for explosive performance capabilities (Warneke et al., 2022). Furthermore, strength training programs that include high-intensity exercises with sprint-related or biomechanically based movements produce multi-level benefits, improving muscle architecture, maximum strength and sprint performance simultaneously which are all important characteristics for sports (Docampo-Blanco et al., 2026).

The neuromuscular adaptations that occur in elite as compared to recreational athletes with resistance training also differ, with elite athletes having greater neural drive, more motor unit recruitment and more precise motor unit synchronization resulting in greater strength and power output. The resulting neural enhancements directly and immediately translate to sport-specific enhancements like sprinting speed and change of direction capacities (Aslam et al., 2025). This highlights the importance of very individual and progressive resistance training programmes, particularly at high-performance levels as found in basketball/Netball.

2.2 Sprint Speed Development and Training Modalities

Increased short-term sprint speed, especially acceleration and maximum velocity within short distances found in the game demands of basketball and netball can be achieved using traditional sprint training methods, as well as sport-specific methods. Overall, the linear and curved sprinting, and jumping abilities of 6-week preseason training in professional basketball players showed significant improvement, with minimal differences in position-specific adaptations (De Pedro-Múñez et al., 2025). Likewise, not just aerobic capacity (VO_2 max), but also average sprint times and lactate tolerance were enhanced in youth female basketball athletes after a period of speed endurance training, demonstrating the significance of holistic metabolic training for sprint speed development (Chumvangvapee et al., 2025).

Sprint interval training (SIT) and particularly programs with basketball-specific drills (SSIT) yield significant improvements in aerobic and anaerobic capacity, sprint times, change of direction speed, and vertical jumping ability in male basketball players. BSSIT seems to produce more sport-specific movement adaptation and transfer effects than generic SIT, providing an effective model to help develop basketball and netball athletes' movement qualities (Song et al., 2023).

Resisted sprint training (RST) activates heavy loads, resulting in more significant improvements in acceleration, maximal velocity and mechanical outputs of sprinting than light loads. It has been shown in football players but is relevant to basketball and netball players as they also require horizontal force production and sprint mechanics to be optimised, thus supporting the potential of RST to improve these aspects of players' performance (Alonso-Callejo et al., 2025). Furthermore, meta-analytical data of soccer players indicates that RST improves agility and COD, with vertical resisted sprinting demonstrating a tendency toward improvement compared to horizontal resistance training. These results may be applicable to basketball and netball training conditions, where rapid multidirectional movements are crucial (He et al., 2025).

2.3 Change-of-Direction and Agility Performance

Change of direction ability is a complex skill that involves neuromuscular coordination, reactive strength and quick force generation. A combination of resistance and plyometric training has been effective in enhancing COD, sprinting, jumping and isometric strength in male basketball players. The order of plyometric and resistance exercises (ascending or descending complex training) can optimize certain qualities of the neuromuscular system, but both have proved effective in improving COD and vertical power performance (Mikołajec et al., 2026).

Linear sprinting, especially unilateral protocols, combined with plyometrics, have shown to enhance youth male basketballers' explosive power, agility (including reactive agility), horizontal power, and repeated sprint ability. Unilateral plyometrics stimulate more generalized adaptations in the neuromuscular system and bilateral plyometrics better stimulate agility and horizontal power. The results highlight the importance of multi-modal plyometric and sprint training to simulate the demands of certain sports movements (Zhang & Li, 2026).

Task-specific neuromuscular evaluations show that a strong relationship can be established between jump height and maximal sprint performance, while the relationship between RSI and COD performance is more consistent. This differential relationship is reflected in the different neuromuscular strategies used during linear sprinting and multi-directional agility tasks, and is considered to be the basis for implementing specific testing to guide training emphases with basketball and netball players (Khumprommarach et al., 2026).

2.4 Neuromuscular Training and Performance Variability

Neuromuscular performance may be dynamic depending on the time of day, as in female basketball players who performed better when tested in the afternoon than in the morning when it came to jump and sprint performance. Circadian influences indicate the need to account for time-of-day when planning training and performance evaluation with regard to optimal neuromuscular output (Gaos et al., 2023).

Furthermore, training methods that include changing loads and contraction speeds (e.g., velocity-based training [VBT]) have been shown to have benefits for enhancing jump and COD performance, but benefits for maximal strength and sprint performance have been similar. Combining training strategies directed towards explosive intent and velocity of movement can lead to synergistic effects on the neuromuscular system, specifically for explosive demands of the sport (Behm et al., 2024; Wang et al., 2026).

2.5 Comparative Considerations for Basketball and Netball

There is limited comparative research between basketball and netball players when it comes to direct comparisons of the neuromuscular demands, however, given the similarities in the demands of both sports (explosive strength, fast sprints and dynamic COD capacities), the training methods shown to be effective in basketball could be used for netball. The focus on various types of plyometrics, complex strength power movements, strength output with resisted sprints and sport-specific speed and endurance work are well suited to the intermittent, high intensity and multi-dimensional nature of both sports (Wang et al., 2026).

To summarize, there is current evidence that maximal strength training, high intensity sprint interval training, resisted sprint training and complex plyometric training are effective strategies to facilitate basketball (and by extension, perhaps, netball) neuromuscular adaptations. Applying sport-specific and scientifically sound modalities to the training to optimize the athlete's explosive power, sprint acceleration, and COD performance improves on-court athletic skills. (Aslam et al., 2025).

3. Theoretical Framework

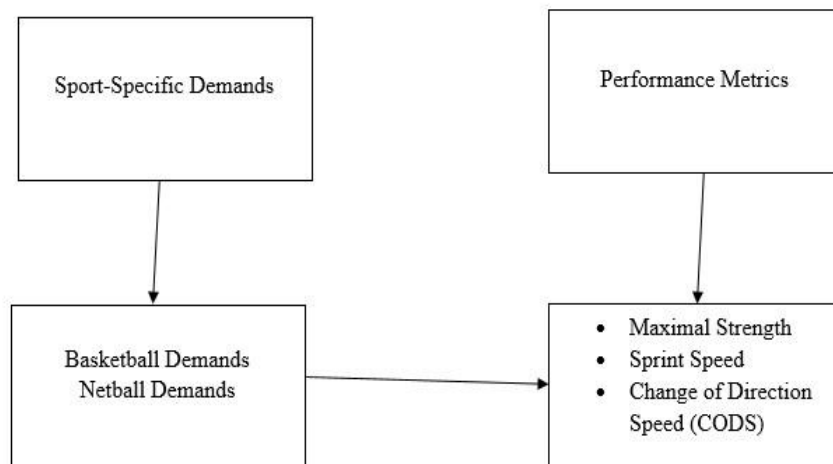
The theoretical model used for this research is based on neuromuscular physiology, motor control, neural plasticity and training specificity to explain sport-specific adaptations of

basketball and netball players. The neuromuscular system is a key component of this framework, as it serves to generate and control force via motor unit recruitment, firing rate, synchrony and co-activation of motor units. Subsequent exposure to resistance, sprint, and plyometric and multidirectional demands can lead to neural and muscle adaptations such as increased neural drive, decreased antagonist co-contraction, increased rate of force development, and changes in muscle architecture (Del Vecchio et al., 2024; Aslam et al., 2025; Casolo et al., 2026). These adaptations apply especially to basketball and netball, which involve many rapid, explosive movements such as jumping, accelerating, decelerating and rapidly changing direction. In this context, variations in sport requirements and training exposure could create different neuromuscular patterns that are associated with differences in strength, sprint and change-of-direction performance.

Motor control theory is also included into the framework, under the concept of task-specific muscle synergies, which are groups of muscles that are organized to act together in order to perform complex movement tasks. Athletes do not use individual muscle movements, but rather they fine-tune the timing, force, and coordination of the muscle synergies that they are already using in relation to the mechanical and technical demands of the action. The results of plyometric and sport-specific movement studies show that neuromuscular activation patterns are reorganized throughout the pre-activation, force absorption, and propulsion phases of the movement as eccentric vs. concentric demands change (Zhao et al., 2026). Likewise, basketball shooting has been demonstrated to involve upper and lower-limb and trunk activation adjustments, which occur in relation to task complexity (Fan et al., 2024). The results of this study confirmed the hypothesis that the neuromuscular adaptations in basketball and netball are very task dependent, allowing players to enhance efficiency and capacity for movement under rapidly changing competitive demands.

Lastly, the mechanisms for developing these neuromuscular adaptations are contained in the principle of training specificity. In addition to factors of load and velocity of muscular contractions, the intent to produce force can also affect adaptations; higher rate coding and motor unit recruitment occurs with explosive force intent even when movement velocity is limited (Behm et al., 2024). Resistance, plyometric, and sprint training thus play a role in the performance, enhancing the maximal force production, the reactive strength, the stretch-shortening cycle efficiency, the horizontal force application, and the rapid neuromuscular coordination (Hung et al., 2025; Del Vecchio et al., 2024). Together, this model suggests that measures of strength, sprint ability, and change-of-direction ability are observable performance traits of sport-specific underlying adaptations of the neuromuscular system. It therefore offers a theoretical framework for the comparison of basketball and netball athletes and as a basis for understanding potential differences in neural drive, motor unit behaviour, muscle synergy organisation and capacity to produce forces due to the different movement demands and training exposures that occur in these two sports.

4. Conceptual Model



5. Research Objectives

- To compare upper- and lower-body maximal strength characteristics between basketball and netball athletes.
- To compare linear sprint performance and acceleration characteristics between basketball and netball athletes.
- To compare change-of-direction speed and deceleration/braking characteristics between basketball and netball athletes.
- To compare explosive strength and jump-related neuromuscular performance.

6. Research Questions

1. Are there significant differences in upper- and lower-body maximal strength characteristics between basketball and netball athletes?
2. Are there significant differences in linear sprint performance and acceleration characteristics across defined sprint distances between basketball and netball athletes?
3. Are there significant differences in change-of-direction speed and deceleration/braking characteristics between basketball and netball athletes?
4. Are there significant differences in neuromuscular performance characteristics, including explosive strength and jump-related performance, between basketball and netball athletes?

7. Research Methodology

The design of this study was cross sectional, comparative and sport specific in nature, looking at the neuromuscular adaptations in basketball and netball players. Sixty athletes took part (30 basketball and 30 netball). Main variables evaluated were maximal strength, sprinting performance, change of direction speed, deceleration ability and explosive neuromuscular performance.

Player-monitoring, observational and movement-analysis techniques were used for the assessment of sport-specific demands. The vertical-jump frequency, contact frequency, total running distance, accelerations, decelerations and changes of direction were all measured for basketball. Netball measurements consisted of positional zoning, pivot frequency, pivot angular velocity and characteristics of acceleration and deceleration.

Front squat and deadlift 1RM were used as a tool to assess maximal strength, and isometric strength was evaluated by using the isometric mid-thigh pull (IMTP) and handgrip strength tests. Rate of force development was determined for two time periods: 0–100 and 0–200 ms. Explosive lower-body performance was quantified by countermovement jump performance, including jump height, peak eccentric and concentric forces.

The sprint performances were assessed over 5 m, 10 m and 20 m using electronic timing gates, as well as the maximum sprint velocity and time to maximum sprint velocity. The change of direction and deceleration performance was evaluated by deceleration time and distance, angular velocity and re-acceleration time, 505 test and Pro Agility 5-10-5 test. The shorter the completion times the better.

Data were evaluated by using descriptive and inferential statistics and $p < .05$ was the criterion for statistical significance. The mean differences, 95 % confidence interval, Cohen's d and MANOVA were used to examine the difference between groups. Correlations (Pearson or Spearman) were used to analyse the relationships between sport specific demands and performance; and multiple regression was conducted to determine the factors that predict 505 changes of direction performance in basketball and netball athletes.

8. Data Analysis

Table 8.1. Participant Characteristics

Characteristic	Basketball (n=30) Mean $\pm$ SD	Netball (n=30) Mean $\pm$ SD	p-value
Age (years)	22.6 $\pm$ 2.4	22.3 $\pm$ 2.2	.616
Height (cm)	184.2 $\pm$ 6.5	179.8 $\pm$ 6.8	.013
Body mass (kg)	80.5 $\pm$ 8.8	76.3 $\pm$ 7.2	.048
Training age (years)	6.8 $\pm$ 2.3	6.5 $\pm$ 2.1	.600
Weekly training (h)	8.9 $\pm$ 1.7	8.6 $\pm$ 1.8	.510
Playing experience (years)	8.1 $\pm$ 2.6	7.8 $\pm$ 2.4	.644

There were no significant differences within the groups of basketball and netball athletes for age, training age, weekly training amount or playing experience (all $p > .05$). Athletes on the basketball team were taller ($p = .013$) and heavier ($p = .048$) than were athletes on the netball team. Since the height and body mass were significantly different amongst groups, the body mass should be taken into consideration as a covariate or strength measures should also be adjusted for body mass. This is based on the reasoning in analysis model.

Table 8.2. Sport-Specific Match Demands

Sport	Sport-Specific Demand	Mean $\pm$ SD	Range
Basketball	Vertical jumps/game	23.8 $\pm$ 5.4	14–35
Basketball	Full-contact duels/game	11.6 $\pm$ 3.9	5–20
Basketball	Contact intensity (1–5)	3.8 $\pm$ 0.7	2.3–5.0
Basketball	Distance covered/game (m)	5,280 $\pm$ 640	4,110–6,480
Basketball	High-intensity accelerations/game	52.3 $\pm$ 11.2	31–73
Basketball	Decelerations/game	49.1 $\pm$ 10.4	29–68
Basketball	COD events/game	43.2 $\pm$ 9.1	27–61
Netball	Time within assigned zones (%)	86.2 $\pm$ 5.9	73.4–95.1
Netball	Pivots/game	38.5 $\pm$ 8.7	23–56
Netball	Peak pivot angular velocity ($^{\circ}$ /s)	462 $\pm$ 52	365–561
Netball	Mean deceleration (m/s^2)	-3.70 $\pm$ 0.50	-2.8 to -4.7
Netball	Stopping time (s)	0.58 $\pm$ 0.08	0.44–0.74

Basketball players showed a high frequency of jumping, accelerating, decelerating and changing direction movements during a basketball match. Rapid pivots were observed at high frequency

and substantial deceleration demands were found among netball athletes. These descriptive outcomes indicate there are separate sport-specific movement profiles within the two groups.

Table 8.3. Reliability of the Performance Testing Battery

Test	ICC	95% CI	CV (%)	SEM	Interpretation
CMJ height	.94	.89–.97	4.1	1.3 cm	Excellent
CMJ peak force	.92	.86–.96	4.8	72 N	Excellent
IMTP peak force	.95	.91–.97	3.9	83 N	Excellent
RFD 0–100 ms	.86	.77–.92	7.8	485 N/s	Good
5 m sprint	.90	.83–.94	3.2	0.03 s	Excellent
10 m sprint	.93	.88–.96	2.7	0.04 s	Excellent
20 m sprint	.95	.91–.97	2.3	0.05 s	Excellent
505 test	.91	.85–.95	3.0	0.05 s	Excellent
5-10-5 test	.92	.86–.96	2.8	0.08 s	Excellent

Relative reliability of the test battery was good to excellent (ICC range .86 to .95). All CVs were below threshold (8%). The other performance tests showed little variation and were within a tolerable range for the data set and were slightly more variable for RFD.

Table 8.4. Comparison of Maximal Strength and Force Characteristics

Variable	Basketball Mean $\pm$ SD	Netball Mean $\pm$ SD	Mean Difference	95% CI	p	Cohen's d
Front squat 1RM (kg)	122.4 $\pm$ 17.8	109.1 $\pm$ 15.9	13.30	4.58 to 22.02	.003	0.79
Relative squat (kg/kg)	1.52 $\pm$ 0.20	1.43 $\pm$ 0.19	0.09	–0.01 to 0.19	.079	0.46
Deadlift 1RM (kg)	157.8 $\pm$ 21.6	143.5 $\pm$ 19.8	14.30	3.59 to 25.01	.010	0.69
Relative deadlift (kg/kg)	1.96 $\pm$ 0.23	1.88 $\pm$ 0.22	0.08	–0.04 to 0.20	.174	0.36
IMTP peak force (N)	2,385 $\pm$ 338	2,192 $\pm$ 315	193	24 to 362	.026	0.59
Relative IMTP (N/kg)	29.7 $\pm$ 3.8	28.7 $\pm$ 3.6	1.00	–0.91 to 2.91	.300	0.27
Handgrip force (kg)	47.8 $\pm$ 6.1	44.6 $\pm$ 5.8	3.20	0.12 to 6.28	.042	0.54
RFD 0–100 ms (N/s)	8,650 $\pm$ 1,450	7,790 $\pm$ 1,390	860	126 to 1,594	.022	0.61
RFD 0–200 ms (N/s)	6,820 $\pm$ 1,110	6,250 $\pm$ 1,030	570	17 to 1,123	.044	0.53

There was a significant difference between both groups in terms of absolute strength of front squat, absolute strength of deadlift, absolute peak force in IMTP, handgrip force and RFD between the two groups of basketball athletes and netball athletes. The largest one was found for front squat 1RM ($d = 0.79$) which indicated a moderate to large effect. There were no statistical differences between groups for relative squat, relative deadlift and relative IMTP force, however. This is an interesting finding in that it indicates that players of basketball may be stronger in absolute terms, but it may not be that much stronger than they are relative to their body size.

Table 8.5. Linear Sprint Performance

Variable	Basketball Mean $\pm$ SD	Netball Mean $\pm$ SD	Difference	95% CI	p	Cohen's d
5 m time (s)	1.08 $\pm$ 0.06	1.13 $\pm$ 0.07	-0.05	-0.08 to -0.02	.004	-0.77
10 m time (s)	1.83 $\pm$ 0.09	1.90 $\pm$ 0.10	-0.07	-0.12 to -0.02	.006	-0.74
20 m time (s)	3.17 $\pm$ 0.13	3.28 $\pm$ 0.15	-0.11	-0.18 to -0.04	.004	-0.78
Peak velocity (m/s)	7.72 $\pm$ 0.39	7.42 $\pm$ 0.41	0.30	0.09 to 0.51	.005	0.75
Time to peak velocity (s)	2.74 $\pm$ 0.23	2.89 $\pm$ 0.25	-0.15	-0.27 to -0.03	.019	-0.62

The findings show that there was a significant difference between the basketball and the netball players and the basketball players performed significantly better than the netball players when it comes to sprint performance. The 5 m, 10 m, and 20 m times were significantly lower ($p = .004$, $.006$, and $.004$, respectively) and peak velocity was significantly greater compared to the other athletes. They also had a peak velocity that was much earlier ($p = .019$). The effect size was moderate to large (Cohen's $d = -0.62$ to -0.78), indicating moderate to large differences between the two groups in terms of speed and acceleration.

Table 8.6. Change-of-Direction and Deceleration Performance

Here, lower times and shorter deceleration distances indicate better performance.

Variable	Basketball Mean $\pm$ SD	Netball Mean $\pm$ SD	Difference	95% CI	p	Cohen's d
Deceleration time (s)	0.63 $\pm$ 0.07	0.58 $\pm$ 0.06	0.05	0.02 to 0.08	.004	0.77
Deceleration distance (m)	2.35 $\pm$ 0.31	2.12 $\pm$ 0.28	0.23	0.08 to 0.38	.004	0.78
COD angular velocity ($^{\circ}$ /s)	418 $\pm$ 44	447 $\pm$ 46	-29	-52 to -6	.015	-0.64
Re-acceleration time (s)	0.74 $\pm$ 0.08	0.70 $\pm$ 0.07	0.04	0.00 to 0.08	.044	0.53
505 test (s)	2.43 $\pm$ 0.12	2.36 $\pm$ 0.11	0.07	0.01 to 0.13	.022	0.61
5-10-5 test (s)	4.71 $\pm$ 0.18	4.59 $\pm$ 0.17	0.12	0.03 to 0.21	.010	0.69

The findings indicate that there are statistically significant differences between the performances of Basketball and Netball players in their change of direction and Deceleration performance. Basketball players' deceleration time and distance were significantly higher and COD angular velocity was significantly higher for netball players. In addition, basketball players had longer times to re-accelerate and slower performance in the 505 test and 5-10-5 test ($p < .05$). The effect sizes were of moderate to large size (Cohen's $d = 0.53$ – 0.78), reflecting that there were significant differences between the two groups.

Table 8.7. CMJ and Explosive Neuromuscular Performance

Variable	Basketball Mean $\pm$ SD	Netball Mean $\pm$ SD	Difference	95% CI	p	Cohen's d
CMJ height (cm)	43.6 $\pm$ 5.2	39.8 $\pm$ 4.8	3.80	1.21 to 6.39	.005	0.76

Peak eccentric force (N)	2,010 ± 282	1,875 ± 260	135	-5 to 275	.059	0.50
Peak concentric force (N)	2,235 ± 305	2,070 ± 290	165	11 to 319	.036	0.55

The findings revealed that the basketball players' CMJ height was significantly higher ($p = .005$) and the peak concentric force was significantly greater ($p = .036$) than that of the netball players with moderate to large effect sizes ($d = 0.76$ and 0.55). There was a moderate effect size ($d = 0.50$), but not a statistically significant difference ($p = .059$) between the peak eccentric force. Basketball players, in general, exhibited greater explosive jumping ability and concentric force production.

Table 8.8. Overall MANOVA Results

Performance Domain	Wilks' Λ	F	df	p	Partial η^2
Maximal strength/force	.710	3.61	6, 53	.004	.290
CMJ/neuromuscular	.820	4.10	3, 56	.010	.180
Sprint performance	.760	3.41	5, 54	.010	.240
COD/deceleration	.680	4.16	6, 53	.002	.320

The overall MANOVA indicated that there were significant differences between the performance of basketball players and netball players on all performance domains. Significant effects were found for maximal strength/force (Wilks' $\Lambda = .710$, $p = .004$), CMJ/neuromuscular performance ($\Lambda = .820$, $p = .010$), sprint performance ($\Lambda = .760$, $p = .010$), and COD/deceleration ($\Lambda = .680$, $p = .002$). Partial eta-squared values ranged between .180 and .320, indicating moderate to large effects and the greatest difference was for COD/deceleration performance.

Table 8.9. Associations between Sport-Specific Demands and Performance

Sport	Sport-Specific Demand	Performance Outcome	r / p	95% CI	p
Basketball	Jump frequency	CMJ height	.58	.28 to .78	<.001
Basketball	Jump frequency	RFD 0–100 ms	.46	.12 to .70	.011
Basketball	Acceleration frequency	5 m sprint time	-.52	-.74 to -.20	.003
Basketball	COD frequency	505 time	-.49	-.72 to -.16	.006
Basketball	Contact frequency	Deadlift 1RM	.44	.09 to .69	.015
Netball	Pivot frequency	505 time	-.55	-.76 to -.24	.002
Netball	Pivot angular velocity	COD angular velocity	.51	.18 to .74	.004
Netball	Deceleration magnitude	505 time	-.57	-.77 to -.26	.001

Moderate to strong positive associations were found between the sport-specific demands and the outcomes of performance in both sports. In basketball, jump frequency was positively correlated with the CMJ height and early RFD and negatively correlated with acceleration frequency and COD frequency with the 5 m sprint and 505 times respectively. There was a positive relationship between contact frequency and 1RM of deadlift. Pivot frequency and deceleration magnitude were negatively related to 505 time in netball, while COD angular velocity was positively related to pivot angular velocity. Overall, the results indicate that there are meaningful relationships between sport specific movement demands and related physical performance characteristics.

Table 8.10. Multiple Regression Predicting 505 Performance

Basketball Athletes Predictor	Standardized β	p
COD frequency	-.31	.049
Deceleration frequency	-.34	.031
RFD 0–100 ms	-.29	.047

Body mass	.16	.286
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Model: $R^2 = .48$; Adjusted $R^2 = .40$; $F(4,25) = 5.77$; $p = .002$

The regression model was statistically significant, accounting for 48% of the variance of the outcome ($R^2 = .48$, adjusted $R^2 = .40$, $p = .002$). COD frequency ($\beta = -.31$, $p = .049$), deceleration frequency ($\beta = -.34$, $p = .031$), and RFD 0–100 ms ($\beta = -.29$, $p = .047$) were significant predictors, whereas body mass was not ($\beta = .16$, $p = .286$). In general, the higher the COD, deceleration and RFD, the better the performance outcome was.

Table 8.10.1

Netball Athletes Predictor	Standardized β	p
Pivot frequency	-.33	.035
Pivot angular velocity	-.28	.048
Deceleration magnitude	-.39	.014
RFD 0–100 ms	-.21	.117

Model: $R^2 = .54$; Adjusted $R^2 = .47$; $F(4,25) = 7.34$; $p < .001$

The overall regression model was statistically significant, with an R^2 of .54, adjusted R^2 of .47 and p value of $< .001$. Pivot frequency ($\beta = -.33$, $p = .035$), pivot angular velocity ($\beta = -.28$, $p = .048$), and deceleration magnitude ($\beta = -.39$, $p = .014$) were significant predictors, while RFD 0–100 ms was not significant ($\beta = -.21$, $p = .117$). Overall, pivot and deceleration demand best predicted performance.

9. Discussion

The results indicate that the basketball and netball athletes exhibited evident neuromuscular differences that reflect the differences in the demands of the specific sport, further confirming that there are indeed sport specific demands that affect strength, sprinting and change of direction (COD) performance. In terms of absolute maximal strength, the basketball player group showed significantly higher front squat values than the FMF group (122.4 ± 17.8 kg vs. 109.1 ± 15.9 kg), which is consistent with previous studies that found the front squat a predictor of explosive performance in basketball (Warneke et al., 2022). This benefit can be attributed to basketball's repeated need for jumping, sprinting and producing force, which promotes neuromuscular adaptations in force production (Docampo-Blanco et al., 2026). But these are not great differences in relative strength, and the fact that the sport of basketball showed a higher absolute strength despite this, highlights the fact that body size does have a significant effect on absolute strength (Pantazis et al., 2025). Basketball athletes also exhibited significantly faster 20 m sprint times (3.17 ± 0.13 s vs. 3.28 ± 0.15 s) and higher CMJ height, which aligns with previous research reporting improvements in sprinting and jumping skills with increases in strength in basketball players (De Pedro-Múñez et al., 2025; Cabarkapa et al., 2024). The findings suggest that the training of repeated exposure to high force accelerations and jumping movements might lead to increase linear speed and explosive power.

Netball players, on the other hand, performed better with respect to COD and deceleration, with quicker deceleration times and higher 505 agility scores. This is related to the movement requirements of netball, where players must frequently stop, pivot and change direction rapidly within the positional constraints of the game (Mathe et al., 2023). A key aspect of effective deceleration is eccentric force production, along with neuromuscular control and momentum absorption and redistribution (Cabarkapa et al., 2024). The large partial η^2 for COD and deceleration performance (.320) also indicates the specificity of these adaptations. Furthermore, the regression models accounted for 48% of the variance in 505 performances by basketball players and 54% by netball players, highlighting that neuromuscular qualities are of importance to COD ability. The results from this study align with the previous studies that showed that

reactive strength and eccentric force absorption are significant factors in predicting change of direction performance (Khumprommarach et al., 2026; Mikołajec et al., 2026). In general, the results indicate that basketball training is mainly focused on maximal strength, linear speed, and explosive power, while netball training focuses on the development of eccentric control, deceleration, and multidirectional movement capacity. Therefore, the training and assessment of these different neuromuscular demands should be sport-specific.

10. Conclusion

The authors conclude that there are sport-specific neuromuscular performance profiles between the basketball and netball athletes. The absolute strength, rate of force development, linear sprint speed and jump performance of the basketball athletes were higher than their netball counterparts, while the deceleration and change of direction qualities of the netball athletes were higher. Importantly, the lack of significant differences among several relative strength measures suggests that some of the basketball advantage in absolute strength may be the result of the larger body mass and not just sport. The results of the study substantiate all four research objectives and show that direction and size of difference are dependent on the performance quality being studied.

The results also indicate that neuromuscular development in team-sport athletes should not be considered as a general characteristic. Adaptations, on the other hand, seem to relate to the needs of moving within the sport context that is repeatedly experienced. It seems that basketball has a greater focus on high absolute acceleration, jumping and high absolute force production, while netball has a greater emphasis on braking, pivoting and rapid change of direction. Strength and conditioning programs should therefore be tailored to the individual sport's neuromuscular needs and not all three acronyms applied for a basketball player and netball player would be the same.

11. Implications of the Study

11.1 Social Implications

The results from a social and athlete-development point of view back the notion of sport-specific and individualized conditioning programs instead of regarding athletes of similar court sports as physically identical. Clarification of the differing requirements of basketball and netball may assist coaches, clubs and sporting organisations to offer suitable physical-development opportunities. This personalized training could also help players become more competitive and safer to play by enhancing their ability to tackle the jumping, sprinting, stopping and changing direction skills they will be exposed to in games.

11.2 Academic Implications

On an academic level, the study adds to the current limited data available for comparisons of the neuromuscular features of basketball and netball within a common research study. The results show that maximal strength, speed of sprint and explosive performance and COD capacity should be considered as related, but different, aspects of the neuromuscular system. There are also large multivariate differences, which support the use of multidimensional testing batteries instead of the one-dimensional approach of a single athletic performance measure. These results could be a starting point for future studies on the mechanisms of sport-specific neuromuscular adaptation.

11.3 Practical Implications

The results suggest that for strength and conditioning coaches, basketball players could benefit from the continued focus on maximal strength, explosive force production, jumping, and short distance acceleration, whereas the conditioning of netball players should be given a focus on eccentric braking capacity, deceleration control, pivoting, COD technique and rapid re-

acceleration. The results should not however be seen as a justification that basketball athletes do not need COD training, or that netball athletes do not need strength and sprint development. Rather, training should emphasize all the big physical traits, and further focus on areas of weakness and on competition.

12. Limitations of the Study

There are a number of limitations to this study. First, it is only an association that is identified through the cross-sectional design, and not a cause-effect relationship between participation in basketball or netball and the observed differences in neuromuscular characteristics. Moreover, the small number of athletes (30 per sport) $n=60$ in total) reduces the generalizability and weakens the strength of the subgroup and regression analyses. Absolute strength and force measures may also have been affected by differences in height and weight between groups, even when using relative strength.

The study could not fully consider the influence of playing position, tactical role, competition level, match exposure or training phase, which can impact on neuromuscular performance. A sport-specific requirement was measured using a combination of observational and objective assessment, and this may lead to measurement variability. Finally, testing was done at one point in time, so there was no capture of changes due to fatigue or seasonal training and competition demands. Larger samples and longitudinal designs over multiple teams and phases of competition are recommended for future studies.

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