Comparison of Muscular Strength, Speed, Flexibility and Agility among Professional and Sub-Professional Players of Basketball

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Abstract

Physical fitness components are widely unspoken, such as the ability to carry out daily tasks with vigor and alertness, maintain energy reserves to enjoy leisure activities and respond effectively to unforeseen challenges. The primary purpose of this study was to compare muscular strength, speed, flexibility, and agility among sub-professional basketball players. A total of 60 (60) subjects participated in this study, which were basketball game players and citizens of Pakistan. The nature of the study was quantitative in approach; all the subjects were selected randomly when they were attending national training camp. The Statistical Package of Social Sciences (SPSS) version 26 was used to analyze the data for descriptive statistics (mean, standard deviation) and inferential statistics tools (independent t-test and ANOVA). The mean and SD of professional basketball players was 5.60±.01, and the mean and SD of sub-professional basketball players was 6.72±.03. Significant differences were observed in both groups of sub-professional players. Professional players reported higher mean scores in muscular strength, flexibility and agility than professional players. This showed that muscular strength, flexibility, and agility were reasonable compared to professional players. At the same time, the professional players of basketball reported higher mean scores in speed than professional players of basketball.

Keywords: Basketball, Muscular Strength, Speed, Flexibility, Agility.

Introduction

Sports science focuses on innovating techniques and training methods to enhance athletes' or teams' performance at elite levels (Saadati, 2023). Experts in movement learning have identified three stages in mastering basketball skills: the cognitive, practice, and automatic stages (Portaz et al., 2024). In the cognitive stage, the player creates a mental image of the skill, often through

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demonstrations or explanations from a coach or teacher (Memmert & Leiner, 2023). In the Automatic stage, the player can perform the skills effortlessly, as they become second nature and can be executed at game speed. Consequently, conditioning drills closely related to basketball should be practiced at game speed to achieve automation. Proficiency in skillful performance is closely tied to specialized physical motor abilities. The perfection of skillful execution depends significantly on developing qualities such as muscular power, endurance, agility, and more (Portaz et al., 2024). The level of a player's skillful performance is often measured by their ability to acquire and enhance these physical abilities. As such, improving these unique physical attributes is vital for achieving excellence in basketball. The interplay between physical fitness and skillful execution underscores the importance of a well-rounded training regimen that prioritizes physical and technical development (Singh & Parmar, 2023).

Physical fitness components are widely understood as the ability to carry out daily tasks with vigor and alertness, maintaining ample energy reserves to enjoy leisure activities and respond effectively to unforeseen challenges (Muhammad et al., 2024). These components encompass various aspects of health and performance, including muscular endurance, cardiorespiratory endurance, muscular strength, muscular power, speed, agility, flexibility, reaction time, balance, reaction time, and body composition (Raj & Maniazhagu, 2022). Together, they contribute to overall physical well-being and readiness to engage actively in routine and unexpected daily life and recreation demands. Muscular strength is a crucial component of physical fitness, characterized by the ability of muscles or muscle groups to generate maximum force in a single effort (Smith et al., 2014). It is the foundation for all physical activities and sports, enabling running, jumping, climbing, throwing, and hitting (Collins & Staples, 2017). Without muscular strength, other aspects of physical fitness lose their significance. The relationship between muscular strength and performance is direct, enhancing one's ability to engage in daily activities and effectively confront challenges confidently (Volaklis et al., 2015). Furthermore, developing muscular strength can reduce daily discomfort and improve overall comfort and quality of life.

The development of muscle strength can be attributed to various factors, including initial strength levels, training methods, and genetic predispositions (Carbone, 2020). Muscular strength is cultivated through resistance activities such as weightlifting and stair climbing, which promote strength gains (Toigo & Boutellier, 2006). These exercises stimulate muscle hypertrophy, leading to increased force production capabilities. Improved muscular strength contributes significantly to overall physical performance, enhancing an individual's ability to excel in daily activities and meet physical demands (American College of Sports Medicine, 2009). Building strength supports functional movements and plays an essential and crucial role in enhancing other physical and performance attributes, positively impacting the overall quality of life. The quality and magnitude of muscular strength depend on the condition and structure of the muscles involved. Healthy and robust muscles produce more muscular contractions, enhancing performance and reducing injury risks in sports and daily activities (Artero et al., 2012; Fisher et al., 2011).

Sprint performance and frequent changes in direction are essential for basketball players, contributing significantly to their overall performance on the court. Yáñez-García et al. (2020) conducted a study that demonstrated significant improvements in the speed and agility of professional basketball players following an 8-week heavy resistance training program, performed 3 to 4 times per week. This highlights the effectiveness of resistance training in enhancing the physical capabilities necessary for high-level basketball performance (Yáñez-García et al., 2020).

Flexibility is a central and solid component of health-related physical fitness, defined as the ability of muscles and joints to move through their full range of motion without pain or discomfort

(Pryimakov et al., 2016). This quality enables individuals to bend, twist, turn, or lunge in various directions using muscle extension and flexion without harming bones, muscles, or surrounding ligaments. Improving flexibility contributes to enhanced work performance, reduced susceptibility to muscle injuries and soreness, and overall better health (Baumgärtner et al., 2015). Several factors influence flexibility, including body composition, gender, physical activity level, and age. Individuals with lower body fat percentages typically exhibit greater flexibility. Women generally tend to be more flexible than men of similar age groups, and physically active individuals tend to be more flexible than those who are inactive. Flexibility peaks during pre-adolescence and can decline with age, although regular stretching, bending, twisting, and relaxation exercises can help maintain flexibility throughout life (Chodzko-Zajko, 2014). The sit and reach test is widely used to assess flexibility, providing a practical measure of how far an individual can reach forward while seated, which reflects the flexibility of the lower back and hamstring muscles (Nishi et al., 2019).

Agility is the ability to swiftly react to changes in direction while maintaining speed and precision. Athletes who can "stop on a dime" demonstrate their capability to sprint at full speed and quickly change direction without losing velocity. This skill requires strength, power, balance, and coordination, enabling seamless transitions between movements performed at maximum velocity. Precision in executing these movements is crucial for achieving success in dynamic sports such as basketball, football, hockey, and handball (Homman, 2002). In sports and activities, agility involves efficiently moving the body or its segments through space or on the ground. It demands coordinated actions from major muscle groups to execute rapid and accurate changes in direction. Both natural ability and targeted training are essential for developing agility, which plays a pivotal role in disciplines like gymnastics, high jump, and aerobic exercises, as well as team sports such as basketball, football, kho-kho, handball, and Kabbadi (Yobu, 2010). Enhanced agility enhances athletic performance and reduces the risk of injury by facilitating controlled and swift movements in various sporting scenarios.

Therefore, comparing professional and sub-professional players often extends beyond just skill level. Professional players frequently have access to top-tier facilities, specialized training programs, and comprehensive support staff (such as trainers, nutritionists, and sports psychologists) that might be less readily available to professional athletes. Furthermore, the intensity and level of competition in professional leagues are usually higher compared to professional. When comparing attributes like muscular strength, speed, flexibility, and agility, these differences in access to resources, training environments, and levels of competition often contribute to disparities in the comparison of sub-professional basketball players. Professional players might have more refined and enhanced physical attributes due to their exposure to elite training programs and a more competitive playing environment. In this research, exploring how various factors affect the physical characteristics of basketball players across different tiers of competition can provide valuable insights into the nuanced differences among professional and sub-professional athletes. By examining body type, gender, physical activity, and age, we can better understand how these variables influence flexibility and overall physical fitness. Professional basketball players, who engage in rigorous training and maintain strict fitness routines, typically exhibit superior flexibility to their professional counterparts. This higher level of flexibility is crucial for their performance, injury prevention, and longevity in the sport. In contrast, professional players may have a different level of access to comprehensive training programs, resulting in lower flexibility and potentially higher susceptibility to injuries.

This study aimed to assess and compare the levels of muscular strength, speed, flexibility, and agility among Sub-professional basketball players within the locality. By examining these physical attributes, the research sought to provide valuable insights into the differences in athletic capabilities between players at different skill levels. This comparative analysis is crucial for understanding the specific training needs and performance benchmarks for aspiring basketball athletes in Punjab and Pakistan. Furthermore, the findings of this study are intended to benefit basketball players actively engaged in the sport within Punjab and beyond. Coaches and trainers can tailor training programs more effectively by identifying the strengths and areas for improvement in muscular strength, speed, flexibility, and agility among sub-professional players. This personalized approach can enhance player development and performance, ultimately contributing to the overall competitiveness and success of Pakistan's basketball teams at regional and national levels.

Methodology

Research Design

Design a study that enables researchers to strategically plan and implement the investigation to optimize the likelihood of achieving the intended outcomes. This section includes the research population and sample size, a tool for the data collection, statistical techniques, and a conclusion as well. The research aims to determine and investigate the comparison of muscular strength, speed, flexibility and agility between professional and sub-professional basketball players. For this purpose, health-related components, muscular strength, flexibility and skills-related components, speed and agility are independent variable constructs to check the comparison of these fitness components between professional and sub-professional basketball players.

Population

A population consists of individuals who meet specific criteria, representing the whole group to which the research findings can be applied. Professional and sub-professional basketball players of Punjab were chosen randomly for this study when attending their national camp. Sixty (60) subjects were selected for this study, divided randomly into two groups (experimental and control group) of thirty each.

Inclusion of Study

- Only professional and sub-professional basketball players were included in this study.
- The subjects between 20 and 26 were included in this study.
- The citizens of the province of Punjab and professional and sub-professional basketball players were included in this study.

Exclusion of Study

- Other sports players were not included in this study.
- Basketball players are older than 26 years.
- Female basketball players were omitted.

Selection of Variable

The researcher reviews the literature comparing muscular strength, speed, flexibility, and agility between professional and sub-professional basketball players using different search engines, search papers, and books. The following variables were selected. The independent variable is the

variable that is intentionally varied or manipulated by the researcher to observe its effect on the dependent variable, serving as the presumed cause in an experimental study. In this research, Professional and sub-professional basketball players were selected as independent variables. The dependent variable is the variable in an experiment that is influenced by the changes in the independent variable and is the outcome or response being measured. The researcher used muscular strength, speed, flexibility and agility as dependent variables in this research.

Table 1: Selection of instrumental for data collection

Sr. No.	Criterion Variable	Test Item	Unit of Measurement
1	Muscular strength	Dynamometer	Kilogram
2	Speed	40 m dash	Second
3	Flexibility	Sit and reach	Centimeter
4	Agility	Agility t-test	Second

Procedure

A grip dynamometer is utilized to assess grip strength, with tests conducted on both the right and left hands. The device's concave edge is positioned between the first and second joints of the fingers, oriented towards the dial. The subject can perform any motion while squeezing the instrument, as long as they avoid contacting any objects with their fist. The most typical motion observed is the uppercut.

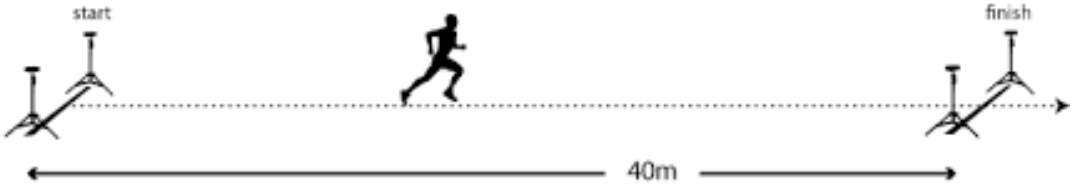
Speed 40 m dash

Purpose: The purpose of the test was to measure the speed of an individual.
Equipment: Stopwatch, Scorecard.

Procedure

The subject took a position behind the starting line. The starter used the command, “ready” and “go”. The latter was accompanied by a downward sweep of the arm as a signal to the timer. The subjects ran across the finish line. The standing start method was adopted for this purpose. The stopwatch is started on the command “go” and stopped when the runner crosses the finish line.

Figure 1: Position of subject



Flexibility Sit and Reach Test

Purpose: The purpose of this test to measure the flexibility of subject.
Equipment: Sit and reach box, scorecard.

Procedure

This test involves sitting on the floor with legs stretched out straight ahead. Shoes should be removed. The soles of the feet are placed flat against the box. Both knees should be locked and pressed flat to the floor - the tester may assist by holding them down. With the palms facing downwards, and the hands on top of each other or side by side, the subject reaches forward along the measuring line as far as possible. Ensure that the hands remain at the same level, not one reaching further forward than the other. After some practice reaches, the subject reaches out and holds that position for at least one-two seconds while the distance is recorded. Make sure there are no jerky movements. The score is recorded to the nearest centimeter or half inch as the distance reached by the hand. Some test versions use the level of the feet as the zero mark, while others have the zero mark 9 inches before the feet. There is also the modified sit and reach test which adjusts the zero mark depending on the arm and leg length of the subject.

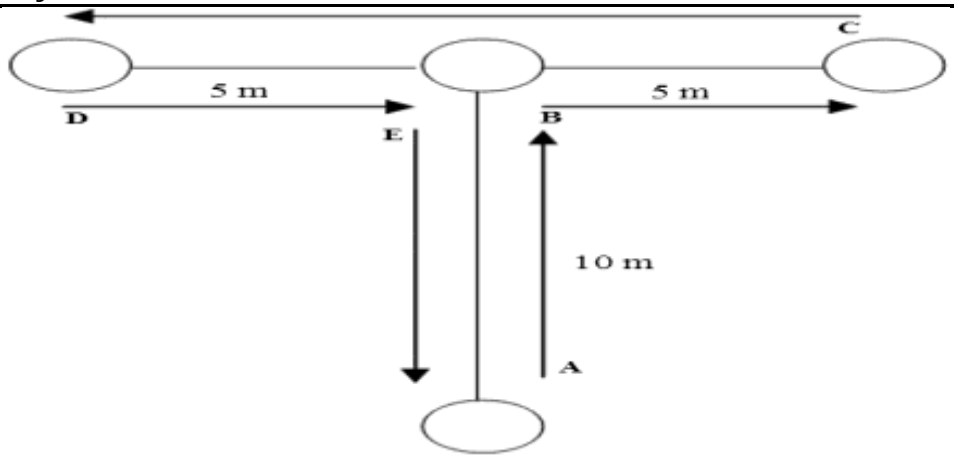
Agility t - test

Purpose: To measure the agility of the performer in running and changing direction.
Equipment: Marking tape, stop watch and four cones.

Procedure

Subject start behind the starting line with the signal "got" point A to B and cover the distance of 10 m. After that subject turns life side to point B to C and cover the distance of 5 m. Rapidly, subject move to point C to D and cover the distance of 10 m more. Now subject move to point D to B and cover the distance 5 m. After all subject move to point B to A and cover the distance of 10 m. Total distance covered by subject in one repetition was 40 m. The score for each subject is the length of time require (to the nearest tenth of second) to complete the course record only the one trial.

Figure 2: Subject score and distance covered



Data Collection

In this study, all variables were measured for each subject before they received their respective training, serving as the pre-test during their attendance at the national camp. After the completing training camp, the subjects were tested again on all variables under the same conditions, which served as the post-test.

Statistical Analysis

The research data collected was edited using the Statistical Package for the Social Sciences (SPSS) version 26. Subsequently, the data was entered into the SPSS data sheet for analysis, utilizing its statistical tools. The data analysis employed several statistical approaches, including descriptive statistics (mean, standard deviation, and percentage), as well as independent t-test analysis.

Results

This chapter describes the basic information derived from analysis of each anthropometric characteristic through descriptive statistics. The results of current study to measure and analyses of comparison of muscular strength, speed, flexibility and agility among professional and sub – profession players of basketball.

Table 2: Descriptive Statistics of Professional Players

Variables	N	Mean	SD
Muscular Strength (kg)	30	41.89	.07
Speed 40m Dash (sec)	30	5.60	.04
Flexibility (cm)	30	11.15	.06
Agility t test (sec)	30	6.20	.09

The above table indicates the description of professional players of basketball. The total number of subject was 30. Muscular strength was measured through hand grip test by dynamometer there mean and SD was 41.89±.07, speed was measured through 40m dash there mean and SD was 5.60±.04, flexibility was measured through sit and reach test there mean and SD was 11.15±.06 respectively agility was measured through agility t test there mean and SD was 6.20±.09.

Table 3: Descriptive Statistics of Sub – Professional Players

Variables	N	Mean	Std. Deviation
Muscular Strength (kg)	30	40.80	.08
Speed 40m Dash (sec)	30	6.7	.02
Flexibility (cm)	30	10.05	.07
Agility t test (sec)	30	7.30	.08

The above table illustrates the description of professional players of basketball. The total number of subject was 30. Muscular strength was measured through hand grip test by dynamometer there mean and SD was 40.80±.08, speed was measured through 40m dash there mean and SD was 6.7±.02, flexibility was measured through sit and reach test there mean and SD was 10.05±.07 respectively agility was measured through agility t test there mean and SD was 7.30±.08.

Table 4: Anthropometric measurement of Professional Players

Variables	N	Mean	SD
Age (year)	30	22.70	1.08
Height (cm)	30	174.30	.91
Weight (kg)	30	67.60	1.30
Body Mass Index	30	22.16	.53

The above table showing the description of age, height, weight, and body mass index measures of total 30 professional players of basketball. While the mean age of these subjects was 22.70±1.08, height 174.30±.91, weight 67.60±1.30 and body mass index 22.16±.53 measured.

Table 5: Anthropometric measurement of Professional Players

Variables	N	Mean	SD
Age (year)	30	22.67	1.02
Height (cm)	30	177.93	1.20
Weight (kg)	30	72.23	1.16
Body Mass Index	30	23.82	.43

The above table showing the description of age, height, weight, and body mass index measures of total 30 professional players of basketball. While the mean age of these subjects was 22.67±1.02, height 177.93±1.20, weight 72.23±1.16 and body mass index 23.82±.43 measured.

Table 6: Comparison of Muscular Strength among Professional and sub –professional players of Basketball

Group Statistics				Levene's Test for Equality of Variances		t-test		
Category	N	Mean	SD	F	Sig.	t	df	Sig. (2-tailed)
Professional	30	41.89	.07	20.664	.001	59.45	58	.001
Sub professional	30	40.80	.09			57.59	58	.002

The above table shows the comparison of muscular strength among professional and sub – professional players of basketball. There were total 60 players of basketball participated in this study, which were 30 professional and 30 sub – professional players. The mean and SD of professional players of basketball was 41.89±.07 and the mean and SD of sub – professional players of basketball was 40.80±.09. There was a significant difference observed between these two groups (t=57.59 and the p-values was .002) which is less than the cut off values ($p<0.05$). According to the table the professional player (41.89) reported higher mean score in muscular strength as compared to sub – professional players (40.80) of basketball therefore; the muscular strength was good as compared to sub – professional players. Therefore, the set hypothesis measured muscular strength between professional and sub professional player of basketball was accepted.

Table 7: Comparison of Speed among Professional and sub –professional players of basketball

Group Statistics				Levene's Test for Equality of Variances		t-test		
Category	N	Mean	SD	F	Sig.	t	Df	Sig. (2-tailed)
Professional	30	5.60	.01	29.084	.001	-306.58	58	.001
Sub professional	30	6.72	.03			-165.95	58	.001

According to the above table the comparison of speed among professional and sub – professional players of basketball. There were total 60 players of basketball participated in this study, which were 30 professional and 30 sub – professional players. The mean and SD of professional players

of basketball was 5.60±.01 and the mean and SD of sub – professional players of basketball was 6.72±.03. There was a significant difference observed between these two groups (t=-165.65 and the sig. p-values was .001) which is less than the cut off p-values (p<0.05). The mean score of speed in professional players is low as compared to sub – professional players of basketball therefore; the skill component speed which was measured through 40m dash in seconds is low as compared to sub – professional players of basketball. Therefore, the hypothesis of set variable speed was accepted between professional and sub professional players of basketball.

Table 8: Comparison of Flexibility among Professional and sub –professional players of Basketball

Group Statistics				**Levene's Test for Equality of Variances**		**t-test**		
Category	N	Mean	SD	F	Sig.	t	df	Sig. (2-tailed)
Professional	30	11.15	.06	27.122	.000	61.316	58	.001
Sub professional	30	10.05	.04			58.421	58	.001

The comparison of flexibility shows in above table among professional and sub – professional players of basketball. Total 60 players of basketball participated in this study, which were professional and sub – professional players equally divided into two groups respectively. The mean and SD of professional players of basketball was 11.15±.06 and the mean and SD of sub – professional players of basketball was 10.05±.04. There was a significant difference occurred between the groups (t=58.421 and the sig. p-values was .000) which is less than the cut off p-values (p<0.05). The mean score of professional players reported higher as compared to sub – professional players. That was clearly show the flexibility of professional players is good as compared to sub – professional players. After that, the hypothesis was accepted of variable flexibility between professional and sub professional players of basketball.

Table 9: Comparison of Agility among Professional and sub –professional players of basketball

Group Statistics				**Levene's Test for Equality of Variances**		**t-test**		
Category	N	Mean	SD	F	Sig.	t	df	Sig. (2-tailed)
Professional	30	6.20	.09	32.201	.001	-46.831	58	.001
Sub professional	30	7.33	.11			-40.831	58	.001

According to the above table the comparison of agility among professional and sub – professional players of basketball. There were total 60 players of basketball participated in this study, which were 30 professional and 30 sub – professional players. The mean and SD of professional players of basketball was 6.20±.09 and the mean and SD of sub – professional players of basketball was 7.33±.11. There was a significant difference observed between these two groups (t=-40.831 and the sig. p-values was .001) which is less than the cut off p-values (p<0.05). The mean score of agility in professional players is low as compared to sub – professional players of basketball therefore; the skill component agility which was measured through agility t test in seconds is low as compared to sub – professional players of basketball. Therefore, the hypothesis was accepted of set variable agility between the professional and sub professional players of basketball.

Discussion

The results of the study demonstrate that professional basketball players possess significantly greater muscular strength than professional players. Professional players typically engage in comprehensive resistance training regimens that not only increase muscle mass but also improve muscle endurance and explosive power, which are critical for basketball-specific movements such as jumping, sprinting, and sudden directional changes (Shalom et al., 2023). Additionally, professional basketball players often benefit from access to superior training facilities and resources, including personal trainers, sports nutritionists, and advanced recovery techniques such as cryotherapy and sports massage (Shalom et al., 2023). The present study was showed with different results that there is a significance difference found in the comparison of muscular strength, speed, flexibility, and agility among professional and sub-professional player of basketball. The mean and SD of professional players of basketball was 5.60±.01 and the mean and SD of sub – professional players of basketball was 6.72±.03. There were significance difference observed in both group sub-professional player of basketball.

This can be attributed to the high-intensity interval training and sport-specific drills that professionals routinely perform, which are designed to enhance their acceleration, top-end speed, and overall quickness (Joyner & Coyle, 2008). Professional players often engage in training, plyometric, and agility drills that are specifically tailored to mimic the high-intensity, short-duration sprints that occur during a basketball game. Furthermore, professional players benefit from advanced techniques in biomechanics and sports science, which optimize their running mechanics and efficiency. These techniques may include video analysis of their sprinting form, force plate analysis to measure ground reaction forces, and specialized footwear designed to enhance performance and reduce injury risk. Professional players, who may not train as intensely or with the same level of expertise, consequently show less impressive speed metrics. Their training may lack the specificity and intensity required to develop the rapid acceleration and deceleration skills needed for competitive basketball, resulting in slower sprint times and less effective performance on the court (Shalom et al 2023).

The study highlights that professional players have significantly better flexibility than professional players. This advantage likely stems from the incorporation of comprehensive flexibility and mobility exercises into their training routines (Talar et al., 2021). Professional athletes often engage in dynamic stretching, yoga, and other flexibility-enhancing practices that help maintain and improve their range of motion. These practices are essential for ensuring that muscles and joints can handle the demands of high-intensity play and recover effectively between games and training sessions (Yáñez-García et al., 2020). Enhanced flexibility allows for smoother and more efficient movement patterns, reducing the risk of muscle strains and joint injuries. Professional players, who may not prioritize flexibility to the same extent, exhibit less flexibility and, consequently, might be more prone to injuries and less efficient in their movements (Talar et al., 2021). Their training routines may lack the regular inclusion of stretching and mobility exercises, leading to tighter muscles and less optimal movement mechanics. This can not only hinder performance but also increase the likelihood of chronic injuries such as tendinitis and muscle strains, which can further limit their ability to train and compete effectively.

The findings indicate that professional players have significantly superior agility compared to professional players. Professional athletes typically engage in specialized agility training that includes ladder drills, cone drills, and plyometric exercises, which enhance their ability to make rapid directional changes with minimal loss of speed (Sheppard & Young, 2006). This training is crucial for performing complex movements on the court, such as dodging defenders, executing

quick pivots, and maintaining balance under dynamic conditions. Moreover, professional players often undergo sport-specific agility drills that replicate in-game scenarios, helping them to develop the ability to anticipate and react quickly to the actions of opponents and teammates. Professional players, who may not have access to such focused training, show less agility, which can impact their overall effectiveness during gameplay (Yáñez-García et al., 2020). Without the same level of agility training, these players may struggle with quick changes of direction, balance, and coordination, which are essential for both offensive and defensive maneuvers in basketball. This lack of agility can result in slower reaction times, decreased ability to evade defenders, and less effective defensive positioning, ultimately reducing their overall performance and impact on the game.

Conclusion

The study concluded that the significant differences observed in muscular strength, speed, flexibility, and agility among professional and sub-professional basketball players highlight the critical role of intensive, specialized training and advanced resources in achieving elite athletic performance. For professional players aspiring to reach professional levels, adopting rigorous training routines that address these key physical attributes is essential. Furthermore, implementing personalized training strategies and leveraging sports science can significantly enhance their development, bridging the gap among professional and sub-professional performance levels. Future research should continue to explore the specific training methodologies that most effectively develop these physical attributes, providing evidence-based guidelines to optimize athletic training and performance. Based on the findings of this study, recommendations can be made to help bridge the performance gap among professional and sub-professional basketball players in terms of muscular strength, speed, flexibility, and agility. These recommendations aim to enhance the training regimens and overall athletic development of professional players, enabling them to improve their physical capabilities and performance.

References

- American College of Sports Medicine. (2009). American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. *Medicine and Science in Sports and Exercise, 41*(3), 687.
- Artero, E. G., Lee, D. C., Lavie, C. J., España-Romero, V., Sui, X., Church, T. S., & Blair, S. N. (2012). Effects of muscular strength on cardiovascular risk factors and prognosis. *Journal of Cardiopulmonary Rehabilitation and Prevention, 32*(6), 351.
- Baumgärtner, M. K., Dwertmann, D. J., Boehm, S. A., & Bruch, H. (2015). Job satisfaction of employees with disabilities: The role of perceived structural flexibility. *Human Resource Management, 54*(2), 323-343.
- Carbone, S., Kirkman, D. L., Garten, R. S., Rodriguez-Miguelez, P., Artero, E. G., Lee, D. C., & Lavie, C. J. (2020). Muscular strength and cardiovascular disease: an updated state-of-the-art narrative review. *Journal of Cardiopulmonary Rehabilitation and Prevention, 40*(5), 302-309.
- Chodzko-Zajko, W. J. (2014). Exercise and physical activity for older adults. *Kinesiology Review, 3*(1), 101-106.
- Collins, K., & Staples, K. (2017). The role of physical activity in improving physical fitness in children with intellectual and developmental disabilities. *Research in developmental disabilities, 69*, 49-60.

- Gorostiaga, E. M., Granados, C., Ibanez, J., Gonzalez-Badillo, J. J., & Izquierdo, M. (2006). Effects of an entire season on physical fitness changes in elite male handball players. *Medicine and Science in Sports and Exercise, 38*, 357-366.
- Jay, H. (2002). *Physiological aspects of Sports Training and Performance, United States of America*. Human Kinetics Publishers.
- Joyner, M. J., & Coyle, E. F. (2008). Endurance exercise performance: The physiology of champions. *The Journal of Physiology, 586*(1), 35-44.
- Memmert, D., & Leiner, S. (2023). *The Mental Game: Cognitive Training, Creativity, and Game Intelligence in Tennis*. Meyer & Meyer Sport.
- Muhammad, U., Abdullahi, U., & Dodo, H. (2024). Assessment of Physical Activity (Walking) and Fitness Levels in Post-Fuel Subsidy Removal among the Staff of Tertiary Institutions in Jigawa State. *International Journal of Education and National Development*, *2*(2), 19-31.
- Nishi, K., Krupa, M., Dinesh, S., & Sheshna, R. (2019). Measuring immediate effects of Surya Namaskar on trunk and hip flexibility among young college going students. *International Journal of Health Sciences and Research*, *9*(10), 73-78.
- Portaz, M., Cabestrero, R., Quirós, P., & Santos, O. C. (2024). AI-Powered Psychomotor Learning through Basketball Practice: Opportunities and Challenges. *Mind, Body, and Digital Brains*, 193-215.
- Pryimakov, O., Iermakov, S., Kolenkov, O., Samokish, I., & Juchno, J. (2016). Monitoring of functional fitness of combat athletes during the precompetitive preparation stage. *Journal of Physical Education and Sport, 16*(2), 551.
- Raj, D. S. L., & Maniazhagu, D. (2022). Effect of circuit training combined with speed agility quickness drills and jump rope drills on upperbody muscular endurance. *Journal of Advances in Sports and Physical Education*, *5*(2), 24-30.
- Saadati, S. A. (2023). Recent Innovations in Sports Physiology: Shaping the Future of Athletic Performance. *Health Nexus*, *1*(2), 15-27.
- Shalom, A., Gottlieb, R., Alcaraz, P. E., & Calleja-Gonzalez, J. (2023). A Narrative Review of the Dominant Physiological Energy Systems in Basketball and the Importance of Specificity and Uniqueness in Measuring Basketball Players. *Applied Sciences*, *13*(23), 12849.
- Sheppard, J. M., & Young, W. B. (2006). Agility literature review: Classifications, training and testing. *Journal of Sports Sciences, 24*(9), 919-932.
- Singh, A., & Parmar, V. S. (2023). Comprehensive approach to managing physical education and sports at all educational levels. *Journal of Sports Science and Nutrition*, *4*(2), 258-263.
- Toigo, M., & Boutellier, U. (2006). New fundamental resistance exercise determinants of molecular and cellular muscle adaptations. *European Journal of Applied Physiology*, *97*(6), 643-663.
- Volaklis, K. A., Halle, M., & Meisinger, C. (2015). Muscular strength as a strong predictor of mortality: a narrative review. *European Journal of Internal Medicine*, *26*(5), 303-310.
- Yáñez-García, J. M., Rodríguez-Rosell, D., Mora-Custodio, R., & González-Badillo, J. J. (2022). Changes in muscle strength, jump, and sprint performance in young elite basketball players: The impact of combined high-speed resistance training and plyometrics. *The Journal of Strength & Conditioning Research*, *36*(2), 478-485.
- Yobu. (2010). *Test measurement and Evaluation in Physical Education and Sports*. New Delhi: Friends Publications.