

How to Cite:

Kumar, D., & Das, R. (2022). Effect of positional role on isokinetic muscles torque production of selected movements of basketball players. *International Journal of Health Sciences*, 6(S5), 11489–11499. <https://doi.org/10.53730/ijhs.v6nS5.11396>

Effect of positional role on isokinetic muscles torque production of selected movements of basketball players

Dinesh Kumar

Ph.D. Scholar, department of physical education and sports science, University of Delhi, Delhi India

Rajdeep Das

Ph.D. Scholar Department of exercise physiology, Lakshmbai National Institute of Physical Education, Gwalior, MP, India

Corresponding author email: rjdpdas94@gmail.com

ORCID Id- <https://orcid.org/0000-0001-7837-3702>

Abstract--The present study compare the isokinetic torque production of major movements like knee extension, shoulder flexion and elbow extension among different playing position players in basketball and to find out whether positional role effect the muscular strength attribute of players. 21 national level basketball players participated in the study voluntarily. For each player measurement of height, weight, age, and training age were taken, the test of isokinetic exercise for knee extension, shoulder flexion, and elbow extension was performed. The study found that the center performs significantly better than forward and guard players for knee extension and shoulder flexion movement and forward perform significantly better than guard for the same. No significant difference was found for elbow extension movement, but after normalization of isokinetic peak torque with body size, comparison of relative isokinetic peak torque showed that center and forward significantly perform better than guard players for isokinetic knee extension movement at 60°s⁻¹, whereas guard and forward players significantly perform better than a center player for elbow extension movement at 60°s⁻¹. Normalization for body size nullifies the significant difference in isokinetic peak torque produced for shoulder flexion movement at 60°s⁻¹. The finding of the present study reveal that there is a difference in isokinetic torque production for different movement in different playing positions, it was also found that apart from body size and weight variation, specific positional role and duties of each position during basketball game also affect the isokinetic peak torque generated by players for the selected movements.

Keywords---isokinetic dynamometer, shoulder flexion, Elbow extension, knee extension, basketball team.

Introduction

Basketball is one of the most popular team sports played all over the world. Basketball players need to perform various skills under dynamic conditions, in most cases, while moving with high speed or changing direction or jumping. Many time-motion studies reported that basketball is intermittent sports which include frequent bout of intense action like sprinting, jumping, throwing the ball, etc. with short period of recovery.⁽¹⁻⁴⁾ Studies also show that in male basketball game a player undergo change in activity for every 2s^(2,3) and female basketball game players change the activity for every 2.82s⁽¹⁾, from these studies one can easily understand the high level of physical attributes basketball players need to possess to become successful.

The physical demands of a game of basketball are complex and there are no specific determinants of performance, rather there are many physical capacities that make up a high standard player. Many researchers have been reported that anaerobic capacity, agility, speed, anaerobic power are major physiological attributes of a successful player^(2,4,5,6) elite level players possess high anaerobic and muscular power of upper and lower limb when compared to lower-level players.⁽⁶⁻⁸⁾ Keeping this in mind, it is very important to maximize training and improve the quality of the training session without increasing the load experienced by the players. After the year 2000 due to change in rules and playing tactics, there is a sharp increase in weight training of players to improve their muscular power and their anaerobic power for fast and more efficient movements.^(9,10)

Previous researchers show us that physical attributes and capacities of players differ with the positions in team games⁽¹¹⁻¹⁴⁾ and same had found in the case of basketball.^(5,6,8) Time-motion studies in basketball show many differences in players according to their playing positions finding shows that center jumps appreciably higher than guard and forward⁽²⁾ where guard cover more distance and possess higher average heart rate compared to other positions.⁽¹⁻³⁾ Many more studies had been done to find out major movements and major muscles important for a basketball player and if there is any difference according to playing positions in them,^(5,6,15,16,17) reported findings show the importance of knee extensor, planter flexion,^(5,6) elbow extension and shoulder flexion and diagonal movement.⁽¹⁶⁻¹⁸⁾

However, many of these studies while assessing muscular strength neglected the fact that basketball players differ in body size and size of muscles has a significant positive relationship in muscle force production or torque production^(19, 20, 21) and reported findings with absolute strength of players without doing normalization of body weight.^(5,7,15,16,18) Very few studies had been carried out in the field of basketball that uses normalization of body size while doing a comparison of muscular strength between basketball players.^(6, 8, 19) For the last few years to compare muscular power between different players and their

movement, assessment of isokinetic torque has been more authentic as isokinetic dynamometer provides stable angular velocity along the full range of motion. (19, 22) Therefore, the purpose of the present study was to compare the isokinetic torque production of major movements like knee extension, shoulder flexion and elbow extension (*which are determinants of a successful basketball player*) among different playing position players in basketball and to find out whether positional role effect the muscular strength attribute of players. Basketball team positions can be classified into 3 positions, guard, forward, and center.(23) We hypothesized that there exists a significant difference in muscle torque production for every movement in different playing positions.

Methods

Experimental Approach to the Problem

For this comparative study, we tested a group of national-level basketball players playing at 3 different playing positions. All players were tested for 3 selected movements, which were chosen due to their high relevance to the game and their biomechanical inclusion in the fundamental skills of basketball. For the assessment of muscular strength we use and isokinetic dynamometer because of its capacity to measure torque production of a particular movement and its ability to provide a linear velocity throughout the range of motion. The experimental procedure and potential risks described to each participant before taking written consent.

Subject

For the study total 21 male basketball players (age: 24.5 ± 1.7 years, training experience: 9.4 ± 1.7 years; mean \pm SD) had participated voluntarily. All the participants played at a national level competition for different teams and at the time of experiment perusing various courses at LNIPE, Gwalior. 12 players were representing their state teams and 9 players were part of the university team. The participants are equal for each playing position, 7 for each guard, forward, and center. The different characteristics of players are listed in Table 1. None of them had any prior chronic or acute injuries for knee, shoulder, and elbow.

Procedure

For measuring the torque production while performing the selected movement we use (CSMI) HUMAC NORMS system as it provides accurate data with very high reliability of 0.94 in case of shoulder and 0.89 in case of knee test. (24) To measure the reliability of the HUMAC NORMS System it was normalized with weight plates for every movement selected before using it for test and found to be reliable. To ensure that participants are well versed with the isokinetic movement and its testing a practice session had conducted before 1 week or actual experiment to make them well familiar with the machine and to avoid any carryover fatigue.

All the subjects were staying in the hostels of L.N.I.PE, Gwalior. As they were residing together, they were getting same food, all subjects undergo for 9

sessions/week training for the last 3 months, including 4 sessions of game skill practice, 2 sessions of weight training, and 2 sessions of high-intensity speed workout with 1 game session. The experiment conducted in the last week of October and every subject was tested with the same pattern of exercise. All the measurements were started at 3 pm in the exercise physiology laboratory of LNIPE, Gwalior, with 20-21 hour overnight rest from any strenuous physical activity, and the last meal was consumed before 3 hours of the experiment. Participants were instructed to do proper warm-up which includes stretching exercise, jogging for 3 minutes and 3-4 short sprints before the measurement.

Knee extensor

The knee extensor muscles of both legs were measured concentrically at speed of 60°s^{-1} with 2 sets of 3 repetitions each and 1 min rest between sets. The measurement was taken in a seated position while following the manual of CISM HUMAC NORMS (25) with hip angle flexed at 85° and chair rotation was set according to the alignment between the dynamometer axis and line passing transversely through the femoral condyles which were taken as the axis of rotation. To resist the inclusion of other muscles participants were secured by the waist, shoulder belt, and thigh stabilizer strap. The length of the lever arm was adjusted individually, and the resistance pad was placed near to the medial malleolus. The range of motion was fixed by assessing participants' comfortable movement of flexion and extension of the knee which ranges between 8° to 90° , gravity correction was applied. The value of peak torque produces for the best repetition was taken as data for the study. There is no significant difference found between dominant and non-dominant leg (19, 26) so an average of peak torque of both the leg was taken and used as the measurement for knee extensor strength.

Shoulder flexion

The measurement was taken in supine lying down position with chair back angle at 0° and dynamometer height at 10, the rotation of chair and dynamometer both were aligned individually to keep the axis of dynamometer and axis of rotation of movement in the same line, for shoulder flexion the axis of rotation keeps on changes with movement so the compromised axis of rotation was taken as medial to the acromion process when the limb is in the neutral position. Length of elbow/shoulder adaptor was determined individually, to make the subject comfortable and to nullify the movement of other body parts fasten the seat belt around pelvis and install the footrest. The range of motion was set for every participant separately, which ranges from 0° to 135° where 0° represents the anatomical position of the limb. After applying gravity correction, best peak torque produced out of 2 sets of 3 repetitions each was taken as measurement, shoulder flexion movement was measured concentrically at speed of 60°s^{-1} , to include both the shoulder in measurement an average of both the shoulders' peak torque production was taken as a variable for comparison.

Elbow extension

This measurement was also taken from supine lying position with chair back angle at 0° and dynamometer height at 10, chair and dynamometer rotation scale

was adjusted to align the dynamometer axis with the axis of rotation of elbow extension which was taken as immediately distal to the lateral epicondyle, and for better alignment dynamometer tilt was also set at 10. After adjusting elbow/shoulder adaptor fasten the seat belt around pelvis and secure contralateral Shoulder Belt across the torso, participants also instructed to not lift the shoulder while doing elbow movement. Range of motion varies from 140° to 2° for elbow extension, all subjects performed 2 sets of 3 repetitions and the best peak torque generated was taken as a measurement. As we were comparing the elbow extension movement because it's a major part of shooting skill only the shooting hand measurement was taken for comparison.

Statistical Analyses

Descriptive statistics (mean & SD) were calculated for physical characteristics and all isokinetic measurements. The Shapiro Wilks test was used to check the normality of the data. To compare mean between different playing positions a parametric test was considered, 1-way analysis of variance (ANOVA) was used to find the presence of a significant difference between positions and to further analysis the positional difference between age, weight, height and other isokinetic measurements least significance difference (LSD) post-hoc test was applied. The level of significance was set at $p \leq 0.05$ for all the tests. IBM SPSS 20 was used for all the calculations.

Result

The physical characteristic and training age according to playing position of all the players were presented in table.1, among 3 playing position significant difference was found ($p \leq 0.05$) for weight and height variable, specifically, center were significantly ($p \leq 0.05$) taller and heavier then forward and guard players and forward were significantly ($p \leq 0.05$) heavier and taller when compared to guard players. There was no significant difference among 3 playing positions for age and training age.

Table 1. The mean and SD value of the physical characteristic of all the basketball players according to playing position.

	All Player (n=21)	Guard (n=7)	Forward (n=7)	Center (n=7)
Age (year)	24.52 ± 1.7	24.85 ± 1.8	23.71 ± 1.1	25.00 ± 2.2
Weight (kg)	80.71 ± 11.3	69.57 ± 6.8* [§]	79.00 ± 3.2* [#]	93.57 ± 5.2* ^{§#}
Height (cm)	183.14 ± 8.7	174.00 ± 5.8* [#]	183.28 ± 4.1* [#]	192.14 ± 2.6* ^{§#}
Training age (year)	9.42 ± 1.8	10.00 ± 2.0	9.14 ± 1.4	9.16 ± 1.7
*Significance difference between guard and center, [§] Significance difference between guard and forward, [#] Significance difference between forward and center				

A comparison of mean for absolute isokinetic peak torque among guard, forward, and center was done in the table.2, a significant difference ($p \leq 0.05$) were found for knee extensor and shoulder flexion movement at 60°s⁻¹ where center performs significantly ($p \leq 0.05$) better than forward and guard players for both movement and forward perform significantly ($p \leq 0.05$) better than guard for knee extension

and shoulder flexion movement. No significant ($p \leq 0.05$) difference was found for the elbow extension movement among 3 playing positions. After normalization of isokinetic peak torque with body size, the measurement was presented in the table.3, comparison of the mean for relative isokinetic peak torque among 3 playing position showed that there is significant ($p \leq 0.05$) difference for knee extension and elbow extension movement among different playing position players, specifically, center significantly ($p \leq 0.05$) perform better than guard players for isokinetic knee extension movement at 60°s^{-1} , also forward significantly ($p \leq 0.05$) perform better than guard for the same movement. Whereas guard players significantly ($p \leq 0.05$) perform better than center player for elbow extension movement at 60°s^{-1} and forward players also perform significantly ($p \leq 0.05$) better than center players for elbow extension movement 60°s^{-1} . Normalization for body size nullifies the significant ($p \leq 0.05$) difference found among 3 playing position in absolute isokinetic peak torque produced for shoulder flexion movement at 60°s^{-1} .

TABLE 2. Mean & SD of absolute isokinetic peak torque production by different playing positions of basketball.

Isokinetic peak torque at 60°s^{-1} (N.m)	All players (n = 7)	Guard (n = 7)	Forward (n = 7)	Center (n=7)
Knee Extension	302.66 \pm 87.8	207.71 \pm 56.27* $\$$	306.42 \pm 29.6* $\#$	393.85 \pm 38.1 $\$$ $\#$
Shoulder Flexion	102.04 \pm 12.7	90.21 \pm 5.5* $\$$	101.35 \pm 9.1* $\#$	114.57 \pm 9.0 $\$$ $\#$
Elbow Extension	74.23 \pm 9.4	73.28 \pm 12.1	76.71 \pm 6.3	72.71 \pm 9.7

*Significance difference between guard and center, $\$$ Significance difference between guard and forward, $\#$ Significance difference between forward and center

TABLE 3. Mean & SD of relative isokinetic peak torque to bodyweight of different playing position player of basketball.

Isokinetic peak torque at 60°s^{-1} (N.m. (kg^{-1}))	All players (n = 7)	Guard (n = 7)	Forward (n = 7)	Center (n=7)
Knee Extension	3.67 \pm 0.70	2.95 \pm 0.62* $\$$	3.84 \pm 0.33*	4.23 \pm 0.41 $\$$
Shoulder Flexion	1.27 \pm 0.10	1.30 \pm 0.10	1.28 \pm 0.11	1.23 \pm 0.10
Elbow Extension	0.93 \pm 0.15	1.05 \pm 0.14 $\$$	0.96 \pm 0.08 $\#$	0.78 \pm 0.10 $\$$ $\#$

*Significance difference between guard and center, $\$$ Significance difference between guard and forward, $\#$ Significance difference between forward and center
 We used the following allometric formula for obtaining muscle strength, S, independent of body size (assessed by body mass, m) = $S_n = S / m^b$ -The allometric parameter should be $b = 1$ for muscle torque (recorded by an isokinetic exercise) (26)

Discussion & Conclusion

The present study aimed to investigate whether the positional role in basketball influence the muscular strength of players and if positional difference found in muscular strength what variables cause these difference, to answer this problem we compare players of different playing position for isokinetic peak torque of major muscular movement that is repeatedly used in the game of basketball like knee extension, shoulder flexion, and elbow extension movements. To find out the effect of body size, we compare the absolute and relative isokinetic peak torque separately.

The initial result of this study shows a significant difference in weight and height of different playing position players which is in agreement with many previous studies (2, 5, 6, 8, 27) the result shows that center was the tallest and heaviest among 3 playing position players followed by forward and then guard. This difference can be understood as particular body size and proportion may be prerequisite for successfully playing the positional duties allotted to players, physical attributes of center player playing under ring help them to reach the ball faster and bigger and heavier body help them to dominate small players in physical contact, rebounding, picks and box-out situations. Whereas guard players due to short body size and less weight possess higher agility (2, 8) and VO₂ max which help them to move faster and set up the game, short height gives them more stability that helps them to do perform complex dribbling and passing skills with ease that are important to become a successful guard player.

A further result of this study about knee extension peak torque production reveal that center players perform better than forward and guard players, and forward perform better than guard players for knee extension movement, the previous study also support these findings and shows that greatest absolute concentric peak torque was produced by centers, followed by forwards and then guards (6) other studies also show many similar results and report a significant effect of playing position on peak torque on knee extensor.(5, 7, 15, 28) On normalizing the peak torque of knee extensor body size the difference between center and forward players peak torque was neutralized but still forward and center have significantly better knee extensor peak torque than guard player, this can be explained by observing that players playing under the ring (center and forward) need to jump more than guard players (1,2) previous study also report that center had more vertical jump power than guard, the positional role of center and forward player need them to jump closer to the ring to capture the ball for rebound and also include in dynamic jump situations to take lay-up shots, fight for the ball when it's in air and to block to opponent shoot attempts, on other hand, guard players normally take shoots from distance and play away from the ring to set the gameplay for the team which includes less static and dynamic jumps compared to other players.(27) Center player has to engage in more physical contact during rebounding and box-out situations where they need higher stability, to compensate high center of gravity, better lower limb strength can be considered very helpful to maintain a stable position, however, more research work needed in this filed for better understanding of the role of lower limb strength in stability.

This is the first study that compares the shoulder flexion movement peak torque according to playing positions, the result of absolute peak torque of shoulder flexion shows us the same result as knee extension movement where center perform best among 3 playing position followed by forward and then guard players, above findings was supported by a previous descriptive study that profiles the isokinetic torque measurement of basketball players for different movement.⁽⁷⁾ However, it seems that this difference in the strength of shoulder flexion movement was only due to body size difference among 3 playing positions because when we normalize the peak torque of shoulder flexion movement with body size and compare the results, we found no significant difference between players. Recent biomechanical analysis of fundamental skills of basketball shows us the inclusion of shoulder flexion movement in nearly all the fundamental skills like shooting^(29,30) passing⁽³¹⁾ and rebound.⁽³²⁾ This may be concluded that basketball players at every position use shoulder flexion movement repeatedly during a game and position role does not affect shoulder flexion movement significantly between the players, only body size and weight difference were the factors that cause the significant difference between playing position players.

In the case of elbow extension movement, finding shows us that body size hides the significant effect of position role. There was no significant difference found while comparing the mean of absolute peak torque but when the normalization of body size was applied and comparison of relative peak torque had done the result reveal that guard and forward performs significantly better than center. This study is first of its kind that compares elbow extension peak torque between different playing position players. This difference can be comprehended as guard players take more shots and many of the shots taken are from long distances. Positional role of forward and especially guard players allows them to take shots and pass the ball over long-range, earlier studies show a positive correlation between long-distance shooting accuracy and elbow extension isokinetic strength⁽¹⁶⁾ and also report that upper limb strength is a good predictor when shots are performed form long-distance.⁽¹⁷⁾ Some experimental study also shows that weight training exercise of elbow extension for maximum strength improved the accuracy of 3-point shooting.⁽³³⁾ Guard player and forward player have to perform dribbling and passing much often then center players, biomechanical analysis of dribbling and passing shows that elbow extension is an integral part of these skills^(31,34) so it may be possible that repeating the same elbow extension movement over many years during gameplay while performing shooting and passing from long-range lead to muscular hypertrophy (particular muscles that are responsible for elbow extension) in guard and forward players.

In conclusion, the finding of the present study indicated that isokinetic peak torque of selected movement used in basketball differ among guard, forward and center, finding of this study also reveal that apart from body size and weight variation among different playing position players, specific positional role and duties of each position during basketball game also affect the isokinetic peak torque generated by players for the selected movements. According to the present study, particular positional player in basketball need to develop specific muscular groups apart from general physical fitness attributes to fulfill their positional role efficiently and to become a successful player, coaches are also recommended to tailor fitness program according to specific playing position of player on court.

References

1. Abdelkrim N. B., Chaouachi A., Chamari K., Chtara M., and Castagna C. (2010). Positional role and competitive-level differences in elite-level men's basketball player. *Journal of Strength and Conditioning Research*. 24(5):1346–1355 <https://doi.org/10.1519/jsc.0b013e3181cf7510>
2. Ayuanda, L. N., Wahidin, W., Raidanti, D., Minarti, M., & Ningsih, D. A. (2022). Online midwife's training on psychoeducation of perinatal mental health during COVID-19 Pandemic. *International Journal of Social Sciences and Humanities*, 6(1), 85–97. <https://doi.org/10.53730/ijssh.v6n1.4741>
3. Ben Abdelkrim, N. B., El Fazaa, S., & El Ati, J. (2007). Time– motion analysis and physiological data of elite under-19-yearold basketball players during competition. *British Journal of Sports Medicine*, 41:69–75 <https://doi.org/10.1136/bjism.2006.032318>
4. Bishop, D. and Wright C. (2006). A time-motion analysis of professional basketball to determine the relationship between three activity profiles: high, medium and low intensity and the length of the time spent on court. *International Journal of performance and sports*, 6(1):130-139 <https://doi.org/10.1080/24748668.2006.11868361>
5. Bradic A. (2009). Isokinetic leg strength profile of elite male basketball player. *Journal of Strength and Conditioning Research*. 23(4):1332– 1337
6. Brown, L. E. (2000). *Isokinetic in human performance*. Champaign. J. Human Kinetics
7. Busko k., Klossowski M., Fizycznego A.W., Warszawa, Poland. (1998). Muscle Torque of male basketball players playing at different floor positions. *Journal of Biology of Sports*.15
8. Chen J. (2014). Biomechanics analysis of shooting in basketball. *J Applied Mechanics and Materials*, 477-480
9. Cohen D. and Delextrat A. (2009). Strength, power, speed, and agility of women basketball players according to playing position. *Journal of Strength and Conditioning Research*. <https://doi.org/10.1519/jsc.0b013e3181b86a7e>
10. Delextrat A., Cohen D. (2008). Physiological testing of basketball players: toward a standard evaluation of anaerobic fitness. *Journal of Strength and Conditioning Research*. 22(4):1066–1072 <https://doi.org/10.1519/jsc.0b013e3181739d9b>
11. Dionne Matthew & Anne Delextrat. (2009). Heart rate, blood lactate concentration, and time–motion analysis of female basketball players during competition. *Journal of Sports Sciences*, 27(8):813-821 <https://doi.org/10.1080/02640410902926420>
12. Djunaid, R., Sahar, J., Widyatuti, W., & Priyo, S. (2022). Predictive factors contributing to violent behavior in adolescents . *International Journal of Health Sciences*, 6(2), 1148–1159. <https://doi.org/10.53730/ijhs.v6n2.11483>
13. Hoare, DG. (2000). Predicting success in junior elite basketball players the contribution of anthropometric and physiological attributes. *J Science Med Sport*, 3:391–405 [https://doi.org/10.1016/s1440-2440\(00\)80006-7](https://doi.org/10.1016/s1440-2440(00)80006-7)
14. Hoffman, JR, Tenenbaum, G, Maresh, CM, and Kreamer, WJ. (1996). Relationship between athletic performance tests and playing time in elite college basketball players. *J Strength Cond Res*, 10:67–71 <https://doi.org/10.1519/00124278-199605000-00001>

- <https://doi.org/10.1590/s1980-65742014000400007>
<https://doi.org/10.3233/ies-2000-0049>
<https://doi.org/10.3233/ies-2012-0458>
15. HUMAC NORM TESTING & REHABILITATION SYSTEM User's Guide. Computer Sports Medicine, Inc. (CSMI): Printed in the United States of America
 16. Hunter, GR, Hilyer, J, and Foster, MA. (1993). Changes in fitness during 4 years of intercollegiate basketball. *J Strength Cond Res*, 7:26–29 <https://doi.org/10.1519/00124278-199302000-00005>
 17. Izzo R. and Russo L. (2011). Analysis of Biomechanical Structure and Passing Techniques in Basketball. *Journal of Physical Education and Rehabilitation*, 3(6)
 18. Izzo R., Sopranzetti S., Altavilla G. (2015). Biomechanical analysis of fundamentals in basketball the rebound. *J Science, Movement and Health*, XV (2)
 19. Jelcic, M, Sekulic, D, and Marinovic, M. (2000). Anthropometric characteristics of high level European junior basketball players. *Coll Anthropol*, 69–76,
 20. Kaya D., Callaghan M. J. (2012). Shoulder joint position sense is negatively correlated with free-throw percentage in professional basketball players. *Journal of Isokinetics and Exercise Science*. 20: 189-196
 21. Li Zhen, Wang L. and Hao Z. A Biomechanical Analysis of Basketball Shooting. DOI 10.5013/IJSSST.a.16.3B.01
 22. McInnes SE, Carlson JS, Jones CJ, et al. (1995). The physiological load imposed on basketball players during competition. *J Sports Science*, 13:387–97 <https://doi.org/10.1080/02640419508732254>
 23. Ostojic S. M., Mazic S., Dikic N. (2006). Profiling in basketball: physical and physiological characteristics of elite players. *Journal of Strength and Conditioning Research*, 20(4):740-744 <https://doi.org/10.1519/00124278-200611000-00003>
 24. Pandey U., Patel S. and Saxsena S. (2012). The relationship of the selected kinematic variables with the performance of low dribble in basketball at execution phase. *Indian Journal of Science and Technology*, 5:2
 25. Pojskic H., Separovic V., Muratovic M., Uzicanin E. (2014). The relationship between physical fitness and shooting accuracy of professional basketball players. *Motriz, Rio Claro*, 20:408-417
 26. Savas S., Yuksel M. F., Uzu A. (2018). The effects of rapid strength and shooting training applied to professional basketball players on the shot percentage level. *Journal of Educational Research*. 6(7) <https://doi.org/10.13189/ujer.2018.060717>
 27. Slobodan J. (2002). Muscle strength testing use of normalization for body size. *Journal of Sports Med*, 32(10):615-631 <https://doi.org/10.2165/00007256-200232100-00002>
 28. Slobodan J.,1 Dragan M., Goran M. (2005). Normalizing physical performance tests for body size: A proposal for standardization. *Journal of Strength and Conditioning Research*, 19(2):467–474 <https://doi.org/10.1519/r-15064.1>
 29. Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2021). Get vaccinated when it is your turn and follow the local guidelines. *International Journal of Health Sciences*, 5(3), x-xv. <https://doi.org/10.53730/ijhs.v5n3.2938>

30. Susana C., A. povoas, Antonio A. M. R. Ascensao, Jose Magalhaes, Andre f. Seabra, Peter Krstrup, Jose M. C. Soares, and Antonio N. C. Rebelo. (2014). Physiological demands of elite team handball with special reference to playing position. *Journal of Strength and Conditioning Research*, 28(2):430–442 <https://doi.org/10.1519/jsc.0b013e3182a953b1>
31. Tang W. T. and Shung H. M. (2005). Relationship between isokinetic strength and shooting accuracy in different shooting range in Taiwanese elite high school basketball players. *Journal of Isokinetic and Exercise science*. 13:169–174 <https://doi.org/10.3233/ies-2005-0200>
32. Theoharopoulos A., Tsitskaris G., Nikopoulou M., Tsaklis P. (2000). Knee strength of professional basketball players. *Journal of Strength and Conditioning Research*. 14(4):457–463
33. Theoharopoulos, A and Tsitskaris, G. (2000). Isokinetic evaluation of the ankle plantar and dorsiflexion strength to determine the dominant limb in basketball players. *J. of Isokinet Exerc Sci.*, 8: 181–186
34. Trninic, S and Dizdar, D. (2000). System of the performance evaluation criteria weighted per positions in the basketball game. *Coll Antropol*, 24:217–234
35. V. D. Salvo and F. Pigozzi. (1998). Physical training of football players based on their positional role in the team. *Journal of sports medicine and physical fitness*, 38:294
36. Wilk, K.E., W.T. Romaniello, and S.M. Soscia. (1994). The relationship between subjective knee scores, isokinetic testing, and functional testing in the ACL reconstructed knee. *J. Orthop. Sports Phys. Ther*, 20:60–73
37. Yusuf Köklü, Utku Alemdaroğlu, Fatma Ünver Koçak, A.Emre Erol, Gülin Fındıkoğlu. (1999). Comparison of Chosen Physical Fitness Characteristics of Turkish Professional Basketball Players by Division and Playing Position. *Journal of Human Kinetics*. volume 30 <https://doi.org/10.2478/v10078-011-0077-y>