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PHYSIOLOGICAL LIMITING FACTORS AND SPORTS SPECIFIC PHYSICAL FITNESS OF FEMALE BASKETBALL PLAYERS OF CENTRAL PART OF KERALA

Viji P. Joseph* — Research Scholar, Department of Sports Science, Punjabi University, Patiala, Punjab *Corresponding Author

Ajita — Professor, Department of Sports Science, Punjabi University, Patiala, Punjab

Sunil G. Purohit — Assistant Professor, Department of Sports Bio Sciences, Central University of Rajasthan, Ajmer, Rajasthan

ABSTRACT **Background:** Basketball demands repeated bursts of high-intensity movement, backed by aerobic fitness, anaerobic power, and sport-specific skills [2]. However, evidence focused on female basketball players in Kerala, especially at the regional level, is still limited. This study aimed to assess selected physiological variables and basketball skills and examine the relationships between morphological and physiological variables among female school- and college-level basketball players from Kottayam, Ernakulam, and Thrissur districts of central Kerala. The study hypothesized that significant differences would exist in morphological and physiological variables among the players from the three selected districts and that significant relationships would exist between physiological limiting factors and basketball skill variables. **Methods:** This descriptive, cross-sectional study involved 391 female basketball players aged 13–23 years from central Kerala (Kottayam, Ernakulam, and Thrissur districts). Height and weight were measured, and body mass index (BMI) was calculated. Aerobic fitness was evaluated with the Katch Step Test and the 20-m multistage shuttle-run (Beep) Test, while anaerobic performance was measured using the Running-Based Anaerobic Sprint Test (RAST) [8]. Basketball ability was assessed through a two-minute shooting test and a shuttle ball-dribbling test. The analysis included descriptive statistics, Pearson correlations, district-wise one-way ANOVA, independent-samples t-tests, and regression analyzes. **Results:** Participants had a mean age of 17.88 years (SD = 2.90) and a mean BMI of 22.83 kg/m² (SD = 3.51). The average Beep Test level was 7.02 (SD = 0.64), while mean RAST average power was 398.51 W (SD = 120.39). RAST average power showed positive correlations with body weight ($r = .833$, $p < .001$) and Beep Test level ($r = .624$, $p < .001$). In contrast, longer dribbling times were associated with lower Beep Test levels ($r = -.679$, $p < .001$) and lower RAST average power ($r = -.579$, $p < .001$). Shooting accuracy was not significantly related to RAST average power ($r = .077$, $p = .126$). Beep Test performance also varied across districts, $F(2, 388) = 7.662$, $p < .001$, $\eta^2 = .038$. **Conclusion:** Among these players, selected aerobic and anaerobic fitness measures were linked to dribbling performance, but the fitness measures examined were not significantly related to shooting accuracy. Since body mass is part of the conventional RAST power equation, the association between weight and power should be interpreted cautiously [8]. These correlational results do not demonstrate causation.

KEYWORDS : Aerobic Fitness; Anaerobic Power; Dribbling; Shooting Accuracy

1. INTRODUCTION

Basketball is an intermittent team sport that requires repeated sprints, jumps, accelerations, decelerations, changes of direction, and technical skills such as dribbling and shooting [2]. Performance, then, depends on how aerobic capacity, anaerobic power, movement efficiency, and basketball-specific skills work together [2, 9]. Aerobic fitness helps players recover between demanding efforts, whereas anaerobic power supports brief, explosive movements [2, 9].

Field tests, including the Katch Step Test, 20-m multistage shuttle-run test and the Running-Based Anaerobic Sprint Test (RAST), offer practical measures of aerobic and anaerobic fitness, respectively [8, 10]. Skill tests add another piece by assessing tasks that are more closely tied to basketball. Fitness measures alone may not account for every difference in technical outcomes, such as shooting accuracy, which can also be shaped by technique, coordination, concentration, and practice [1, 5].

Although research has explored physical characteristics and basketball-specific performance in female players, evidence concerning female players in central Kerala is still limited [1, 5]. This study aimed to assess selected physiological variables and basketball skills and examine the relationships between morphological and physiological variables among female school- and college-level basketball players from Kottayam, Ernakulam, and Thrissur districts of central Kerala. The study hypothesized that significant differences would exist in morphological and physiological variables among the players from the three selected districts and that significant relationships would exist between physiological limiting factors and basketball skill variables.

2. Review of Literature

Physiological fitness testing in basketball helps describe athletes' physical abilities and guide training choices [2, 3]. Key areas include aerobic capacity, anaerobic power, agility, body composition, and basketball-specific skills. Still, the relationships among these factors can differ depending on the athletes studied, the tests selected, and the playing situation [2, 3, 5].

Léger et al. developed the 20-m multistage shuttle-run test to assess aerobic fitness in the field and estimate maximal oxygen uptake (VO_2max) [10]. However, shuttle-run estimates of VO_2max are influenced by both the prediction equation and the population to which it is applied [7, 10].

Because basketball requires repeated bursts of short, intense activity, anaerobic performance is also an important part of physical assessment [2, 9]. The RAST is a field-based test for estimating sprint-related anaerobic power, but its results need to be considered alongside the protocol and equation used to calculate them [8].

Studies involving female basketball players have explored physical fitness, maturation, training load, and skill-related outcomes [1, 3, 6]. Claims that programs delivered from 2020 to 2025 consistently improve every outcome listed should be tied to particular studies and not extended beyond the populations and interventions they examined [1, 3, 6].

Basketball-focused evaluations, such as shooting and dribbling tests, capture separate technical outcomes [1, 5]. Current evidence does not support the claim that better physiological fitness is invariably accompanied by greater shooting accuracy, faster dribbling, and improved overall game performance. Instead, this association may depend on the particular skill and fitness measures selected [1, 5].

The referenced studies cover basketball testing, female players, and athlete development [2, 3, 6]. Although the present study examines a regional sample of female basketball players in Kerala, statements that most earlier research involved elite international players or male athletes should be backed by a systematic review before being presented as definitive.

3. MATERIALS AND METHODS

3.1 Study Design and Participants

A quantitative, comparative, cross-sectional design was adopted. Using purposive sampling, 391 female basketball players aged 13–23 years were recruited from Kottayam, Ernakulam, and Thrissur districts

in central Kerala. Participants were eligible if they played on a school or college basketball team, trained regularly, had at least three years of practice, and volunteered with informed consent. Participants were excluded if they had heart disease, a musculoskeletal disorder or injury, a known metabolic disease, recent use of performance-enhancing substances, or a history of smoking or alcohol use.

3.2 Anthropometric and Physical Fitness Assessments

Height was measured in centimeters, and body mass was recorded in kilograms. BMI was determined by dividing weight in kilograms by height in meters squared. Aerobic fitness was evaluated with the Katch Step Test and the 20-m multistage shuttle-run (Beep) Test, a widely used field measure of aerobic capacity [10]. According to the study protocol, Katch Step Test involved three minutes of stepping, followed by measurement of the recovery pulse. VO_2 max ($mL \cdot kg^{-1} \cdot min^{-1}$) = 65.81 − (0.1847 × recovery heart rate in beats per minute) [11].

Anaerobic performance was measured using the RAST. Participants performed six all-out 35-m sprints, with 10-second recovery periods between efforts, following the stated RAST procedure [8]. Sprint times were measured to the nearest 0.01 s. Power was calculated using body mass (kg) × distance² (m^2) / sprint time³ (s^3) [8]. Peak power was the highest power value across the six sprints, while minimum power was the lowest. Average power was calculated as the arithmetic mean of all six values. The fatigue index was calculated by subtracting minimum power from peak power and dividing the result by total sprint time [8].

3.3 Basketball Skill Tests

The two-minute shooting test assessed basketball shooting performance. Participants took shots from designated two-point positions for two minutes, with performance recorded according to the test protocol [12]. Dribbling ability during repeated movement was evaluated using the shuttle ball-dribbling test. Participants covered 212.4 m, and performance was measured by the time required to finish the course. Three trials were completed, and the fastest time was included in the analysis [12].

3.4 Statistical Analysis

The SPSS analysis produced means and standard deviations, Pearson product–moment correlations, one-way ANOVA with Tukey post hoc comparisons, independent-samples t-tests, and multiple regression results. Statistical significance was defined as $p < .05$. The analyzes presented here address descriptive statistics, correlations, district comparisons, and regression models.

4. RESULTS

The sample included 391 female basketball players. Their mean age was 17.88 years (SD = 2.90), with a mean height of 158.52 cm (SD = 5.72), mean weight of 57.51 kg (SD = 10.16), and mean BMI of 22.83 kg/m^2 (SD = 3.51). The mean Beep Test level was 7.02 (SD = 0.64), while the mean reported VO_2max was 39.89 (SD = 1.08) $mL \cdot kg^{-1} \cdot min^{-1}$. Mean shooting accuracy was 57.83% (SD = 9.39), while the mean best dribbling time was 42.32 s (SD = 4.06).

Table 1: Shows the Descriptive Statistics for the Selected Morphological, Physiological and Basketball Skill Variables.

Variable	Mean	SD
Age (years)	17.88	2.90
Height (cm)	158.52	5.72
Weight (kg)	57.51	10.16
BMI (kg/m^2)	22.83	3.51
Beep Test level	7.02	0.64
Vo_2 max ($mL \cdot kg^{-1} \cdot min^{-1}$)	39.89	1.08
Shooting accuracy (%)	57.83	9.39
Best dribbling time (s)	42.32	4.06
RAST maximum power (W)	447.23	133.26
RAST average power (W)	398.51	120.39
RAST minimum power (W)	353.16	109.61
Fatigue index (W/s)	0.620	0.417

4.1 Correlations Between Physical Fitness and Basketball Skills

The Beep Test level showed a positive correlation with RAST average power ($r = .624$, $p < .001$). Positive correlations with RAST average power were also found for body weight ($r = .833$, $p < .001$), height ($r = .654$, $p < .001$), and BMI ($r = .652$, $p < .001$). Since body mass is part of the conventional RAST power calculation, the relationship between body mass and RAST power should be viewed cautiously [8]. Dribbling time was negatively correlated with both Beep Test level ($r = −.679$, $p < .001$) and RAST average power ($r = −.579$, $p < .001$). Because completing the drill in less time means faster dribbling, these results suggest that higher fitness values were linked to quicker dribbling in this sample. Shooting accuracy was not significantly related to RAST average power ($r = .077$, $p = .126$), Beep Test level ($r = .050$, $p = .322$), or VO_2max ($r = .017$, $p = .745$). [7, 10].

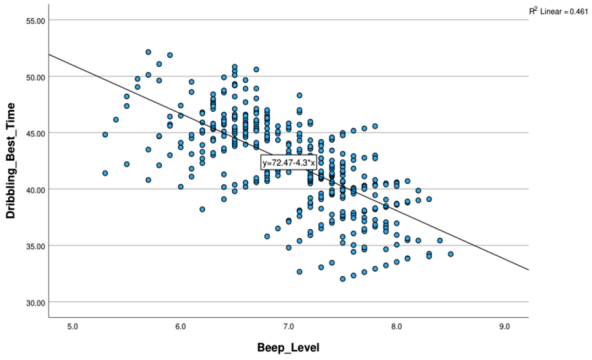


Figure 1. Relationship Between Beep Test Level and Dribbling Time Among Female Basketball Players (N = 391).

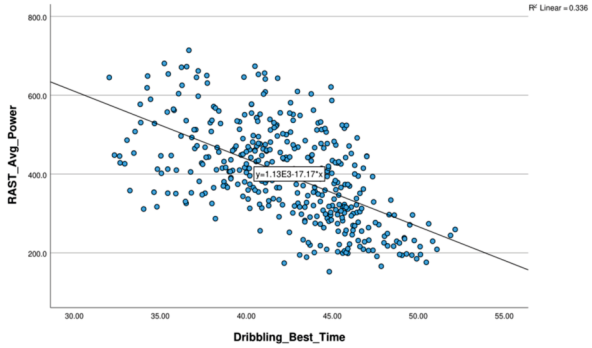


Figure 2. Relationship Between RAST Average Power and Dribbling Time Among Female Basketball Players (N = 391).

4.2 District Comparisons and Regression

One-way ANOVA showed a significant difference among districts in Beep Test level, $F(2, 388) = 7.662$, $p < .001$, $\eta^2 = .038$. Tukey's test found that Kottayam had a higher mean than Ernakulam (mean difference = 0.269, $p < .001$), while the comparisons involving Thrissur were not statistically significant. No significant district differences were found for the other anthropometric, fitness, or skill variables listed.

The regression model for shooting accuracy was not statistically significant, $F(6, 384) = 1.197$, $p = .307$, $R^2 = .018$. By contrast, the model predicting dribbling time was significant, $F(6, 384) = 87.493$, $p < .001$, $R^2 = .578$ (adjusted $R^2 = .571$). In this model, Beep Test level ($B = −1.913$, $p < .001$) and VO_2max ($B = 0.391$, $p = .003$) were significant predictors. These coefficients describe conditional associations only and should not be taken as evidence that one variable causes the other.

5. DISCUSSION

The main finding was fairly clear: players with better Beep Test results and higher RAST average power tended to complete the dribbling task in less time. That fits with research on basketball's intermittent, high-intensity demands and the role of both aerobic and anaerobic fitness [2, 9]. Honestly, the pattern makes practical sense—players who can sustain effort and produce power may move through the drill more efficiently. Studies of female basketball players likewise indicate that the link between physical fitness and basketball-specific skills may depend on the test used and the intervention applied [1, 5]. Still, dribbling is a technical skill, and because this study was cross-sectional, it cannot show whether better fitness leads to better dribbling or whether other traits account for some of the relationship.

The strong positive relationship between body weight and RAST average power needs to be viewed cautiously. Body mass is part of the standard RAST power equation, meaning heavier participants can receive higher calculated power values even if their sprint times are about the same [8]. Height and BMI were also positively related to

calculated RAST average power, but these findings do not show that higher body weight or BMI independently improves basketball performance.

Shooting accuracy was not significantly related to any of the selected fitness indicators in the supplied analyzes. In other words, the aerobic and anaerobic measures assessed here did not show a statistically significant linear relationship with shooting accuracy in this sample. Basketball performance also depends on technical and skill-based factors, and results in female basketball players can differ depending on the skill test and physical attribute being examined [1, 5]. Technique, perception, psychological influences, and exposure to practice were not assessed independently in this study, so their individual contributions cannot be established.

The district analysis found a statistically significant, though small, difference in Beep Test level between Kottayam and Ernakulam. None of the other reported district comparisons reached statistical significance. The dribbling regression model accounted for 57.8% of the observed variation; however, overlapping anthropometric measures and the link between Beep Test level and VO_2max call for cautious interpretation. [7, 10].

6. CONCLUSION

Among 391 female basketball players aged 13–23 years in central part of Kerala, Beep Test level and RAST average power were associated with dribbling time: higher fitness scores were linked to faster dribbling. Shooting accuracy, however, was not significantly related to the selected fitness measures. Beep Test level differed modestly across district groups, whereas the other reported district comparisons were not statistically significant. These findings indicate associations, not causal effects.

7. Recommendations

Coaches might combine aerobic conditioning, repeated-sprint work, and regular dribbling practice while still setting aside time for focused shooting-technique training. Basketball field tests are useful for tracking fitness, provided they are given consistently and interpreted according to the quality they are designed to measure [2]. Research involving female basketball players also supports targeted, sport-specific practice, although training effects may differ across fitness and skill outcomes [1]. Fitness and skill assessments should follow consistent protocols and be considered alongside each athlete's age, training background, and individual development. Future research should use longitudinal designs, account for maturation and training experience, and assess a broader range of skills and movement outcomes. Researchers should also examine outcomes that depend less directly on body mass when studying relationships with RAST-derived power.

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