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Study on Statistical Parameters in Basketball for Junior Female Players in The Age Categories Under 13, Under 14, Under 15 and Under 16 Years Old

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Abstract
This study analyses the performance of junior female basketball players from CSM Bucharest by examining statistical parameters recorded during official matches of the 2024–2025 Romanian National Championship finals in the age categories U13, U14, U15, and U16. Thirty-nine female athletes aged 12–16 years (mean height 1.68 m) participated in the study. Eleven classical game-related statistical indicators were collected from 24 official matches, documented by certified FIBA game staff and centralized by the authors. The study proposes a performance model based on quantitative and comparative analyses of key performance indicators across age groups. The model is validated by the competitive success of CSM Bucharest teams, all ranked within the top five teams nationally. The findings may serve as a reference framework for specialists involved in designing training programs for junior female basketball players.

Keywords: *Basketball; Game-Related Statistics; Female Players; Performance Model, Performance Indicators; Junior Athletes.*

INTRODUCTION

Basketball is a rapidly evolving sport, characterized by increased game pace, tactical diversification, and continual refinement of players' technical skills [1]. These dynamic changes require the systematic reassessment of performance indicators, especially in youth categories where physical, technical, and cognitive development varies significantly [2-4]. The application of sport science and analytics to basketball has grown substantially, providing detailed insights into physical, tactical, and technical demands [5-7]. According to Wang, Sarker, and Hosoi [8], the integration of data-driven decision-making in basketball enhances performance outcomes, a finding consistent with developments in professional and semi-professional environments. Despite increased scientific interest, research on performance indicators in junior female basketball remains limited in the Romanian context. Given the central role of possessions and efficiency metrics in modern basketball analytics [9,10], studying these parameters in youth categories becomes essential for developing age-appropriate performance models.

Purpose of the study

The present research aims to:

1. Quantitatively and qualitatively evaluate game-related performance indicators for U13–U16 female basketball teams participating in the 2024–2025 Romanian National Championship Finals;
2. Compare statistical outcomes between CSM Bucharest and their opponents across age categories;
3. Develop a performance model based on empirical data that may guide training design and tactical planning in youth female basketball.

MATERIALS AND METHODS

Participants

The study included 39 female basketball players aged 12–16 years from CSM Bucharest who competed in the National Championship Finals of the U13, U14, U15, and U16 categories during the 2024–2025 season. All games analyzed were official competition matches and all athletes were registered competitors with valid FIBA medical certification.

Data sources and ethical considerations

Statistical data were collected from 24 official matches, using the standardized match sheets completed by the official scoring staff assigned by the Romanian Basketball Federation. The use of official records ensures data reliability and reduces observer bias. After each match, all individual and team statistics were centralized and verified for accuracy. Data were extracted from official FIBA game statistics recorded during the matches played in the 2024–2025 National Championship Finals. Because all data originated from publicly available official match reports, no personal or sensitive information was processed. Ethical approval was therefore not required.

Selection criteria

- participation in official final-stage matches;
- complete availability of game statistics;
- players with regular competitive participation throughout the season.

Data collection procedures

Statistics were collected by licensed FIBA statistician teams using standard digital scoring software. After official validation, records were centralized and re-verified by the research team to ensure data integrity.

Research Methods

To ensure analytical rigor, the following methods were used:

- Observation method: systematic evaluation of team performance across all official matches.
- Documentation method: review of specialized literature on basketball statistics and performance indicators.
- Statistical and mathematical analysis: descriptive statistics, percentage calculations, and comparative analysis between CSM Bucharest and opponents.

Performance Indicators

The study focused on 11 classical basketball parameters, as defined by Ley & Jack (2024)[9]:

- Points (PTS)
- Field goals made/attempted (FGM, FGA)
- 2-point and 3-point shooting (P2, P3)
- Free throws (FTM, FTA)
- Total, offensive, and defensive rebounds (OREB, DREB, TREB)
- Assists (AST)
- Steals (STL)
- Blocks (BLK)
- Turnovers (TO)
- Personal fouls (PF)
- Efficiency (EFF)

In table no. 1 we have the representation of the statistical parameters that were the basis of our research. The data represent average values derived from centralized statistical records collected during the final tournament games of the National Championships for each age category in the 2024-2025 edition. Using the observation method, it is possible to observe the differences between the average values recorded by our teams and their opponents. Preliminary observations:

- referring to the percentage of shots from action (FG %) we notice a decrease in the intermediate categories U14 and U15 determined by the age characteristics but also by the tactical progress specific to these age categories.
- free throw accuracy (1p %), assists (AST %), rebounds (REB) but especially efficiency in play (EFF) have a constant increasing trend from one category to another
- achievements in the chapter of foul balls (TO) are decreasing.

Statistic	U13	Opp U13	U14	Opp U14	U15	Opp U15	U16	Opp U16
Games (n)	7	7	7	7	5	5	5	5
2P Made	20.7	16.9	19.4	15.0	18.2	15.0	24.6	21.6
2P Attempts	57.6	60.0	60.1	53.1	55.2	48.0	62.0	54.8
2P %	36.0	28.1	32.3	28.2	33.0	31.3	39.7	39.4
3P Made	2.0	0.6	1.1	1.1	3.4	3.8	3.8	3.6
3P Attempts	11.6	5.4	12.3	9.0	20.8	21.2	19.2	17.2

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Statistic	U13	Opp U13	U14	Opp U14	U15	Opp U15	U16	Opp U16
3P %	17.3	10.5	9.3	12.7	16.3	17.9	19.8	20.9
FGM Total	22.7	17.5	20.5	16.1	21.6	18.8	28.4	25.2
FGA Total	69.2	65.4	72.4	62.1	76.0	69.2	81.2	72.0
FG%	32.8	26.8	28.3	25.9	28.4	27.2	35.0	35.0
FT Made	11.3	13.9	11.0	10.0	12.2	7.8	12.4	10.2
FT Attempts	27.3	28.1	23.4	19.9	22.2	16.6	28.4	17.0
FT %	41.4	49.2	47.0	50.4	55.0	47.0	43.7	60.0
Total Rebounds	53.4	55.1	56.7	51.3	62.6	48.2	66.6	45.4
Assists	7.9	7.6	10.7	6.9	11.6	11.0	12.8	16.2
Fouls (committed)	19.9	20.3	15.7	17.9	15.8	16.6	15.0	21.0
Turnovers	34.9	39.1	33.1	37.6	26.2	27.2	32.4	30.4
Steals	21.1	18.4	22.4	20.3	16.2	15.4	21.2	20.0
Blocks	3.7	1.6	3.9	3.1	3.4	3.0	1.8	1.6
Efficiency (EFF)	47.6	32.1	49.6	31.6	62.0	40.4	74.2	63.4
Points	58.7	49.3	53.3	43.4	58.8	49.2	73.0	64.2

Table 1. Statistical and performance representation for all age categories

Possession calculation

The definition of possession during a basketball game is absolutely necessary in establishing the starting point of our statistical analysis. A possession begins when a team gains control of the ball and ends when control is lost. [10].

Teams can lose possession of the basketball in several situations: through scored baskets or free throws, defensive rebounds, and turnovers. To win, teams and individuals try to score more points per possession than their opponents. Therefore, it is necessary to establish the average number of possessions at this competitive level. Possessions were computed using Oliver's formula to estimate possessions for team is [10]:

$$POSS = FGA + 0.44 \times FTA - Rof + TO$$

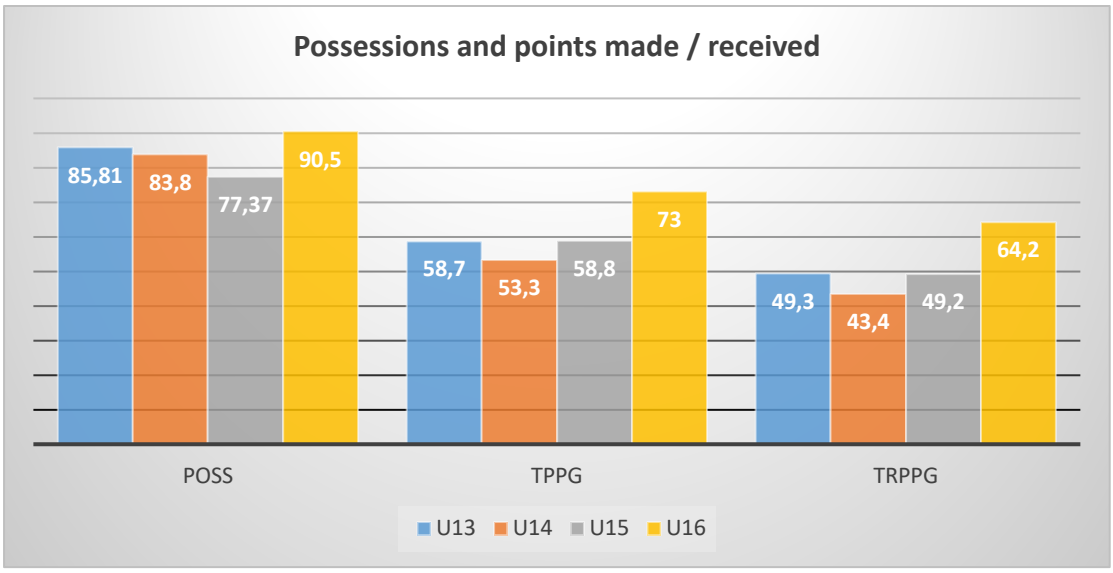

Figure 1. The evolution of the relationship between possessions, points scored and points

The the following statistical parameters Effective Field Goal percentage calculated using the formula EFG%= (2Pt + 1.5 x 3Pt) / FGA [10] and FT% (1p), FG% (2p) plus (3p represented in figure no. 2 provides specialists in the field an instant snapshot of what's happening in the game. If your team have beter results beat in all four stats, you will always win.

Basketball outcomes are strongly influenced by shooting efficiency and shot volume relative to the opponent, a finding consistently supported by performance analytics literature.

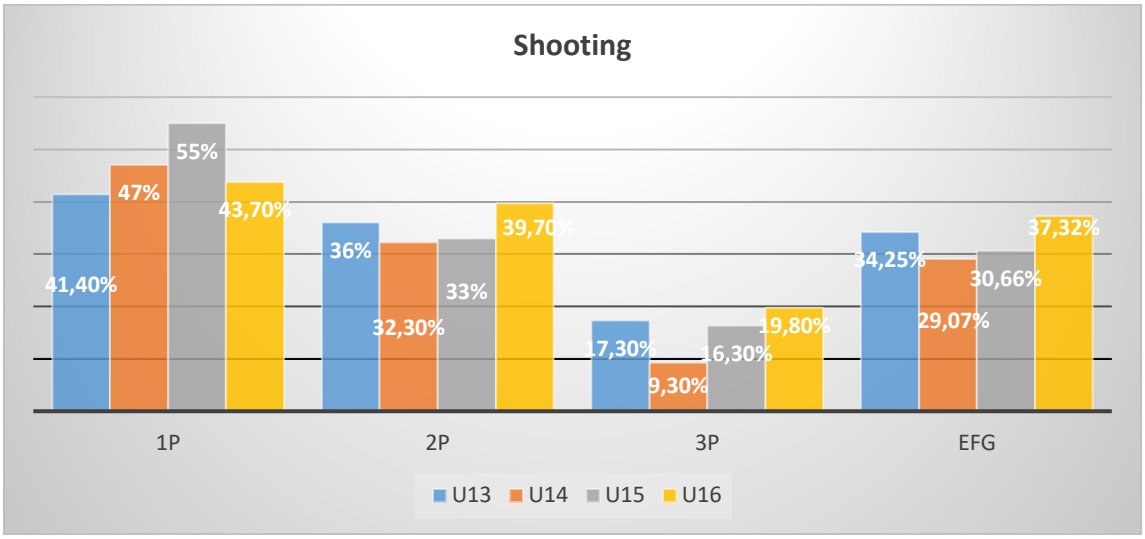

Figure 2. The evolution of percentage efficiency of throws to the basket

Data Analysis

- Descriptive statistics (mean, SD, skewness, kurtosis, CI 95%) were computed.
- Age group and opponent comparisons were interpreted descriptively to identify performance trends.

RESULTS

1. Shooting Performance

Across age groups, shooting efficiency showed:

- a slight decline in FG% for U14–U15, likely due to increased defensive and tactical complexity;
- a consistent increase in free-throw percentage (FT%) from U13 to U16;
- higher 3P% values in older age groups (U15–U16), reflecting improved shooting mechanics and tactical spacing.

2. Rebounding and Playmaking

Rebounding increased progressively with age, culminating in 66.6 total rebounds per game in U16. Assists also showed a positive trend, increasing from 7.9 (U13) to 12.8 (U16), indicating improved team coordination.

3. Defensive Indicators

Steals remained consistently above 16 per game across all categories, with peaks at U13 (21.1) and U16 (21.2). Turnovers showed a decreasing trend with age, suggesting improved ball-handling and tactical discipline.

4. Efficiency (EFF) and Scoring Output

EFF improved significantly with age group, from 47.6 (U13) to 74.2 (U16). Scoring followed a similar pattern, with U16 averaging 73 points per game.

5. Descriptive Statistical Analysis (Table 2)

Descriptive statistics	*FG%*	*FT %*	*REB T*	*AST*	*TO*	*STL*	*EFF*	*PTS*
Mean	29.92	49.21	54.91	10.59	32.61	19.38	50.11	56.24
Standard Error	1.32	2.12	2.50	1.10	1.62	0.88	5.45	3.35
Median	28.37	48.10	54.25	10.85	32.75	20.15	48.60	56.00
Mode	#N/A	47.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Standard Deviation	3.74	6.01	7.07	3.10	4.59	2.49	15.43	9.47
Sample Variance	14.00	36.07	49.97	9.62	21.11	6.22	238.02	89.73
Kurtosis	-1.73	0.20	-0.43	0.04	-1.06	-0.85	-1.15	0.00
Skewness	0.58	0.69	0.45	0.59	-0.05	-0.69	0.25	0.54
Range	9.07	18.60	21.20	9.30	12.90	7.00	42.60	29.60
Minimum	25.93	41.40	45.40	6.90	26.20	15.40	31.60	43.40
Maximum	35.00	60.00	66.60	16.20	39.10	22.40	74.20	73.00
Sum	239.37	393.70	439.30	84.70	260.90	155.00	400.90	449.90
Count	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Confidence Level (95.0%)	3.13	5.02	5.91	2.59	3.84	2.08	12.90	7.92

Table 2. Statistical analysis of the main game parameters

Descriptive statistics (table 2) were computed for eight performance variables, including field-goal percentage (FG%), free-throw percentage (FT%), total rebounds (REB T), assists (AST), turnovers (TO), steals (STL), efficiency (EFF), and points scored (PTS). Across variables, the means and medians were comparable, indicating generally symmetric distributions within the sample. Shooting performance showed moderate efficiency, with mean FG% of 29.92 and mean FT% of 49.21.

Productivity indicators also demonstrated consistent central tendency, with mean values of 54.91 for rebounds, 10.59 for assists, and 56.24 for points. Measures of variability revealed modest dispersion in most variables; standard deviations for AST (3.10) and STL (2.49) were relatively low, whereas EFF (15.43) and PTS (9.47) exhibited greater variability, indicating wider performance differences among observations. Ranges followed the same pattern, with the largest spread observed in efficiency (42.60) and points (29.60).

Distributional characteristics suggested largely normal or slightly platykurtic patterns. Skewness values were mild across all variables ($|skew| < 1$), with slight positive skew in FG%, FT%, AST, and PTS, and slight negative skew in TO and STL. Kurtosis values were predominantly negative, indicating flatter-than-normal distributions and an absence of extreme outliers. FT% and PTS displayed kurtosis close to zero, suggesting near-normal behavior.

Confidence intervals (95%) varied in width according to underlying dispersion. Narrow intervals for STL (±2.08) and AST (±2.59) indicated relatively precise estimates, whereas wider intervals for EFF (±12.90) and PTS (±7.92) reflected higher variability and reduced precision. Given the sample size ($n = 8$), these intervals should be interpreted with caution.

Overall, the descriptive analysis indicates stable performance patterns with limited skewness and moderate dispersion across most variables. Variation in efficiency and points scored suggests meaningful differences in player or team output, whereas more stable

indicators such as assists and steals appear consistent across observations. These characteristics provide a reliable foundation for subsequent inferential analyses

The descriptive statistics (Table 2) reveal:

- moderate variability across most variables;
- larger dispersion for EFF and PTS, suggesting performance differences among matches;
- normal to slightly platykurtic distributions, consistent with youth-level competitive heterogeneity;
- narrow confidence intervals for AST and STL, indicating stable team behaviors.

These findings support the reliability of the performance trends identified.

DISCUSSION

Quantitative analysis of basketball represents a specialized area within sports analytics that has, to a large extent, developed outside traditional academic environments. The objective of this paper is to synthesize the fundamental and broadly accepted elements of basketball performance analysis within an academic framework, thereby providing a unified reference point for future research in basketball analytics.

Performance analysis in team sports has predominantly focused on identifying performance indicators that discriminate successful teams from less successful ones [11–13].

Consequently, much of the existing research has employed static descriptive models, in which game performance is characterized through aggregated statistical measures that are subsequently examined in relation to final match outcomes [14].

The results confirm several age-related performance trends previously reported in the literature:

1. **Shooting performance** improves with age, particularly in 3-point accuracy, consistent with studies highlighting maturation and technical skill acquisition [1,3].
2. **Rebounding dominance** at U16 aligns with growth in anthropometric attributes and positional specialization [12].
3. **Turnover reduction** reflects better decision-making and tactical awareness, a critical aspect of youth player development [7].
4. **Efficiency output** correlates positively with scoring ability and possession management, reinforcing the value of possession-based metrics in youth basketball analytics [10].

The proposed performance model consolidates these findings into actionable benchmarks for coaches.

PROPOSED PERFORMANCE MODEL FOR U13–U16 FEMALE BASKETBALL

Based on empirical data and statistical interpretation, the following performance thresholds are recommended:

- **Possessions (POSS):** minimum **85 per game**
- **Points scored:** ≥ **70**; points allowed ≤ **51**
- **Field goal percentage (FG%):** approximately **30%**
- **Free-throw accuracy:** approximately **50%**
- **Rebounds (REB):** ≥ **55 total rebounds**
- **Assists (AST):** ≥ **11 per game**
- **Personal fouls (PF):** average around **17 per game**
- **Turnovers (TO):** < **30 per game**
- **Steals (STL):** > **20 per game**

- **Blocks (BLK):** maximum **3 per game**
- **Efficiency (EFF): ≥ 50**

These indicators may guide training priorities and tactical planning in junior female basketball. These findings demonstrate that statistical analysis provides essential feedback for optimizing training processes, improving tactical competencies, and enhancing long-term player development in junior basketball.

CONCLUSIONS

The quantitative analysis of game-related statistics provides valuable insight into the performance characteristics of junior female basketball teams. The study demonstrates clear developmental trends across age categories, including improvements in shooting efficiency, rebounding, teamwork, and defensive behavior. The proposed performance model offers a practical tool for coaches and performance analysts to evaluate and enhance team effectiveness.

Future research should include:

- inferential analyses comparing age groups statistically;
- longitudinal tracking of individual player development;
- integration of physical and biomechanical performance data.

Understanding performance patterns in youth basketball is essential for designing effective training periodization and optimizing long-term athlete development.

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