The impact of growth and maturation on athletic performance in adolescent female cricketers: age-related trends and training implications

El impacto del crecimiento y la maduración en el rendimiento deportivo de jugadoras de críquet adolescentes: tendencias relacionadas con la edad e implicaciones del entrenamiento

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Abstract

Purpose: This study aimed to investigate the growth, maturation, and performance characteristics of young female cricketers across the U15, U17, and U19 age categories, with a focus on age-related variations in performance relationships.
Material and Methods: This cross-sectional study included 93 female cricket divided into three age groups: U15 (n = 30), U17 (n = 36), and U19 (n = 27). Anthropometric data (height, weight, sitting height) and performance metrics (jump tests, sprint speed, agility, and aerobic capacity) were assessed. One-way ANOVA with Tukey's post hoc tests and Pearson correlations were used to analyze group differences and variable relationships.
Results: Significant differences in standing height and age at peak height velocity (PHV) were observed across all three age groups ($p < 0.01$), with U19 cricketers being the tallest and reaching PHV later. Weight differences were significant between the U17 and U19 groups but not between the U15 and U17 groups. Strong positive correlations were found between most performance metrics within each age group ($p < 0.05$), although these relationships generally weakened with age. For example, the correlation between speed and agility decreased significantly from U15 to U19. Interestingly, the Yo-Yo IR1, a measure of aerobic fitness, showed a negative correlation with speed, particularly in the U15 and U17 groups, indicating a potential trade-off between these attributes in younger Players
Conclusions: Growth, maturation, and physical performance are closely interrelated in young female cricketers, but the nature of these relationships changes with age.

Keywords

Adolescence; athletic performance; female players; growth; maturation; physical development.

Resumen

Propósito: Este estudio tuvo como objetivo investigar las características de crecimiento, maduración y rendimiento de jóvenes jugadoras de críquet en las categorías sub-15, sub-17 y sub-19, con un enfoque en las variaciones relacionadas con la edad en las relaciones de rendimiento.
Material y métodos: Se realizó un estudio transversal con 93 jugadoras divididas en tres grupos de edad: sub-15 (n = 30), sub-17 (n = 36) y sub-19 (n = 27). Se evaluaron datos antropométricos (estatura, peso, altura sentado) y métricas de rendimiento (saltos, velocidad, agilidad y capacidad aeróbica). Se aplicaron ANOVA de una vía con pruebas post hoc de Tukey y correlaciones de Pearson para analizar diferencias y relaciones entre variables.
Resultados: Se encontraron diferencias significativas en la estatura y la edad de pico de velocidad de crecimiento (PHV) entre los tres grupos ($p < 0.01$), siendo las sub-19 las más altas y las que alcanzaron la PHV más tarde. El peso fue significativamente mayor en sub-19 comparado con sub-17 ($p < 0.05$), pero no entre sub-15 y sub-17. Se observaron correlaciones positivas entre la mayoría de las métricas de rendimiento en todos los grupos ($p < 0.05$), aunque estas disminuyeron con la edad. La capacidad aeróbica (Yo-Yo IR1) mostró una correlación negativa con la velocidad en los grupos sub-15 y sub-17.
Conclusiones: El crecimiento, la maduración y el rendimiento físico están interrelacionados en jugadoras jóvenes de críquet, y estas relaciones varían según la edad.

Palabras clave

Adolescencia; rendimiento deportivo; atletas femeninas; crecimiento; maduración; desarrollo físico.

Introduction

Cricket is one of the most popular sports worldwide, especially in South Asia, Australia, the United Kingdom, and parts of Africa, with millions of participants and viewers. Although the sport has traditionally been dominated by male players, recent decades have seen a marked increase in female participation due to greater institutional support, expanding development pathways, and the growing visibility of elite women's competitions (Elyasi, 2024; Meier et al., 2021). It is widely regarded as a sport that demands a high level of skill, advanced tactics, and exceptional physical prowess (Noorbhai & Noakes, 2015). This is reflected in its growing popularity worldwide, particularly among women. In recent years, there has been increased attention to this field, especially regarding female Players transitioning into adolescence, as several developmental factors may influence their performance (Belton et al., 2014).

Adolescence, marked by significant physiological system growth and maturation, influences physical features that not only shape body measurements but also enhance athletic potential, mental health, supporting skill acquisition and overall performance progression (Jawis et al., 2005). In applied sport sciences, adolescence is widely recognized as a key phase in athlete development, rather than being uniquely significant to cricket (Dongoran et al., 2025). This period is characterized by rapid biological changes including increased estrogen levels, alterations in body composition, and shifts in musculoskeletal structure—physiological adaptations specific to females that can influence strength, power, speed, and endurance (Desbrow, 2021; Jimenez et al., 2023; National Academies of Sciences et al., 2019). These processes, occurring between the onset of puberty and biological maturity, affect athletic performance and injury susceptibility in complex ways (Towlson et al., 2021). For this reason, it is important to evaluate physical performance (rather than general fitness) within age-appropriate categories that reflect distinct developmental stages.

There is compelling evidence from sports science research indicating that growth and maturation play a crucial role in athletic development across various sports (Gunnar Mathisen & Pettersen, 2015). Multiple longitudinal studies have documented changes in anthropometric measurements, such as height and weight, throughout the maturation process. These changes significantly impact various physical attributes, including speed, strength, power, agility, and endurance (McNamara et al., 2017). Additionally, puberty is accompanied by hormonal changes that influence muscle mass, bone density, and cardiovascular capacity, which are particularly relevant for prepubescent coaches who set performance-oriented goals for Players aged 10 to 14 (Belton et al., 2014; Gunnar Mathisen & Pettersen, 2015).

Despite the extensive literature in sports science regarding the influences of menstrual cycle phases, few studies have specifically examined female Players in cricket. Most prior research has focused on male cricketers, providing valuable data on anthropometric and physiological determinants that could inform women's programs (McNamara et al., 2017). However, these findings may not be directly applicable to female Players due to inherent sex-specific differences in growth patterns, hormonal profiles, and physiological responses to training (Jawis et al., 2005).

Although research on female cricketers is comparatively limited, existing exploratory studies have revealed some interesting findings. Previous research has demonstrated a positive relationship between bat speed and greater muscle mass, as well as favorable anthropometric characteristics (e.g., height and body composition) (Fowlie et al., 2021). This suggests that taller individuals may have a higher likelihood of generating power when hitting compared to their shorter teammates at senior levels. Furthermore, anthropometric measures have been linked to bowling performance, and physical characteristics may be key determinants of skill in cricket players (Malina et al., 2015; Taylor et al., 2010). Earlier research examining the physical profiles of international-level cricketers has revealed distinct attributes between bowlers and batters, underscoring the importance of identifying unique physiological requirements related to playing position (Fowlie et al., 2021). Additionally, studies have shown a strong correlation between measures of strength, power, and throwing velocity in cricket players, highlighting the significance of these physical attributes in the context of fielding performance (McNamara et al., 2017).

The present study focused on female Players, using the terms "female" and "male" in reference to biological sex. The U15, U17, and U19 categories were selected because they align with typical phases of growth and maturation, as well as with the competitive structure of youth cricket programs. These groupings also correspond with key points in the adolescent trajectory when physiological development and training responses begin to diverge substantially. This study addresses a critical gap by examining the growth, maturation, and performance profiles of young female cricketers across the U15, U17, and U19 age groups. Specifically, we investigated anthropometric characteristics, age at peak height velocity, and key performance indicators, including jump height, speed, agility, and endurance, within each age group. Furthermore, we explored the evolving relationships between these performance attributes across the age groups to understand how the interplay between growth, maturation, and athletic performance may change during this crucial developmental period.

Therefore, the objective of this study was to investigate the growth, maturation, and performance characteristics of adolescent female cricketers across sub-15, sub-17, and sub-19 age categories, with a specific focus on age-related differences in the relationships among key physical performance attributes. This research will offer valuable insights for coaches, trainers, and sports scientists working with young female cricketers. Ultimately, it seeks to contribute to the development of more effective training programs that maximize athletic potential while safeguarding long-term health and well-being.

Method

Research Design

This study employed a cross-sectional design to investigate anthropometric characteristics, and physical performance among adolescent female cricket players in Bangladesh across three age groups (U15, U17, and U19). As a cross-sectional analysis, the findings reflect developmental differences at a single time point without projecting growth or maturation trends over time.

Participants

A total of 93 adolescent female cricketers from Bangladesh participated in this study. Participants were selected using a non-probabilistic, convenience sampling method, as no a priori sample size calculation was conducted. This limitation may affect the generalizability of the findings, and results should be interpreted with caution regarding external validity. Participants were drawn from inter-district competitive cricket squads and were categorized into three developmental age groups: Under-15 (U15, n = 30), Under-17 (U17, n = 36), and Under-19 (U19, n = 27). The age categories align with competitive youth structures in Bangladesh and were selected to reflect key developmental stages during adolescence. The mean chronological ages were 13.2 ± 0.3 years (U15), 15.4 ± 0.3 years (U17), and 17.3 ± 0.5 years (U19), respectively. All participants had a minimum of two years of formal cricket training and were actively engaged in regular training and match play. Inclusion criteria required that players be healthy, injury-free for the past six months, and actively training with their team at the time of data collection. Written informed consent was obtained from participants or their legal guardians, and ethical approval was granted by the institutional research ethics committee. Participants were classified as Tier 2 (Development Level) Players, following McKay et al. (2022), reflecting consistent training exposure and regional competitive experience (McKay et al., 2022). All participants followed a structured training schedule, participating in cricket practice four to five times per week, with each session lasting approximately 90 to 120 minutes. During the regular competitive season, players typically competed in one to two official matches per week. Training sessions were divided into approximately 40% technical skill development, 30% tactical instruction, and 30% physical conditioning. However, all data collection for this study was conducted during the pre-season phase, prior to the start of match play.

Familiarization and Pilot Testing

A pilot test was conducted one week before the formal assessment with five players from each age group to ensure equipment functionality, protocol standardization, and participant familiarization. Two familiarization trials were provided before data collection for each physical test.

Testing Environment and Schedule

All data were collected during the pre-season phase (December to January), between 8:30 a.m., and 11:30 a.m. prior to the start of competitive matches, to minimize fatigue-related performance variability and ensure consistent training exposure (Tillmann & Clayton, 2001). The sequence of tests followed the order in Table 1, beginning with anthropometric measurements immediately after warm-up to minimize spinal compression effects on height readings (Norton, 2018).

Warm-Up

All players completed a standardized 12-minute warm-up including light aerobic activity, dynamic mobility drills, and neuromuscular potentiation. This served to prepare the body physiologically and to stabilize height and posture before anthropometric measures, as early-morning compression effects can influence stature estimates.

Criterion Measures

Table 1 outlines all physical and anthropometric measures used, with corresponding equipment details, validity, reliability indices (ICC, CV, SEM), and source protocols.

Table 1- Overview of Physical Fitness and Anthropometric Measures

Test	Equipment (Brand & Country)	Outcome	Validity / Reliability	CV (%)	SEM	ICC	Protocol Source
Standing Height	Seca 213 Stadiometer (Germany)	cm	High (r > .98)	0.7	0.34	0.98	(Mirwald et al., 2002)
Sitting Height	Harpenden Sitting Height Table (UK)	cm	High (r > .96)	0.9	0.41	0.97	(Malina et al., 2015)
Body Weight	Tanita HD-351 Digital Scale (Japan)	kg	High (r > .99)	0.6	0.27	0.99	(Stewart et al., 2011)
Squat Jump (SJ)	Optojump Next (Microgate, Italy)	cm	ICC = 0.91–0.96	2.3	1.12	0.94	(Cormack et al., 2008)
Countermovement Jump (CMJ)	Optojump Next	cm	ICC = 0.93–0.98	2.7	1.45	0.96	(Bosco et al., 1983)
Drop Jump (DJ)	Optojump Next	cm	ICC = 0.87–0.92	3.1	1.68	0.91	(McMahon, 2020)
Speed (5m, 20m)	Brower Timing Gates (USA)	s	ICC = 0.92	1.8	0.07	0.93	(Cronin & Hansen, 2005)
Pro-Agility (5-10-5)	Brower Timing Gates	s	ICC = 0.90–0.93	2.2	0.09	0.91	(Draper & Lancaster, 1985)
MBCP	3kg Med Ball, Tape (Decathlon, France)	m	Moderate Validity	3.9	0.18	0.88	(Castro-Piñero et al., 2010)
Yo-Yo IR1	Yo-Yo Test Kit (Denmark)	m	ICC = 0.91–0.94	2.5	22.3	0.92	(Krustrup et al., 2003)

Note: MBCP assesses upper-body power indirectly via throwing distance, not in Newtons or Joules.

Data Collection Procedure

Measurements followed the order presented in Table 1. Anthropometric assessments were performed immediately after the warm-up and included standing height, sitting height, and body weight using calibrated equipment. Each measurement was taken twice; a third reading was used if values differed beyond predefined tolerances (0.5 cm for height; 0.2 kg for weight). Maturity offset was estimated using the sex-specific regression equation developed by Mirwald et al. (2002), which predicts the number of years before or after the individual's age at peak height velocity (PHV). A value of 0.0 indicates the predicted time point of PHV, while negative values indicate years before PHV and positive values indicate years after. PHV age was then calculated by subtracting the maturity offset from the athlete's chronological age (Mirwald et al., 2002). *Performance testing included Medicine Ball Chest Pass (MBCP), Squat Jump (SJ), Countermovement Jump (CMJ), Drop Jump (DJ), Sprint tests (5 m and 20 m), Pro-Agility Shuttle (5-10-5), and Yo-Yo Intermittent Recovery Test Level 1 (Yo-Yo IR1). Each test was administered according to validated protocols with two measured trials; the best performance was retained for analysis* (Bosco et al., 1983; Krustrup et al., 2003)*. Two to three minutes of rest were allowed between attempts to reduce fatigue.*

Personnel and Equipment

Testing was supervised by three trained assessors, each holding ISAK Level 1 certification and possessing experience in physical performance testing. All equipment was calibrated before each session, following the manufacturers' guidelines.

Measurement Tools and Reliability

Table 1 presents the measurement tools, outcomes, brands, country of origin, and reliability statistics including Intraclass Correlation Coefficient (ICC), Coefficient of Variation (CV), and Standard Error of

Measurement (SEM) (Koo & Li, 2016; Lexell & Downham, 2005; Sainani, 2017). All reliability values reported meet accepted thresholds for field-based testing in adolescent populations (ICC > 0.80).

Statistical Analysis

Statistical analyses were performed using SPSS (Version 26, IBM Corp., Armonk, NY, USA). Descriptive statistics (mean ± SD) and 95% confidence intervals were calculated for all variables. Normality was assessed using histograms, and Q–Q plots. Between-group differences in physical performance variables were analyzed using one-way ANOVA, followed by Tukey's HSD test for post hoc comparisons. Cohen's d effect sizes were calculated for pairwise comparisons using pooled standard deviations and interpreted as small (≥ 0.2), moderate (≥ 0.5), and large (≥ 0.8).

Pearson product–moment correlation coefficients were computed and visualized using heatmaps to examine relationships among anthropometric, maturational, and performance variables within each group. All correlations were tested at $p < 0.01$. Correlation strength was categorized as weak (r = 0.10–0.39), moderate (r = 0.40–0.69), or strong (r ≥ 0.70) (Evan, 1996). Given the large number of comparisons, the potential for inflated Type I error was acknowledged, and findings are interpreted accordingly.

Results

Distribution Plots of Anthropometric and Performance Variables

Here Histograms show the distribution of values, while Q–Q plots assess normality (figure 1). Alignment with the diagonal line indicates approximate normal distribution.

Figure 1. Histogram and Q–Q plots of Standing Height, Sitting Height, and Body Weight across age groups (U15, U17, U19).

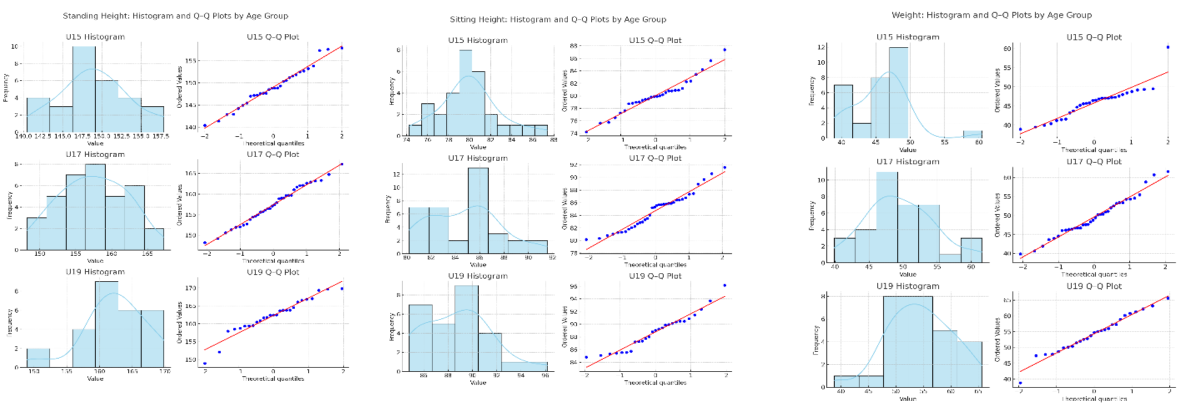
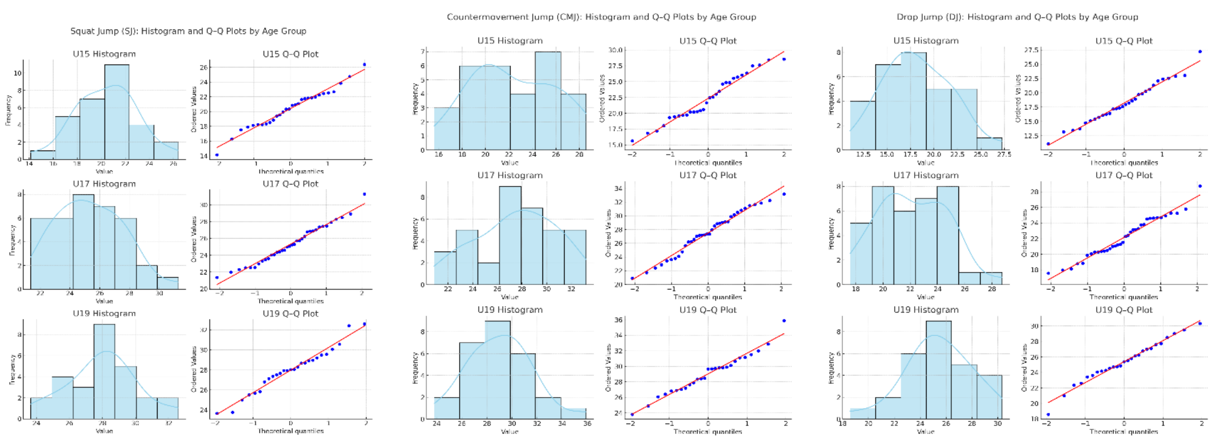
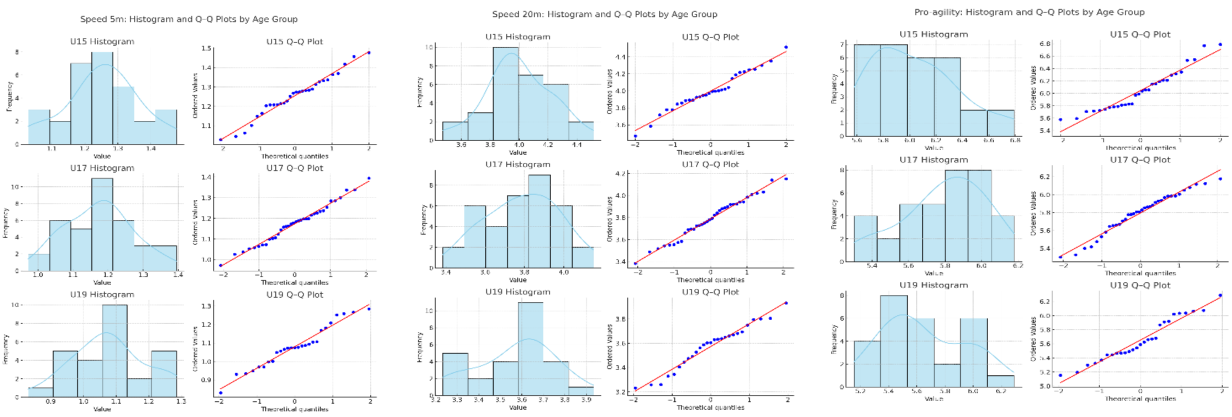


Figure 2. Histogram and Q–Q plots of Squat Jump (SJ), Countermovement Jump (CMJ), and Drop Jump (DJ) across all age groups (U15, U17, U19).



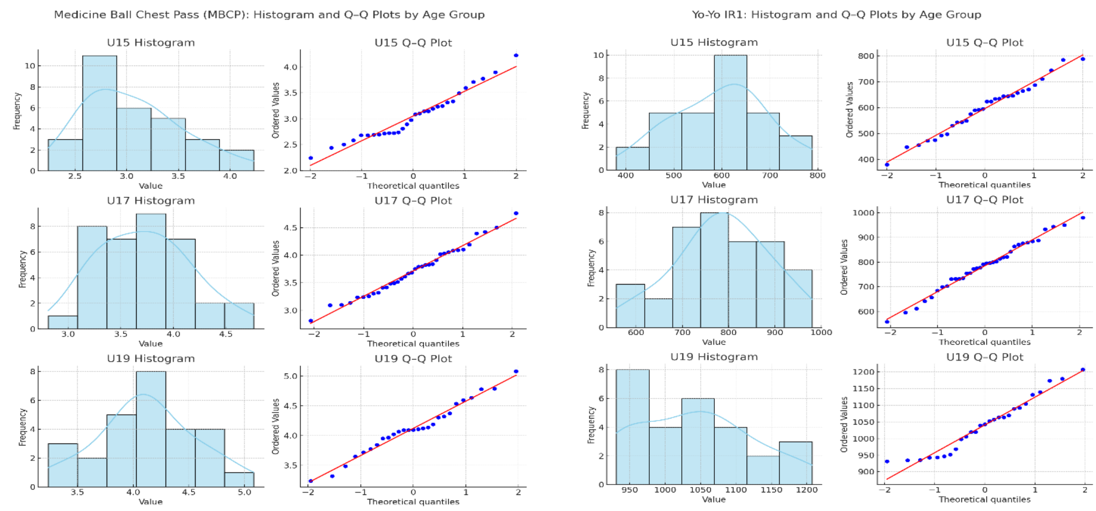
Here, Histograms show the distribution of values, while Q–Q plots assess normality. Alignment with the diagonal line indicates approximate normal distribution (Figure 2).

Figure 3. Histogram and Q–Q plots of Speed 5m, Speed 20m, and Pro-agility across age groups (U15, U17, U19).



Here, Histograms show the distribution of values, while Q–Q plots assess normality. Alignment with the diagonal line indicates approximate normal distribution (figure 3).

Figure 4. Histogram and Q–Q plots of Medicine Ball Chest Pass (MBCP), and Yo-Yo Intermittent Recovery Test Level 1 (Yo-Yo IR1) across age groups (U15, U17, U19).



Histograms show the distribution of values, while Q–Q plots assess normality. Alignment with the diagonal line indicates approximate normal distribution (figure 4).

Anthropometric and Maturation Characteristics

Table 2- Group-wise means (± SD), ANOVA results, and post hoc comparisons for anthropometric and maturation variables across U15, U17, and U19 players. Tukey's HSD test applied where significant.

Variable	U15 (Mean ± SD)	U17 (Mean ± SD)	U19 (Mean ± SD)	F (2, 90)	*p*-value	Post Hoc Comparison
Standing Height (cm)	162.0 ± 5.5	166.0 ± 5.5	168.0 ± 5.1	11.26	< .001	U15 < U17 < U19
Weight (kg)	57.7 ± 7.1	59.5 ± 6.8	63.0 ± 8.2	4.92	.009	U15 = U17 < U19
Sitting Height (cm)	83.0 ± 2.7	85.0 ± 3.4	86.0 ± 3.0	6.11	.003	U15 < U17 = U19
Maturity Offset (yrs)	−1.0 ± 0.3	−0.8 ± 0.4	−0.5 ± 0.4	89.30	< .001	U15 < U17 < U19
PHV Age (yrs)*	14.2 ± 0.3	16.2 ± 0.4	17.8 ± 0.4	—	—	—

Note: Maturity Offset refers to the number of years before (negative) or after (positive) peak height velocity (PHV), estimated using the Mirwald et al. (2002) equation. PHV age was calculated as: PHV age = chronological age – maturity offset. All F-tests significant at p < .05.

Table 2 presents the mean values, standard deviations, ANOVA test statistics, and post hoc comparisons for anthropometric and maturation-related variables across the three age groups (U15, U17, U19). Significant developmental differences were observed in standing height, body mass, sitting height, and maturity offset. A one-way ANOVA showed a significant effect of age group on standing height, F(2, 90) = 11.26, p < .001, with post hoc comparisons indicating that U15 players were significantly shorter than U17 and U19 players, and U17 players were shorter than U19 players.

Significant group differences were also observed in body weight, F(2, 90) = 4.92, p = .009. U19 players were significantly heavier than both U15 and U17, although no significant difference was found between the U15 and U17 groups. Sitting height differed significantly across age groups, F(2, 90) = 6.11, p = .003; U15 players had significantly shorter sitting heights than both U17 and U19, while the latter two did not differ from each other.

The largest between-group difference was found in maturity offset, F(2, 90) = 89.30, p < .001. U15 players had the most negative values (furthest from PHV), followed by U17 and U19 players. These results indicate progressively greater biological maturity with age. To aid interpretation, PHV age was calculated by subtracting the maturity offset from chronological age, confirming that older players were nearer to or past their peak height velocity, thus supporting the appropriateness of the developmental groupings used in this study.

Physical Performance Characteristics

Table 3- Descriptive statistics (mean ± SD), 95% confidence intervals, and Cohen's d effect sizes for physical performance variables across age groups (U15, U17, U19). Bolded values represent large effect sizes (≥ 0.80).

Variable	U15 (Mean ± SD, 95% CI)	U17 (Mean ± SD, 95% CI)	F (2, 90)	*p*-value	Post Hoc Comparison	U19 (Mean ± SD, 95% CI)	*d* (U15–U17)	*d* (U17–U19)	*d* (U15–U19)
Squat Jump (cm)	21.90 ± 3.40 (20.63–23.17)	24.50 ± 3.20 (23.42–25.58)	41.02	< .001	U15 < U17 < U19	27.50 ± 3.70 (26.04–28.96)	0.79	0.87	1.58
CMJ (cm)	25.70 ± 3.70 (24.32–27.08)	28.20 ± 3.30 (27.08–29.32)	28.84	< .001	U15 < U17 < U19	30.40 ± 3.10 (29.17–31.63)	0.71	0.69	1.38
Drop Jump (cm)	18.30 ± 2.50 (17.37–19.23)	19.60 ± 2.20 (18.86–20.34)	17.64	< .001	U15 < U17 < U19	21.20 ± 2.30 (20.29–22.11)	0.55	0.71	1.21
5m Sprint (s)	1.28 ± 0.04 (1.27–1.29)	1.26 ± 0.05 (1.24–1.28)	14.61	< .001	U15 > U17 > U19	1.24 ± 0.04 (1.22–1.26)	−0.44	−0.44	−1.00
20m Sprint (s)	3.91 ± 0.14 (3.86–3.96)	3.82 ± 0.15 (3.77–3.87)	28.49	< .001	U15 > U17 > U19	3.73 ± 0.13 (3.68–3.78)	−0.62	−0.64	−1.33
Pro-Agility (s)	5.48 ± 0.17 (5.42–5.54)	5.38 ± 0.15 (5.33–5.43)	35.62	< .001	U15 > U17 > U19	5.26 ± 0.13 (5.21–5.31)	−0.62	−0.85	−1.45
MBCP (m)	5.50 ± 0.70 (5.24–5.76)	5.80 ± 0.60 (5.60–6.00)	18.07	< .001	U15 < U17 < U19	6.30 ± 0.60 (6.06–6.54)	0.46	0.83	1.23
Yo-Yo IR1 (m)	790.00 ± 58.00 (768.34–811.66)	860.00 ± 61.00 (839.36–880.64)	76.45	< .001	U15 < U17 < U19	970.00 ± 63.00 (945.07–994.93)	1.18	1.77	2.97

Note: CMJ = Countermovement Jump; DJ = Drop Jump; MBCP = Medicine Ball Chest Pass; Yo-Yo IR1 = Yo-Yo Intermittent Recovery Test Level 1. F-values and *p*-values are from one-way ANOVAs with Tukey's HSD post hoc comparisons. Cohen's d effect sizes were calculated using pooled standard deviations. Bolded values represent large effects (≥ 0.80). Negative values indicate better performance for lower scores (e.g., sprint times).

Building upon the anthropometric and maturation profiles, table 3 presents descriptive statistics, 95% confidence intervals, ANOVA results, and Cohen's d effect sizes for physical performance variables across the U15, U17, and U19 groups. Significant differences were observed in all performance tests (p < .001), with progressively improved outcomes in older age categories. Jump performance (squat jump, countermovement jump, and drop jump) increased across groups. Squat jump height rose from 21.90 ± 3.40 cm (U15) to 27.50 ± 3.70 cm (U19), with a large effect size between the youngest and oldest groups (d = 1.58). Similar patterns were observed for countermovement (d = 1.38) and drop jump (d = 1.21), suggesting greater lower-limb power in older players. Sprint performance improved with age, as reflected by decreased sprint times. The 20 m sprint time decreased from 3.91 ± 0.14 s (U15) to 3.73 ± 0.13 s (U19), with a large negative effect size (d = −1.33), indicating enhanced linear speed. The 5 m sprint followed a similar trend (d = −1.00). Change-of-direction ability, measured by the pro-agility test, also improved, with performance times decreasing from 5.48 ± 0.17 s (U15) to 5.26 ± 0.13 s (U19). The large effect size (d = −1.45) reflects meaningful differences in agility across age groups. Upper-body power, as measured by the medicine ball chest pass, increased from 5.50 ± 0.70 m (U15) to 6.30 ± 0.60 m (U19), with a large effect size (d = 1.23). Finally, aerobic capacity, assessed using the Yo-Yo IR1 test, showed substantial improvements, increasing from 790 ± 58 m (U15) to 970 ± 63 m (U19). The effect size between U15 and U19 was the largest in the study (d = 2.97), indicating pronounced group differences in cardiovascular fitness.

These findings reflect distinct differences in physical capacities between age groups. While cross-sectional in design, the data suggest that older players may demonstrate superior physical attributes, potentially due to accumulated training exposure, maturational progression, or both.

Interrelationships among Performance Variables

Figure 5. Heatmaps of Pearson correlation coefficients among physical performance metrics across U15, U17, and U19 female cricket players.

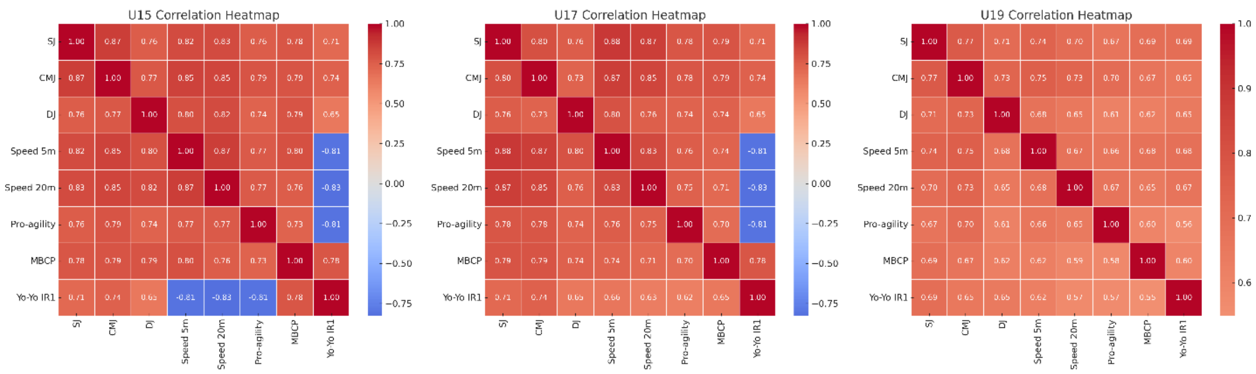


Figure 5 presents heatmaps of Pearson correlation coefficients among eight physical performance variables (SJ, CMJ, DJ, 5m sprint, 20m sprint, Pro-agility, MBCP, and Yo-Yo IR1) across the U15, U17, and U19 age groups. Each cell represents the strength and direction of association between two performance variables, with warmer colors indicating stronger positive correlations and cooler colors denoting weaker or negative associations.

In the U15 group, nearly all performance variables were strongly and positively correlated with one another ($r = 0.71$ to 0.87, $p < 0.01$), particularly among jump tests (SJ, CMJ, DJ) and sprint metrics. Notably, sprint performance (5m and 20m) demonstrated strong positive correlations with vertical jumps (e.g., CMJ and 5m sprint: $r = 0.85$) and a strong negative correlation with Yo-Yo IR1 performance ($r = –0.83$ for 20m sprint), suggesting a trade-off between anaerobic speed and aerobic capacity at younger ages.

In the U17 group, these relationships remained strong, with a continued trend of high correlations between explosive strength (SJ, CMJ, DJ) and sprint/agility outcomes (e.g., SJ and 5m sprint: $r = 0.88$). However, correlation magnitudes began to moderate slightly in comparison to the U15 group, indicating potential specialization or differentiation of performance capacities with increasing age. The inverse relationship between sprinting speed and Yo-Yo IR1 endurance performance persisted ($r = –0.81$), suggesting consistent physiological trade-offs during mid-adolescence.

In the U19 group, while most correlations remained statistically significant ($p < 0.01$), the strength of associations generally declined. For example, the correlation between CMJ and 5m sprint dropped to $r = 0.75$, and DJ with 20m sprint to $r = 0.65$. These findings suggest that as players mature, physical qualities may develop more independently, possibly due to biological, technical, or positional specialization. Interestingly, in contrast to younger groups, the Yo-Yo IR1 demonstrated moderate positive correlations with other metrics (e.g., SJ: $r = 0.69$; CMJ: $r = 0.65$), indicating a greater integration of endurance with explosive performance characteristics in older adolescent players.

Overall, the correlation analysis highlights a developmental progression in physical performance interrelationships. Younger players show more homogenous performance profiles, where improvements in one domain (e.g., jumping) are strongly associated with others (e.g., sprinting, agility). As players age, these relationships appear to become more specific and differentiated, reflecting maturational, training, and positional influences.

Discussion

This study aimed to examine differences in anthropometric, maturational, and physical performance characteristics among adolescent female cricketers across U15, U17, and U19 age categories. The findings revealed significant between-group differences in body size, maturity status, and physical performance outcomes, which may reflect the influence of biological maturation and accumulated training exposure during adolescence.

Significant group differences in standing height, sitting height, and maturity offset followed expected patterns of somatic growth in youth athletes (Carranza-García et al., 2024; Lloyd et al., 2016; Malina et al., 2015). U19 players were significantly taller and biologically more mature than their younger counterparts, consistent with prior work showing inter-individual variability in the timing of peak height velocity (PHV) among adolescent girls (McKay et al., 2022; Mirwald et al., 2002). The progression in maturity offset and estimated PHV age across groups supports the appropriateness of the selected age bands for developmental comparison.

While standing and sitting height increased consistently with age, body mass only differed significantly between U17 and U19 players. This finding may reflect variability in fat-free mass development (Petersen et al., 2011), training intensity (Jawis et al., 2005), and nutritional factors (Petersen et al., 2011), which are known to influence weight gain during adolescence.

All physical performance measures showed statistically significant differences across age groups. Vertical jump height (squat jump, countermovement jump, drop jump) increased progressively from U15 to U19, which may reflect maturational enhancements in neuromuscular coordination and lower-limb power output (Bosco et al., 1983; Hermassi et al., 2020). These results are in line with previous studies showing that muscle strength and coordination improve through adolescence as a function of both maturation and training exposure (Faigenbaum et al., 2009; Myer et al., 2013).

Sprint and change-of-direction performance (e.g., 5 m, 20 m sprints, pro-agility test) also improved with age, suggesting possible enhancements in force production, stride efficiency, and motor control with development (Bishop et al., 2021; Cronin & Hansen, 2005). Improvements in upper-body power (medicine ball chest pass) were moderate between U15 and U17 but became more pronounced in U19 players, potentially due to accumulated resistance training experience.

Aerobic capacity, assessed by the Yo-Yo IR1 test, showed the largest between-group difference, particularly between U15 and U19 ($d = 2.97$). This finding aligns with literature demonstrating significant improvements in cardiorespiratory fitness and oxygen transport capacity during adolescence (Baquet et al., 2003; Krustrup et al., 2003; McNamara et al., 2017). The ability to sustain high-intensity intermittent efforts becomes increasingly important in cricket (Portus et al., 2000; Renshaw et al., 2010), and age-related improvements in Yo-Yo IR1 scores suggest functional maturation of aerobic and recovery systems relevant to game demands.

Correlation analysis revealed age-dependent relationships among physical attributes. In U15 and U17 groups, explosive power (e.g., squat and countermovement jumps) was strongly associated with sprint and agility performance, suggesting that these physical qualities may develop in a tightly linked manner during early adolescence (Panoutsakopoulos et al., 2014; Taylor et al., 2010). In contrast, these associations were weaker in the U19 group, potentially reflecting increasing specificity in physical development based on positional roles, individualized training responses, or divergent biological maturity (Fowlie et al., 2021; Munro & Christie, 2018).

Furthermore, endurance performance (Yo-Yo IR1) showed moderate-to-strong negative correlations with sprinting ability in the U15 and U17 cohorts, indicating a possible physiological trade-off between aerobic and anaerobic development in early adolescence (Christie et al., 2020; Atan et al., 2012). However, this inverse relationship was less evident in the U19 group, where aerobic capacity became positively associated with strength and speed variables, suggesting more efficient integration of energy systems in later adolescence (Edwards et al., 2021; Weldon et al., 2021).

Limitations

This study has several limitations. First, the cross-sectional design prevents inference of causal relationships or developmental trajectories; longitudinal tracking would offer more robust insights into growth and performance changes over time. Second, participants were recruited through convenience sampling without an a priori power calculation, which may limit the generalizability of findings to the broader population of adolescent female cricketers in Bangladesh. Third, while Pearson correlation analyses were conducted across multiple variables, no formal correction for multiple comparisons (e.g., Bonferroni or False Discovery Rate) was applied. As such, there is an increased risk of Type I error, and correlation results should be interpreted cautiously. Finally, although maturity offset was used to estimate biological maturation, the Mirwald method may have reduced accuracy in females and should be interpreted within its known limitations.

Implications for Training and Talent Development

These findings have important implications for coaches and sports scientists working with adolescent female cricketers. First, the observed progression in performance metrics supports the need for age-appropriate training programs that align with biological development stages. Strength and power development should be emphasized in early adolescence, while later stages may benefit from increased focus on endurance and position-specific conditioning (Lloyd et al., 2016; Munro & Christie, 2018).

Second, the changing nature of correlations suggests that training priorities should evolve with age. For younger players, general athleticism—developed through multisport exposure and broad physical training may enhance overall potential. In contrast, older Players may require more tailored interventions that reflect the demands of their specific roles on the cricket field.

Finally, regular monitoring of growth, maturation, and performance indicators is essential for preventing injury and optimizing development. Tracking PHV and using maturity offset calculations can help identify Players at risk of overuse injuries during growth spurts (Brown et al., 2017; Malina et al., 2015). Incorporating individualized training loads and recovery strategies will further support long-term athletic success.

Conclusions

This cross-sectional study identified significant differences in anthropometric, maturational, and physical performance characteristics across three adolescent age groups of female cricketers. While older players generally demonstrated superior performance, the findings underscore the importance of considering maturation status when evaluating youth athletes. The evolving interrelationships among physical qualities across age groups suggest that training priorities and testing strategies should be developmentally appropriate. Future longitudinal research is needed to confirm these trends over time and to understand how biological maturation interacts with training to influence performance in female cricket players.

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