Physical profiling of international cricket players: an investigation between bowlers and batters

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ABSTRACT: This study aimed to develop a physical profile of international cricketers, and investigate if positional differences exist between bowlers and batters. Nineteen, international male cricketers, eleven bowlers (age 24.1 ± 5.2 years; height 179.73 ± 5.27 cm; weight 73.64 ± 6.65 kg), and eight batters (age 22.9 ± 3.8 years; height 180.25 ± 5.57 cm; weight 77.01 ± 8.99 kg) participated in this study. The physical test battery included; power, speed, strength and aerobic fitness tests. Batters demonstrated significantly higher scores for the countermovement jump ($p < 0.03$; ES = -1.55) and squat jump ($p < 0.03$; ES = -0.98). Furthermore, batters showed non-significant but small ES for faster 0–5 m (ES = 0.40) and 0–10 m (ES = 0.35) sprint times, superior hand grip strength (ES = -0.20), and higher Yo-Yo intermittent recovery test scores (ES = -0.46). Bowlers showed non-significant but small ES for faster 5 km time trials (ES = -0.51), lower bodyweight (ES = -0.42) and lower body fat percentage (ES = -0.30). However, intra-positional (i.e., seam and spin bowlers) and individual differences amongst players were observed. The physical profiles presented in this study can be used by coaches responsible for the physical development of cricket players to compare their existing data with. Furthermore, it is recommended that practitioners account for individual physical fitness profiles in addition to team profiles, to effectively design and evaluate tailored programs, with the aim of improving both physical and cricket performance.

INTRODUCTION

Cricket is an intermittent sport, characterized by prolonged low-intensity activity, interspersed by periods of high-intensity movements such as bowling and batting [1–4]. The physical demands of cricket depend on the match format (i.e. T20, one-day or multi-day cricket) and players' on-field position (i.e., bowler or batter) [3,5–7]. Performance indices such as total distance covered, high-speed running and the number of accelerations and decelerations are typically lower for shorter formats, whilst longer multi-day matches are more physically demanding [3,5–7]. However, recovery time between high-intensity efforts are almost a third longer in one-day and twice as long in multi-day matches, compared to T20 format cricket [5].

Successful performance in cricket requires a variety of physical and technical abilities [1,2,15,16,4,8–14]. There are similar traits between bowlers and batters, such as performing maximal sprints whilst approaching a bowling delivery and sprinting between the wickets to score runs [7,9,16]. Whereas, differences in the physical profiles of bowlers and batters have been previously identified [8]; therefore it is important players are physically prepared for the general demands of cricket, but also for their individual roles [8].

Fast bowling is considered the most physically challenging activity in cricket, due to bowling at speeds in excess of 140 km·h⁻¹ more than 120 times per day [1]. Fast bowlers can achieve ground reaction forces between 5 to 9 times their body mass, requiring high eccentric strength in the quadriceps, and a strong lumbopelvic area, in order to withstand this repetitive action [2]. Furthermore, lower-body power, such as the static jump, has demonstrated strong correlations with bowling velocity in both junior ($r = 0.86$) and senior players ($r = 0.74$) [10]. There is considerably less literature on spin bowlers, which may be due to fewer spin bowlers being selected in a team [17]. However, it has been reported that spin bowlers will conduct less high speed running and total distance covered when compared to fast bowlers [17].

Similarly, limited research exists on the physical and physiological attributes of cricket batters; however, it is suggested that developing upper-body strength, grip strength, rotational power, balance and proprioception, can benefit batting performance [4,18]. For example, higher upper-body strength levels in batters were correlated ($r = 0.63$) with increased maximum hitting distance [11]. Furthermore, a batter

scoring 100 runs could cover approximately 3.2 km in eight discontinuous 'active' minutes, running at approximately 24 km·h⁻¹ [12], with at least 100 decelerations [2]. Therefore, the ability to perform and recover from repeated high-intensity efforts is essential for batters. Although fielding is an important duty in cricket for bowlers and batters, requiring substantial aerobic and anaerobic fitness, as well as the physical ability to perform powerful multi-directional movements [1, 8], the focus of this study is explicitly between bowlers and batters.

Therefore, considering the positional variation, and similarities in physical demands, the aim of this study was to: 1) develop a physical profile of an international cricket team and 2) identify if any differences exist between bowlers and batters, prior to commencing an international cricket tournament.

MATERIALS AND METHODS

Subjects

Nineteen male cricketers (*n* = 11 bowlers and *n* = 8 batters), aged 23.6 + 4.6 years participated in this study, with 4.5 + 2.9 years competitive international cricket experience. Players were required to self-determine their predominant position as either a bowler or batter. Descriptive, anthropometric and body composition statistics are presented in Table 1. At the time of study the cricket team was an associate member of the International Cricket Council and ranked in the top 23 international teams for T20 cricket.

All players were available for international selection and currently participating in domestic club cricket. Players were free from injury during physical testing, which took place in February 2020, the middle of player's 50-over domestic season (i.e., 10 out of 18 matches played). Due to no international fixtures during this period, it was considered a pre-season. The eight weeks preceding physical testing, included; three 90 mins strength and conditioning (S&C) sessions, one 90 mins prehabilitation session, and 10 hrs of cricket skill practice, which were conducted with the international team. Players participated in one domestic club match each week during this period, with no additional training with domestic teams

due to being involved in the international high-performance program. The predominant focus of S&C programs during this phase was strength and power development. Subtle position specific variations were included within the S&C program, but training intensity and volume was kept the same across all players. This study was conducted in accordance with the ethical standards of the Helsinki Declaration and approved by the Research Ethics Committee of The Technological and Higher Education Institute of Hong Kong.

Design

A cross-sectional experimental design was used to create a physical profile of international cricketers using body composition measures and different physical tests. Some physical tests were required under the International Cricket Council High-Performance Programme (IC-CHPP) minimum standards testing battery (Table 3). The ICCHPP was designed based on different physical tests and standards established by the English Cricket Board, which have been used in prior research assessing professional cricketers [13]. Other physical tests were included to assess players muscular strength and aerobic fitness, and are outlined in the methodology. Although research has demonstrated differences between bowling positions [17], due to a low sample of spin bowlers (*n* = 3) compared to seam bowlers (*n* = 8) in this study, it was decided to pool all bowlers data together for statistical analysis. Thereafter, individual and intra-positional differences can be presented as figures within the results section.

Methodology

Body Composition: Height was recorded using a height measurement tape (Seca stadiometer, model 206, Germany), with bodyweight and body composition recorded using a bioelectrical impedance analyzer (InBody 720, InBody, Korea). This protocol was adopted from Esco et al [19]. Before each measurement, player's palms and soles were wiped with electrolyte tissue. Then, the players stood on the InBody 720 scale with their soles in contact with the foot electrodes and bodyweight was measured. Descriptive information was entered into the instrument. Then, the player grasped the handles with the palms,

TABLE 1. Descriptive and body composition measures for international cricket players.

	Team (*n* = 19)		Bowlers (*n* = 11)		Batters (*n* = 8)		Effect Size (between groups)	
	Mean ± SD	*95% CI*	*Mean ± SD*	*95% CI*	*Mean ± SD*	*95% CI*	*Hedges G (95% CI)*	
Age (years)	23.58 + 4.60	21.5–25.6	24.09 + 5.22	21–27.2	22.88 + 3.80	20.3–25.5	0.25 (-0.67, 1.16)	Small
Height (cm)	179.95 + 5.25	178–182	179.73 + 5.27	177–183	180.25 + 5.57	176–184	-0.11 (-1.02, 0.80)	Trivial
Weight (kg)	75.06 + 7.68	71.6–78.5	73.64 + 6.65	69.7–77.6	77.01 + 8.99	70.8–83.2	-0.42 (-1.34, 0.50)	Small
Body Fat (%)	13.4 + 3.35	11.9–14.9	12.95 + 3.72	10.8–15.1	14.01 + 2.91	12–16	-0.30 (-1.21, 0.62)	Small

SD = standard deviation; CI = confidence interval.

fingers, and thumbs of each hand making contact with the hand electrodes, and the body composition analysis was undertaken.

Following familiarization of procedures and prior to each testing session, players completed a standardized whole body warm up for 15–20 mins, which included light jogging, movement drills, and dynamic stretching, followed by progressive plyometric drills and speed runs. Players completed all physical tests in the week preceding an international cricket tournament. Subjects were instructed not to perform any vigorous physical activities 24 hrs before testing, and to consume a normal diet.

Countermovement Jump (CMJ) and Squat Jump (SJ): Protocols were adopted from the ICCHPP, and an electronic jump mat was used for data collection (Kinematic Measurement System, Innervations, USA). Each jump test required players to stand on the jump mat with feet shoulder width apart and hands fixed to their hips throughout the movement. For the CMJ, players performed a quick countermovement to a self-selected depth, then immediately performed a maximal jump. Whereas, for the SJ players squatted to a 90° knee angle where a 4 sec count was held, then on the administrator's command of "go" players performed a maximal jump. Three trials, with 1 min recovery between trials, were completed for both jumps, and highest jumps used for data analysis.

20-Meter Sprint: This protocol was adopted from Nimphius et al [20]. Four pairs of photocells (Smart Speed, Fusion Equipment, AUS) were positioned at 0 m, 5 m, 10 m, and 20 m, at a height of 1.2 m and width of 1.5 m, to measure the 0–5 m, 0–10 m and 0–20 m intervals. Players started 0.3 m behind the starting line while another target cone was placed 4 m after the finish line to ensure no deceleration during the end of sprint. A standing start was used, and players self-selected their lead leg, which was kept constant throughout. Three trials, with 3 mins recovery between trials, were completed. Each split time and total sprint time was recorded to the nearest 0.01 sec, and fastest times used for data analysis.

Six-Repetition Maximum (6RM) Bench Press: This protocol was adopted from Wong et al [21]. A spotter was present throughout for safety, assisting with moving the bar to and from the starting position to above the chest, and changing loads between trials. Bench press grip was approximately 165% of biacromial breadth, and the movement started when the arms were fully extended above the chest. The barbell was lowered until it touched the chest at approximately nipple level and returned to the start position to complete one repetition. Players completed 2 warm-up sets of 8 repetitions at 65% and 75% of their 1RM bench press, which was estimated using previous 6RM bench press scores. Then players self-selected their 6RM load for the bench press test. Two-kilogram increments were added until players failed to complete 6 repetitions with proper technique, and no more than 4 total sets were completed. Five mins recovery was provided between trials.

Grip Strength: This protocol was adapted from Gatt et al [22]. The handheld dynamometer (Takei T.K.K.5001 GRIP-A, Takei Scientific Instruments, Japan) was individually modified for each player to ensure the base of the device rested on the first metacarpal and the handle rested on the middle of the four fingers. Players started in a standing position and arms positioned by their side in full extension, then were verbally encouraged to squeeze the dynamometer as hard as possible for 3 sec. Three trials were completed with dominant and non-dominant hands, and a 1 min recovery provided between trials. Each score was recorded to the nearest 0.1 kg, and highest scores used for data analysis.

Repetition Maximum (RM) Pull Ups: This protocol was adapted from Coyne et al [23]. Players performed pull ups using a neutral grip, and started with arms fully extended for a period of 2 sec (to eliminate initial body movements), then performed as many pull ups as possible. Repetitions were standardized as the mandible passing the horizontal plane of the pull up bar, and returning to the start position, with each repetition taking 4 sec to complete.

Yo-Yo Intermittent Recovery Test (IRT) Level 1: The protocol outlined by Krustrup et al [24] was used. The test consisted of two 20 m runs back and forth, between the starting and turning lines, with players required to finish each bout at the start line. Speed was controlled by audio beeps using a mobile device and Bluetooth speaker. Between each shuttle players had 10 sec recovery time, which allowed them to slowly jog between a 10 m recovery box, and be stood still on the start line ready for the next shuttle. Each player had one warning, if they did not reach the corresponding line before the beep or started a shuttle early before the beep. The second time this happened resulted in the previous shuttle's level being recorded for that players score. The tests consisted of four running bouts at 10–13 km·h^{-1} then another seven runs at 13.5–14 km·h^{-1}. Thereafter, levels progressed in increments of 0.5 km·h^{-1} after every eight running bouts. The test was marked out using cones with a 1 m width for each player.

Five-kilometer time trial: Players completed a 5 km time trial using commercially available mobile phone application Runkeeper (Asics Digital., Inc, Kobe, Japan). The Runkeeper application is valid and reliable for the measurement of running distance and time, with a 3% error value [25]. This application uses a global positioning system sensor within a mobile phone to accurately calculate distance and time [25]. Players placed their mobile device securely in their pocket throughout the time trial. Due to the international team having limited access to a cricket pitch at the time of testing, players completed their time trials using their club cricket pitch. Players were instructed to independently (i.e., not in groups) run around the circumference of the cricket pitch and send their times into the testing administrator for data analysis.

TABLE 2. Test reliability data for physical testing trials.

	Fitness Tests	ICC (95% CI)	SEM	CV (%)
Jump tests	CMJ (cm)	0.93 (0.84–0.97)	0.55	10.17
	SJ (cm)	0.96 (0.91–0.98)	0.56	11.17
Linear speed	5 m (s)	0.80 (0.61–0.91)	0.01	6.40
	10 m (s)	0.76 (0.54–0.89)	0.01	4.41
	20 m (s)	0.83 (0.67–0.93)	0.02	3.76
Strength	Hand grip (kg)	0.95 (0.90–0.98)	0.58	11.71

ICC = intraclass correlation coefficient; CI = confidence interval; SEM = standard error of the measurement; CV% = coefficient of variation; CMJ = countermovement jump; SJ = squat jump.

Statistical Analyses

A cross-sectional design was used to assess the body composition and physical capacities of international male cricketers. Statistical analysis was carried out using SPSS Version 26 (IBM SPSS Inc., Chicago, IL). All data was presented as mean scores ± standard deviation (SD) with 95% confidence intervals (CI). Normality was checked using the Shapiro-Wilk method, and intraclass correlation coefficients (ICC) and the coefficient of variation (CV) was used to calculate the relative and absolute reliability respectively between trials for all tests. The ICC values were interpreted as: < 0.50 = poor, 0.50–0.74 = moderate, 0.75–0.90 = good, and > 0.90 = excellent [26], whilst CV values < 15% were deemed acceptable [27]. To assess differences between positions, an independent samples *t*-test was used with statistical significance set at $p < 0.05$. The magnitude of differences were calculated using Hedges *g* effect

sizes (ES) and further interpreted as: < 0.2 = trivial, 0.2–0.59 = small, 0.60–1.19 = moderate, 1.2–1.99 = large, and ≥ 2 = very large [28].

RESULTS

All data was normally distributed ($p > 0.05$) and ICC's demonstrated good to excellent reliability and CV shown acceptable variability for all physical testing trials (Table 2). Batters showed significantly higher test scores for lower-body power compared to bowlers, with large to moderate ES for CMJ (ES = -1.55; $p < 0.03$) and SJ (ES = -0.98; $p < 0.03$), respectively (Figure 1). No other significant differences ($p > 0.05$) and trivial to small ES were observed between bowlers and batters for all other body composition and physical test variables measured (Table 3).

TABLE 3. Mean scores ± standard deviations (SD) for the group, bowlers and batters, and effect sizes between groups, for physical test best scores.

Fitness Test	Minimum Standards (ICCHPP)	Team (*n* = 19) Mean + SD	Bowlers (*n* = 11) Mean + SD	Batters (*n* = 8) Mean + SD	Effect Size (between groups) Hedges G (95% CI)	
Power:						
CMJ (cm)	40	41.93 ± 4.46	39.54 ± 3.35	45.21 ± 3.70*	-1.55 (-2.58, -0.51)	Large
SJ (cm)	36	38.64 ± 4.11	37.03 ± 3.80	40.86 ± 3.60*	-0.98 (-1.95, -0.02)	Moderate
Speed:						
5 m (s)	1.02	1.09 ± 0.07	1.10 ± 0.08	1.07 ± 0.06	0.40 (-0.52, 1.31)	Small
10 m (s)	1.76	1.84 ± 0.08	1.85 ± 0.09	1.82 ± 0.07	0.35 (-0.57, 1.27)	Small
20 m (s)	3.03	3.13 ± 0.12	3.14 ± 0.13	3.12 ± 0.11	0.16 (-0.76, 1.07)	Trivial
Strength:						
6RM bench press (kg)	-	67.14 ± 8.42	67.11 ± 9.53	67.19 ± 7.25	-0.01 (-0.92, 0.90)	Trivial
Hand grip (kg)	-	54.76 ± 5.98	54.23 ± 4.99	55.5 ± 7.45	-0.20 (-1.11, 0.71)	Small
RM pull ups	-	11.74 ± 3.74	11.82 ± 4.07	11.63 ± 3.50	0.05 (-0.86, 0.96)	Trivial
Aerobic fitness:						
Yo-Yo IRT (Level)	18.7	18.34 ± 0.81	18.17 ± 0.88	18.56 ± 0.70	-0.46 (-1.38, 0.46)	Small
5 km (minutes:seconds)	-	21.63 ± 1.28	21.34 ± 1.26	22.02 ± 1.28	-0.51 (-1.44, 0.41)	Small

* Denotes significance at $p < 0.05$. ICCHPP = International Cricket Council High Performance Programme; SD = standard deviation; CI = confidence interval; CMJ = countermovement jump; SJ = squat jump; 6RM = six repetition maximum; RM = repetition maximum; IRT = intermittent recovery test.
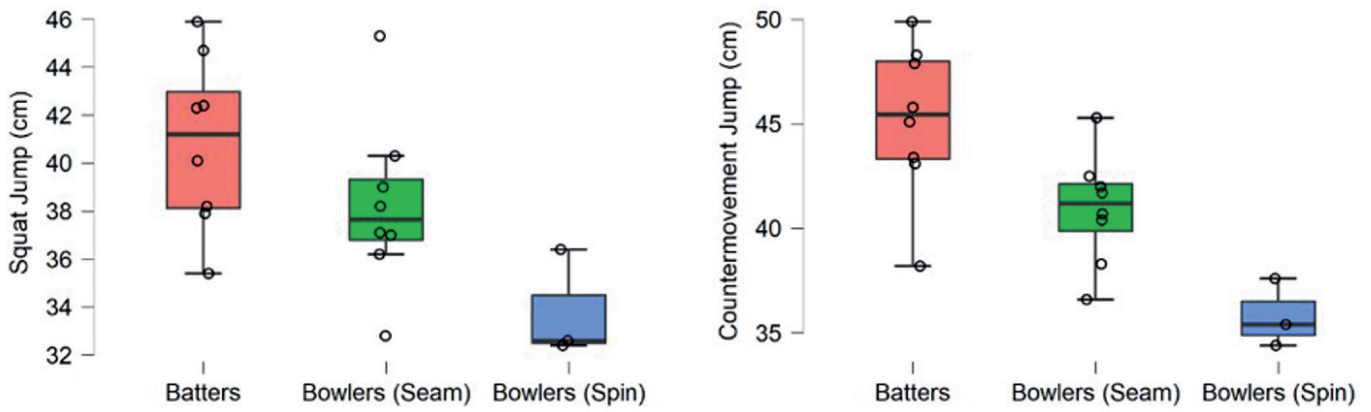
FIG. 1. Mean + standard deviations (SD), with individual data points of power test scores for batters, seam bowlers and spin bowlers.
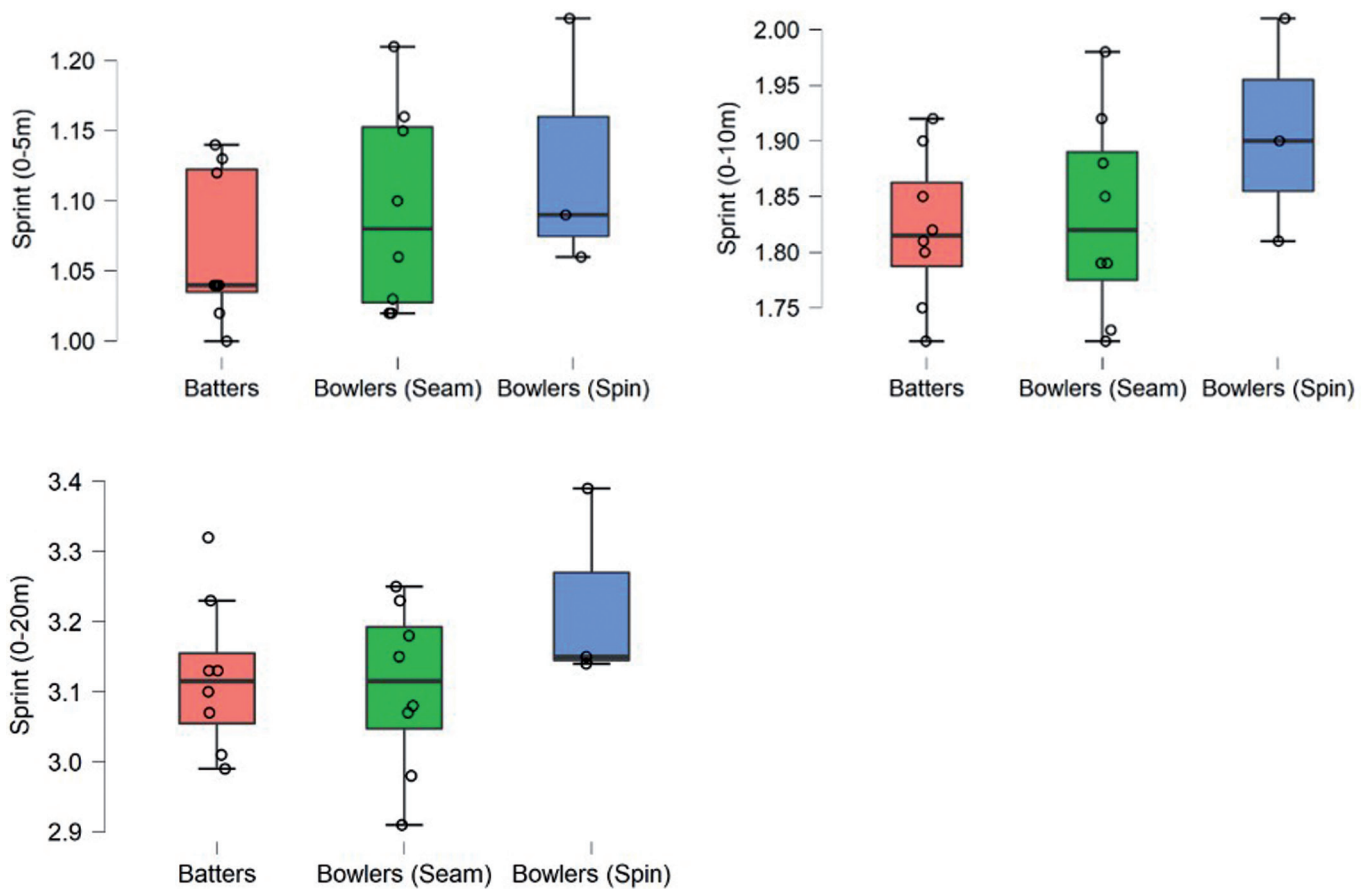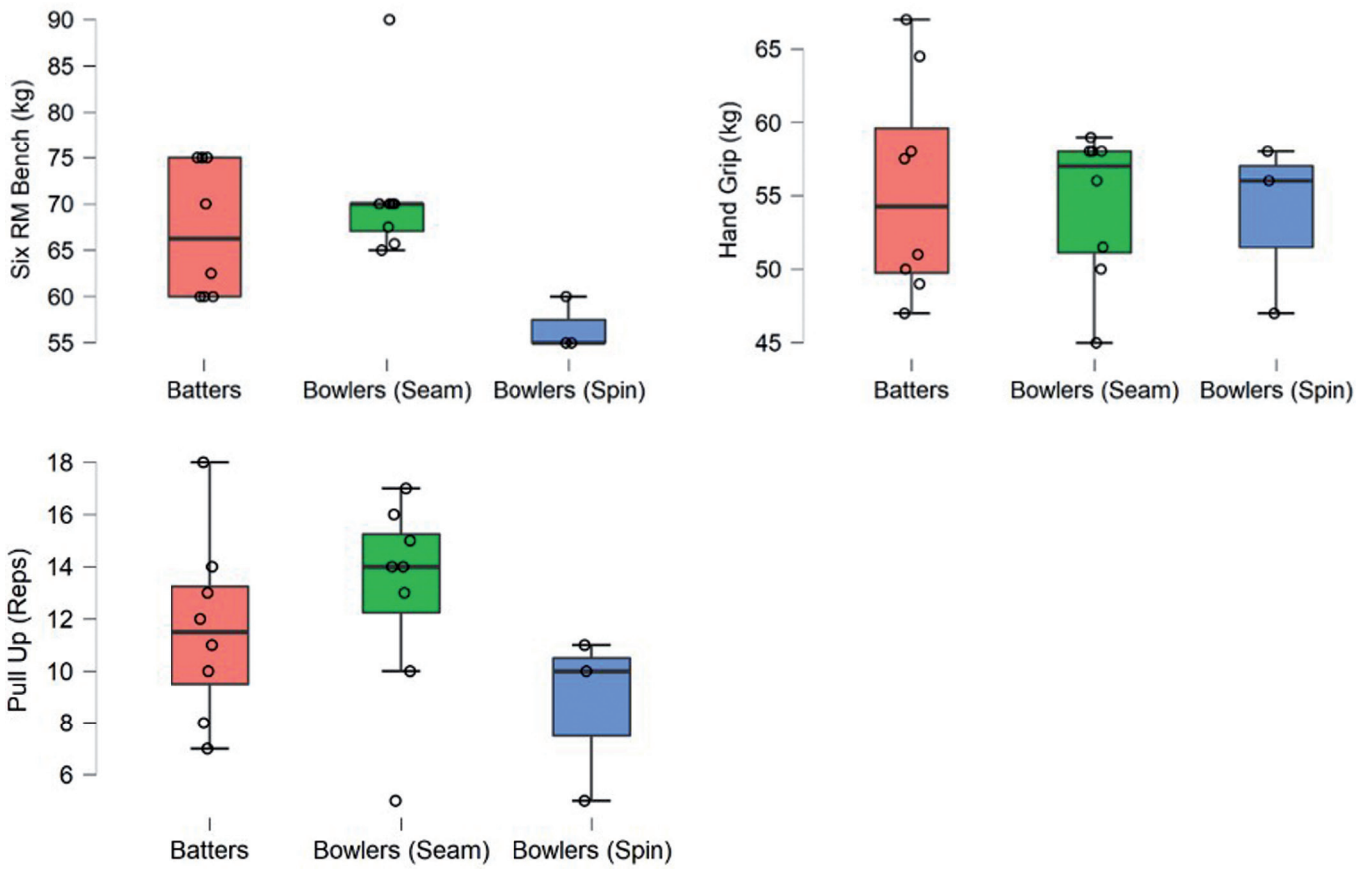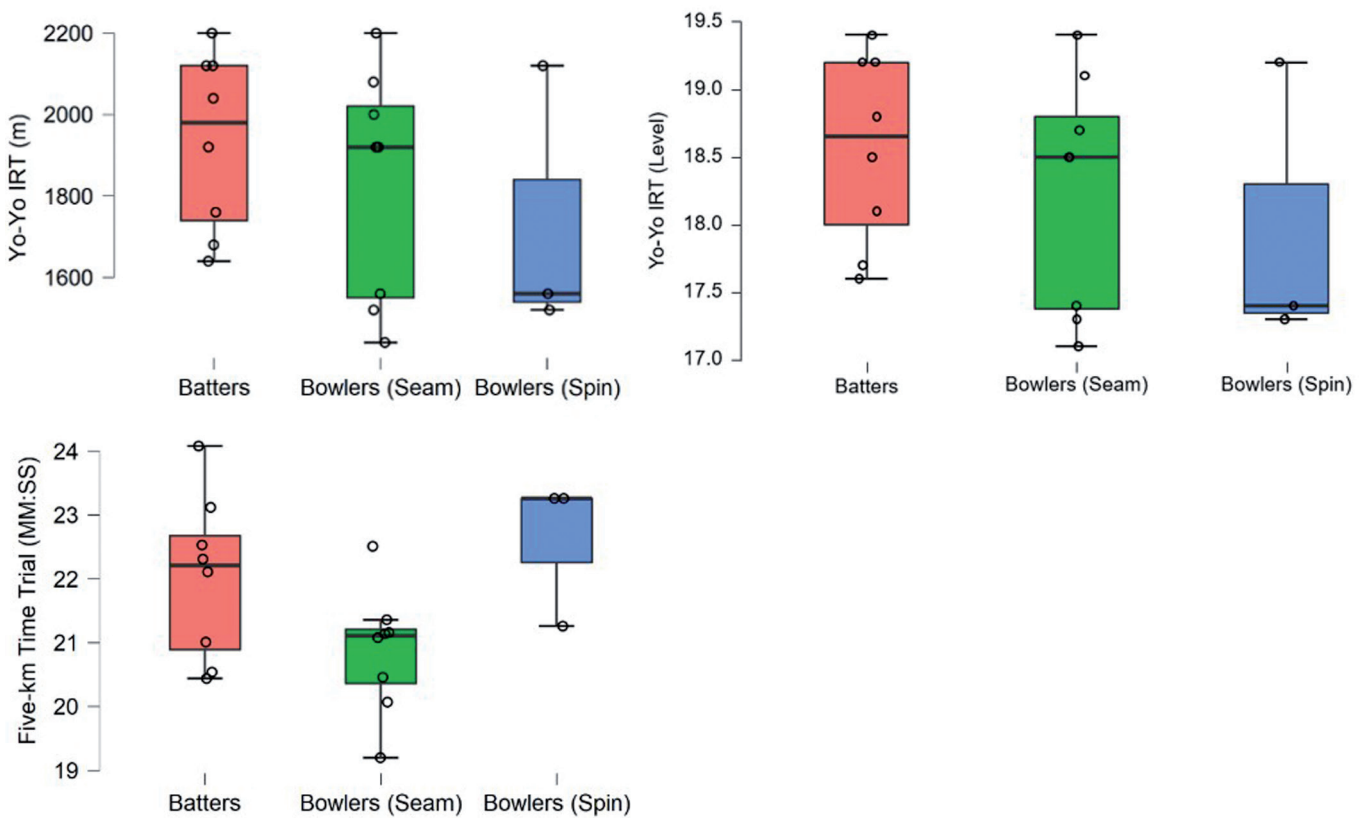

FIG. 2. Mean + standard deviations (SD), with individual data points of best speed test scores for batters, seam bowlers and spin bowlers.

FIG. 3. Mean + standard deviations (SD), with individual data points of best strength test scores for batters, seam bowlers and spin bowlers.

FIG. 4. Mean + standard deviations (SD), with individual data points of best aerobic fitness test scores for batters, seam bowlers and spin bowlers.

DISCUSSION

The aims of this study were to: 1) develop a physical profile of international cricketers and 2) investigate if positional differences existed between bowlers and batters, prior to an international cricket tournament. The most important findings were that batters showed significantly higher test scores for lower-body power compared to bowlers. Whereas, individual and intra-positional (i.e., seam and spin bowlers) differences were also observed.

Mean team values for lower-body power tests exceeded the ICCHPP minimum standards (Table 3) and were similar to elite English cricketers for SJ = 34–38 cm and CMJ = 37–44.5 cm [13–15]. Batters showed significantly higher SJ and CMJ scores than bowlers, and were 13% above the ICCHPP minimum standards. Results are similar to Indian state and national level cricketers for the broad jump, where batters showed superior scores compared to bowlers (233.55 cm versus 216.85 cm) [29]. Conversely, in elite English cricketers bowlers outperformed batters for the CMJ (45.7 cm versus 43.9 cm; ES = 0.2) [8]. Spin bowlers reported the lowest SJ and CMJ scores compared to batters and seam bowlers (Figure 1). Bowling velocity is strongly correlated ($r = 0.74$) with lower-body power, therefore possessing higher CMJ and SJ scores is likely more applicable to seam bowlers [17]. The strength and power development program conducted by players prior to testing, had small position and player specific variations, but no substantial differences in the intensity and volume of exercises prescribed. Therefore, differences in lower-body power may be attributable to the natural physical abilities of players leading to their suitability for their respective positions or position specific cricket practice and match-play. But it should also be considered that if greater individualization of physical training was prescribed, this may have developed players weaknesses as such.

Sprint test scores for 0–5 m, 0–10 m and 0–20 m were slower than the ICCHPP minimum standards. Twenty-meter sprint times were similar to elite English cricketers reported at the end of season, over 0–5 m (1.08 s), 0–10 m (1.83 s) and 0–20 m (3.12 s) [13,15]. However, were below elite English cricketers at the beginning of the season [13], in-season [15] and end of season [14], for 0–5 m (0.94–1.03 s), 0–10 m (1.68–1.76 s) and 0–20 m (2.96–3.07 s). Comparable to prior research in professional cricketers, no significant differences were observed between positions for speed [8]. However, in this study, batters produced quicker mean times over 0–5 m and 0–10 m although the effect size was small (ES: 0.35–0.40), which may be attributable to the relationship between lower-body power scores and acceleration [14,30]. Whereas, over 20 m, individual scores showed seam bowlers had the two fastest times and spin bowlers were commensurate with other positions except for one player who recorded the slowest time (Figure 2), demonstrating individual and intra-positional differences.

Upper-body strength scores were similar between positions, except for batters who possessed slightly higher scores for hand grip strength. Six out of eight batters recorded their highest hand grip scores with their dominant hand which was also the same as their batting stance

(e.g., right handed). It is suggested possessing higher hand grip strength positively influences batting performance, particularly when controlling the bat during ball impact [4]. Hand grip scores for bowlers and batters were greater than reported in elite Indian cricketers (42–51 kg) [31]. The estimated team values for 1RM bench press, derived from 6RM scores were 80 kg [32], which is below reported in elite South African cricketers (96 kg) [11]. However, similar to previous research, no differences were observed between positions in bench press or pull up strength scores [4,29]. The average number of pull ups achieved in Indian state and national level cricketers were 14, which is above the mean team values in this study [29]. However, the aforementioned study did not fully report the methods used for recording pull ups [29], therefore results may not be comparable. The similar results between positions is likely due to the S&C program prior to physical tests, prescribed similar loads and intensities for certain compound exercises including the bench press and pull up exercises. However, individual differences were still observed. For example, one seam bowler performed a 6RM bench press of 90 kg (Figure 3), therefore individual strength profiles should be accounted and tailored for.

The mean team values for Yo-Yo IRT scores were slightly below the ICCHPP minimum standards and similar to previous research in elite cricketers (level 17.3–18.6) [13]. Small positional differences were observed with batters achieving slightly higher Yo-Yo IRT scores, which prior research suggests that batters possess higher predicted VO_{2max} values compared to bowlers, using an intermittent shuttle test [2,8]. It is suggested that batters may have higher aerobic fitness levels, due to long and continuous bouts of high intensity running between the wickets [8]. However, seam bowlers demonstrated quicker 5 km time trials when compared to batters and spin bowlers (Figure 4), which may be attributable to the superior distances covered by fast bowlers during a cricket match [3]. For example, in elite Twenty20 format cricket, total distances covered by fast bowlers were approximately 4576 m walking, 752 m jogging and 803 m running, compared to batters who covered 1294 m walking, 134 m jogging and 300 m running [3].

In previous cricket studies, separately reporting positional body composition data is scarce, where studies have either focused on one position or pooled positional data together. Batters in this study tended to have higher body fat percentages compared to bowlers, which is demonstrated by small ES. Team values for body fat percentages were between 12–14%, similar to prior research [2,12]. Contrastingly, research has suggested that bowlers tend to be taller and heavier [4,8], whereas in this study there were no discernible differences in height and batters were heavier. The reason for differences with prior research are uncertain, but is possibly due to the small pool of players for selection in the country of study, whereas larger countries may use anthropometrical and body composition data for talent identification and position selection [33].

Limitations: This studies sample size is commensurate of prior research for international cricketers, however when interpreting results

for intra-positional differences only a very small sample was available for spin bowlers ($n = 3$). Therefore, pooling data across different nations using the same physical tests would provide a larger sample, but access to this information is limited. Nonetheless, to be transparent with our data, individual scores for all physical tests are provided. Although not all physical test scores met the ICCHPP minimum standards, this study provides much needed data on the physical capacities of international cricketers. In hindsight more comprehensively reporting body composition (i.e., lean muscle mass), would have provided further clarity to the similarities and differences amongst positions, and to further explain results of physical tests. Lastly, players independently reported 5 km time trials, where pitch surface and environment were not standardized, therefore reliability issues maybe raised with the reported data.

Practical applications

The team and positional physical profiles presented can be used by S&C coaches, and other personnel responsible for the physical development of cricket players, to compare existing player data with and encourage the continued use or adoption of reliable and reproducible methods in testing cricketers. It is important for practitioners to observe intra-positional differences (i.e., seam and spin bowlers), given the different match-play demands and physical capacities of players. Therefore, using team, positional and individual physical fitness profiles, provides S&C coaches a basis to design tailored programs, with the aim of improving both physical and cricket performance.

CONCLUSIONS

There is limited peer-reviewed information on body composition and physical profiles of international cricketers, which this study provides. Batters demonstrated superior lower-body power scores in the CMJ and SJ compared to bowlers. An eight-week strength and power development program led to similar physical test scores for strength, speed and aerobic fitness measures for bowlers and batters. However, differences were observed when assessing intra-positional (i.e. seam and spin bowlers) and individual test scores. Therefore, monitoring individual data and comparing that to the physical profiles presented, provides S&C coaches' valuable information to design and evaluate their programs.

Conflict of interest

No conflict of interest is declared.

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