Title: Comparison of the physical and technical demands of cricket players during training and match-play.

Running Title: Training and match demands of elite cricket players

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ABSTRACT

This study aimed to determine which training method (net-based sessions or centre-wicket simulations) currently used in national level and U19 male players cricket provided a more physical and technical match-specific training response. The heart rate, rating of perceived exertion and movement patterns of 42 male, cricket players were measured across the various training and match formats. Video analysis was coded retrospectively to quantify technical loads based on the cricket skills performed. Magnitude based inferences were based on the standardization of effect and presented with ±90% confidence intervals. Regardless of playing position, differences in physiological demands between training modes and match-play were unclear, with the exception of higher heart rates in fielders during traditional net sessions (mean heart rate: *d*= -2.7 [-4.7; -0.7]; 75% of maximum heart rate: *d*= -1.7 [-3.2; -0.2]). Typically, the movement demands of centre-wicket simulations were similar or greater than match-play, which was most evident in the distance travelled at a high-intensity within each playing position (batsmen: *d*= 6.4 [3.7; 9.2]; medium-fast bowlers: *d*= 1.71 [0.1; 3.3]; spin bowlers: *d*= 6.5 [0.01; 13.0]; fielders: *d*= 0.8 [-0.2; 1.7]), respectively. The technical demands of traditional net cricket training exceeded that of a typical match for each playing position. Specifically, fast bowlers delivered a greater number of balls during net-bowling compared to a match (*d*= -2.2 [-3.6; 0.9]). In conclusion, centre-wicket simulations more closely matched the physical demands of a One-Day match within batsmen and spin bowlers, whereas traditional cricket training often exceeded match-specific demands.

KEY WORDS: batting, bowling, movement analysis, team sports, training load

INTRODUCTION

In preparing training programs, coaches must consider the principle of specificity that the demands and movement patterns experienced during training should closely replicate that of match-play to gain maximal adaptation (18). Additionally, this principle must also be applied to the skills performed by the athletes to allow for improvements in technical performance, alongside match-specific movements. Ideally, coaches will develop effective skill-oriented training sessions that incorporate appropriate physical conditioning stimuli. As an example, the football codes often use match-specific training activities to replicate the physiological responses and physical demands of typical match-play (4, 12). Unfortunately, limited data exists examining the demands associated with match-specific training activities within more skill-oriented sports such as cricket.

Within high-performance cricket environments the majority of training sessions have typically involved net-based activities combined with fielding-specific drills, which are held separately to conditioning based training exercises (17). Petersen, Pyne, Dawson, Kellet and Portus (16) reported that skills sessions were performed at lower physical and physiological intensities than a typical competitive cricket match. Similarly, centre-wicket (game-based) simulations present a popular pre-competition training method that is implemented to replicate match demands, though such training is also performed at lower intensities than competitive match-play (16). Given the rigors of the current professional cricket schedules, elite cricket players are expected to perform to a continuous high standard with limited training and acclimation time prior to competition. In order to maximise the time available, training

sessions which more closely replicate a cricket match environment are more likely to provide the required specificity in the training response. (21,22). Furthermore, whilst this previous research informs as to the physical training stimuli of respective training modes, cricket training is often focused on the development of specific skill, especially given the high technical demands of the game. However, despite prior foci on the physical demands, the technical demands of the respective training modes remain to be reported. Given the importance of technical skill execution, while maintaining appropriate physical conditioning, it remains unclear which training modalities currently used by elite cricket are most effective at providing a match-specific environment.

Accordingly, the aim of the study was to quantify and compare the physiological, physical and technical demands of cricket players within respective playing positions, during traditional net-based training sessions and centre-wicket game simulations as to which was more representative of a typical limited over cricket match. Given the similarity to match conditions it was hypothesized that centre-wicket game-simulations would provide a more match-specific physical and technical demand.

METHODS

Experimental Approach to the Problem

The physical, physiological and technical demands of elite cricket training methods have attracted limited research attention and have been poorly described. To determine the comparative demands of training, two training methods (traditional net-based and fielding training, and centre-wicket game-based training) were compared to that of One-Day match demands. The physical (time-movement

characteristics), physiological (heart rate, rating of perceived exertion [RPE]) and technical (video analysis) demands were measured during all training sessions and matches for each playing position.

Subjects

A total of 42 male, cricket players (age: 23 ± 4 yr, height: 1.86 ± 0.07 m, body mass: 85.8 ± 8.5 kg) from the National Cricket Centre (Australia) participated in centre-wicket simulations and traditional net-based training throughout an 8 week training camp. Subjects performed a minimum of three cricket-specific training sessions per week along with a minimum of three strength and conditioning sessions. Additionally, 12 players (age: 18 ± 1 yr, height: 1.79 ± 0.06 m, body mass: 79.5 ± 11. kg) from the Australian under-19s squad (who were included in the original group of subjects which completed centre-wicket simulations and traditional net-based training) participated in competitive One-Day matches. Each player provided verbal and written informed consent after the study was approved by the University of Newcastle Human Research Ethics Committee (H-2010-1288).

Procedures

Prior to each training session (traditional net-based training: n= 14; centre-wicket: n= 5) and match (n= 5), participants completed a standardised 30 min warm-up, which included low-intensity running, dynamic stretches and cricket skill-based exercises as led by coaching staff. Before the commencement of each training session and match the coaching staff selected participants that were required to wear global positioning system (GPS) and heart rate monitoring devices. All players were

required to provide a RPE based on the Borg CR-10 Scale (7) following each training session and match.

During centre-wicket simulations participants practised technical skill under match-like conditions on a typical cricket field with the training environment (e.g. field dimensions, playing rules) controlled by the coaching staff and were performed under normal cricket rules (11) unless stated otherwise by the coaching staff. The duration of each centre-wicket simulation was determined for each playing position: batsmen: 33 ± 17 min, medium-fast bowlers: 77 ± 35 min, spin-bowlers: 81 ± 48 min and, fielders: 43 ± 35 min.

The net-based sessions required batsmen to continuously bat whilst a maximum of three bowlers per net continuously bowl during the session. All players were instructed by coaching staff to bat and bowl as they would during a typical match. During the net sessions bowlers were separated into specific nets dependent on whether they were a medium-fast or spin bowler. Batsmen swapped between the different nets during a session to ensure they batted against both types of bowling. The average duration of the batting session was 32 ± 10 min. Each bowler was restricted to bowling a maximum number of balls each session as determined by their individual bowling plans. The mean duration of a medium-fast and spin bowling session was 38 ± 12 min and 35 ± 9, respectively. Fielding sessions were completed separately to the net-based sessions and lasted 60 ± 16 min. During the fielding sessions participants were involved in a range of group and individual drills designed to train all aspects of cricket fielding including catching, throwing and ground fielding.

Data collected during both the centre-wicket simulation and the traditional cricket training sessions were compared to 50-over One-Day cricket matches, which were played against several national (under-19s) teams immediately prior to the ICC under-19s World Cup tournament. The difference in age and anthropometrical characteristics was evident between the training and playing groups was recognised as a possible limitation for the study. Participants performed as they would normally during any competitive One-Day match, only restricted by the rules outlined by the International Cricket Council (11). The duration of each match was categorised by playing position: batsmen: 47 ± 45 min, medium-fast bowlers: 148 ± 43 min, spin-bowlers: 149 ± 36 min and, fielders: 149 ± 43 min. Given the limited availability of players during matches the small number of measures taken from participants during One-Day match in comparison to the training formats was recognised as a limitation.

Physiological Measures

A Polar Team^2 System (Polar Electro Oy, Kemple, Finland) continuously measured (at 5 second intervals) heart rate throughout each training session and match. Each individual's maximum heart rate (HR_{max}) was determined based on the HR achieved prior to exhaustion from the performance of a Yo-Yo Intermittent Recovery Test Level 1 that was completed during a single separate session at the beginning of the training camp. The time spent (percentage of total time) >75%HR_{max} during each training session and match was calculated using Logan Plus 4.6 software (Catapult Innovations, Melbourne, Australia).

Following each centre-wicket simulation, traditional cricket training session and upon completion of each innings of each match; each participant provided a RPE using

the category-ratio 10 (CR-10) RPE scale (1). Training load (TL) was then calculated by multiplying each player's RPE by the duration (min) of each training session or match (7).

Movement Demands

The movement patterns of each participant during all training sessions and matches were recorded via global positioning system (GPS) devices (v6.65, MinimaxX, Catapult Innovations, Melbourne, Australia) sampling at a frequency of 10 Hz situated between the shoulder blades of each participant using a specially designed harness. Each GPS device was turned on 15 min prior to data collection beginning to ensure a satellite lock was established. Data was downloaded to determine movement characteristics of each participant following each session and match using Logan Plus 4.6 software (Catapult Innovations, Melbourne, Australia). Data was then reported as per hour to standardise between sessions of different durations (15). To ensure consistency between training sessions and match play the starting point of each bout was classified as the initial increase in velocity of the initial delivery and completed when no increase in velocity was observed following the final delivery/dismissal using Logan Plus 4.6 software (Catapult Innovations, Melbourne, Australia). To be classified as a high-intensity effort, subjects were required to perform for a minimum of 0.2 s at a speed of 3.5 $m \cdot s^{-1}$ or above (15). The time spent completing high- (running, striding, sprinting) to low-intensity (standing/walking, jogging) activity (15) was defined as high-intensity to low-intensity ratio.

Technical Skills

Each training session was filmed using a number of fixed video cameras (HDR-JP10E, Digital HD Video Camera Recorder, Sony, Japan) that were time aligned for analysis. During the net-based sessions, one was positioned on the cricket pitch behind the stumps at the opposite end to which each ball was delivered. During fielding training sessions another camera was placed to allow all players to be in view of the camera. During centre-wicket simulations and match-play, one camera was placed perpendicular to the pitch outside the playing area was used and a second was placed at one directly behind the pitch, above the sightscreen.

The video was retrospectively analysed after each training session and match to examine the technical characteristics of each playing position. Specifically, the number of deliveries faced and hit by batsmen was tallied from the video footage, along with the number of times dismissed and chances provided. During centre-wicket simulations and One-Day matches, chances were defined as a missed opportunity for dismissing a batsman by an opposing player (e.g. dropped catch or a missed stumping/run-out). As no fielders were present during traditional cricket training sessions, only dropped catches from bowlers (with no assistance from the surrounding nets) and edges hit directly behind the batsmen were considered to be a chance. Batting performance was assessed by classifying bat-ball contact as “good’, “bad” or “no” contact, with “no” being separated into “dot balls” and “play/miss” (10, 13). The number of balls bowled by fast- and spin-bowlers was also recorded. Further to this, the number of throws completed by each player when fielding was counted.

Statistical Analyses

All data were reported as mean ± standard deviation (SD). Any data recorded whilst a player was not directly involved in a training session or match was not included in analyses. Effect sizes (Cohen's *d*) (3) (small= 0.2-0.49, moderate= 0.5-0.79, large= >0.8) were used to quantify the magnitude of difference of the physiological, physical and technical measures within each playing format between the different formats. Confidence intervals (CI) (90%) for the (true) mean changes or between-group differences in the playing format were estimated using based on Hopkins (9). If the chance of both higher and lower values were both >5%, the true difference was deemed to be unclear (based upon the range of the confidence interval relative to the smallest worthwhile effect: 0.2 multiplied by between-subject SD)(9).

RESULTS

Batsmen

Despite changes in training and playing formats, there were no clear differences in any measures of HR were evident (Table 1). However, the RPE following both training formats was lower (traditional cricket training: *d*= 0.7 [0.0; 1.4], centre-wicket simulation: *d*= 0.8 [0.1; 1.4]) than that of match-play (Table 1). As expected a greater total relative distance was covered during match-play compared to centre-wicket simulations (*d*= 2.7 [0.6; 4.9]), although the comparison to net-sessions was unclear (*d*= 4.4 [-0.8; 9.7]) (Table 2). Further, the relative distance covered at a high-intensity was greater during match-play than both training formats (traditional cricket training: *d*= 10.4 [1.1; 19.7] and centre-wicket simulations: *d*= 6.4 [3.7; 9.2]). Interestingly though, the relative high-intensity distance covered and the number of high-intensity efforts during centre-wicket simulations was more comparable to

match-play than traditional cricket training (Table 2). Finally, a greater technical demand was provided through traditional cricket training than One-Day matches (Figure 1), whereas the opposite was observed during centre-wicket simulations. Specifically, more balls were faced (99 ± 37 balls·h^{-1}; *d*= -1.7 [-3.2; 0.1]) and hit (81 ± 33 balls·h^{-1}; 2.1 [-4.0; 0.2]) during traditional cricket training (One-Day match; 51 ± 15 balls·h^{-1}; 39 ± 13 balls·h^{-1}, respectively).

*****INCLUDE FIGURE 1 ABOUT HERE*****

Medium-Fast Bowlers

There was a a large difference (*d*= -1.0 [-5.6; 3.6]) in the percentage of time spent performing above 75%HR_{max} during traditional cricket training session compared to One-Day matches (Table 1). However, this did not translate into a greater RPE given both training formats reported lower RPE scores and by virtue, a lower TL (traditional cricket training: *d*= 1.3 [0.6; 1.9], centre-wicket simulation: *d*= 0.6 [0.3; 1.0]) than match-play (Table 1). However, greater relative distance covered at a high-intensity by medium-fast bowlers during traditional cricket training was evident (*d*= 1.71 [0.1; 3.3]) compared to match-play. Conversely, less relative distance was coveredduring centre-wicket simulations (*d*= 0.93 [0.0; 1.9]) compared to match-play (Table 2). Similarly, fewer high-intensity efforts were performed in net training compared to a match (traditional cricket training: *d*= -1.2 [-2.2; -0.2], centre-wicket simulation: *d*= -1.2 [-2.2; -0.3]) (Table 2). In regards to the technical demands of medium-fast bowlers, a greater number of balls were bowled each hour during traditional cricket training (62 ± 14 balls·h^{-1}; *d*= -2.3 [-3.2; -1.4]) and centre-wicket simulations (24 ± 13 balls·h^{-1};*d*= -2.2 [-3.6; -0.9]) than One-Day matches (21 ± 6 balls·h^{-1}), respectively.

*****ADD TABLES 1-2 ABOUT HERE*****

Spin Bowlers

As with batsmen, the difference between match and training formats for all HR measures remained unclear (Table 1). There was a reduced RPE following traditional cricket training (*d*= 2.0 [1.2; 2.8]) compared to One-Day match, although unclear differences were reported when compared to centre-wicket simulations (*d*= 0.8 [-0.2; 1.9]) (Table 1). Despite this, a moderate effect for a lower TL (*d*= 0.5 [-0.2; 1.9]) during centre-wicket simulations compared to One-Day matches was reported. With respect to the physical demands of spin bowlers, a greater relative distance was covered at a high-intensity during One-Day matches compared to traditional cricket training (*d*= 8.9 [3.5; 14.4]) and centre-wicket simulations (*d*= 6.5 [0.01; 13.0]) (Table 2). Yet the time between high- and low-intensity efforts was comparable between centre-wicket simulations and One-Day matches (*d*= 0.0 [-0.1; 0.1]), whereas a greater time between efforts was observed when compared to traditional cricket training (*d*= -1.2 [-2.7; 0.2]) (Table 2). A greater number of balls were delivered per hour during traditional cricket training methods, when compared to One-Day matches (102 ± 23 balls·h^{-1}; *d*= -3.4 [-3.9; -2.8]). Opposing this, was an unclear difference in the number of balls bowled during centre-wicket simulation (29 ± 24 balls·h^{-1}) and One-Day matches (18 ± 7 balls·h^{-1}).

Fielders

Unlike the other playing positions, traditional cricket training sessions resulted in a greater HR_{mean} (*d*= -2.7 [-4.7; -0.7]) compared to a match, which likely results from the greater time spent above 75%HR_{max} (*d*= -1.7 [-3.2; -0.2]) (Table 1). A lower TL

following centre-wicket simulations (*d*= 0.9 [0.6; 1.2]) was evident when compared to match-play (Table 1). Significantly less relative distance was covered during both formats (Table 2) than during One-Day matches (traditional cricket training: *d*= 1.2 [-0.1; 2.5], centre-wicket simulation: 1.4 [0.1; 2.6]). The moderate effect in the relative number of high-intensity efforts performed (*d*= 0.8 [0.2; 1.4]) and high- to low-intensity ratio (*d*= -0.7 [-1.1; -0.4]) suggest a decrease and increase, respectively, when compared to a One-Day match (Table 2). Unsurprisingly the relative number of throws was greatest during traditional cricket training, (68 ± 18 $\cdot h^{-1}$; *d*= -3.25 [-3.62; -2.88]) when compared to One-Day matches (4 ± 1 $\cdot h^{-1}$). By comparison though, there was a small effect (7 ± 4 $\cdot h^{-1}$; *d*= -0.20 [-0.33; -0.06]) for more throws per hour during centre-wicket simulations when compared to match-play was evident.

DISCUSSION

This is the first study comparing the physiological and physical, alongside the technical demands of national level and U19 male cricket players to compare match-specific responses for individual playing positions. Overall, no one specific training modality was more effective at providing players with a suitable environment for replicating all the demands of a typical One-Day cricket match with the most match replicable training environment dependant on the playing position. Regardless of playing position and physical demands however, a greater technical skill volume resulted from the traditional net-based cricket training as opposed to both centre-wicket simulations and One-Day matches.

Batsmen

The present findings suggest that centre-wicket simulations provide batsmen with a training environment that replicates a One-Day cricket match physical demands more so than traditional net-based training sessions (6, 15). Similar to the study of Vickery et al. (22) in which small-sided games were adapted for cricket, the use of game-based training appear more conducive to high-intensity running. This in part is likely due to the inclusion of running between the wickets as opposed to the practice of remaining stationary during traditional cricket training. This however did not translate into a greater RPE, as batsmen still perceived One-Day matches to be more intense than either training format. Unfortunately it is unclear if the increased running demands during centre-wicket simulations led to the greater heart rate responses during centre-wicket simulations in batsmen. This supports past observations that more game-based cricket training methods provide an increased physiological demand that are more replicable of a cricket match (22).

Despite increased physical loads during centre-wicket simulations, batsmen received greater opportunity to improve technical skill during net-based training with all measures of technical skill being significantly greater than those observed during a One-Day match. Most notably, the relative number of balls faced during traditional cricket training sessions was approximately double that faced during One-Day match-play or centre-wicket simulations. A similar result was reported within a previous study (22), whereby a more ‘closed’ environment such as a net session lead to an increase in the technical demands of batsmen. Although there was a greater opportunity for increased technical training during traditional net-based environments, the use of centre-wicket simulations provided physical demands that

were more representative of a One-Day match. Based on this evidence it is plausible to suggest that the use of centre-wicket game-simulations as a training format could provide cricket batsmen with a more match-specific, physically demanding training environment. However, this should be coupled with an environment that provides a greater technical stimulus.

Medium-Fast Bowlers

Unlike Vickery et al. (22), a more traditional cricket training approach provided a greater physiological response for elite cricket players as a result of the greater time spent performing above player's 75%HR_{max}. The current evidence also demonstrated that the physical demands during traditional cricket training sessions greatly exceeded those of medium-fast bowlers during One-Day matches. By comparison a lower physiological and physical demand resulted from centre-wicket practice. Despite previous research suggesting that the use of a game-based approach is effective at providing a match intensive environment for medium-fast bowlers, the comparatively reduced physiological and physical demand during centre-wicket simulations may be due to the greater size of the training environment. Within the current study, medium-fast bowlers trained on a full size cricket field whereas in the study of Vickery et al. (22), all players when bowling were restricted to the enclosed environment. This increase in playing field size may have led to an increase in the amount of low-intensity activity (stationary, walking or jogging), which is demonstrated by the fewer number of high-intensity efforts performed during centre-wicket simulations in the current study. Based on these findings it appears that net-based training sessions may provide a more physically demanding and match-specific training environment for elite cricket players.

The results also demonstrate that traditional cricket training is more likely to provide a technically demanding training environment, than that of a typical One-Day match. This increased technical demand during traditional cricket training most likely accounts for the physical demand of medium-fast bowlers given they are often synonymous (i.e. run in to bowl). Therefore, it appears that traditional cricket training in the current study more closely replicates, and in some instances exceeds the physiological, physical and technical demands of a One-Day cricket match within the current study and previous research (15). However, Renshaw et al. (19) suggests that the use of traditional training methods such as those used in the current study may limit the transference of decision-making ability and technical skill into an actual match-play.

Spin Bowlers

The small number of spin bowlers in the current study is likely to account for the lack of clear results particularly in regards to the physiological responses reported. Regardless, it was apparent that the physical demands observed during centre-wicket simulations, specifically the amount of high-intensity activity performed were more likely to re-create certain aspects of match play. These results concur with previous data that has observed game-based training to provide a more match-specific physical demand, particularly in regards to high-intensity performance for spin bowlers (21, 22). The more closely matched loads resulting from centre-wicket practice is likely the result of the greater proportion of distance spent performing at a high-intensity, and less time between low- and high-intensity efforts. The inclusion of the fielding aspect during centre-wicket simulations is likely the cause of the

similarity in the physical demands when compared to actual match-play, limiting the time between periods of high- and low-intensity in particular. It should be noted however that neither training format sufficiently provided spin bowlers with a physical demanding, match-specific training environment.

However as with medium-fast bowlers, traditional cricket training provided the most appropriate match-specific training environment from a technical perspective. A greater number of balls were bowled during traditional cricket training than One-Day matches. This however was not observed for centre-wicket simulations, with considerably fewer deliveries being bowled during the entire training session. Therefore, as suggested with medium-fast bowlers the use of both training methods is advantageous for specific aspects of a spin bowler's performance when training. A possible solution is that coaches may want to consider increasing the technical demands of spin bowlers during centre-wicket simulations which may lead to a more match-intensive and technically demanding training environment, although this may then have a significant overall effect on the TL placed upon spin bowlers.

Fielders

Previously, a similar physical and physiological demand resulted from the use of both game-based training and traditional fielding training (22). However there was a large disparity in the demands placed upon fielders in the training formats, with a similar TL resulting from traditional cricket training methods. Furthermore, the current study also shows a considerably greater physiological load occurs during traditional cricket training compared to One-Day match-play, which is related to the similar physical match demands. Similar to that which was reported for medium-fast

bowlers, traditional cricket training appears to provide a more suitable, match-appropriate physical training environment for fielders.

As in the study of Saw, Dennis, Bentley and Farhart (20) significantly more throws were completed during traditional fielding sessions compared to One-Day matches and centre-wicket simulations. Based on this, it has been recommended that throwing workload be monitored to minimise the chance of throwing-related injuries (20). The results of the current study suggest that the significantly greater number of throws completed during traditional cricket training sessions may increase the chance of injury. Therefore, the number of throws completed by fielders during centre-wicket simulations may be more appropriate in matching technical match demand. However, given the small number of throws completed during this training method, this may limit any improvements in throwing performance. As such, a compromise between traditional cricket training and centre-wicket simulations may be required in order to maintain a sufficient technical training volume.

PRACTICAL APPLICATIONS

The major finding of this study is that the most beneficial training format for conditioning purposes may be dependent on playing position combined with the objective of the training session. For example, with the current data suggesting that traditional cricket training may be more appropriate for providing a physically demanding yet match-specific training environment for medium-fast bowlers and fielders, yet the opposite for both batsmen and spin bowlers. Regardless of playing position however, the use of more traditional cricket practices was more likely to provide a considerably greater technical demand, however in the case of fielders

centre-wicket simulations provided more similarity to typical match-play. A major limitation of the use of traditional cricket training is that compared to game-based training such as centre-wicket practice the inclusion of match-specific scenarios for the purposes of developing a sense of match-awareness is difficult to employ. Therefore, the use of traditional cricket training methods is likely to be more beneficial when the objective of the training session is solely focused on developing the technical performance of elite cricket players. On the other hand, improving the physical conditioning response in a match-specific environment may be more suitable when performed using a more game-based approach.

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Table 1: Comparison of the physiological and perceptual responses (mean ± SD) by playing position during traditional cricket training, centre-wicket simulation and One-Day matches.

Position and Format	Mean Heart Rate ($b \cdot min^{-1}$)	Percentage Time >75%HR_{max}	RPE (CR-10)	Training Load (A.U.)
Batsman				
Traditional (n= 62)	137 ± 14	32 ± 30	2.9 ± 1.0	182 ± 78
Centre-Wicket (n= 25)	146 ±12	48 ± 27	2.7 ± 0.9	163 ± 55
Match (n= 11)	152 ±13‡‖	50 ± 29‡‖	3.4 ± 0.9§#	202 ± 55§
Standardised Difference				
Traditional/One-Day	0.8 (-0.4; 1.9)[a]	0.5 (-0.7; 1.8)[a]	0.7 (0.0; 1.4)	4.0 (-0.7; 8.8)
Centre-Wicket/One-Day	0.3 (-8.0; 8.6)[a]	0.3 (-4.0; 4.7)[a]	0.8 (0.1; 1.4)	0.1 (-1.8; 2.1)[a]
Medium-Fast Bowler				
Traditional (n= 101)	148 ± 16	54 ± 29	4.7 ± 1.1	301 ± 151
Centre-Wicket (n= 17)	128 ± 17	28 ± 15	4.5 ± 1.5	360 ± 209
Match (n= 9)	148 ± 9#	41 ± 13§‖	6.1 ± 1.0§#	366 ± 60§¶
Standardised Difference				
Traditional/One-Day	-0.4 (-1.8; 0.9)[a]	-1.0 (-5.6; 3.6)	1.6 (1.1; 2.2)	1.3 (0.6; 1.9)
Centre-Wicket/One-Day	-1.3 (-5.2; 2.7)[a]	0.2 (0.1; 0.4)[a]	1.6 (1.0; 2.3)	0.6 (0.3; 1.0)
Spin Bowler				
Traditional (n= 19)	130 ± 14	8 ± 16	3.6 ± 0.8	127 ± 48
Centre-Wicket (n= 9)	130 ± 22	15 ± 11	4.1 ± 1.0	249 ± 64
Match (n= 8)	125 ± 18‡¶	5 ± 6§¶	4.9 ± 0.6§#	293 ± 38§¶
Standardised Difference				
Traditional/One-Day	-0.7 (-3.3; 1.9)[a]	-0.3 (-2.9; 2.3)[a]	2.0 (1.2; 2.8)	1.0 (-0.1; 2.0)
Centre-Wicket/One-Day	-0.5 (-2.6; 1.6)[a]	2.1 (-1.4; 5.6)[a]	0.8 (-0.2; 1.9)[a]	0.5 (-0.2; 1.2)
Fielder				
Traditional (n= 35)	137 ± 12	32 ± 18	4.5 ± 1.0	307 ± 144
Centre-Wicket (n= 13)	116 ± 11	6 ± 9	3.0 ± 1.0	180 ± 60
Match (n= 10)	116 ± 19§#	21 ± 24§	5.0 ± 0.8‡#	300 ± 50#
Standardised Difference				
Traditional/One-Day	-2.7 (-4.7; -0.7)	-1.7 (-3.2; -0.2)	0.7 (-0.2; 1.7)[a]	0.1 (-0.3; 0.6)[a]
Centre-Wicket/One-Day	1.2 (-0.2; 2.7)	-0.2 (-1.7; 1.4)[a]	2.1 (1.4; 2.8)	0.9 (0.6; 1.2)

Difference in comparison to Traditional cricket training († small; ‡ moderate; § large); Difference in comparison to Centre-wicket (‖ small; ¶ moderate; # large). [a]Unclear true difference between formats.

Table 2: Comparison of the movement characteristics (mean ± SD) by playing positions during traditional cricket training, centre-wicket simulation and One-Day matches.

Position and Format	Total Distance ($m \cdot h^{-1}$)	High-Intensity Distance ($m \cdot h^{-1}$)	# High-Intensity Efforts ($\cdot hr^{-1}$)	High Intensity-to-Low Intensity Ratio (1:*x*)
Batsman				
Traditional (n= 62)	1512 ± 379	36 ± 71	11 ± 17	487 ± 445
Centre-Wicket (n= 25)	2284 ± 309	555 ± 191	59 ± 41	33 ± 15
Match (n= 11)	3230 ± 2702§#	772 ± 905§#	132 ± 250§#	41 ± 36§¶
Standardised Difference				
Traditional/One-Day	4.4 (-0.8; 9.7)[a]	10.4 (1.1; 19.7)	2.8 (0.2; 5.2)	-1.3 (-2.6; 0.1)
Centre-Wicket/One-Day	2.7 (0.6; 4.9)	6.4 (3.7; 9.2)	2.6 (1.4; 3.7)[a]	-0.7 (-4.6; 3.1)
Medium-Fast Bowler				
Traditional (n= 101)	4931± 788	1573 ± 370	183 ± 40	11 ± 3
Centre-Wicket (n= 17)	3854 ± 795	771 ± 385	88 ± 37	28 ± 15
Match (n= 9)	4653 ± 1743†‖	977 ± 527§#	114 ± 46§#	19 ± 6§#
Standardised Difference				
Traditional/One-Day	0.3 (-1.5; 2.1)[a]	1.71 (0.1; 3.3)	-1.2 (-2.2; -0.2)	1.8 (0.5; 3.1)
Centre-Wicket/One-Day	-0.3 (-1.9; 1.3)[a]	0.93 (0.0; 1.9)	-1.2 (-2.2; -0.3)	2.5 (1.2; 3.8)[a]
Spin Bowler				
Traditional (n= 19)	2975 ± 619	64 ± 163	72 ± 73	725 ± 549
Centre-Wicket (n= 9)	3075 ± 747	262 ± 141	42 ± 25	79 ± 47
Match (n= 8)	3486 ± 1248§‖	499 ± 420§#	59 ± 49	55 ± 38§
Standardised Difference				
Traditional/One-Day	1.1 (-0.6; 2.7)[a]	8.9 (3.5; 14.35)	0.1 (-0.7; 0.8)[a]	-1.2 (-2.7; 0.2)
Centre-Wicket/One-Day	0.3 (-1.9; 2.5)[a]	6.5 (0.01; 13.00)	0.1 (-0.5; 0.7)[a]	0.0 (-0.1; 0.1)
Fielder				
Traditional (n= 35)	2980 ± 850	394 ± 321	51 ± 37	63 ± 54
Centre-Wicket (n= 13)	2544 ± 697	219 ± 117	30 ± 17	96 ± 50
Match (n= 10)	3822 ± 1736§#	571 ± 431‡#	63 ± 48‡¶	40 ± 19‡¶
Standardised Difference				
Traditional/One-Day	1.2 (-0.1; 2.5)	0.8 (-0.2; 1.7)	0.5 (-0.4; 1.5)[a]	-0.5 (-1.4; 0.3)[a]
Centre-Wicket/One-Day	1.4 (0.1; 2.6)	1.0 (-0.2; 1.7)	0.8 (0.2; 1.4)	-0.7 (-1.1; -0.4)

Difference in comparison to Traditional cricket training († small; ‡ moderate; § large); Difference in comparison to Centre-wicket (‖ small; ¶ moderate; # large). [a]Unclear true difference between formats.

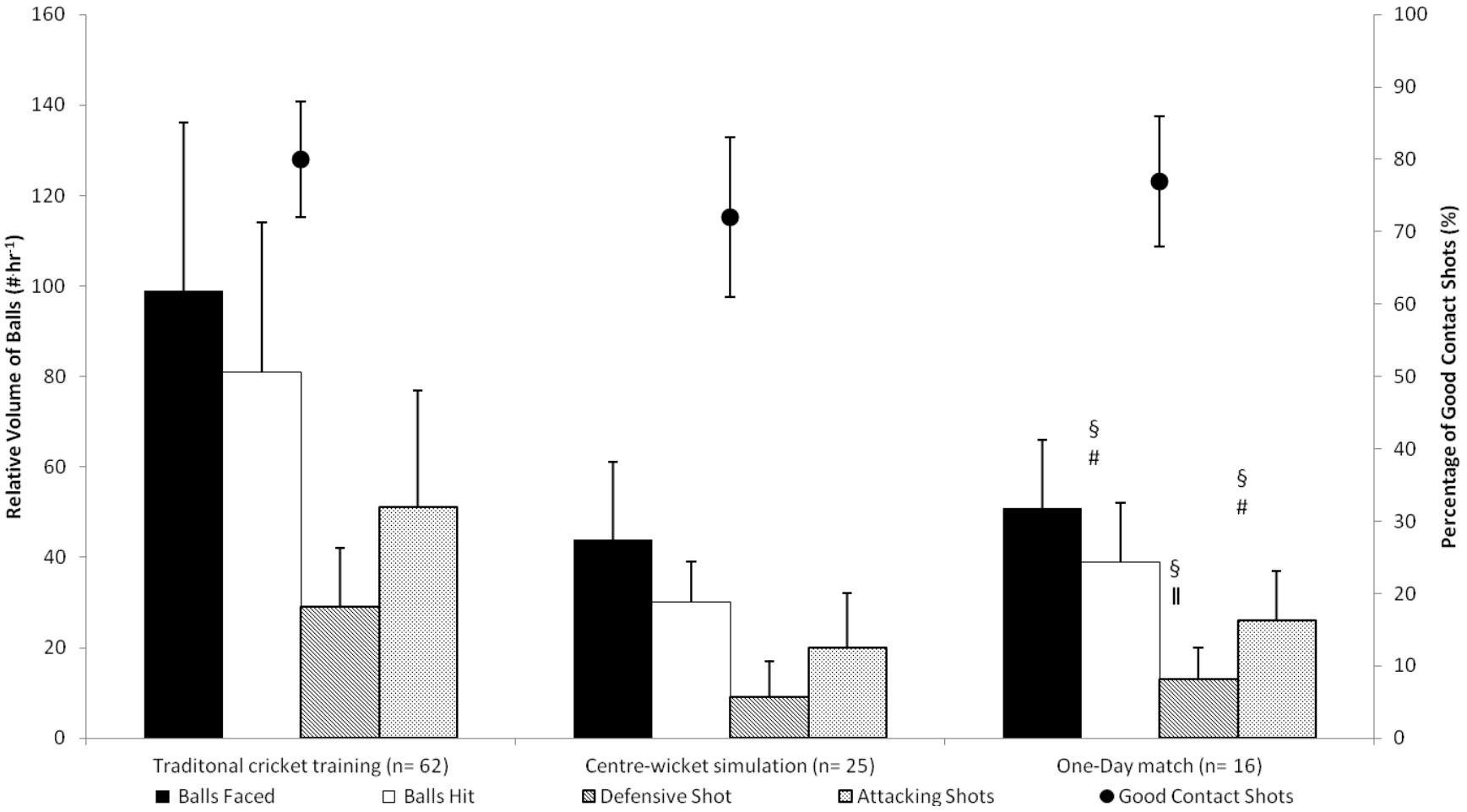

Figure 1: Technical characteristics of elite batsmen during traditional cricket training, centre-wicket simulation and One-Day matches. Difference in comparison to Traditional cricket training (Ⅱ small, § large); Difference in comparison to Centre-wicket simulations (# large).