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Research article

Movement Demands of an Elite Cricket Team During the Big Bash League in Australia

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Abstract
There is a lack of research on the movement patterns within Twenty20 (T20) cricket, thus the purpose of this study was to investigate the movement demands placed on elite T20 cricket players playing in The Big Bash League, in Australia, in the 2017/2018 season. Player positional movements were determined from the time motion data obtained from a portable 10 Hz global positioning (GPS) unit. Overall, all the players covered between 1.77km and 6.54km in a time ranging between 40.4 minutes and 96.5 minutes. Fast bowlers covered a mean distance of 6.5 (±0.5) km, batsmen 1.7 (±1.2) km and fielders 5.9 (±0.9) km. This is the first study that has looked at the movement demands of players in The Big Bash League and found that bowlers have the highest movement demands followed by fielding. With that, arguably, more attention needs to be devoted to bowling and particularly fielding which is often not prioritized. However, overall demands of T20 cricketers have decreased. Cricketers and coaches need to ensure that they adapt training to ensure that their players are physically prepared for the associated demands.

Key words: Twenty20, GPS, fast bowling, batting, fielding.

Introduction

Whilst cricket is one of the oldest organised sports, there has been little research done on the physical demands of the game (Christie, 2008; Woolmer and Noakes, 2008; MacDonald et al., 2013; Noakes and Durandt, 2000). Of the studies that have been done, most have used simulation protocols (Christie, 2008; Perera and Swartz, 2012; Pote, 2016) which have been criticised by some, questioning their applicability to 'real world' cricket (Petersen, 2010). Notwithstanding these debates, it is now understood that there are increased physical demands placed on cricketers which provides a further need for cricketers to be in peak physical condition at all times (Christie, 2008). The best physically prepared players will perform better, more consistently, have less injuries, and will have a longer and more successful career (Woolmer and Noakes, 2008).

Twenty20 (T20) cricket is the latest version of the game, (Perera and Swartz, 2012), and only one publication has quantified the positional movements in a study, which was delimited to state level players, and was done over 10 years ago. One of the more modern T20 competitions is The Big Bash League (BBL), which was established in 2011 by Cricket Australia, and which is the focus of this research.

The rules in T20 are effective in speeding up the game and with less time comes a greater chance of error, and with the margin for error being so small, there is a large amount of scrutiny placed on the execution of appropriate skills (Irvine and Kennedy, 2017). Winning T20 sides take more wickets in the first and last six overs of an innings (Petersen et al., 2009), and so one or two overs can have a significant impact on the outcome of the match (Irvine and Kennedy, 2017).

The T20 format is arguably the most physically demanding of all the formats and requires players to execute precision skill, under high levels of fatigue (Petersen et al., 2009). Physical fitness impacts on the ability to execute the required skills to carry out a particular game strategy, particularly when fatigued (Petersen et al., 2009). T20 has changed certain physical requirements for players (Robert et al., 2014) and requires 50-100% more maximal sprints per hour for all players when compared to multi-day matches (Petersen, 2010).

Sprints in cricket are often revolved around crucial match situations, such as running between wickets, a bowler's run-up, or sprinting to field the ball (Robert et al., 2014). A minimum of five players have to bowl in a T20, although more players can bowl if need be, making up just under half the team. All eleven players are tasked with batting, if required, however, the specialist batsmen are tasked with scoring the majority of the runs. All players must field and complete maximal sprints when fielding (Robert et al., 2014). In addition to superior physical fitness being a requirement of the game, strategies and tactics in all formats of the game, have not been looked at in scientific literature (Petersen, 2010).

With the increased knowledge of the positional game requirements of T20 cricketers, an understanding of this will allow conditioning coaches to design more effective, and individualised training programs (Petersen et al., 2009). Petersen et al (2009) found that, fast bowlers undergo the greatest workload at the highest intensities, and have 13 seconds less recovery time between high intensity efforts, as opposed to fielders. To account for this, it would be optimal for fast bowlers to seek fielding placements where they can enhance recovery between high intensity efforts, and limit the potential of fielding tasks, which impact on their bowling performance (Petersen et al., 2009). Petersen et al (2009) found that fast bowlers spent most of their time walking and their least amount of time running in the T20 format (Table 1).

The same has also been found with fast bowlers in the One Day International (ODI) format (Webster and Travill, 2018), and across all three formats, including T20, ODI and Multi-day (Petersen at al., 2010). In contrast, spin

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bowlers are able to commence their bowling with twice the recovery time from high intensity efforts (Petersen et al., 2009). Fielders spend most of their time walking and the least amount of their time running (Table 1) during a T20 game (Petersen et al., 2009). The ODI format has shown similar for fielders in terms of walking, but their least amount of time is spent striding and sprinting (Webster and Travill, 2018). Further, for fielders, they spend their least amount sprinting in all three formats (Petersen et al., 2010).

Wicket-keepers spend most of their time walking, and their least time sprinting (Table 1) in T20, which is the same for those playing in ODIs (Webster and Travill, 2018; Petersen et al., 2010) and multi day formats (Petersen et al., 2010).

Table 1. Petersen et al. (2009) percentage (%) of time spent at different speeds.

	Fast Bowling	Fielding	Batting	Wicket-Keeping
Walking	51	54	68	73
Jogging	26	25	16	20
Running	7	6	3	3
Striding	9	8	6	3
Sprinting	9	7	7	1

Batting in T20, requires more high intensity efforts than other formats of the game (Petersen et al., 2009). This results in higher levels of biomechanical and/or neuromuscular fatigue (Houghton et al., 2011). Batting, in this format, requires more frequent changes of direction when running between the wickets, as batters tend to run more frequently between the wickets, at a very fast pace, in order to gain extra runs where possible and to optimize the batting team's score (Houghton et al., 2011). It is therefore interesting that even in the T20 format, batsmen spend most of their time walking and less of their time running (Table 1) which is the same across all formats (Webster and Travill, 2018; Petersen et al., 2010). Since Petersen and colleagues (2009) work over 10 years ago, there have been no further published studies looking at these demands in T20 cricket.

It is clear that there has been a lack of research of movement patterns (inter-player total distance covered, number of sprints, and the mean sprint distance) of different positions in T20 cricket (Petersen et al., 2009), which is something that needs to be investigated further. However, coaching techniques have changed with different aspects coming into focus. For example, less time could be devoted to fitness and sprinting and more focus placed on power hitting, in order to maximise runs.

Global Positioning System (GPS) receivers can be considered a reliable tool for measuring distance travelled by athletes, in field-based team sports, where numerous changes in direction at high speed may reduce both reliability and validity (Gray et al., 2010). 10 Hz GPS units are acceptable for distinguishing the smallest change in velocity (Nell, 2016). With this being said, it would be recommended to have consistency in training, and competition, in terms of the equipment used. Thus, even if the device is not 100% accurate, one can compare current season to past season and/or training vs. competition. For example, conditioning coaches can measure speeds over a distance in all aspects of the game (Petersen et al., 2009). GPS data is being used by cricket conditioning coaches as a means to adapt the training of individuals. The use of this data is in direct relation to the measurement of both distances covered, and the different intensities of efforts used by individual players (Petersen et al., 2009).

The purpose of this study was to investigate the movement demands placed on elite T20 cricket players playing in the Big Bash League 2017/2018.

Methods

This study was a retrospective cohort study, with the methods adapted from Petersen et al (2009).

Participants

The sample was a sample of convenience and included seven male cricketers who were part of the same team playing in the Big Bash League in Australia during the 2017/2018 season. The twelve games were analysed which made up the competition.

Ethical considerations

Prior to the study, ethical approval was obtained by the Department of Human Kinetics and Ergonomics, Grahamstown, South Africa Ethical Standards Committee (HKE-2018-23). All players gave their written and informed consent, to obtain their data retrospectively. Permission was also granted by the team coaching staff and Cricket Australia.

Measurements and Quantification of Movement Demands

Player positional movements were determined from the time motion data was obtained from a portable 10 Hz global positioning (GPS) unit (Catapult, Melbourne, Australia), during all of the teams Big Bash games in the 2017/2018 season. Each player, while in competition, had a GPS unit positioned via an elasticised shoulder harness, between the scapulae, at the base of the cervical spine. Various movements were selected by the coaching staff and were quantified including: total distance (m), distance travelled walking (movement speed 0-3.1 $m \cdot s^{-1}$), jogging (3.1-3.9 $m \cdot s^{-1}$), running (3.9-5.8 $m \cdot s^{-1}$), striding (5.8-7.2 $m \cdot s^{-1}$) and sprinting (7.2+ $m \cdot s^{-1}$). The number of sprints, maximum speed ($m \cdot s^{-1}$), the total sampling duration (s), and the frequency of striding and sprinting were also recorded. These objective GPS derived measures were then linked to players' positional movements during a game.

Objective measures obtained from the GPS were then linked to players' positional movements during a game. This data was obtained by the Strength and Conditioning coach and then the data was checked by other members of the research team. This can be considered a limitation of the study, although the coach does have considerable experience with this technology and data.

Procedures

The GPS unit was activated, and the GPS satellite lock was established at least 15 minutes before the player went onto the field, as per the manufacturer's recommendation. The GPS portable unit was then fitted to each player prior to the

start of the game. Once a game was completed, the GPS unit was removed immediately and the data was downloaded using the Logan Plus 4.0 software (Catapult Innovations, Melbourne, Australia) for analysis. Each player was grouped into different classifications, such as: a batsman, a fast bowler, and a fielder. It was not possible to analyse fielding positions further, due to the nature of T20 cricket, and the frequency of changes that occur in the field during an innings.

Statistical analyses

Descriptive statistics (mean ± SD) were used to describe the data, while the effect size statistic was used to determine the magnitude of difference in patterns of movement between positions. The effect size statistic was created to assess the magnitude of difference between the fielders (just in bowling innings), fast bowlers (just in a bowling innings), spin bowlers (just in a bowling innings) and batters (just in a batting innings). The criteria for interpreting effect size were <0.2 trivial, 0.2-0.6 small, 0.6-1.2 moderate, 1.2-2.0 large, and > 2.0 very large (Hopkins, 2004).

Results

The movement characteristics, and the magnitude of the difference in movement demands between all three cricketing positions during a T20 competition, are illustrated in Table 2. On average, fast bowlers covered the greatest distance during the competition (6.5km), followed by fielders (5.92km) and lastly batsmen (1.77km). In all player disciplines, the highest percentage of their total distance was covered walking (fielding = 74%; batting = 73%; fast bowling = 70%) and the least was spent sprinting (fielding = 0.7%; batting = 0.05%; fast bowling = 0.6%). Jogging accounted for 11%, 8% and 12%, and running accounted for 11%, 17% and 12%, of the total distance covered for fielding, batting and fast bowling respectively. Fast bowlers strode more of their total distance (6%) compared to fielders (4%) and batsmen (2%).

Fast bowling took, on average, the longest duration (96.5 ± 9.4 minutes) and bowled an average 3 overs per innings, followed by fielding (86.4 ± 14) and lastly, batting (40.4 ± 29.1 minutes). Fielders sprinted 0.1 times (ES = 0.07) and 1.7 (ES = 1.3) more than fast bowlers, and batsmen, respectively. Moreover, bowlers sprinted 1.6 times (ES = 2.3) more than batsmen. Fast bowlers strode 9.3 times (ES = 1.1) and 21.9 times (ES = 4.1) more than fielders and batsmen. However, fielders strode 12.6 times more than batsmen (ES = 1.6). Fast bowlers had the greatest maximum velocity of 29.5 km·h^{-1}, with batting (24.6 km·h^{-1}) and fielders (28.8 km·h^{-1}) approximately 1 km·h^{-1} slower in their maximum velocity effort.

Discussion

This is the first study that has described the movement characteristics of elite T20 cricketers participating in the Big Bash League in Australia. There has only been one other study which has looked at these characteristics in T20 cricketers, a study completed on players at state level, also in Australia (Petersen et al., 2009). When comparing to Petersen et al. (2009), it must be noted that there were differences in data collection methods between their study, and this study. This is largely due to technological changes in GPS, which impacted the comparisons. Petersen et al. (2009) used a 5Hz GPS unit (Catapult) where this study used more recent technology; which was a 10Hz GPS unit (Catapult). Further, and probably as a result, categorizations of effort were slightly different (intensities or speeds of effort). For example, Petersen et al. (2009) categorized lower intensity speeds from 0-3.5 m·s^{-1}, where in this study the same categorization was 0-3.9 m·s^{-1}.

An unpublished master's thesis by Nell (2016) had three categorisations for pace: low-speed activity (0 to 5 m·s^{-1}), high-speed running (≥5.1 m·s^{-1}) and sprinting (≥7.1 m.s^{-1}), which is similar to this study, as sprinting in this study was defined as speeds greater than 7.2 m·s^{-1}. Nell (2016) highlighted that a higher number of categories is more accurate, which lends more credibility to this study as more categorizations were utilised in this study. It is worth noting that the data published by Petersen et al (2009) was done 10 years ago, making direct comparisons, in the present time period, substantially more difficult due to the extensive time that has elapsed, as cricketers' performance has developed in the last decade. However, where possible, comparisons have been made. Game standards have changed and different venues influence playing conditions and scores. For example, a wicket/pitch that is slow

Table 2. Absolute GPS movement variables (mean ± SD) of elite Twenty20 cricketers (n=120 files).

Workload characteristics		Fast bowlers (n=4)	Batsmen (n=4)	Fielders (n=6)
Distance	Walking 0-3.1 m·s^{-1} (m)	4576 ± 406 $^{b\,v}$	1294 ± 850 ^{e}	4382 ± 596
	Jogging 3.1-3.9 m·s^{-1} (m)	752 ± 88 $^{c\,v}$	134 ± 112 ^{e}	641 ± 162
	Running 3.9-5.8 m·s^{-1} (m)	803 ± 156 $^{c\,v}$	300 ± 228 ^{d}	618 ± 185
	Striding 5.8-7.2 m·s^{-1} (m)	377 ± 124 ^{c} v	43 ± 34 ^{d}	244 ± 158
	Sprinting >7.2 m·s^{-1} (m)	38 ± 20 $^{a\,v}$	1 ± 2 ^{d}	39 ± 33
	Total distance (m)	6547 ± 530 $^{c\,v}$	1771 ± 1204 ^{e}	5924 ± 910
Time	Total Duration (s)	5787.6 ± 561 $^{c\,v}$	2424 ± 1746.7 ^{e}	5183.8 ± 838
Intensity of Efforts	Number of times Striding	24.6 ± 7.1 $^{c\,v}$	2.7 ± 2.8 ^{d}	15.3 ± 9.5
	Number of times Sprinting	1.6 ± 1 $^{a\,v}$	0.0 ± 0.0 ^{d}	1.7 ± 1.7
	Max Velocity (km·h^{-1})	29.5 ± 1.9 $^{b\,v}$	24.6 ± 1.7 ^{d}	28.8 ± 2.5

^{a} Trivial, ^{b} Small, ^{c} moderate, ^{d} large and ^{e} very large magnitude of difference of time-motion variables of positions (Fast bowlers and batsmen) from the generic fielder position. ^{t} Trivial, ^{s} Small, ^{m} moderate, ^{l} large and ^{v} very large magnitude of difference of time-motion variables of Batsmen from Fast Bowlers

(more challenging to score runs and hit the ball hard) and has a slow outfield (where the ball goes to the boundary with more power required), will be more physically demanding, because the fielders will be able to chase the ball down, and the batsmen will have to run more runs as the ball won't go to the boundary. A field with a quicker pitch and a quicker outfield will result in a batsman potentially hitting the ball harder, which will then go to the boundary more easily, requiring them to run less and the fielders won't chase the ball down.

This study found fast bowlers covered more distance and did more high intensity bouts than fielders and batsmen. T20 cricketers in the field (excluding wicket-keepers) covered 5.9km, with 38.3m of this distance spent sprinting. Fast bowlers covered the most distance (6.5km) with 38.3m of this sprinting. This is less than what Petersen et al. (2009) reported (distance of 8.5km with 723m spent sprinting). This was in contrast to the batsmen who covered 1.7km, of which 0.8m of this was spent sprinting. The low distance of sprinting may be contradictory, as you would expect batsmen to have more meters covered at that speed, in a T20 match as they look to score quickly, and rotate strike. Batting, in this study, was similar to Petersen et al. (2009); the batsmen in Petersen et al. (2009)'s study covered 2.5km, with 160m of that sprinting, which was 0.7 km more than the batsmen in this study who also did less sprinting, 159.2m less. In the ODI format batsmen did a total of only 1.5km (Webster and Travill, 2018) which is less than both T20 studies. Petersen et al. (2010) found that batsmen in T20 and ODI perform at similar intensities covering 2.4km per hour, yet in a multi-day match they cover 0.4km less.

However, it is important to note that the sprinting categorization starts high (at 7.2 $m \cdot s^{-1}$), which will show less meters covered at that speed because of this higher speed categorization for sprinting.

With the game evolving, it requires that all the players be good fielders, as poor fielding can result in extra runs for the opponents. Therefore, fast bowlers have been trained to be more agile and more fielding training has been done. Thus, fast bowlers could be fielding in the inner ring, and not fielding in less important positions making them run further to those positions. The game in the last ten years has also turned into more of a batsmen game, with the balls being hit hard, and therefore going either over the rope for a six, which requires no chasing, or being hit for a hard four, where a chase isn't necessary. This is as a result of teams constantly getting higher scores, which has been achieved through new training techniques for batting. In addition, the size and quality of bats have increased, resulting in batsmen being able to hit the ball further, and harder.

During ODI games, fast bowlers also cover the most distance; 8.8 km with 567m spent sprinting (Webster and Travill, 2018). Relatively, both Petersen et al. (2009) and Webster and Travill (2018) found that bowlers spent 9% and 6% of their time sprinting. This is in contrast to this study, which showed overall workload for bowlers has reduced, with less distance covered, and only 0.6% of their time spent sprinting.

Fielders in this study covered less ground in a game (5.9km), but with a similar sprint distance (38.7m), thus the time spent sprinting as a fast bowler could mainly be done while in the field, and not during their actual bowling. Petersen et al (2010) found that fielders had the greatest intensity in T20 cricket sprinting, being 129 meters per hour. Petersen et al. (2009) showed that fielders covered 6.3 km in an hour, where this study showed fielders covered 4.2 km in an hour. This is due to the increase in runs being scored in boundaries and fielders not having to run after the ball to collect it. In ODI games, fielder's sprinted 81 meters per hour, and in a multi-day game they sprinted 52 meters her hour.

A finding from this study was that fast bowlers had the overall highest intensity workloads which is in agreement to Petersen et al. (2009), who reported that fast bowlers had the highest load in this intensity bracket. When combining striding and sprinting, Petersen et al. (2009) found overall higher workloads in their fielders (17% of their time spent sprinting and striding), which in this study was only 5% when fielding.

These results suggest that bowlers may use more speed/acceleration, but may prefer to settle into a rhythm approach, which may not be at maximal effort (Feros, 2015). Therefore, it makes sense that the pace of bowlers isn't always important, but rhythm is key, which would result in a more constant pace.

Striding accounted for 6% of the total distance covered by fast bowlers, 2% by batsmen and 4% by fielders, which was similar in proportion to Petersen et al. (2009). They reported that striding accounted for 9% of the total distance covered by fast bowlers, 6% by batsmen and 8% by fielders. However, striding was lower in fast bowlers, batsmen and fielders in the current study.

All these findings suggest that the movement demands have got less, which could be explained by more intense focus on a high skill set for T20 cricket, as it requires a short amount of time to bat, bowl and field. Therefore, skills have to be executed precisely in order to yield successful performances. The use of GPS may be a poor tool for measuring demands for batsmen in the T20 format, due to it not being able to measure upper body power (required for hitting far distances), thus a tool for upper body power may be of more use for batsmen, for example. With cricket, in all formats, having become more of a game suited for batsmen, it is also a tactic used for the bowling side to change up and potentially get someone else to bowl, in order to not let the batsmen settle, resulting in bowlers bowling less overs.

When using the mean data for fielders, the difference of just over 2km in an hour is relatively small as it only equates to approximately 210m per player in an hour. However, with both this study, and that of Petersen et al. (2009) it shows that T20 fielders have higher physical demands than those fielders fielding in other formats of the game, such as a one-day game. English county fielders were reported to cover only 2.6 km in an hour during a one-day game (Rudkin and O' Donoghue, 2008). It is therefore plausible to state that fielders in T20 competitions arguably have the highest loads, by the mere fact that it takes the longest. Therefore, more attention needs to be devoted to fielding, an often-neglected part of the game, and particularly in terms of high intensity efforts or interval training.

However, with certain movement demands getting less, T20 cricketers need to hone in on their skill sets in order to gain a greater advantage. This may also be why we have seen less papers published on movement demands as they have not been as much as a point of interest as originally thought.

This study provides a description of the movement demands placed on a team of T20 cricketers participating in Australia's Big Bash League and showed that the demands have lessened. However, this should be interpreted with caution as we probably need to focus on other measures, rather than just the positional demands.

Practical implications

Understanding positional movements will help conditioning coaches to determine the amount of physical preparation and recovery that players need.

Coaches need to ensure they do not neglect fielding in their training methods as it is an important part of the game, particularly in T20. However, as with bowling, fielding requires a high amount of time spent standing, or walking, and so explosive power and agility become important to either, chase a ball, or dive after one (in the case of fielding). Similarly, for bowling, there is a need for explosive power through the crease. Emphasis thus needs to be on the development of these physical traits within ecologically, valid environments, such as small sided games and with dedicated training sessions focused on these parameters (explosive power and agility).

Bowling required lots of striding, which is in the speed range of 21-26 $km \cdot h^{-1}$, and emphasizes the importance of high speed, intermittent running for fast bowlers.

A noteworthy finding for batsmen was that, on average, their innings lasted for around 40 minutes, which ranged from 2 balls faced to 69 balls faced. Therefore, in training, batsmen should bat that amount of time at high intensity in order for the appropriate adaptations (such as fitness levels, power hitting early, getting their 'eye-in' quicker and adjusting to pitch conditions) to occur.

As the game is evolving, the need for better conditioned cricketers is highlighted and both coaches and players need to adapt physical, and other preparation, before the format does.

Conclusion

In conclusion, we found that fast bowlers required the highest workload, which was expected. However, fielding workloads were higher than originally thought.

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Key points

- It is important to apply successful game tactics and select players that are more able to perform the required movement demands, or to train appropriately, to complete them.
- With increased knowledge of movements, it will help design more individualized training programs.
- Fielders have higher loads than originally thought; therefore, more attention needs to be devoted to fielding, in terms of training, the demands required of them- are an often-neglected part of the game.

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