FACTA UNIVERSITATIS
Series: **Physical Education and Sport** Vol. 15, N° 1, 2017, pp. 11 - 23
DOI: 10.22190/FUPES1701011C

Original research article

THE KINEMATIC VARIATIONS BETWEEN BATSMEN AND FAST BOWLERS WHEN COMPLETING A QUICK SINGLE IN CRICKET

UDC 796.358.012

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Abstract. *The introduction of the shorter match formats in cricket (i.e. Twenty20 cricket) has led to a greater emphasis placed upon the successful performance of a quick single in match play. Therefore, the study aim was to investigate the kinematic variables between batsmen and fast bowlers when completing a quick single. Eighteen male cricketers completed 17.68-meter (m) sprints utilizing a match-specific start (walking start, bat dragged through crease and leg guards worn). Timing gates recorded 0-5 and 0-17.68 m time. Joint and step kinematics were analyzed through the first and second steps via motion analysis. Participants were split into batsmen and fast bowler groups based on their primary role within a team. A one-way analysis of variance determined significant (p< 0.05) differences between the batsmen and fast bowler groups. Effect sizes (Cohen's d) were also calculated. Selected between-group kinematic differences were found. Fast bowlers had a significantly greater non-dominant elbow flexion, and second step swing leg ankle dorsi flexion. The requirements of fast bowling may have resulted in a cross-training effect, as increased range of motion in the bowling arm, and increased dorsi flexion on front and back foot landing, is associated with fast bowling technique. Nevertheless, there were no differences between the groups regarding quick single sprint performance. All cricket players should be proficient in the mechanisms of quick single sprint acceleration, regardless of their primary role in the team.*

Key words: *acceleration, sprinting, biomechanics, motion capture, running between the wickets*

Received February 13, 2017 / Accepted Jun 05, 2017

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INTRODUCTION

There are a number of different match formats in cricket, with the duration of play the defining factor. Cricket matches can range in length from a few hours (e.g. Twenty20 [T20] and one-day cricket) to several days (e.g. Test match cricket). However, the introduction and increasing popularity of T20 cricket has led to a shift in the pivotal physical and technical demands imposed upon all players, due to the reduction in match duration. This is evident when investigating the movement demands of players, as T20 cricket requires approximately 50-100% more sprints per hour than multi-day matches from all players (Petersen, Pyne, Dawson, Portus, & Kellett, 2010). These sprint efforts are often centered about crucial match situations, and can be essential for a teams' success (Bartlett, 2003; Duffield & Drinkwater, 2008; Petersen, Pyne, Dawson, Portus, & Kellett, 2010). With regards to players when batting, this refers to running between the wickets. The technique adopted when maximally sprinting between the wickets must allow the batsmen to accelerate as quickly as possible, so as to provide the greatest chance of successfully completing a run.

Batsmen in the shorter formats of the game (e.g. T20 cricket) tend to take greater risks to increase the scoring rate, due to a reduction in the number of deliveries per innings (Petersen, Pyne, Portus, & Dawson, 2008). Petersen et al. (2008) further states that one of the methods adopted by batsmen to increase the scoring rate is to attempt more runs between the wickets that require maximal sprints. The distance a player must at least cover when completing a run is 17.68 meters (m), as this is the length between the creases on a cricket pitch. A maximal sprint over the 17.68-m distance for both the striking (facing the delivery from the bowler) and non-striking (not facing the delivery from the bowler) batsmen is labeled a quick single (Callaghan, Lockie, & Jeffriess, 2014). Coaching practices outline that the non-striking batsmen will typically use a consistent walking start to the sprint (Buckley, 2010), and as a consequence, this movement pattern will be the focus of this study. Although not all singles over the 17.68-m crease-to-crease distance will require a maximal sprint, due to the value of the quick single, there is a need to understand more about the mechanisms of this skill. In the context of this investigation, more information is required to ascertain whether a player's primary role within a team may affect the technique they produce when performing a quick single.

Within a cricket team, players have particular roles they perform, which dictates what the players' primary responsibilities are during a game. Cricketers can be defined as batsmen, bowlers, and fielders. All players will bat and field; however, only select players will bowl. A batsman's primary responsibility is to score as many runs as possible in the allocated overs. For example, in T20 cricket, this requires batsmen to attempt scoring shots which accumulate multiple runs (i.e. 4's and 6's), while also ensuring that some form of run is scored off each delivery (Petersen, Pyne, Portus, & Dawson, 2008). A bowler's primary goal is to dismiss the batsman for as few runs as possible, and fielders are expected to aid in this task (e.g. catching a ball on the full or performing a run-out). Out of all cricket bowlers (e.g. fast and spin bowlers), fast bowlers will typically perform a greater number of sprint efforts within a match (Petersen et al., 2010). Due the greater volume of high-intensity running performed by this sub-group of cricketers, this could have implications upon their quick single performance. More sprinting in the field could provide a training effect that may influence running between the wickets when batting. Therefore, despite batsmen typically possessing greater skill in accumulating runs and potentially completing a greater number of quick singles, fast bowlers could be more efficient in the mechanisms of a quick single.

A key determinant of the success of a quick single will be the batsman's ability to effectively accelerate, as a quick single occurs over a relatively short distance (Callaghan, Lockie, & Jeffriess, 2014; Duffield & Drinkwater, 2008; Webster & Roberts, 2011). There are several kinematic factors acknowledged as being important contributors to acceleration performance. An increase in step frequency in field sport athletes, concurrent with a reduction in contact time, has been associated with higher running velocities during acceleration (Lockie, Murphy, Knight, & Janse De Jonge, 2011). Greater step lengths have also been linked to faster short sprint performance in both field sport athletes (Lockie, Murphy, Schultz, Jeffriess, & Callaghan, 2013) and cricketers (Lockie, Callaghan, & Jeffriess, 2014). The actions of the arms during the running cycle aids in the transfer of angular momentum between the upper- and lower-body about the vertical axis (Hinrichs, 1992), while a strong extension of the drive leg is recommended for acceleration (Côh, Tomazin, & Stuhee, 2006). Nonetheless, further analysis is required to determine whether a player's primary responsibility within a team affects the technique produced during acceleration while completing a quick single. This could be influenced by the fact that batsmen should achieve more opportunities to complete quick singles during a game, even though fast bowlers tend to complete more maximal sprints when considering fast bowling, fielding, and batting actions (Petersen et al., 2010). It is important that these technical factors are identified specifically for batsmen and fast bowlers, given that despite considerable differences in the player's role, all cricketers are expected to be proficient in the mechanisms of a quick single.

The key kinematics associated with faster acceleration within the first 5 m of a quick single for non-striking batsmen and fast bowlers should be defined. This is of particular note considering the importance of the first few meters of a short sprint for athletes from field-based sports (Lockie, Murphy, Knight, & Janse De Jonge, 2011; Murphy, Lockie, & Coutts, 2003), and how the workloads of cricketers whose primary roles are batting or fast bowling can vary considerably (Petersen et al., 2010). Therefore, the purpose of this study was to compare the acceleration kinematics in the first 5 m of a match-specific quick single between batsmen and fast bowlers. It is hypothesized that batsmen will produce faster acceleration performances in the 0-5 m via superior acceleration technique, which will be demonstrated by longer step lengths and higher step frequencies, as well as greater range of motion in the lower-body. This faster acceleration will also result in a faster 0-17.68 m interval. This hypothesis is based upon the fact that batsmen should spend more time batting during a cricket match, and thus will be in a position to complete more quick singles under match conditions. Establishing the kinematic variations specific to batsmen and fast bowlers when completing a quick single could also be useful in the development of effective acceleration sprint training programs, and efficacious coaching feedback, for cricketers.

METHODS

Participants

Eighteen males (age = 24.1 ± 4.9 years; body mass = 79.7 ± 10.4 kilograms [kg]; height = 1.8 ± 0.1 m), currently playing cricket at the same club in a regional competition in Australia, were recruited for this study. Participants were recruited if they: were 18 years of age or older; were currently playing premier league or division one in the regional competition; were training for cricket (≥ three hours per week); and did not have any existing medical conditions that would compromise participation in the study. The institutional ethics committee approved the procedures used in this study. All participants received a clear explanation of the study, including the risks and benefits of participation. Written informed consent was obtained prior to testing.

The method for defining participants as batsmen or fast bowlers was adapted from previous research (Lockie, Callaghan, & Jeffriess, 2014). The premier league captain and club coach were asked to define each participant as either a batsman or fast bowler, which was based on the participant's primary role within the team. Spin bowlers and wicketkeepers were excluded from this study due to a lower number and total distance of maximal sprint efforts during a cricket match when compared to batsmen and fast bowlers (Petersen et al., 2010). If there was a difference in opinion as to a player's primary role, a resolution was obtained through discussion between the captain and coach (Lockie et al., 2014). Following this process, nine participants were defined as batsmen (age = 25.0 ± 5.12 years; height: 1.79 ± 0.05 m; body mass: 82.78 ± 9.70 kg), and nine as fast bowlers (age = 23.11 ± 5.01 years; height: 1.84 ± 0.07 m; body mass: 76.56 ± 11.22 kg). Although it is acknowledged that all players will bat during a match, the terminology used in this study to characterize the participant groups was based upon the cricketer's primary role within the team.

Procedures

The testing procedures required participants to completed two testing sessions, separated by 48 hours. The first testing session was a familiarization session, which allowed the participants to become accustomed with the standardized cricket equipment (i.e. cricket leg guards and bat) and the procedures used in this study. The second testing session required participants to complete three maximal quick single sprints over a distance of 17.68 m, with a three-minute recovery between each trial. The mean time and kinematic data of the three sprints was used for analysis. All testing was conducted indoors in a laboratory with a textured concrete running track.

The participant's age, height, mass, and anthropometric data were collected at the start of the first session. Height was measured barefoot using a stadiometer (Ecomed Trading, Seven Hills, Australia). Body mass was recorded using digital scales (Tanita Corporation, Tokyo, Japan). Selected bone breadths were measured using Harpenden bone calipers (Baty International, London, UK), while limb lengths were measured using a Lufkin Executive Thin-line tape measure (Apex Tool Group, Cleveland, USA). The collection of anthropometric data was necessary for the motion capture analysis. Each participant completed a standardized warm-up at the commencement of both sessions. This consisted of five minutes of jogging on a treadmill at a self-selected pace, 10 minutes of dynamic stretching of the lower limbs, and progressive speed runs over the 17.68-m testing distance.

The quick single

The non-striking batsmen will typically use a walking start to the quick single as the bowler delivers the ball. The procedures for this sprint were adopted as per Callaghan, Lockie, & Jeffriess (2014) (Figure 1). Participants wore standardized leg guards and carried a standardized cricket bat (Iridium 5000, Puma, Herzogenaurach, Germany) during the quick single to replicate match conditions per (Callaghan, Lockie, & Jeffriess, 2014). Participants' started 1.5 m behind the start line, which was a simulated bowling crease, completed a walking start into the sprint, and were instructed to undertake this action as if it were under match conditions. As a consequence, participants adopted a relatively standard walking gait past the start line and into the sprint, as the bat was slid behind the participant through the crease (Figure 1). Participants were instructed to only carry the bat in their dominant hand throughout the entire sprint; if two hands were used the trial was disregarded (Houghton, 2010). Participants completed each sprint maximally, and slid the bat through the finish line (a simulated batting crease) to conclude the sprint.

Fig. 1 The standardized start position for the quick single
(1: stage one approach; 2: stage two approach; 3: initial take-off).

The 0-5 m and 0-17.68 m intervals were measured using a timing light system (Fusion Sports, Coopers Plains, Australia). The 0-5 m interval has previously been investigated in speed testing for cricketers (Callaghan, Lockie, & Jeffriess, 2014; Lockie, Callaghan, & Jeffriess, 2013; Lockie, Jeffriess, & Callaghan, 2012). Furthermore, the timing light system configuration to assess the quick single in the current investigation was as per Callaghan, Lockie, & Jeffriess (2014), and thus was adopted in this study.

Motion capture data

All trials were recorded using a Vicon motion capture system (Oxford Metrics Group, Oxford, United Kingdom), via six MX infrared cameras mounted on 2.1-m high tripods, with a frame rate set at 200 Hertz (Callaghan et al., 2014; Webster & Roberts, 2011). The six cameras provided a capture volume of approximately 5 m (length) by 2 m (width) by 2 m (height). Following the warm-up and prior to testing, 59 reflective markers (Oxford Metrics Group, Oxford, United Kingdom) were placed on anatomical landmarks on the upper- and lower-body of the participant. Marker locations were determined through palpation, and were held in place through double-sided tape. A static capture was undertaken prior to sprint testing, to identify local joint and segment coordinate systems to the kinematic model.

Markers placed on the ankle, tibia, and knee were removed following the static capture, as participants wore leg guards during the quick single. Due to the need for participants to wear leg guards, a standard marker set-up was not appropriate, and the calibrated anatomical systems technique (CAST) method was used (Cappozzo, Catani, Della Croce, & Leardini, 1995; Webster & Roberts, 2011). The CAST method used in this study has been previously found to be accurate and valid(Callaghan et al., 2014), and was thus used in this study.

Data processing and analysis

All sprint trials for each participant were digitized in the Vicon Nexus 1.8.3 software (Oxford Metrics Group, Oxford, United Kingdom) to retrieve joint kinematics. A Woltring filter was passed over the data to address small random digitizing errors (Fosang & Baker, 2006), while the Vicon Bodybuilder 3.6.1 software (Oxford Metrics Group, Oxford, United Kingdom) was used to derive all kinematic variables. The kinematic variables assessed were during the first and second steps. The step kinematics analyzed were: step length, which was the horizontal distance in the sagittal plane from toe-off to toe-off of consecutive steps; step frequency, calculated from the inverse of step time through the equation *step frequency* = $(1 \cdot step\ time)^{-1}$(Hunter, Marshall, & McNair, 2004); step width, measured as the horizontal distance in the frontal plane between toe-off of two consecutive steps; and contact time, which was the duration when the foot was in contact with the ground.

Joint kinematic data were reported in Euler angles, with an axis order rotation of YXZ. Maximum values of flexion and extension, and abduction and adduction, and selected range of motion about these axes, were calculated for both the upper- and lower-body. To clearly identify which arm was carrying the bat, the kinematics of the upper-body were divided into the dominant and non-dominant arm. The following upper-body kinematics was assessed: shoulder range of motion, calculated as the difference between maximum values about axes of rotation; elbow angle, calculated as the relative angle between the upper-arm and the forearm; and wrist range of motion, derived from the difference between the peak values about the measured axes of rotation. Dominant arm length was also calculated, and was defined as the vertical distance from the acromion process to the most distal part of the phalange of the third finger. Arm length was investigated due to the need for batsmen to reach both posteriorly at the start, and anteriorly at the end of the quick single.

Lower-body kinematic variables were firstly divided into step one and step two, which were then sub-divided into the drive leg and the swing leg for each step. This was based upon the actions of the limb during the step cycle. The following lower-body kinematics was assessed and defined as: hip angle, which was the relative angle between the trunk and thigh; knee angle, calculated as the relative angle between the thigh and shank; and ankle angle, derived as the relative angle between the shank and foot.

Statistical analysis

Descriptive statistics (mean ± standard deviation) were calculated for all variables. Outliers in the data were treated with a winsorization method (Lien & Balakrishnan, 2005), which has been used in previous sprint kinematics research (Callaghan, Lockie, & Jeffriess, 2014). A one-way analysis of variance was conducted to calculate any differences for kinematic variables, as well as to ensure there was no difference in age, height, and body mass between the batsmen and fast bowler groups. All tests were two-tailed, and an alpha level of $p < 0.05$ was set for significance. Effect sizes (Cohen's *d*) were also calculated for the between-group comparisons, where the difference between the means was divided by the pooled standard deviations (Cohen, 1988). For the purpose of this research, 0.19 or less was considered a trivial effect; 0.20 to 0.59 a small effect; 0.60 to 1.19 a moderate effect; 1.20 to 1.99 a large effect; 2.00 to 3.99 a very large effect; and 4.00 and above an extremely large effect (Hopkins, 2004). All statistical analyses were computed using the Statistics Package for Social Sciences Version 20.0 (IBM, Armonk, USA).

RESULTS

There were no significant differences in age (batsmen = 25.0 ± 5.12 years; bowlers = 23.11 ± 5.01 years; p = 0.441; d = 0.37), height (batsmen = 179.00 ± 5.39 m; bowlers = 183.61 ± 6.56 m; p = 0.123; d = 0.77), or body mass (batsmen = 82.78 ± 9.70 kg; bowlers = 76.56 ± 11.22 kg; p = 0.226; d = 0.59) between the batsmen and fast bowler groups. The 0-5 m and 0-17.68 m time, and first and second step kinematics, revealed no significant differences between batsmen and fast bowlers (Table 1). The difference in arm length between the groups had a moderate effect (d = 0.85), with the fast bowlers (0.80 ± 0.04) having a greater arm length when compared to the batsmen (0.77 ± 0.03). However, this was non-significant (p = 0.177).

Table 1 Sprint times for the 0-5 meter (m) and 0-17.68m intervals, first and second step kinematics (mean ± *standard deviation*) and effect sizes for the batsmen (n = 9) and fast bowler groups (n = 9) for the 0-5 m and 0-17.68 m intervals for the quick single. s = seconds; Hz = Hertz.

	Batsmen	Fast Bowlers	*p*	*d*
Time				
0-5 m (s)	0.968 ± 0.068	0.965 ± 0.068	0.917	0.04
0-17.68 m (s)	2.808 ± 0.057	2.755 ± 0.180	0.401	0.40
First Step Kinematics				
Step Length (m)	1.08 ± 0.11	1.12 ± 0.12	0.426	0.35
Step Frequency (Hz)	4.25 ± 0.32	4.04 ± 0.27	0.164	0.71
Step Width (m)	0.24 ± 0.06	0.30 ± 0.09	0.123	0.78
Contact Time (s)	0.163 ± 0.018	0.164 ± 0.014	0.860	0.06
Second Step Kinematics				
Step Length (m)	1.21 ± 0.11	1.24 ± 0.13	0.612	0.25
Step Frequency (Hz)	4.25 ± 0.29	4.27 ± 0.29	0.912	0.07
Step Width (m)	0.26 ± 0.09	0.23 ± 0.06	0.374	0.39
Contact Time (s)	0.147 ± 0.012	0.152 ± 0.016	0.473	0.35

Table 2 outlines selected upper-body kinematics throughout the first two steps of a quick single. The fast bowlers recorded an 11% greater non-dominant elbow flexion angle (large effect) when compared to the batsmen. First step lower-limb kinematics for both the drive and swing leg in batsmen and fast bowlers are displayed in Table 3. The batsmen recorded a significantly greater first step drive leg hip abduction when compared to fast bowlers, resulting in a large effect. The batsmen also had a greater first step swing leg hip adduction, with a moderate effect. However, this was non-significant (p = 0.088). Second step swing leg ankle dorsi flexion was significantly greater for the fast bowlers by 46% when compared to the batsmen, resulting in a large effect (Table 4). No other significant kinematic differences were found between the groups.

Table 2 The dominant (D) and non-dominant (ND) shoulder and wrist range of motion (ROM) about both the sagittal and frontal planes, and D and ND elbow maximum flexion, and extension (mean ± standard deviation) during the first and second steps of a quick single with effect sizes for the batsmen (n = 9) and fast bowler groups (n = 9).

	Batsmen	Fast Bowlers	*p*	*d*
Shoulder				
D Sagittal Plane ROM	78.87 ± 31.32	86.01 ± 19.22	0.568	0.27
D Frontal Plane ROM	42.29 ± 14.86	39.37 ± 8.14	0.612	0.24
ND Sagittal Plane ROM	111.86 ± 19.73	120.31 ± 19.42	0.388	0.43
ND Frontal Plane ROM	35.87 ± 6.32	42.71 ± 12.13	0.153	0.71
Elbow				
D Flexion	101.64 ± 6.56	99.44 ± 20.72	0.766	0.14
D Extension	57.56 ± 6.12	61.25 ± 16.22	0.555	0.30
ND Flexion	93.96 ± 5.34$^{\alpha}$	104.31 ± 9.28	0.010	1.37
ND Extension	41.72 ± 14.86	51.49 ± 14.18	0.173	0.67
Wrist				
D Sagittal Plane ROM	72.24 ± 20.39	59.09 ± 23.10	0.218	0.60
D Frontal Plane ROM	37.10 ± 15.32	30.05 ± 7.38	0.231	0.59
ND Sagittal Plane ROM	31.98 ± 7.87	41.44 ± 25.46	0.303	0.50
ND Frontal Plane ROM	26.35 ± 5.91	30.10 ± 7.32	0.249	0.56

$^{\alpha}$Significant ($p < 0.05$) difference between the batsmen and fast bowler groups.

Table 3 Drive and swing leg maximum flexion, extension, abduction, and adduction for the hip, knee, and ankle in degrees (°) for the first step (mean ±standard deviation) and effect sizes for the batsmen (n = 9) and fast bowler groups (n = 9) for the quick single.

	Batsmen	Fast Bowlers	*p*	*d*
Hip				
Drive Leg Extension (°)	6.32 ± 4.86	9.15 ± 4.79	0.231	0.59
Drive Leg Abduction (°)	10.99 ± 2.76$^{\alpha}$	4.95 ± 4.94	0.006	1.51
Swing Leg Flexion (°)	89.06 ± 10.28	93.02 ± 9.60	0.424	0.40
Swing Leg Adduction (°)	-25.88 ± 4.55	-18.77 ± 10.83	0.088	0.86
Knee				
Drive Leg Extension (°)	23.36 ± 10.90	23.99 ± 11.40	0.668	0.06
Swing Leg Flexion (°)	120.32 ± 15.68	112.45 ± 33.70	0.534	0.30
Ankle				
Drive Leg Plantar Flexion (°)	- 34.51 ± 8.48	-39.10 ± 21.92	0.592	0.28
Swing Leg Dorsi Flexion (°)	-32.06 ± 19.32	-30.95 ± 11.88	0.899	0.07

$^{\alpha}$Significant ($p < 0.05$) difference between the batsmen and fast bowler groups.

Table 4 Drive and swing leg maximum flexion, extension, abduction, and adduction for the hip, knee, and ankle in degrees (°) for the second step (mean ± standard deviation) and effect sizes for the batsmen (n = 9) and fast bowler groups (n = 9) for the quick single.

	Batsmen	Fast Bowlers	*p*	*d*
Hip				
Drive Leg Extension (°)	7.39 ± 5.25	9.95 ± 6.13	0.373	0.45
Drive Leg Abduction (°)	6.85 ± 6.29	8.97 ± 6.03	0.477	0.34
Swing Leg Flexion (°)	89.44 ± 9.33	87.50 ± 4.32	0.580	0.27
Swing Leg Adduction (°)	-19.61 ± 3.99	-19.99 ± 4.58	0.855	0.09
Knee				
Drive Leg Extension (°)	6.66 ± 29.54	24.73 ± 23.11	0.168	0.68
Swing Leg Flexion (°)	126.92 ± 9.23	121.47 ± 12.12	0.299	0.51
Ankle				
Drive Leg Plantar Flexion (°)	27.22 ± 9.90	39.17 ± 31.05	0.428	0.52
Swing Leg Dorsi Flexion (°)	29.11 ± 7.05$^{\alpha}$	42.51 ± 14.62	0.038	1.17

$^{\alpha}$Significant ($p < 0.05$) difference between the batsmen and fast bowler groups.

Discussion

The results of this study indicated that there were no significant differences in acceleration performance between batsmen and fast bowlers when completing a quick single, as shown by the time to complete the 0-5 m and 0-17.68 m intervals. This is contrary to the study hypothesis, and indicated that the specific roles of players within a cricket team did not affect their acceleration performance when completing a quick single. This is particularly pertinent when considering the importance of the quick single to modern-day cricket (Callaghan, Lockie, & Jeffriess, 2014; Duffield & Drinkwater, 2008; Webster & Roberts, 2011). Regardless of position in the batting order, all cricketers should be proficient in the sprint mechanics of the quick single, so as to maximize their teams' ability to score runs.

The lack of significant differences pertaining to acceleration performance between the batsmen and fast bowlers is partially a function of step kinematics, in that there were also no significant between-group differences in these variables. The batsmen and fast bowlers from this study utilized similar step characteristics during the initial stages of a quick single, and recorded no sprint time differences. Despite batsmen being expected to complete a greater number of quick singles during a match, fast bowlers are also required to perform this skill when they are batting. This may provide some explanation for the similar step characteristics between the groups.

A practical application of this finding is that any training directed towards speed development for running between the wickets could be implemented for both batsmen and fast bowlers. Step length could be a technique variable specifically targeted for speed development in cricketers. Callaghan, Lockie, & Jeffriess (2014) reported a significantly longer first and second step during the more dynamic start position of a quick single when compared to a traditional static starting position in experienced cricketers. In addition, previous research investigating acceleration performance in field sport athletes has also identified the value of longer steps for initial acceleration (Lockie et al., 2013), and this technique parameter is trainable via protocols such as free and resisted sprinting, plyometrics, and weights training (Lockie, Murphy, Schultz, Knight, & Janse De Jonge, 2012). As such, strength and conditioning practitioners should employ some form of sprint training to improve acceleration performance for all players regardless of their primary role within a team, with particular emphasis upon the mechanisms for enhanced step length.

Elbow flexion of the non-dominant arm during quick single initial acceleration was significantly greater for the fast bowlers when compared to the batsmen. This may be a function of the requirements of fast bowling within a match. Fast bowlers are required to perform repeated high-intensity sprints during their run-up and delivery, all while carrying a cricket ball, throughout a match (Duffield, Carney, & Karppinen, 2009). Coaching practices typically outline that fast bowlers should employ greater range of motion of the arm carrying the ball during their run-up to aid in transition to the delivery stride and ball release (Buckley, 2010). As a consequence, the greater elbow flexion present in the fast bowlers may be an example of training crossover, due to the high frequency of deliveries a bowler will perform not only in a match, but as part of their training as well (Noakes & Durandt, 2000). Nevertheless, there was no difference in acceleration performance between the two groups, regardless of the variations in arm kinematics. It can be assumed that this difference in non-dominant elbow motion did not greatly influence the final quick single acceleration performance.

The unique starting position of the quick single requires greater range of motion at the hips in the frontal plane when compared to traditional sprinting (Callaghan, Lockie, & Jeffriess, 2014). This is because of the more side-on starting position adopted to augment reach, necessitating increased range of motion in the frontal plane to adopt more typical sprint kinematics (Callaghan, Lockie, & Jeffriess, 2014). This was particularly evident for the batsmen, as they recorded a significantly greater first step drive leg hip abduction angle when compared to the fast bowler group. Interestingly, the batsmen also recorded a moderate effect for a greater first step swing leg hip adduction when compared to the fast bowlers. Although the batsmen illustrated greater hip abduction of the drive leg, the opposing leg (i.e. the swing leg) demonstrated greater hip adduction. This resulted in the batsmen attaining a relatively similar starting position to the fast bowlers, which was also shown by no significant between-group differences in either first or second step width. Regardless of the frontal plane differences in hip joint kinematics, there were no significant differences in acceleration performance between the two groups, identifying that batsmen and fast bowlers use relatively similar kinematics during the initial stages of a quick single.

The fast bowling action is associated with large ground reaction forces at back and front foot contact during the delivery stride(Hurrion, Dyson, & Hale, 2000). To aid in the absorption of ground reactions forces and reduce the risk of trunk and lower limb injuries in fast bowlers, increases in ankle dorsi flexion have been advocated during rear and front foot contact (Dennis, Finch, McIntosh, & Elliott, 2008). As a consequence, fast bowlers may employ greater dorsi flexion of the ankle joint during maximal acceleration and sprinting, such as that required when completing a quick single, due to a possible cross-training effect. This may provide an explanation for the increase in second step swing leg ankle dorsi flexion for the fast bowlers within this study. Despite this, the minimal variations in lower-body kinematics between the batsmen and fast did not influence any between-group differences in quick single performance. It must be acknowledged that this study contains certain limitations. Players may have multiple roles within a team (i.e. all-rounders), hence categorizing them based on their primary role may not provide a complete insight into the movement demands and activities they perform within a match. The additional roles a player may perform within a team could impact upon their ability to perform a quick single. Nonetheless, previous research has categorized cricket players based on their primary fielding positions (i.e. infield or outfield) to assess acceleration kinematics (Lockie, Callaghan, & Jeffriess, 2014), providing a demonstration of the value of categorizing cricketers according to their primary match function. In addition, other parameters which have been shown to influence acceleration performance, such as stance kinetics (Hunter, Marshall, & McNair, 2005; Lockie et al., 2013), and strength and power (Lockie, Murphy, Knight, & Janse De Jonge, 2011), were not analyzed. There is still value in this study's findings, as previous research investigating acceleration performance has also only utilized kinematic analysis (Callaghan, Lockie, & Jeffriess, 2014; Hunter, Marshall, & McNair, 2004; Murphy, Lockie, & Coutts, 2003), which indicates the value of this type of analysis. Nevertheless, future research investigating the influence of other parameters, such as stance kinetics, strength, and power, upon both batsmen's and fast bowlers' quick single performance would be of benefit.

CONCLUSION

There were no significant differences between batsmen and fast bowlers in quick single performance or acceleration step kinematics, despite batsmen being anticipated to complete a greater number of quick singles within a match. Additionally, there were few differences in upper- and lower-body kinematics between the groups. The kinematic variations that were present were likely due to the demand of specific movement patterns for fast bowlers during their delivery (e.g. greater arm range of motion for the bowling arm during the run-up, and greater dorsi flexion of the ankle just prior to back and front foot contacts during the delivery stride), which engendered a degree of crossover into the quick single acceleration gait pattern. Nonetheless, these variations generally did not influence quick single acceleration performance. The results from this study suggest that irrespective of a cricketer's primary role within a team (i.e. batting or fast bowling), they will produce similar acceleration kinematics during a quick single.

Acknowledgments: *We would like to acknowledge our participants for their contribution to the study. Thank you to Tim Ingram, James Tysoe, Tawni Luczo, and Professor Dennis Taaffe for assisting with this research. This research project received no external financial assistance. None of the authors have any conflict of interest.*

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KINEMATIČKE RAZLIKE IZMEĐU UDARAČA I BACAČA NA PRIMERU QUICK SINGLE UDARCA U KRIKETU

Uvođenje skraćenih mečeva u kriketu (takozvani Twenty20 kriket) dovelo je do toga da pravilno izvođenje quick single udarca tokom meča dobije na značaju. Ovo istraživanje ima za cilj da analizira kinematičke razlike između udarača i bacača na primeru quick single udarca. Ukupno 18 igrača pretrčalo je 17.68 m sprintom, pri startu karakterističnom za kriket (hodanjem, provlačenjem drvene palice i uz upotrebu štitinika za noge). Prolazno vreme mereno je na 0-5 i 0-17.68 m. Kinematička analiza sprovedena je kod prvog i drugog koraka. Na osnovu primarnih pozicija u timu učesnici su podeljeni na grupu udarača i brzih bacača. Analiza varijanse utvrdila je da postoje statistički značajne razlike (p< 0.05) između grupa igrača. Izračunata je i vrednost Cohen's d, i utvrđeno da postoje i određene međugrupne razlike. Kod brzih bacača utvrđena je značajno veća fleksija lakta ne-dominantne ruke, i dorsi fleksija u skočnom zglobu leve noge pri drugom koraku. Priprema brzih bacača možda je dodatno doprinela ovoj razlici, s obzirom na to da se uvećanje opsega pokreta ruke kojom se baca, i uvećanje dorsi fleksije stopala u iskoraku dovode u vezu sa tehnikom brzog bacanja. Ipak, nisu utvrđene razlike između grupa kada je u pitanju sprint. Svi igrači trebalo bi da budu upoznati sa mehanizmima sprinta kao što je ubrzanje, bez obzira na primarne pozicije u timu.

Ključne reči: *ubrzanje, sprint, biomehanika, hvatanje pokreta, trčanje između stativa*.