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SPORTS & EXERCISE | RESEARCH ARTICLE

The use of a smartphone based mobile application for analysing the batting backlift technique in cricket

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Abstract: The batting backlift technique has been shown to be a contributing factor to successful batsmanship. No study or platform has yet been conceptualised to specifically design a mobile application to analyse the batting technique of cricket batsmen, especially the batting backlift technique in cricket. The backlift in cricket software system was divided into three components: a frontal view interface, a lateral view interface, and a back-end system. Android, Open Computer Vision (CV) and JavaScript were used for this particular project as they are both well documented and supported by a software development platform called Qt 5.3. The use of the backlift in cricket mobile application can be used to evaluate the backlift type of a batsman by analysing and tracking the bat position of batsmen in cricket. The development of the backlift in cricket mobile application is the first complimentary mobile application that can record and analyse the backlift of a batsman through a smartphone without the need for connectivity from parent software on computers. The mobile application provides real-time data that can be stored on the user's phone and device for subsequent usage and analysis.

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Habib has published papers in reputable journals and has presented at both local and international conferences. He has had the pleasure of working with international sports teams and currently volunteers as an Expert on Health24.com. In 2013, he was voted in South Africa's top 100 brightest young minds and in 2015, he was nominated among Mail and Guardians top 200 young South Africans.

PUBLIC INTEREST STATEMENT

The batting backlift technique has been shown to be a contributing factor to successful batsmanship. No study or platform has yet been conceptualised to specifically design a mobile application to analyse the batting technique of cricket batsmen, especially the batting backlift technique in cricket.

The use of the backlift in cricket mobile application can be used to evaluate the backlift type of a batsman by analysing and tracking the bat position of batsmen in cricket. The development of the backlift in cricket mobile application is the first complimentary mobile application that can record and analyse the backlift of a batsman through a smartphone without the need for connectivity from parent software on computers. The mobile application provides real-time data that can be stored on the user's phone and device for subsequent usage and analysis.

Subjects: Ergonomics of Sport and Exercise; Sport and Exercise Science; Sports Performance Analysis

Keywords: mobile application; performance analysis; cricket; batting backlift technique; coaching

1. Introduction

The mechanics of the backlift in cricket batting are poorly understood (Davis, 1983; Gibson & Adams, 1989). Qualitative biomechanical analyses of movement in sports are key to its investigation (Noorbhai & Noakes, 2015). Such a mode of investigation can provide important insights in the biomechanics of technique in sports. This is especially important with those skills that have to satisfy performance outcomes by choosing from a kinematically redundant set of joint angle time-histories (Gelinas & Hoshizaki, 1988; Mullineaux, Bartlett, & Bennett, 2001).

A batting technique consists of many elements such as the stance, grip of the bat, backlift, initiation, downswing and follow through (Stretch, Bartlett, & Davids, 2000). An important component of the overall batting technique is the backlift, which is a technical component of batting that has defied the traditional attempt to constrain its motion to the linear plane (McLean & Reeder, 2000). Cricket coaches have been teaching batting techniques to cricketers at various levels since the inception of the game (Noorbhai & Noakes, 2015). Fry was one of the first cricket coaches who institutionalised the straight batting backlift technique in 1912 (Fry, 1912).

Research conducted in Australia by Stuelcken, Portus, and Mason (2005) on international batsmen ($n = 9$) was the only study until 2015 that demonstrated findings of the backlift in cricket batting. The study showed that path tracings of the bat indicated a distinctive loop, which was unexpected. No clear evidence was provided by the authors to explain why this occurred, aside from the fact that increasing the number of strokes would be a likely outcome. This warranted for further research into the backlift in cricket batting.

In our first research study, we showed that the batting backlift technique is a contributing factor to successful batsmanship (batsmen with a high average, career runs scored and high strike rate). A vast majority of successful batsmen (77%) (between 1895 and 2014) and un-skilled cricketers (70%) used a lateral batting backlift technique whereas skilled cricketers used a straight batting backlift technique (23%) (Noorbhai & Noakes, 2016). The lateral batting backlift technique is one in which the bat is lifted laterally in the direction of second slip. Using this technique, both the toe of the bat and face of the bat points directly towards the off-side (usually between slips and point). With the straight batting backlift technique, the toe of the bat is directed towards the stumps and/or the face of the bat points towards the ground or the wicket-keeper. In the same study, batsmen who used a lateral batting backlift technique were also found to demonstrate an open face of the bat (the bat face in the direction of point or towards the off-side) (Noorbhai & Noakes, 2016).

Our second research study showed that if such players are not coached, they automatically hit the ball using a lateral batting backlift technique. This finding indirectly suggests that early coaching emphasising the traditional straight batting backlift technique could be disadvantageous to the young cricketer (Noorbhai & Noakes, in press). Although this straight backlift coaching philosophy received universal exposure with the publication of the first edition of the Marylebone Cricket Club (MCC) coaching manual in 1954, this explanation does not include any reference to the direction in which the bat face should be pointing. The text included the following statement: “A correct back-lift is not natural but can easily be obtained and too much attention cannot be given to getting it right, the bat should be taken back directly over the middle stump” (MCC, 1954). The assumption therefore may have been that the bat face must also point directly backwards.

Forty years later, the 1994 edition of the MCC coaching manual continued with the same interpretation of teaching the backlift which should be directed towards the stumps to ensure that the bat

will come down straight, in line with the stumps. Many years later, a majority of the coaching literature advocated for the traditional norm to coach the backlift of the bat in the direction of the wicket-keeper, towards the stumps or towards the slips (Chappell, 2004; MCC, 1954; Palmer, 1999; Tyson, 1976; Woolmer, 1993).

According to both the scientific and coaching literature, a backlift is a key element of the overall batting technique and more emphasis should be drawn towards the analysis of the backlift of players, especially at the junior levels (Noorbhai & Noakes, 2015, 2016; Woolmer, Noakes, & Moffett, 2009). The formulation of adequate technique is paramount at the junior levels (under-6 to under-17) in order for players to improve their skill development and motor control prior to playing at a higher level (Handford, Davids, Bennett, & Button, 1997). One can argue the fact that this has been neglected due to the tedious process of accurately analysing certain techniques in sport. The use of technology has therefore filled this void and has shown to be valuable in assisting scientists and coaches (www.sportstec.com, accessed 11 April 2016, www.nacsport.com/en/, accessed 11 April 2016; Dartfish, 1999, www.dartfish.com, accessed 11 April 2016; www.coachseye.com, accessed 11 April 2016; www.stevasports.com, accessed 11 April 2016).

1.1. The use of technology for analysis and improvement in sport

The introduction of technology has revolutionised sports in general. High performance sports have combined technology with science and medicine to be a game changer in professional sports analysis (Soomro, Noorbhai, & Sanders, 2015). One particular study conducted a study on the validation of a mobile application for measuring jump performance and found that height can be easily, accurately and reliably evaluated using a specially developed iPhone 5s app. (Balsalobre-Fernández, Glaister, & Lockey, 2015). Advances in computing, networking, information technology and multimedia technologies have led to a tremendous growth of sports video content and accelerated the need of analysis and understanding of sports video content. Sports video analysis has been a niche research area and a number of potential applications have been identified (Xu, Cheng, & Zhang, 2009).

From a motor control theory perspective, it is well documented in the literature that when feedback is provided in an appropriate manner, motor skill acquisition improves significantly (Liebermann, Katz, & Hughes, 2002; Sullivan, Kantak, & Burtner, 2008). Consequently, feedback is a major factor in the improvement of sport skill performance. Recently, advances in information technology have made it possible to augment and improve the feedback athletes receive during training and competition (Liebermann et al., 2002).

From a biomechanics perspective, there have been a handful of mobile applications that have been designed to provide feedback, improve performance and analyse a range of variables (Dartfish, 1999, www.dartfish.com, accessed 11 April 2016; Noraxon, 1991, www.noraxon.com; Quintic, 1996, www.quintic.com). Specifically with cricket, there are also mobile applications that pay more attention towards injury prevention, match predictions, team analysis and logging of training hours (Cricket-21, 2011, www.cricket-21.com, accessed 11 April 2016; www.vcamcricket.com, accessed 11 April 2016; Eagle Eye, 2012, www.eagleeyedv.com, accessed 11 April 2016; Soomro et al., 2015). However, there are limited applications that speak to the enhancement and improvement of cricket batting.

1.2. The backlift in cricket mobile application

To our knowledge, no study or platform has yet been conceptualised to specifically design a mobile application in order to analyse the batting technique of cricket batsmen and especially with regards to the batting backlift technique in cricket. Therefore, the aim of this paper was to document the rationale and protocol of a smartphone based mobile application in the use of analysing the batting backlift technique in cricket.

The backlift in cricket mobile application can assist in the understanding and provides coaches and players with the platform to analyse the backlift type of a batsman. This mobile application paper aims to describe and illustrate the methodology, languages and protocols associated with the

development of the backlift in cricket mobile application, which is a complimentary smartphone based mobile application for monitoring the batting backlift type in cricket.

2. Methods

2.1 Biomechanical analysis of the backlift in cricket (frontal and lateral view)

2.1.1. Frontal view analysis

For the purpose of biomechanical analysis of the backlift, the toe of the bat is defined as the vector orthogonal to the toe being the pointer (Glazier, Davids, & Bartlett, 2003). This strengthens the validity and reliability of the analysis as the backlift can be readily detected and analysed at different positions and time points in the lift (Hopkins, 2000). Drawing a vector is a common approach in defining the toe of the bat and how it will point in a particular direction (Kreighbaum & Barthels, 1996). Lines and vectors were drawn (1) vertically from the head to the hands (green line), (2) a line drawn horizontally to show where the hands rest (blue line) and (3) a line drawn obliquely to show the direction of the bat during the backlift (red line). The still photo that was captured from the video footage and the last frame just before the bowler had released the ball was analysed. These lines create an angle to show how far away the bat is from the body in the frontal plane and how much rotation has occurred before making impact with the ball (Figure 1) (Noorbhai & Noakes, 2016, in press).

The researchers accounted for perspective error by limiting the type of videos observed with the various deliveries bowled to the batsmen (to the off-side, middle and leg-side; full length, back of a length and short length).

2.1.2. Lateral view analysis

The face of the bat is a key indicator of what the batsman does just before impact with the ball. Previous analysis of batsmen had shown that batsmen either have an open or closed face of the bat (Noorbhai & Noakes, 2016). Most batsmen who have a lateral batting backlift technique had an open face of the bat (77%) whereas batsmen who have a straight batting backlift technique had a closed face of the bat (23%) (Noorbhai & Noakes, 2016).

The critical indicator in this view of the analysis is how much of the face of the bat does the batsman show prior to impact with the ball and just before the bowler releases the ball. For the lateral view analysis, a rectangle is used to depict how much of the face of the bat is shown (or none). If more than 50% of the face of the bat is shown, it is categorised as an open face of the bat whereas if it is less than 50% of the face of the bat shown, it is categorised as a closed face of the bat.

Right-hand batsman *Left-hand batsman*

Figure 1. Lines and vectors drawn to depict the angle of the batting backlift technique (Adapted from Noorbhai & Noakes, 2016a).

2.2. Software system development

The backlift in cricket software system was divided into two components: a frontal view interface and a lateral view interface. This relies on client-server architecture, with two different view interfaces operating as clients.

2.3. Mode of availability of software

The client-side has been built in a manner that can simplify importing it to diverse smartphone operating-systems, with the initial release aimed at the larger Android ecosystem (database version of Android) (Android, 2007). The server-side of the mobile application was implemented to also be compatible with various server operating systems such as the iPhone Operating System (iOS) and Windows, in order to reduce dependability upon a single technology.

2.4. Tools and languages

2.4.1. Client-side software

A software development platform (Qt 5.3), was chosen to programme the functionality of the client-side software because it is a cross-platform framework. This means that even though the initial release is compatible with Android only, the source code can later be ported to 15 other operating systems with relative ease. It also allows developers to programme software using a range of different programming languages. Android (www.developer.android.com, accessed 22 January 2016), Open Computer Vision (CV) (Android, 2007) and JavaScript are used for this project as they are both well documented and supported by Qt 5.3.

The aforementioned platform and languages simplify the construction of custom-user interfaces, and provide the opportunity to augment user-interface components with high-level logic. The Qt Software Development Kit (SDK) was used to develop the client-side software. The architecture of the system is further described in Section 2.4.2.

2.4.2. Software architecture

The software architecture chosen to build the project kept in mind the two components of the system (Figure 2):

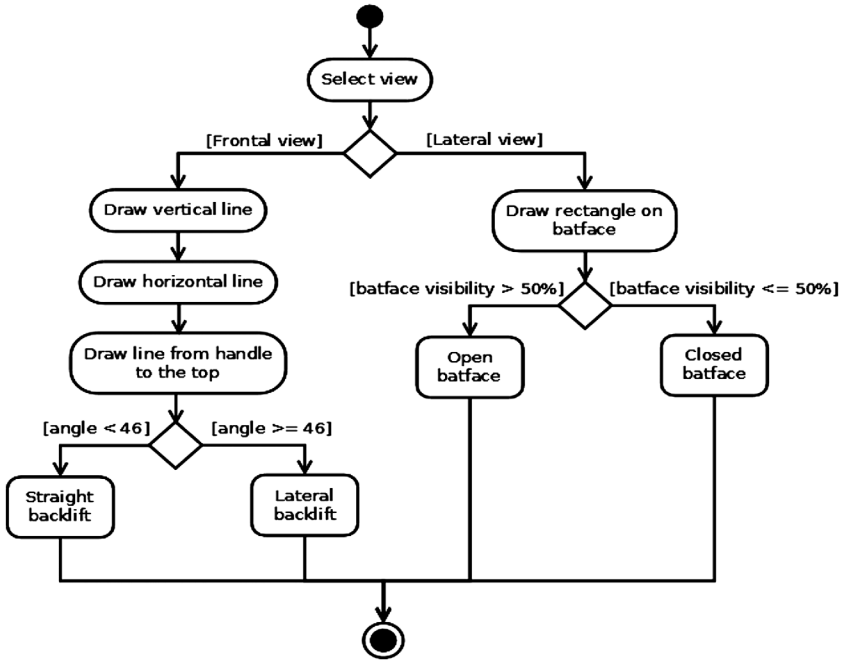


Figure 2. A Unified Modelling Language (UML) diagram showing the algorithm that defines the working process of the mobile application.

- Frontal view interface.
- Lateral view interface.

2.5. User interface design

The user interface of the backlift in cricket mobile application was designed for ease-of-use. All interfaces are represented as screenshots (see Figures 3–7).

When a user selects the *frontal view interface*, they would be analysing the batsman in the frontal view. Before taking the video, the leads would need to be set as this is crucial part in the analysis to determine the backlift type. There are three leads/lines for the user to illustrate before analysis:

(1) The vertical orthogonal; the person draws a line with their finger from the head of the batsman to the batsman's gloves.

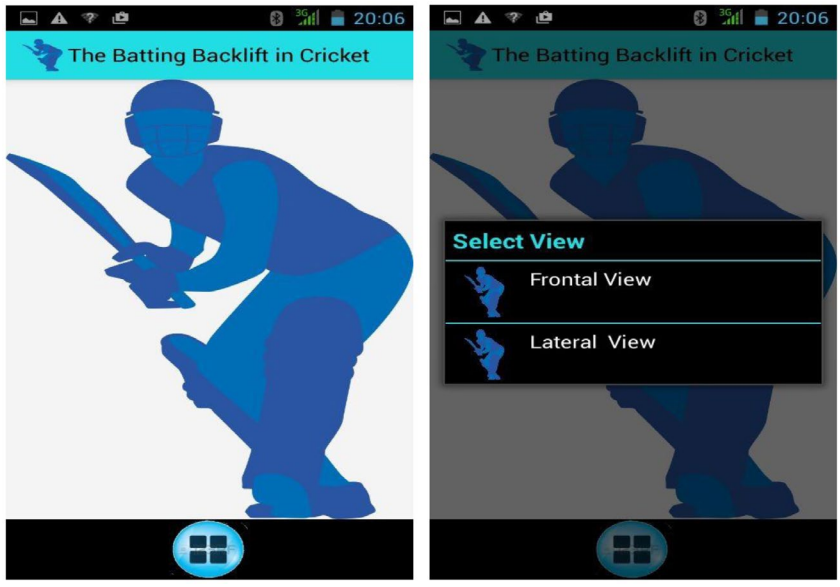


Figure 3. The home screen of the BICMA.

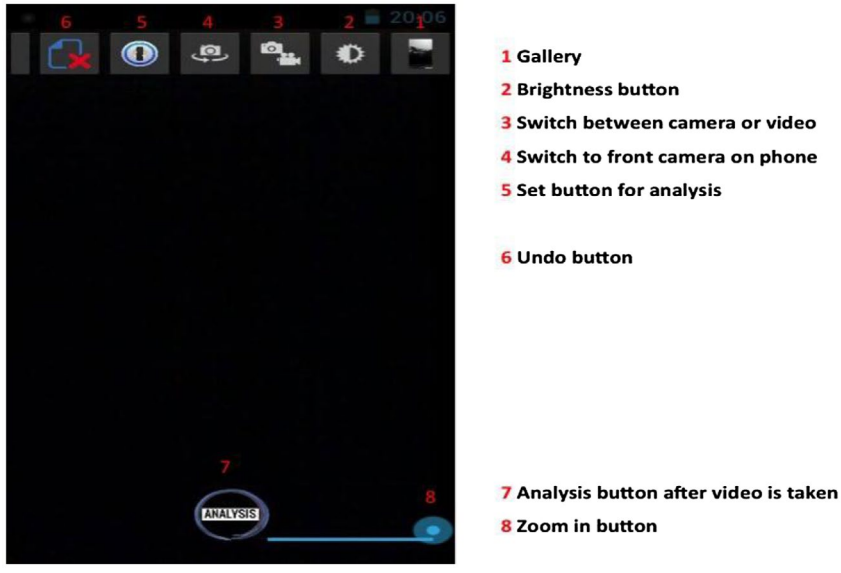
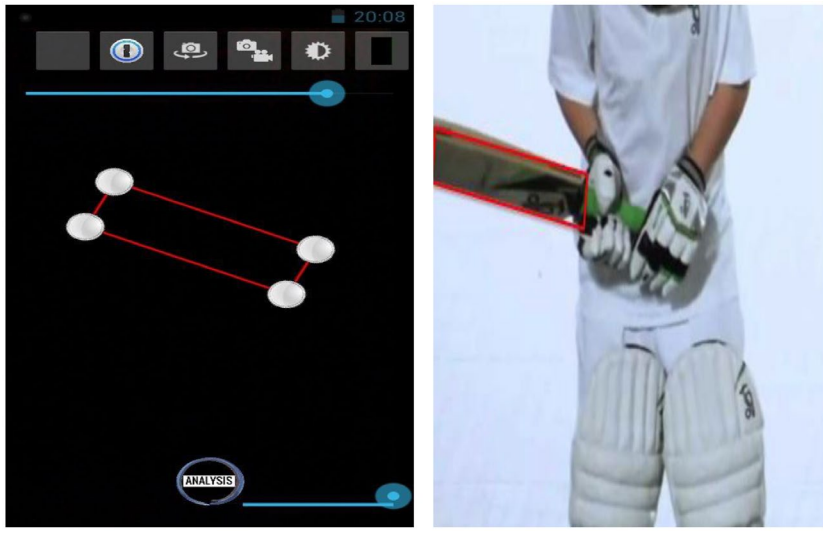


Figure 4. The frontal view.

Figure 5. Analysis in the frontal view.

Figure 6. Analysis in the lateral view.



(2) Horizontal line, a line that they draw where the hands of the batsman rests.

(3) The line drawn from the handle/hands to the top of the bat.

The user can then click "set" and once the video of the batsman has been captured, the user can click "analyse". From here on, the mobile application determines the type of backlift as:

(a) The straight batting backlift technique or,

(b) the lateral batting backlift technique (Figure 5).

When a user selects the *lateral view interface*, they are only observing for two things: is the face of the bat open or closed (Figure 7).

2.6. The use of the backlift in cricket mobile application for analysis

For the purpose of this study, a trial was conducted among previously analysed coached cricketers (n = 30) (Noorbhai & Noakes, in press) utilising existing video footage captured. This was done to verify and attenuate if the mobile application was able to depict accurate results from the analysis

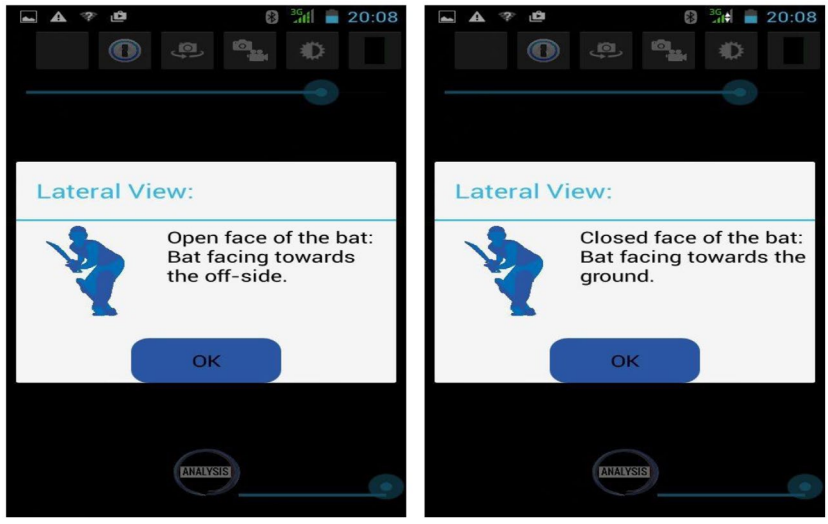


Figure 7. An illustration of the Lateral view when users click on the set button.

conducted in the previous study without the use of the mobile application. The analysis in the previous study was conducted traditionally with the use of two high definition Canon LEGRIA HF R506 HD Camcorder™ video cameras in both the frontal and lateral views. The footage was then exported to a laptop computer for analysis utilising the Kinovea™ (Version 0.8.15) software package. In this study, a brief comparison was also conducted between the mobile application and Kinovea to see if the results had matched.

The analysis with Kinovea is demonstrated as classifiers. Classifiers were utilised to identify the type of batting backlift technique employed by all batsmen. These classifiers were coded as 1 (bat face facing straight back and towards the wicket-keeper or the ground), 2 (bat face facing first or second slip), 3 (bat face towards gully or point). If the bat is directed fairly straight back or towards the slips/gully regions but has an open face of the bat, it is classified as classifier 3. Angle ranges were conceptualised to determine these classifiers (1: between 0° and 25°), (2: between 25° and 45°), (3: 46° or more and an open face of bat). Seeing that classifiers provide angle ranges only, it was needed to see if the mobile application can also depict the exact angle of the backlift.

2.7. Statistical analysis

STATISTICA 11 analysis software was used for all statistical analyses. A *t*-test was conducted for measuring the difference in backlift angles and angle ranges between the mobile application and Kinovea software. The level of significance was set at $p < 0.05$.

3. Results and discussion

Upon completion of analysing the existing video footage with the mobile application using an Android phone, the results obtained had matched the results from the previous study in terms of the backlift type. In addition, the mobile application did not just confirm the backlift type and angle ranges (classfiers) but also provided the exact angles of the backlift in the frontal view (Table 1).

The results in table show the findings gathered in the previous study utilising the Kinovea software (classifiers 1–3) whereas the findings from the use of the application in this study is displayed in the exact angles column.

The results from the mobile application show that a vast majority of the cohort (73%) employed a straight batting backlift technique with an exact angle of 33.3°. This is consistent with the previous study after which the batsmen were analysed traditionally utilising video cameras and analysis with a software on a laptop computer ($p < 0.05$) (Noorbhai & Noakes, in press).

Table 1. Matching backlift results of a mobile application among adolescent coached cricketers

Adolescents age groups	*n*	Lateral BBT	Straight BBT	Classifier 1 (0–25°)	Classifier 2 (26–45°)	Classifier 3 (46°>)	Exact angles
Under-13	10	3	7	5	3	2	31.2°*
Under-15	10	3	7	5	2	3	34.7°*
Under-19	10	2	8	6	1	3	33.1°*
Total (%)	**30**	**8 (27)**	**22 (73)**	**16 (54)**	**6 (20)**	**8 (23)**	**33.3°**

Notes: *n* = number; BBT = batting backlift technique.

*$p < 0.05$.

4. Strengths and limitations

The strengths of this mobile application allow a user to instantly record and analyse the backlift of cricket batsmen and articulate real-time feedback gained from the analysis. In addition, from the footage stored, the user will also be able to observe other pertinent variables of the overall batting technique (stance, feet, head position and follow through). The limitation however is the fact that this mobile application has only been programmed and designed to analyse the backlift of the batting technique. As such, users will only be able to gauge other said variables with a naked eye and without the use of accurate verification as with the backlift and face of the bat.

5. Coaching and practical implications

Biomechanical and video analysis in cricket can be a tedious process that includes the use of expensive equipment, third-party softwares and analysis tools. The backlift in cricket mobile application provides ease of access to the scientist, player and cricket coaches to analyse the type of backlift and face of the bat in cricket combining a three-step process into one.

6. Conclusions

The use of the backlift in cricket mobile application can be used to evaluate the backlift type of a batsman by analysing and tracking the bat position of batsmen in cricket. The development of the backlift in cricket mobile application is the first complimentary mobile application that can record and analyse the backlift of a batsman through a smartphone without the need for connectivity from parent software on computers. The mobile application provides real-time data that can be stored on the user's phone and device for subsequent usage and analysis.

7. Future plans

The mobile application needs to go through testing for a full cricket season to gauge response of usability from the players and the coaches. It needs to be ported to other platforms and operating systems such as iOS and Windows. Connectivity with other platforms in the future can assist in a better, well-rounded analysis for the batsmen.

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Competing Interests
The authors declare no competing interest.

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