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Seam or Swing? Identifying the most effective type of bowling variation for fast bowlers in men's international 50-over cricket

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Abstract

In this study, 13,176 balls bowled by international level fast bowlers were analysed in order to investigate the relationship between the types of delivery and their effectiveness. The results of Chi-Squared analyses revealed significant associations between the type of delivery and runs conceded ($p < 0.001$) as well as wickets taken ($p < 0.001$). Seam movement was revealed to be more effective than swing bowling at both producing dot balls and taking wickets. Specifically, balls that 'seam-away' were revealed to be the most effective for bowling dots and 'seam-in' for taking wickets. The 'away-swinger' resulted in significantly greater than expected dot balls as did the 'in-swinger' but only the in-swinger resulted in significantly greater than expected wickets. Both the 'off-cutter' and 'slower-balls' were revealed to result in significantly fewer than expected dot balls but significantly greater than expected wickets, implying bowlers must assess for themselves the risk versus reward of these two types of variation. Balls with no-movement, were revealed to have no significant relationship with runs conceded, but did result in significantly fewer than expected wickets. Evidence suggests that lateral movement is crucial to bowling success with seam movement revealed to be more effective than swing.

Keywords: Slower ball, ODI, off-cutter, leg-cutter, magnus effect, swerve

Introduction

Fast bowling in cricket has been the focus of much research in recent years with the majority of it centring on biomechanical analysis or injury prevention (Johnstone et al., 2014). Further to this, fast bowlers tend to draw the most attention from researchers due to the established link between successful team performance and the performance of these higher "rated" individuals (Wormgoor et al., 2010). Fast bowlers are therefore integral members of any team as they have the ultimate objective of restricting the number of runs scored by the batting team whilst also dismissing opposing batters (Feros et al., 2018). In fulfilling their objectives, they often develop a repertoire of skills which consist of inducing swing movement and seam movement or deliberately varying their bowling speed (Edwards & Beaton, 1996; Justham et al., 2006; Justham et al., 2010; Phillips et al., 2012; Scobie et al., 2020).

In cricket, the main tactic used by bowlers to outfox (and subsequently bring about an error) in a batter's performance is to make the ball deviate away from a straight-line trajectory somewhere between the delivery of the ball to when the ball arrives at the batter (Edwards & Beaton, 1996). This is why fast bowlers will often attempt to make the ball 'swing' which consists of curving the trajectory of the ball's flight path, ultimately making it more difficult for the batter to make contact with the ball (Phillips et al., 2010; Scobie et al., 2020). Swing bowling generally exists in two forms, *conventional* swing, which tends to occur in the opening overs of an innings with a new (and shiny) ball and *reverse* swing, which skilful bowlers can induce after roughly 30 overs, provided the bowling team has carefully manipulated the surface of the ball (Scobie et al., 2013). *Conventional* swing consists of in-swinging and out-swinging deliveries, which will move in towards the bat, or away from the bat respectively, whilst *reverse* swing causes the ball to move in the opposite directions (Scobie et al., 2020). Both forms of swing bowling require skill and experience, particularly as the bowler has to bowl the ball in excess of 80 mile/h (35.8 metres per second) and also impart some backspin on the ball through their bowling action in order to stabilise the seam as a wobbling seam would result in no swing (Scobie et al., 2013, 2020). Highly skilled bowlers can induce *late swing*, which can help deceive batters as it occurs late in the trajectory of the ball and thus offers batters less time to react (Scobie et al., 2020). Previous research as well as anecdotal reports suggest a higher difficulty in intercepting a swinging ball (Sarpeshkar et al., 2017), but that has not been often investigated in the elite competitive cricket setting with batting and bowling performance indicators.

Another highly coveted skill for bowlers is the ability to induce seam movement, which refers to the movement of the ball off the pitch (Edwards & Beaton, 1996; Müller et al., 2006). Seam movement can occur when the seam makes contact the pitch and subsequently causes the ball to bounce/deviate at an awkward angle on its way to the batter (Edwards & Beaton, 1996; Müller et al., 2006). The stock seam delivery consists of the bowler holding the ball between the two first fingers and the tip of the thumb with a vertically aligned seam position (Justham et al., 2010). Subtle changes in gripping the ball however can also help induce post-bounce seam movement and these deliveries are commonly referred to as off-cutters or leg-cutters, depending on the direction of the desired movement off the seam. Cutter deliveries will impart some partial spin on the ball and are usually bowled at a slightly slower pace (Justham et al., 2008). Furthermore, skilled bowlers can deliberately vary the speed of their stock ball and bowl what are commonly known as 'slower balls', which consist of a substantial drop in speed designed to induce mis-timing of a shot and/or wrong-foot the batter (Feros et al., 2019; Justham et al., 2006). These strategic variations in pace are however often only effective if the slower ball is well disguised by the bowler and bowled with an unaltered bowling action (Justham et al., 2010).

Although different types of bowling deliveries have been examined in previous research, the dynamics of these delivery types have often been studied in isolation, been examined in laboratory-based experiments, or consisted of junior and sub-elite cricketers. There is therefore, a lack of research directly comparing the effectiveness of these various delivery types, particularly with regards to fast bowling in an elite setting. In a study on spin bowling, Chin et al. (2009), compared the upper body kinematics of bowlers when performing the off-break and 'doosra' delivery types. Kinematic differences between different types of spin bowling were also investigated by Beach et al. (2016) that offered insights into the biomechanical contrasts that can be observed between off-spin and leg-spin bowlers. While these studies add to the technical understanding of different bowling types, they do not discuss to any great extent the effectiveness of these bowling types when it comes to batting, especially not at the highest competitive level. Recent studies have started addressing competitive match performance to assess the effect of specific factors such as the brand of ball used (Connor et al., 2019), while previous work has also dwelled into the effect of innings type (first or second) on batting and bowling performance in competitive matches, but still do not entail the deployment of different types of bowling. This study will therefore fill this gap in literature by examining the relationship between various types of bowling with their associated bowling (and batting) performance measures. Analysing the occurrence and effectiveness of elite competitive data could help better understand batter-bowler interactions at the highest level and thereby guide training interventions and experimentation further.

Methods

Design and Data

While bowling variations are often deployed to prompt a mistake or misjudgement from the batter, the effectiveness of variations (and bowling as a whole) is largely also driven by the ball-pitching location, commonly referred to as *line and length* (Chin et al., 2009). Pinder et al. (2012), identified a metastable zone of multiple solutions somewhere around 6 to 8 metres away from the batter’s stumps and in line with the stumps (often called a “good length” zone in bowling). Additionally, most cricketers know of a “corridor of uncertainty” which is an area where several batting strokes are available, while the batter also must decide whether to strike or leave the ball. This corridor is considered to exist at a distance of 6-8 metres while being in line with the stumps or just outside off stump – an area exhibiting a low average runs for batters historically, as well as a zone where the coaching strategies of defensive or low-risk batting have been advised (Connor et al., 2020; Feros et al., 2018). Given that different bowling lengths and lines cannot be ignored in understanding whether seam or swing is more effective, this investigation consists of 13,176 balls that were bowled in the most commonly deployed bowling zones in cricket - that is the ‘good length’ and ‘back of a good length’ zones (straddling the 6 to 10 metres distance from the batter) while being in the stump line (off-stump, middle stump and leg stump) or outside the off-stump. Bowling performance data from two international 50-over tournaments were analysed in this study (the ICC Champions Trophy 2017 and the ICC Cricket World Cup 2019). Performance data was obtained from Opta (London, UK), known for their high levels of reliability (Jamil et al., 2021). A full list of definitions provided by the data provider are presented in Table 1. Frequently used key performance indicators, such as ‘wickets taken’ and ‘runs conceded’ were used as measures of bowling performance (Douglas & Tam, 2010; Jamil et al., 2021). Run-outs were removed from the original sample (resulting in the final sample size of 13,176 balls) as it was considered that these dismissals are more to do with decision making exhibited by batters rather than bowling variation. Ethical approval for this study was obtained by the ethics committee of the local institution.

**** Table 1 near here****

Statistical Analysis

In this study, Chi-Squared (χ^2) tests of independence were conducted in order to determine whether there was any association between the various types of bowling delivery and the key performance indicators of 'wickets taken' and 'runs conceded'. The dataset consisted of nominal data variables and the data passed each of the assumption conditions outlined by McHugh (2013). In the event of statistically significant (alpha = 0.05) χ^2 test results, standardised residuals were calculated to identify the specific cells making the greatest contribution to the Chi-Square test result and thus determine the source of the significant result (Sharpe, 2015). Bonferroni corrections were applied to account for the relatively large number of cells present in the contingency tables (Sharpe, 2015) resulting in the adjusted ($p = 0.0031$) with the associated critical values of ± 2.96. Cramer's V effect sizes were also calculated (McHugh, 2013) and interpreted with the widely used thresholds of 0.1 ≤ *weak* < 0.3, 0.3 ≤ *moderate* < 0.5, and *strong* ≥ 0.5 (Cohen, 1988). All statistical analyses were performed using IBM SPSS version 25 (IBM Corp. Released 2017. IBM SPSS Statistics for Macintosh, Version 25.0. Armonk, NY: IBM Corp).

Results

Bowling delivery types were revealed to have a significant association with both, conceding runs ($p < 0.001$; $\chi^2 = 304.479$) and taking wickets ($p < 0.001$; $\chi^2 = 196.404$). With regards to conceding runs, the post-hoc analysis of the standardised residuals (Table 2), revealed that bowling 'seam away' deliveries resulted in greater than expected dot balls (SR = 7.2), followed by 'seam in' deliveries (SR = 5.4). Bowling swinging deliveries also resulted in greater than expected dot balls with 'away-swinger' and 'in-swinger' (SR = 3.3 for both). The 'off-cutter' (SR = -4.1) and 'slower ball' (SR = -3.2) deliveries were revealed to result in fewer than expected dot balls. The 'leg-cutter' and 'no-movement' delivery types were revealed to have no significant association with conceding runs. With regards to taking wickets, the post-hoc analysis of the standardised residuals revealed that bowling 'seam in' deliveries resulted in greater than expected wickets being taken (SR = 7.3), followed by 'seam away' deliveries (SR = 7.1). Only 'in-swingers' were revealed to result in greater than expected wickets (SR = 3.8). The 'off-cutter' (SR = 4.2) and 'slower ball' (SR = 5.7) deliveries were revealed to result in greater than expected wickets being taken. The 'leg-cutter' and 'away-swinger' deliveries were revealed to have no significant association with taking wickets. The bowling deliveries with 'no-movement' were revealed to result in fewer than expected wickets being taken (SR = -4.7). Bowling delivery types had a *small* effect on conceding runs (Cramer's $V = 0.182$) and a *small* effect on taking wickets (Cramer's $V = 0.122$), however this is to be expected due to the multi-faceted nature of cricket where optimal batting and bowling performances are a result of many contributing factors including technical, tactical, and contextual aspects (McErlain-Naylor, King, et al., 2021; McErlain-Naylor, Peploe, et al., 2021).

**** Table 2 near here****

Discussion

This study aimed to investigate which bowling delivery types were the most effective at enabling bowlers performing at the elite level to fulfil their objectives of taking wickets and conceding fewer runs. The results have revealed that inducing seam movement was the most effective delivery type for both taking wickets and bowling dot balls. Interestingly, inwards seam movement towards the batter was revealed to be more effective for taking wickets, while away seam movement was more effective for bowling dot balls. Swinging deliveries are also positively associated with bowling dot balls, but only in-swinging deliveries result in greater than expected number of wickets being taken. Slower balls and off-cutter deliveries result in higher than expected runs conceded, but they have also been revealed to be effective at taking wickets, implying bowlers must assess for themselves the risk versus reward of bowling these delivery types.

Given that cricket batting is a highly time-pressured task, efficient decision making requires the recognition of advanced informational cues regarding the exact location of interception (Ford et al., 2010; Müller et al., 2006). A ball can be bowled at up to 160km/hr at international level, meaning the ball can travel the distance between the batter and the bowler in less than 500ms, far less than the combined sum of the batter reaction time (200ms) and movement time of the batter's lower limbs and bat (700ms) (Müller et al., 2006). Batter reaction times are further complicated by the lateral or vertical movement of the incoming ball caused by swing or seam bowling (Müller et al., 2006). This lack of time is also why studies regarding ball-tracking gaze in hitting bouncing balls reveal that elite batters do not follow the ball throughout its trajectory but make predictive saccades to areas where the final interception may occur due to the excessive lack of adjustment time (Sarpeshkar et al., 2017). This would suggest that deviations from expected trajectory that are enacted later (i.e. seam movement) would be more difficult to anticipate and integrate into the final motor response. Therefore, as seam movement gives the batter the least reaction time, it makes these deliveries dangerous for the batter and beneficial for the bowler, as is reflected in the results of fewer runs conceded and greater wickets taken in comparison to other bowling variation types. Additionally, the lower effectiveness of swing bowling could partly also be explained by prevailing environmental/atmospheric conditions, which have been known to effect bowling performances (Jamil et al., 2021; Petersen, 2017). Both tournaments analysed in this study were hosted by the UK and the tournaments were played out during the British summer months where temperatures nearing 28 to 30 degrees Celsius were recorded – conditions that are not conducive to swing bowling (Scobie et al., 2020). Given that these are not ideal conditions for swing bowling, it is possible that bowlers identified the lack of attainable swing and adjusted their bowling strategies accordingly. High temperatures in conjunction with other unfavourable atmospheric conditions (i.e. wind-speed, humidity, air-density etc) could also partly explain why the total frequency of swinging balls bowled recorded in this dataset accounted for less than 3% of the total number of balls bowled. It should also be noted that these results are specific to the "good length" and "back of a length" bowling lengths that have been analysed in this study. An argument could be made that fuller bowling lengths may present more opportunities for swing (and the amount of swing) and thus future research could further examine and compare the effectiveness of seam and swing bowling at varying bowling lengths.

When examining the results of swing bowling in greater detail, some insightful findings about bowling intentions and plans are revealed. When looking at performance measures of runs and wickets, swinging trajectories (in-swinger and away-swinger) generally show fewer run-conceding balls than expected, as well as wickets. Specifically, wicket-taking frequencies are higher for in-swinging deliveries and not for away-swinging deliveries, despite away-swingers considered to be the most effective for a bowler owing to the maximum possible types of dismissals being possible (Leamon & Jones, 2021). This could be partly explained by bowlers struggling to induce swing owing to the unfavourable environmental conditions ultimately compelling bowlers to bowl on stricter lines nearer to the wickets (Mehta & van der Kamp, 2021). In unfavourable bowling conditions bowlers tend to bowl straighter (in line with the wickets) as a means of attempting to restrict runs as offering batters width can encourage them to freely swing their arms and score runs in the limited balls they have (Mehta & van der Kamp, 2021; Leamon & Jones, 2021).

In every bowler-batter interaction performers are consistently weighing up the risk vs reward of their actions (Connor et al., 2020; O'Donoghue, 2016). Whereas batters will hope to minimise the risk of their dismissal, whilst still scoring runs with their proposed actions (Connor et al., 2020), bowlers will attempt to dismiss their opposing batter or at least prevent the concession of runs from their proposed actions (O'Donoghue, 2016). The results of this study revealed that the slower ball and the off-cutter deliveries resulted in greater than expected runs being conceded, but also greater than expected wickets being taken suggesting they are classic examples of high risk-high reward variations. The results therefore imply that bowlers must assess for themselves the opportune moment to bowl these particular variations, which can be effective for taking wickets, but not effective at restricting runs being scored.

This study was not without limitations. Specifically, both international tournaments analysed in this study were hosted in the UK and during the summer months. Previous studies have revealed that environmental/overhead conditions can impact bowling performances (Jamil et al., 2021; Petersen, 2017). To this end, it may be highly valuable to conduct such research on cricket in different locations where matches are highly frequented, such as South Asia, Oceania and Africa, to compare and constitute the best bowling (and batting) plans and probabilities according to location. There were also some limitations of the data. Specifically, data utilised in this study consisted of only two bowling lengths (good and back of a length) and no data were coded with multiple categories (for example, a slower ball that also exhibited seam movement was simply coded as a slower ball and in this instance the seam movement was not recorded in the data). Similarly, the data did not provide any detail on the amount of swing (degrees of movement). Furthermore, this study did not account for bowling partnerships where bowlers may work in unison and bowl specific variations to batters as a means of setting them up to eventually create a wicket taking opportunity (O'Donoghue, 2016). In addition, only One-Day International matches were analysed in this study and batter skill was not accounted for. This therefore presents future researchers with the opportunity to investigate the effectiveness of bowling variations in other forms of cricket, such as Test cricket, T20 cricket, Women's cricket and the newly formed "The Hundred" format, whilst also accounting for the skill level of the opposing batters.

Conclusion

This study has discovered evidence confirming that seam movement is the most effective bowling delivery variation for both, taking wickets and bowling dot balls at the elite One-Day International level. Inwards seam movement towards the batter is revealed to be more effective for taking wickets, while away seam movement is more effective for bowling dot balls. Swinging deliveries were also revealed to be effective for bowling dot balls, but only in-swinging deliveries were revealed to be effective at taking wickets. Whilst, slower balls and off-cutter deliveries were revealed to go for runs, they were also revealed to be effective at taking wickets. From a practical perspective the results of this investigation could inform the in-game decision making of team captains. Furthermore, the results of this study could well inform coaching practice, particularly with regards to training bowlers to induce seam movement and extract maximum value from the playing surface. In addition, the results have highlighted the importance of bowlers possessing good decision-making attributes as they must assess for themselves the risk versus reward of certain bowling variations such as the slower ball and the off-cutter.

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Table 1 – Definitions list for all variables provided by the data supplier

Variable	Definition
Away Swinger	A delivery from a seamer (pace bowler) where the trajectory of the ball through the air deviates away from the batter
In-Swinger	A delivery from a seamer where the trajectory of the ball through the air deviates towards the batter
Leg-Cutter	A delivery from a seamer where the bowler runs their fingers down the inside of the ball (the left side for a right arm bowler, the right side for a left arm bowler)
No-Movement	A delivery from a seamer where the ball does not deviate from a linear trajectory or speed
Off-Cutter	A delivery from a seamer where the bowler runs their fingers down the outside of the ball (the right side for a right arm bowler, the left side for a left arm bowler).
Seam Away	A delivery from a seamer which deviates away from the batter after pitching (bouncing)
Seam In	A delivery from a seamer which deviates towards the batter after pitching
Slower Ball	A delivery from a seamer which is bowled deliberately slower than their usual pace. The bowler will attempt to disguise the slower ball so that their action appears quicker than the resulting delivery.

Table 2 – Observed and (Expected) Counts for Bowling Variations

Bowling Variation Type	Runs Conceded NO	Std Residual	Runs Conceded YES	Std Residual	Wickets Taken NO	Std Residual	Wickets Taken YES	Std Residual
Away Swinger	145 (110.7)	3.3*	50 (84.3)	-3.7*	191 (190.0)	0.1	4 (5.0)	-0.5
In-Swinger	98 (70.4)	3.3*	26 (53.6)	-3.8*	114 (120.8)	-0.6	10 (3.2)	3.8*
Leg-Cutter	28 (36.3)	-1.4	36 (27.7)	1.6	61 (62.3)	-0.2	3 (1.7)	1.0
No-Movement	6282 (6345.5)	-0.8	4894 (4830.5)	0.9	10966 (10886.8)	0.8	210 (289.2)	-4.7*
Off-Cutter	326 (409.4)	-4.1*	395 (311.6)	4.7*	684 (702.3)	-0.7	37 (18.7)	4.2*
Seam Away	247 (156.7)	7.2*	29 (119.3)	-8.3*	250 (268.9)	-1.2	26 (7.1)	7.1*
Seam In	152 (98.8)	5.4*	22 (75.2)	-6.1*	154 (169.5)	-1.2	20 (4.5)	7.3*
Slower Ball	203 (253.2)	-3.2*	243 (192.8)	3.6*	415 (434.5)	-0.9	31 (11.5)	5.7*

*: Significant at Bonferroni corrected ($p < 0.0031$), corresponding critical value ±2.96

Expected Counts in brackets

Runs Conceded NO is referred to as dot ball in the text

Wickets Taken YES refers to: bowled (wickets struck by bowler), caught (by fielder), hit-wicket (batter struck own wicket) and LBW (leg before wicket, implying the ball would have struck the wickets if not for the intervention of the pads)