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Investigating the impact age has on within-over and death bowling performances in international level 50-over cricket

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ABSTRACT

The aims of this investigation were to determine if ageing effects were present in elite international level cricket. Ball-by-ball data were analysed for 96 bowlers in the 50-Over World Cup 2019. Bowlers were categorized into 1 of 3 age groups *GROUP 1* (18–24), *GROUP 2* (25–31) and *GROUP 3* (32+). Ordinal Logistic Regressions (OLR) and Multinomial Logistic Regressions (MLR) were conducted to estimate the relationship between age and bowling performances. OLR Results revealed that younger bowlers were significantly more likely to concede a greater number of runs on the last ball of their overs than their older counterparts ($p = 0.001$). A separate MLR analysis was conducted for those bowlers entrusted to bowl during the "death" phase of an innings, and results revealed that *GROUP 2* bowlers were significantly more likely to take wickets than either *GROUP 1* ($p = 0.021$) or *GROUP 3* ($p = 0.022$) bowlers. The evidence indicates that wicket taking "death bowlers" will likely perform at their peak between the ages of 25–31, which could inform the bowling strategy of team captains. Furthermore, there is evidence to suggest that younger bowlers are not as skilled as their older counterparts at restricting runs conceded.

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Age; peak age; ageing trend; peak years; career length; performance analysis

Introduction

Recent years have seen a growing body of research on the concept of ageing effects in sports, primarily to determine when athletes perform at the peak of their capabilities (Hollings et al., 2014; Jamil & Kerruish, 2020; Kalén et al., 2021, 2019; Kovalchik, 2014). Research on the topic of peak performance years have been conducted across various sports, with studies on golf (Tiruneh, 2010), tennis (Kovalchik, 2014), baseball (Fair, 2008), ice hockey (Brander et al., 2014), track and field events (Hollings et al., 2014), the triathlon (Rüst et al., 2012), football (Jamil & Kerruish, 2020; Kalén et al., 2019) and basketball (Kalén et al., 2021). Each of these studies mentioned above has discovered varying peak ages for performance, which is expected as each of these sports requires performers to possess a diverse range of physical characteristics and varying technical skill sets (Allen & Hopkins,

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2015). Knowing when athletes peak has become increasingly important as this information can inform athlete selection for major competitions (Barreira, 2016), aid talent identification procedures (Allen & Hopkins, 2015), allow coaches to develop individualized training programmes (Hollings et al., 2014), as well as inform financial decisions such as wage negotiations with athletes (Kalén et al., 2019).

It is a surprise then that ageing effects on performances have not been previously investigated in cricket. Part of the reason for this may be that the physiological demands of cricket have long been misunderstood and underestimated due to the intermittent nature of the activity that occurs within a cricket match (Noakes & Durandt, 2000). On the contrary, cricket players require a high level of aerobic fitness to play for up to 6 hours per day, with intermittent, short bursts of high-intensity effort needed throughout the match (MacDonald et al., 2013). It is also surprising that ageing effects have been overlooked in cricket given how popular and lucrative the sport of cricket has become in recent years (Irvine & Kennedy, 2017; Johnstone et al., 2014), with cricketers now able to earn roughly 100,000 USD per match for performing in just one of many annual domestic tournaments (Najdan et al., 2014). Further need for a study investigating the peak age of cricket players is emphasized by the fact that players can suffer from both physical and mental fatigue during a match (Connor et al., 2019).

This study will focus solely on bowling performances for three main reasons. Firstly bowlers and, in particular, fast bowlers are considered to be the most important and most influential players in determining the outcome of a match (Glazier & Wheat, 2014). Secondly, fast bowlers perform at the highest intensity of any members of a cricket team (Vickery et al., 2018) and are thus particularly susceptible to fatiguing effects (Johnstone et al., 2014) due in part to the fact that bowling requires repeated eccentric muscle contractions (Johnstone et al., 2014; Noakes & Durandt, 2000). Bearing in mind a full over consists of a bowler bowling 6 balls (legal balls), a bowler will experience intermittent eccentric muscle contractions throughout their over and they could be required to bowl up to 10 overs in any one 50 over innings. Finally, it could be argued that bowling has become more difficult in recent years as rule and format changes have significantly diminished a bowler's margin for error and thus the pressure placed upon them to successfully execute their skills has significantly increased (Douglas & Tam, 2010).

As far as the authors are aware, ageing effects have not been investigated at the highest level in the sport of cricket. Taking this into consideration, as well as the points raised above, this study aims to examine the ageing effects of elite bowlers in 50 over One-Day International (ODI) cricket.

Methods

Design and data

This study consisted of a primary and secondary analyses. In the primary analysis, ball-by-ball data from all bowlers who have participated in the International Cricket Council (ICC) 50 over World Cup 2019 were analysed. In the secondary analysis, only the performances of specialized "death" bowlers were analysed.[1] Death bowling was defined as having bowled in the last four overs of the first innings throughout the entire tournament (in cases where the full 50-overs had been bowled) and the last four overs of the second

Table 1. Compositions of bowler types in the 50 over cricket world cup 2019.

	50 Over All Bowlers Age Groups			50 Over Death Bowlers Age Groups		
Type of Bowler	18–24 (%)	25–31 (%)	32+ (%)	18–24 (%)	25–31 (%)	32+ (%)
Fast	48	56	31	60	81	69
Medium	14	13	0	20	19	31
Off-Spin	14	10	46	10	0	0
Leg-Spin	14	11	15	10	0	0
Orthodox	5	8	8	0	0	0
Unorthodox	5	2	0	0	0	0

innings in closely contested cases where matches were won or lost by ≤24 runs,[2] in order to acquire a fair representation of death bowling performances. Performance data were provided by Opta sports (Jamil (2019), Jamil et al. (2020) and Liu et al. (2013) have previously reported a high degree of accuracy). A total of 96 bowlers were analysed in the primary analysis, 36 of which had bowled some of their overs at the death (secondary analyses). The sample consisted of bowlers that had bowled a minimum of one full over (6 legal balls) in a match.

The dependent variables in all analyses conducted consisted of naturally ordered age group categories, suited to both Ordinal Logistic Regression (OLR) and Multinomial Logistic Regression (MLR) methods (Field, 2017). The independent variables in both the primary and secondary analyses consisted of "runs conceded" and "wickets taken" both previously identified as key performance indicators for bowlers (Irvine & Kennedy, 2017; Premkumar et al., 2020). Bowlers were then categorized into 1 of 3 age groups, *GROUP 1* (18–24), *GROUP 2* (25–31) and *GROUP 3* (32+). In the primary analysis, the youngest bowler represented was 18 years of age and the oldest bowler 40 (28.72 ± 4.403). In the secondary analysis, the youngest bowler to bowl at least one over during the death phase of an innings was also 18 years of age, but the oldest was 35 (27.47 ± 3.918). The compositions of the types of all bowlers represented in each age group in the ICC 50 Over World Cup 2019 are presented in Table 1. Opta also provided data on player ages. Players were categorized into their age groups depending on their age at the commencement of the tournament. Ethical approval for this study was obtained by the ethics committee of the local institution.

Statistical analysis

In both analyses, Variance Inflation Factors (VIF) and Tolerance statistics were estimated to detect multicollinearity. In both cases, no multicollinearity between variables was detected as VIF statistics were revealed to be well below the generally accepted threshold of 10 (C. C. Robinson & Schumacker, 2009). In the primary analysis, an OLR estimation was conducted, and the final model fitting results were revealed to be significant ($p = 0.009$), and the Pearson ($p = 0.500$) and Deviance ($p = 0.959$) Goodness of Fit estimations were both revealed to be non-significant indicating a good fit. The Nagelkerke pseudo R-Square was 0.215. Tests for parallel lines revealed a non-significant result ($p = 0.302$), confirming that the proportional odds assumption had not been violated, thereby ensuring an OLR was a suitable estimation method.

A significant result for the tests for parallel lines ($p = 0.007$) revealed a violation of the proportional odds assumption in the secondary analyses. Consequently, an MLR method

was adopted, which is still applicable when outcome categories have a meaningful order (Field, 2017). In the subsequent MLR estimation, the final model fitting results were revealed to be significant (p = 0.009), and the Pearson (p = 0.645) and Deviance (p = 0.598) Goodness of Fit estimations were both revealed to be non-significant, indicating a good fit. The Nagelkerke pseudo R-Square was 0.371.

In both analyses, the count values for the variable "total balls bowled" were transformed into standardized z-scores, and Bootstrapped One-Way ANOVA's were conducted to test for any differences in the mean balls bowled between the three age groups. Non-significant p-values (p = 0.173) and (p = 0.457) confirmed no significant differences between the mean number of balls bowled between the three age groups of all bowlers and death bowlers. Fisher r to z transformations were conducted in order to test for significant differences between correlation coefficients between groups (see Table 5). As there were three age groups, Fisher rz values were calculated in accordance with the protocol set out by Weaver and Wuensch (2013). When assessing the number of runs conceded, a Chi-Square value of 0.2683 and a corresponding p = 0.8745 revealed no significant differences between the correlation coefficients of the three age groups. When assessing the number of wickets taken, a Chi-Square value of 0.2613 and a corresponding p = 0.8775 revealed no significant differences between the correlation coefficients of the three age groups. Statistical analyses were performed on IBM SPSS version 25 (IBM Corp. Released 2017. IBM SPSS Statistics for Macintosh, Version 25.0. Armonk, NY: IBM Corp).

Results

A summary of *GROUP 1, GROUP 2* and *GROUP 3* bowling performances in the 50 over World Cup 2019 (mean ± standard deviations) are presented in Table 2.

Table 3 revealed evidence of ageing effects in the 50 over format of cricket. Specifically, the number of runs conceded on ball 6 was revealed to have a statistically significant (p = 0.001) and negative association with the dependent variable (age). The odds ratio of 0.923 suggests a decreasing probability of being in a higher level of the dependent variable for every unit of increase in the runs conceded (holding all other independent variables constant). In other words, as runs conceded on the final ball of the over increased, they were less likely to be bowled by the bowlers in the older age categories. Effect sizes assessed as the Nagelkerke Psuedo R-Square were small.

In the death bowling analysis (Table 4), no significant association between the three age categories in the dependent variable and independent variable runs conceded were

Table 2. Summary of bowling performances in the 50 over world cup 2019.

Variable	GROUP 1 (18–24)	GROUP 2 (25–31)	GROUP 3 (32+)
Runs Conceded Ball 1	46 ± 26	35 ± 26	38 ± 31
Runs Conceded Ball 2	46 ± 27	36 ± 25	32 ± 25
Runs Conceded Ball 3	47 ± 25	35 ± 26	31 ± 25
Runs Conceded Ball 4	45 ± 24	37 ± 26	34 ± 29
Runs Conceded Ball 5	44 ± 23	34 ± 22	34 ± 26
Runs Conceded Ball 6	49 ± 28	35 ± 24	26 ± 20
Wickets Taken (tournament)	8 ± 6	6 ± 6	5 ± 5
Death Bowling			
Runs Conceded (DB overs only)	26 ± 24	23 ± 16	19 ± 14
Wickets Taken (DB overs only)	1 ± 1	3 ± 2	1 ± 1

Table 3. Parameter estimates all bowlers – primary OLR.

Variable (Group 1)	B	B (EXP)	P-Value	Lower Bound (EXP B)	Upper Bound (EXP B)
Runs Conceded Ball 1	0.036	1.036	0.120	0.989	1.086
Runs Conceded Ball 2	0.001	1.001	0.971	0.961	1.042
Runs Conceded Ball 3	−0.017	0.983	0.462	0.941	1.028
Runs Conceded Ball 4	0.044	1.045	0.095	0.991	1.101
Runs Conceded Ball 5	0.006	1.006	0.794	0.960	1.055
Runs Conceded Ball 6	−0.080	0.923	0.001**	0.880	0.969
Wickets Taken (tournament)	−0.051	0.951	0.412	0.842	1.073

* = Significant at 95% CI, ** = Significant at 99% CI

Table 4. Parameter estimates death bowlers only – secondary MLR.

Variable (Group 1)	B	B (EXP)	P-Value	Lower Bound (EXP B)	Upper Bound (EXP B)
Runs Conceded	0.020	1.021	0.460+	0.967	1.077
Wickets Taken	0.186	1.204	0.732+	0.417	3.479
Variable *(Group 2)*	**B**	**B (EXP)**	**P-Value**	**Lower Bound (EXP B)**	**Upper Bound (EXP B)**
Runs Conceded	−0.013	0.987	0.745+	0.915	1.066
Wickets Taken	1.255	3.506	0.022*	1.200	10.248

* = Significant at 95% CI, ** = Significantat 99% CI

Reference category = *GROUP 3*

Variable *(Group 2)*	B	B (EXP)	P-Value	Lower Bound (EXP B)	Upper Bound (EXP B)
Runs Conceded	−0.033	0.967	0.363	0.901	1.039
Wickets Taken	1.069	2.913	0.021*	1.178	7.200

* = Significant at 95% CI, ** = Significant at 99% CI

Reference category = *GROUP 1*

Table 5. Correlation coefficients and fisher r to z values.

	Runs Conceded Ball 6 (Correlation)	P – Value (Correlation)	Fisher rz (grp 1)	Fisher rz (grp 2)	Fisher rz (grp 3)
Group 1 (18–24)	r = 0.024	0.916+	0.024	-	-
Group 2 (25–31)	r = – 0.034	0.793+	-	- 0.034	-
Group 3 (32+)	r = 0.136	0.658+	-	-	0.137
	Wickets Taken Death Bowling	**P – Value (Correlation)**	**Fisher rz (grp 1)**	**Fisher rz (grp 2)**	**Fisher rz (grp 3)**
Group 1 (18–24)	r = 0.642	0.046*	0.762	-	-
Group 2 (25–31)	r = 0.684	0.003**	-	0.837	-
Group 3 (32 +)	r = 0.514	0.193+	-	-	0.568

discovered. However, *GROUP 2* bowlers (25–31 years old) were revealed to be significantly more likely to take a wicket than either *GROUP 1* bowlers (18–24 years old, p = 0.021) and *GROUP 3* bowlers (32+ years of age, p = 0.022). A look at the odds ratios reveals that *GROUP 2* bowlers are around 3 times more likely to take a wicket at the death bowling phase of an innings than their younger and older counterparts. Results indicate that wicket-taking death bowlers are most effective when they are between the ages of 25–31. Effect sizes assessed as the Nagelkerke Psuedo R-Square were medium.

Discussion

This study aimed to investigate what effects if any, age had upon bowling performances in the sport of cricket. Bowling performances in an international world cup tournament were analysed, and the results revealed the presence of ageing effects. Expressly, older bowlers are significantly more likely to restrict the number of runs scored at the end of the over, specifically the 6th and final ball of the over. In contrast, their younger counterparts are much more likely to concede runs at the end of their over. Furthermore, the results have revealed that bowlers between the ages of 25–31 are the most adept at taking wickets in the death bowling phase of an innings.

The results revealed that the older bowlers were significantly less likely to concede runs than their younger counterparts on the 6th and final ball of the over. There could be several potential reasons explaining this discovery. Firstly, the oldest age group consisted mainly of spin bowlers (Table 1). In total, 61% of bowlers in GROUP 3 (32+) were spin bowlers as opposed to only 28% in GROUP 1 (18–24) and 21% in GROUP 2 (25–31). As emphasized by Petersen (2017), the impact of the weather on-pitch performance is not to be understated as hot and dry conditions can favour spin bowling. As the ICC World Cup 2019 was played in England and Wales between the summer months of May and July, where temperatures as high as 34°C were recorded (metoffice.gov.uk), it is possible that summer conditions advantaged spin bowlers for specific matches throughout this tournament. Secondly, the laws of cricket and in particular those about field restrictions may also be partially responsible for this particular, finding. As was the case in the ICC World Cup 2019 tournament, field restrictions (restricting the number of fielders outside the 30-yard circle) applied during what is known as powerplay overs. Upon the conclusion of a powerplay, field restrictions are lifted, allowing many fielders to patrol the boundary, consequently making boundaries harder to obtain (Najdan et al., 2014). Ultimately, this causes batsmen to purposely try and consolidate the batting innings and score more singles and regularly rotate strike (Najdan et al., 2014), which coincides with a common tactic employed by captains, which is to introduce a spinner to the bowling attack immediately after a powerplay (Irvine & Kennedy, 2017). Finally, it is possible that the quality of spin bowling throughout this tournament was of an exceptionally high level, thus making it difficult for batsmen to score runs. Although spin bowling may not be as dominant in the sport of cricket as fast bowling (Chin et al., 2009) or perceived by the general public in the same light as fast bowling, spin bowling is, in fact, an incredibly subtle art (G. G. Robinson & Robinson, 2016). Spin bowlers are required to apply various types of spin to the ball, either within the air or off the ground, with the ultimate aim of deceiving batsmen (Beach et al., 2016). It is because of this unpredictability spin bowlers can become difficult for batsmen to attack, and thus elite level "mystery" spin bowlers should be selected whenever possible as strike (wicket taking) bowlers (Irvine & Kennedy, 2017).

With regards to the results obtained for the death bowling analysis, the findings can be partly explained by the fact that there were a greater proportion of fast bowlers in GROUP 2 (81%) than there were in both GROUP 1 (60%) and GROUP 3 (69%). Fast bowlers are considered prized players in cricket due to their ability to dismiss opposing batsmen and restrict their ability to score runs (Wormgoor et al., 2010). Developing fast bowlers, however, is no mean feat and many teams internationally strive to produce fast bowlers

who can generate high ball release speeds (Wormgoor et al., 2010). Typically, fast bowlers are required to have a high level of aerobic fitness as, in a standard 10 over spell, they will be required to perform a minimum of 60 episodes of upper and lower body high-intensity actions whilst covering approximately 1.9 km in 5.3 minutes of discontinuous bowling activity (Johnstone et al., 2014; MacDonald et al., 2013). Although fast bowlers can be vital to a team's chances of success, they typically have the shortest careers compared with their peers (Johnstone et al., 2014), which also helps to explain the smaller proportion of fast bowlers in GROUP 3.

It is also important to note how this particular discovery could have been impacted by mental fatigue as death bowling occurs at the end of an innings. Cricketers are susceptible to both physical and mental fatigue during a match (Connor et al., 2019), partly because they are required to perform multiple roles throughout the match, including their specialism in either batting or bowling as well as the essential requirement of fielding (MacDonald et al., 2013). Fielding requires cricketers to possess a great deal of mental resilience (MacDonald et al., 2013). Fielders are required to concentrate intensely for long periods, which no level of physical fitness can compensate (Noakes & Durandt, 2000). Even in the shortest T20 format, fielders are required to maintain concentration levels for an entire inning, usually around 90 minutes in duration (MacDonald et al., 2013). It is beyond the scope of this study to assess the mental conditioning of cricket players of varying ages, but this may present a theme for future research.

This study provided a fascinating insight into ageing effects and their impact upon the technical and physiological demands of both completing an over successfully and bowling at the death effectively. This study however, was limited in the main by an absence of physical parameters, which may influence some of the ageing trends discovered in this study. Future studies, therefore, could continue this theme of research and incorporate physical data to further inform practitioners of ageing trends in cricket. In addition, future research on ageing effects could be conducted on the most extended format of cricket, test match cricket. It is possible that ageing effects could be more prevalent in test cricket as this format consists of multiple innings being played over the course of 5 days and requires players to possess immense composure, patience and discipline (Edgar, 2020).

Conclusion

This investigation has discovered evidence confirming that ageing effects impact bowling performances in the 50 over format of cricket at the elite level. Specifically, the evidence suggests that wicket-taking death bowlers will peak between the ages of 25–31. Furthermore, the results have revealed that younger bowlers tend to concede significantly more runs on the last ball of their overs than their older counterparts. From a practical perspective, the results obtained in this investigation should encourage coaches to focus their efforts on younger bowlers in order to refine their death bowling skills further and aid them to maintain their consistency of delivery towards the end of an over. Furthermore, team captains can utilize these findings during a match to devise strategies for effective bowling during the death bowling phase of an innings. Finally, the results of this study could inform the board of selectors for upcoming international tournaments or an international series tour to

ensure there is an appropriate blend of youth and experience within their chosen bowling line up.

Notes

1. In both the primary and secondary analyses, it is reasonably assumed that all bowling representatives have accumulated varying levels of national league (first class) experience prior to the commencement of the world cup tournament.
2. 24 runs were selected as this represents a required run rate of 6.00 runs per over for the batting team during the death phase of the innings.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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