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The change in Test cricket performance following the introduction of T20 cricket: Implications for tactical strategy.

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27 **Abstract**

28 Cricket has evolved from predominantly Test cricket, to shorter formats of competition. With

29 the high player overlap between formats, the introduction of T20 cricket is proposed to have

30 influenced Test cricket and therefore the tactical strategies coaches and players should attempt

31 to implement. The aim of this study was to identify the change in specific Test cricket

32 performance metrics following the introduction of T20 cricket across a 20-year period (2000-

33 2020). A total of 667 matches involving the top 8 ICC Test-cricket nations were analysed.

34 Overall, the introduction of T20 cricket has been associated with a change in the way in which

35 test cricket is currently played. Results identified significantly (p < 0.001) more runs being

36 scored by sixes and less by fours. A significant decrease was also present in the percentage of

37 Test matches ending in draws (17.1%; p < 0.001), whilst run rates were altered for several

38 teams analysed. However, there was no change in the number of days Test matches lasted, with

39 the average number of days continuing to last into day five (4.5 decreasing to 4.3). Findings

40 highlight that improving the ability to strike a greater number of sixes, increase the overall run

41 rate, and facilitate strike rotation when batting to be a focus for coaches and players alike.

42 Future studies should ascertain whether the introduction of T20 has had an impact on ODI

43 performance variables whilst further considering the impact of home advantage and team

44 quality, to facilitate enhanced tactical and strategic decision-making.

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47 Keywords: Cricket, Batting, Performance Analysis, Match Analysis, Match Strategy, Coaching

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Introduction

Performance analysis is a key element of sport science support and an important component within the coaching process (Carling, Williams & Reilly, 2005). It aims to provide coaches with a greater depth of information to inform their decision-making process more effectively, e.g., match strategy, training focus, and player recruitment (Barron, Ball, Robins & Sunderland, 2018; Irvine & Kennedy, 2017; Petersen, Pyne, Portus & Dawson, 2008a). International cricket has evolved significantly over the years into three main formats (Test, One Day International [ODI] and Twenty20 [T20]), each of which has a different playing style focusing primarily on the speed of run scoring (Cannonier, Panda & Sarangi, 2015; Lohawala & Rahman, 2018). Much of the research in cricket performance analysis has focused on the performance variables associated with winning in T20 cricket (Bhattacharjee, Pandey, Saikia & Radhakrishnan, 2016; Douglas & Tam, 2010; Moore, Turner & Johnstone, 2012; Najdan, Robins & Glazier, 2014; Petersen et al., 2008a). Such research, and the indicators identified, can be used to underpin a coach's decision-making and therefore the team's tactical strategy. Facing fewer dot balls, taking more wickets specifically in the last six overs, having a higher run rate and scoring a higher percentage of runs from boundaries have all been found to be key indicators of success across different domestic and international tournaments, including the Indian Premier League (IPL; Petersen et al., 2008a), English domestic T20 matches (Moore et al., 2012), and the T20 World Cup (Douglas & Tam, 2010; Irvine & Kennedy, 2017). Thus, considering team selections, bowlers who take more wickets should be potentially favoured ahead of bowlers who bowl more economically (Petersen et al., 2008a). Additionally, batters should potentially be selected on their ability to score runs quickly and therefore increase the team's run rate, a metric that has shown a positive outcome in IPL matches (Petersen et al., 2008a).

Whilst there may be similarities across these tournaments, the extent to which they are indicators of success do vary and often depend on the environment and context of the match. Research has shown that whilst there was a small effect size for taking wickets in the PowerPlay, there was a moderate effect size for lower percentage of runs from boundaries in the first six overs (ES = 0.96 ± 0.56) and fewer runs conceded in the first six overs (ES = 0.75 ± 0.55; Moore et al., 2012). Within the English domestic tournament, for the PowerPlay, winning teams appear to place more

83   emphasis on minimising the runs, and in particular the boundaries scored in this period
84   rather than the more attacking nature of taking wickets. The opposite has been shown
85   in the IPL which places emphasis on wicket taking (Petersen et al., 2008a). Whilst
86   these may be explained by tournament differences, it could arguably be caused by an
87   evolution in tactics over time; having a higher run rate in the 2008 IPL and the cricket
88   World Cup was found to be the highest correlating variable to match success (Petersen
89   et al., 2008a; Petersen, Pyne, Portus, Cordy & Dawson, 2008b). In addition, the
90   percentage of runs from boundaries has tended to increase in various short forms of
91   cricket. Such changes begin to suggest a possible evolution in batting tactics and
92   coaching strategy over time, with batting becoming more aggressive by virtue of the
93   increase in run scoring in general alongside the increase in runs scored via boundaries.
94   However, it must be noted that various environmental (e.g., weather/climate) and
95   tournament variations (e.g., number of matches played) that exist between these T20
96   tournaments may explain aspects of any changes identified.

97   Given that 6 of the 10 ECB players awarded a central contract for Test cricket
98   were also awarded one of the 12 white ball contracts in 2019 (ECB, 2019), it may well
99   be logical to assume some playing style overlap exist between Test and the short
100 formats of the game. Previous research has attempted to assess the influence of T20
101 cricket on Test cricket by analysing several indicators of performance, such as draw
102 percentage, run rate, match length, and runs scored in boundaries, eight years prior to
103 and eight years subsequent to the introduction of the IPL (Ray, 2019). The study
104 focused considerably on India and Australia identifying a decline in the percentage of
105 draws for India and a considerable increase of 35% for Australia. Surprisingly, it was
106 identified that there was an increase in runs per over prior to the introduction of the
107 IPL from 3.09 in 2000 to 3.38 in 2007, but a significant decrease to 3.11 run per over
108 post-IPL introduction (Ray, 2019). Additionally, there was no evidence that the length
109 of Test matches decreased; however, a reduction in the number of overs bowled per
110 Test match was identified (Ray, 2019). However, this study had a considerable focus
111 on India and subcontinent conditions, not considering other major test playing nations
112 and so the generalisability of the findings is limited. Whilst there is limited research
113 identifying any changes in Test Cricket strategies after the introduction of T20, there
114 are several studies identifying changes in draw percentage in Test cricket. Research
115 has shown a substantial 21% decrease (Lenton, 2008) in draw percentage in test
116 matches, however a decrease of 7% has also been identified (Allsopp, 2005).

117   Research examining the impact of T20 on test cricket has typically grouped
118 together several seasons before and after its introduction to determine its influence on
119 Test performance and though this might overcome statistical issues (e.g., anomalies
120 and outliers), grouping many seasons together might hinder the ability to identify a
121 more subtle trend. It would therefore be beneficial to combine the key strengths of
122 these studies and analyse each metric across a smaller period and for each team
123 individually, to identify any changes and whether this is applicable to all countries.
124 Equally, limited research has mentioned matches being excluded where considerable
125 rain delays were present resulting in play abandonment on one or more full days (e.g.,
126 matches ending in draws due to weather). Of the research that has looked at this, no
127 significant impact upon match outcome was reported at international level (Forrest &
128 Dorsey, 2008). However, Forrest and Dorsey (2008) highlighted the impact of toss and
129 weather on English County Championship outcomes (e.g., match and league table
130 adjustment).

131   Previous research has identified varying indicators of successful and
132 unsuccessful performances across the three cricket formats (Najdan et al., 2014;
133 Petersen et al., 2008a) with such differences arguably the result of the need to take a
134 far more attacking approach to scoring runs within the shorter formats. However, only
135 two studies have focused on changes in the way in which Test cricket has been played
136 since the introduction of T20 (Lohawala & Rahman, 2018; Ray, 2019). Further, there
137 is some contradictory evidence depending on the time-period studied therefore more
138 research is needed to identify any changes in key performance metrics within Test
139 cricket following the introduction of T20 to inform future coach decision-making. A
140 more specific analysis, using shorter periods around the introduction of the T20 format
141 focused on individual nations, is warranted to further understand the positive or
142 negative impact that T20 has had on Test Cricket and the tactical approach required to
143 be successful. Therefore, the aim of this study was to identify the change, if any, of
144 specific performance variables in Test match cricket following the creation of T20
145 cricket.

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150 **Methods**

151 *Sample*

152 Match statistics from 724 international Test cricket matches involving the top eight

153 Test nations (Australia, England, India, New Zealand, Pakistan, South Africa, Sri

154 Lanka and the West Indies, reviewed from ICC Cricket on 1st May 2020; ICC, 2020)

155 played between the 1st January 2000 and the 31st March 2020 were selected for

156 analysis. Only fixtures between the top eight Test teams were selected to ensure the

157 highest level of competition. Higher ranked teams will often field a weaker team

158 against those outside of the top eight, potentially resulting in data unrepresentative of

159 typical performance (Dewart & Gillard, 2019). Of the 724 matches played, 57 were

160 excluded as one or more of the five days saw no play due to adverse weather.

161 Additionally, any matches where teams forfeited an innings or withdrew from the

162 match were also excluded. As a result, data from 667 test matches was used for

163 analysis. Matches were split into pre-T20 (2000-2005) and post T20, with this post

164 T20 period being split into five groups each consisting of 3 years of competition (Table

165 1 and 2).

166

167 *Table 1. Number of matches and innings played by each country across the six time*
168 *periods*

Team	Type	Pre- T20	Post T20				
		2000-'05	2006-'08	2009-'11	2012-'14	2015-'17	2018-'20
Australia	Matches	68	26	33	31	27	21
	Innings	123	48	62	59	50	38
England	Matches	63	35	29	32	36	25
	Innings	121	65	49	61	69	47
India	Matches	46	34	29	26	27	18
	Innings	85	66	52	47	46	33
New Zealand	Matches	32	18	17	23	18	16
	Innings	61	36	33	45	35	28
Pakistan	Matches	43	19	25	19	21	13
	Innings	80	36	49	38	42	25
South Africa	Matches	55	31	22	23	19	20
	Innings	101	58	39	40	36	40
Sri Lanka	Matches	45	18	23	20	26	17
	Innings	85	32	45	40	51	33
West Indies	Matches	58	19	20	16	22	10
	Innings	109	37	36	32	44	20

169

170 *Table 2. Number of test matches played, per year, per country pre- and post-*
171 *introduction of T20*

Team	Average Test matches pre-T20	Average Test matches post-T20	Change
Australia	11.3	9.2	-2.1
England	10.5	10.5	0.0
India	7.7	8.9	1.2
New Zealand	5.3	6.1	-0.8
Pakistan	7.2	6.5	-0.7
South Africa	9.2	7.7	-1.5
Sri Lanka	7.5	6.9	-0.6
West Indies	9.7	5.8	-3.7
Overall	**8.5**	**7.7**	**-0.8**

172

173 *Variables and Procedure*

174 The variables of interest included the: overall match result, total number of fours and

175 sixes scored, total number of runs scored, number of days the match lasted, and run

176 rate of each innings played (Ray, 2019). All data was manually collected from ESPN

177 Cricinfo (www.espncricinfo.com) and collated into a Microsoft Excel spreadsheet for

178 further analysis.

179

180 *Reliability*

181 As the data was collected from a secondary source (ESPN Cricinfo), and despite this

182 source being utilised within several previous research publications to date (Douglas &

183 Tam, 2010; Petersen et al., 2008a; Ray, 2019) it was imperative the data was assessed

184 for reliability. As such, data from approximately 10 % of the matches analysed from

185 each year was recollected from howstat.com. This equated to 69 matches out of the

186 667 being rechecked. Agreement was assessed for each variable between the two

187 sources using a percentage error assessment. All variables demonstrated 100%

188 agreement and provided confidence that the collected data reliably represented actual

189 match performance.

190

191 *Data Analysis*

192   Normality assumptions were checked using the Kolmogorov-Smirnov test.

193 Descriptive data was presented as mean ± SD where appropriate. A series of Welch's

194 ANOVAs (IBM SPSS Statistics, Version 25) were used, to identify differences in the

195 dependent variables between time periods. Data was then split per country and
196 assessed for differences in the dependent variables relative to each period. Where
197 statistical significance ($p < 0.05$) was identified, post-hoc analyses with Games-
198 Howell multiple comparison method was performed to identify where specific
199 differences were evident. The effect size calculation (Cohen's d) was used to
200 characterise the magnitude of difference between each season (Hopkins, 2004). The
201 criteria for interpreting effect sizes were: < 0.2 trivial, 0.2-0.5 small, > 0.5-0.8 medium,
202 > 0.8 large. Only "large" effect sizes were presented in the findings.
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205 **Results**

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207 **All Teams**

208 ***Percentage of Runs Scored by Boundaries***

209 A significant main effect of time on the percentage of runs scored by fours was
210 observed ($F_{5,1328} = 5.703$, $p < 0.001$; Figure 1). Post-hoc tests revealed a significant 2.8
211 % decrease in the percentage of runs scored through fours between 2000-2005 and
212 2009-2011 ($p = 0.001$). There was also a significant 2.1 % ($p < 0.05$) and 3.1 % ($p =$
213 0.006) decrease between 2000-2005 and 2012-2014 and, 2000-2005 and 2018-2020,
214 respectively. There was a significant main effect of time on the percentage of runs
215 scored by sixes ($F_{5,1328} = 4.859$, $p < 0.001$; Figure 1). Post-hoc tests revealed a
216 significant 0.8% increase in the percentage of runs scored through sixes between 2000-
217 2005 and 2015-2017 ($p < 0.05$).

218

219 ***Run Rate and Number of Days Played within Matches***
220 There was no significant main effect of time on the average run rate (3.4) or on the
221 average number of days a match lasted (4.4; Figure 1). However, a steady but small
222 decrease in the number of days played was observed from 2009-11 (4.5) through
223 2012-14 (4.4), 2015-17 (4.3), and 2018-20 (4.3).

224

225 ***Draw Percentage***

226 There was a significant main effect of time on the percentage of matches ending in a

227 draw ($F_{5,179}$ = 12.390, p < 0.001; Figure 1). Post-hoc tests revealed a significant 17.1

228 % decrease in draw percentage between 2000-2005 and 2018-2020 (ES; 1.27; p <

229 0.001), as well as a 12.8 % decrease between 2000-2005 and 2015-2017 (ES = 0.92; p
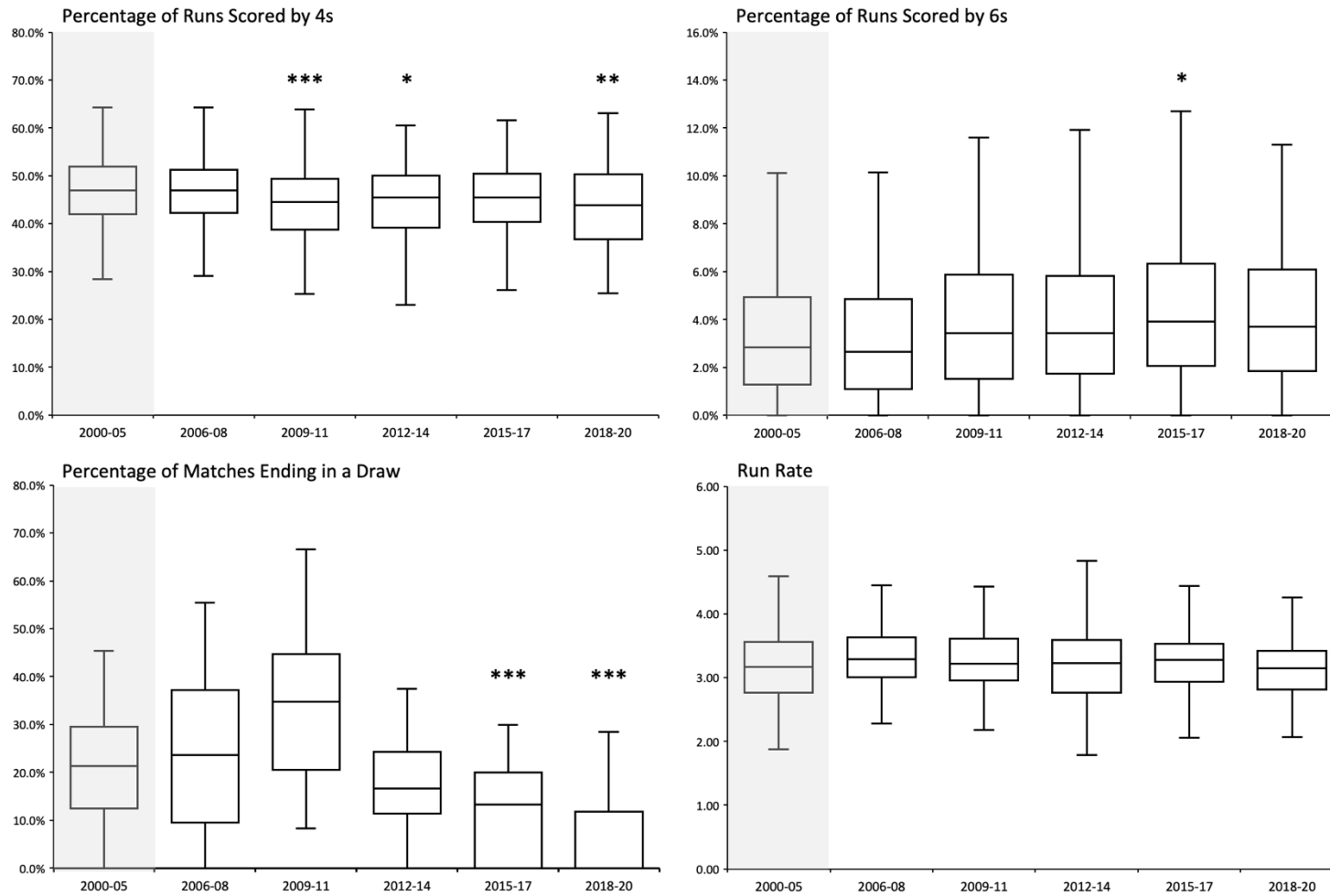
230 = 0.002)

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Figure 1: Box plots illustrating Four%, Six%, Run Rate and Draw% for all teams. Shaded area represents the period prior to T20 introduction. Key: * = p < 0.05; ** = p < 0.01; *** = p < 0.001.

263   **Analysis by Country**

264   *Percentage of Runs Scored by Boundaries*

265   There was a significant difference in the percentage of runs scored by fours pre- and

266   post-introduction of T20 for India, New Zealand, Pakistan, Sri Lanka, and West Indies

267   (Table 3). Post-hoc tests revealed a significant decrease in the percentage of runs

268   scored by fours between 2000-2005 and 2015-2017 (7.3 %) for India. A significant (p

269   = 0.032) 5.8 % decrease between 2000-2005 and 2018-2020 was identified within New

270   Zealand's performance whereas a much larger decrease was identified for Pakistan

271   between 2000-2005 and 2012-2014 (9.5 %; p = 0.013) and between 2000-2005 and

272   2015-2017 (8.7 %; p = 0.003). There was a significant difference in the percentage of

273   runs scored by sixes pre- and post-introduction of T20 for India and the West Indies

274   (Table 3). India significantly increased their percentage of runs scored via sixes by

275   3.6 % between 2000-2005 and 2018-2020 (p = 0.004). West Indies saw the greatest

276   overall increase in percentage of runs scoring by sixes of 2.6% (p = 0.035) between

277   2000-2005 and 2009-2011 and by a further 1.9% (p = 0.007) through 2018-2020.

278

279   *Run Rate and Number of Days Played within Matches*

280   There was no significant difference in run rates, or the number of days played on an

281   individual team basis. Run rates ranged between 2.9 and 3.7, with no team

282   demonstrating a consistent increase or decrease over time. New Zealand were the only

283   teams to score less than 3.0 runs per over, which occurred during 2000-2005. The

284   number of days played ranged between 3.9 and 4.9, with only the West Indies in 2018-

285   2020 falling below 4.0 days of play (Table 3).

286

287   *Draw Percentage*

288   There was a significant difference in the percentage of matches ending in a draw for

289   the West Indies, with post-hoc analysis identifying a significant 26.3 % increase in

290   draw percentage between 2000-2005 and 2009-2011 (Table 3). In contrast however,

291   there were no differences in the percentage of matches ending in a draw for the

292   remaining 7 teams within the analysis.

293 *Table 3: Individual countries average for each variable and each time period.*

	2000-2005	2006-2008	2009-2011	2012-2014	2015-2017	2018-2020
Percentage of Runs Scored by 4s (%)						
Australia	45.8 ± 8.1	41.9 ± 6.4	45.5 ± 5.0	43.3 ± 7.0	44.9 ± 6.3	43.5 ± 8.0
England	45.8 ± 8.6	44.8 ± 7.2	44.2 ± 6.3	45.9 ± 6.5	47.2 ± 7.7	43.7 ± 8.9
India	48.7 ± 6.6	47.0 ± 7.1	46.1 ± 8.2	47.1 ± 7.3	41.4 ± 5.1***	43.3 ± 6.3
New Zealand	44.9 ± 7.1	49.5 ± 4.5**	44.0 ± 6.3	44.5 ± 7.6	48.7 ± 5.1*	39.1 ± 6.5**
Pakistan	47.0 ± 7.1	49.0 ± 4.1	43.5 ± 9.4	37.5 ± 9.8*	38.3 ± 8.3**	43.4 ± 9.4
South Africa	46.9 ± 7.7	46.8 ± 6.8	41.9 ± 7.1	45.6 ± 5.4	48.1 ± 6.3	50.8 ± 8.3
Sri Lanka	47.9 ± 7.6	46.2 ± 5.3	43.1 ± 6.2	44.3 ± 5.9	45.9 ± 6.9	40.4 ± 7.4**
West Indies	47.2 ± 7.5	48.1 ± 8.0	40.8 ± 8.7*	48.1 ± 6.4	45.9 ± 6.7	42.7 ± 6.9
Mean	**46.7 ± 7.7**	**46.3 ± 6.9**	**43.9 ± 7.4***	**44.6 ± 7.4***	**45.0 ± 7.4**	**43.6 ± 8.5***
Percentage of Runs Scored by 6s (%)						
Australia	4.4 ± 3.2	3.6 ± 2.2	3.9 ± 2.2	4.9 ± 3.1	4.6 ± 2.5	3.0 ± 1.9
England	3.6 ± 3.2	2.5 ± 2.1	2.0 ± 1.9	3.5 ± 3.5	3.5 ± 2.6	4.9 ± 3.6
India	2.9 ± 2.3	3.5 ± 2.4	4.3 ± 3.0	3.5 ± 2.4	5.6 ± 2.5**	6.5 ± 4.9**
New Zealand	4.3 ± 3.5	5.1 ± 2.4	4.6 ± 2.5	6.0 ± 4.2	5.6 ± 3.0	4.8 ± 2.5
Pakistan	4.9 ± 4.4	3.8 ± 3.1	5.0 ± 2.7	4.2 ± 3.0	4.8 ± 3.0	3.7 ± 2.5
South Africa	3.8 ± 5.1	2.1 ± 1.9	4.3 ± 3.8	3.1 ± 2.1	3.3 ± 2.6	4.2 ± 2.8
Sri Lanka	2.4 ± 1.6	2.2 ± 2.2	2.9 ± 2.1	3.4 ± 2.5	3.8 ± 3.2	3.5 ± 2.4
West Indies	3.2 ± 2.4	5.0 ± 3.6	5.8 ± 4.0*	6.1 ± 4.4*	5.3 ± 3.9	7.7 ± 4.8**
Mean	**3.7 ± 3.5**	**3.3 ± 2.6**	**3.9 ± 3.0**	**4.2 ± 3.3**	**4.5 ± 3.1***	**3.2 ± 3.1**
Run Rate						
Australia	3.7 ± 0.5	3.5 ± 0.4	3.4 ± 0.3	3.5 ± 0.7	3.6 ± 0.7	3.2 ± 0.5
England	3.2 ± 0.6	3.1 ± 0.5	3.5 ± 0.5	3.0 ± 0.6	3.3 ± 0.5	3.1 ± 0.4
India	3.1 ± 0.6	3.4 ± 0.6	3.4 ± 0.4	3.3 ± 0.5	3.4 ± 0.5	3.2 ± 0.5
New Zealand	2.9 ± 0.5	3.4 ± 0.5	3.1 ± 0.3	3.1 ± 0.6	3.6 ± 0.5	3.0 ± 0.4
Pakistan	3.1 ± 0.5	3.5 ± 0.6	2.9 ± 0.4	3.0 ± 0.6	3.1 ± 0.3	3.2 ± 0.5

South Africa	3.0 ± 0.6	3.2 ± 0.5	3.2 ± 0.6	3.2 ± 0.6	3.1 ± 0.6	3.1 ± 0.5	294
Sri Lanka	3.1 ± 0.4	3.3 ± 0.4	3.4 ± 1.0	3.0 ± 0.4	3.1 ± 0.3	3.1 ± 0.5	295
West Indies	3.0 ± 0.5	3.2 ± 0.4	3.1 ± 0.5	3.2 ± 0.3	2.9 ± 0.4	3.1 ± 0.4	
Mean	**3.2 ± 0.6**	**3.3 ± 0.5**	**3.3 ± 0.6**	**3.2 ± 0.6**	**3.3 ± 0.5**	**3.1 ± 0.5**	296
Days Lasted							297
Australia	4.3 ± 0.8	4.7 ± 0.6	4.5 ± 0.7	4.4 ± 0.7	4.1 ± 0.8	4.4 ± 0.6	
England	4.4 ± 0.8	4.6 ± 0.6	4.5 ± 0.6	4.4 ± 0.7	4.3 ± 0.8	4.4 ± 0.6	298
India	4.5 ± 0.7	4.6 ± 0.6	4.6 ± 0.5	4.3 ± 0.8	4.3 ± 0.7	4.2 ± 0.7	299
New Zealand	4.6 ± 0.6	4.3 ± 0.7	4.6 ± 0.6	4.3 ± 0.7	4.4 ± 0.7	4.5 ± 0.6	
Pakistan	4.6 ± 0.7	4.4 ± 0.8	4.4 ± 0.6	4.4 ± 0.7	4.9 ± 0.3	4.1 ± 0.6	300
South Africa	4.6 ± 0.7	4.3 ± 0.8	4.5 ± 0.7	4.3 ± 0.7	4.2 ± 0.8	4.2 ± 0.7	301
Sri Lanka	4.5 ± 0.7	4.4 ± 0.7	4.7 ± 0.6	4.6 ± 0.7	4.4 ± 0.7	4.3 ± 0.7	
West Indies	4.4 ± 0.8	4.5 ± 0.7	4.5 ± 0.7	4.3 ± 0.8	4.3 ± 0.8	3.9 ± 0.7	302
Mean	**4.5 ± 0.7**	**4.5 ± 0.7**	**4.5 ± 0.6**	**4.4 ± 0.7**	**4.3± 0.7**	**4.3 ± 0.7**	303
Percentage of Matches Ending in a Draw (%)							
Australia	13.0 ± 11.5	9.5 ± 16.5	15.7 ± 7.0	13.1 ± 6.1	12.5 ± 11.4	3.3 ± 5.8	304
England	22.0 ± 9.1	34.5 ± 18.2	30.2 ± 13.5	19.8 ± 5.4	14.5 ± 5.5	6.1 ± 5.4	305
India	24.9 ± 19.6	42.9 ± 8.6	36.9 ± 11.8	18.5 ± 10.1	21.4 ± 8.0	0.0 ± 0.0	
New Zealand	38.8 ± 34.5	12.2 ± 11.3	34.2 ± 8.0	22.0 ± 8.4	4.2 ± 7.2	15.1 ± 14.4	306
Pakistan	22.8 ± 17.9	38.8 ± 1.8	33.5 ± 12.0	20.8 ± 11.0	6.7 ± 11.5	6.3 ± 8.8	307
South Africa	23.9 ± 16.7	12.8 ± 4.8	24.3 ± 10.5	21.8 ± 13.9	4.8 ± 8.3	0.0 ± 0.0	
Sri Lanka	23.0 ± 19.9	17.5 ± 20.5	51.5 ± 16.9	30.7 ± 16.7	11.4 ± 10.3	10.0 ± 14.1	308
West Indies	19.5 ± 10.2	31.9 ± 6.4	45.8 ± 7.2*	11.4 ± 10.3	10.4 ± 10.0	10.0 ± 14.1	309
Mean	**23.5 ± 17.4**	**25.0 ± 11.0**	**34.0 ± 10.9**	**19.8 ± 10.2**	**10.7 ± 9.0***	**6.4 ± 7.8***	
							310

311   Key: * = $p < 0.05$; ** = $p < 0.01$; *** = $p < 0.001$. Difference indicated between pre-T20 (2000-2005), and period noted.

Discussion

312 **Discussion**

313 An important finding of this study was that significantly ($p < 0.05$) more runs have been scored
314 by sixes and fewer by fours since the introduction of T20 cricket. From an individual team
315 perspective, the same trend was observed for England, India, New Zealand, Sri Lanka, and
316 West Indies. This together with the fact that fewer matches ended in draws (2015-2017, ES =
317 0.92, $p = 0.002$; 2018-2020, ES = 1.27, $p < 0.001$) could indicate T20 has had an impact on
318 Test match cricket over time. Both the 2015-2017 (12.8 %) and 2018-2020 (17.1%) period
319 had a significantly lower draw percentage than Pre-T20, a finding which has been alluded to
320 in previous studies (Allsopp, 2005; Lenten, 2008). Furthermore, the fact that most significant
321 differences were seen in the latter years (2012 onwards) could mean that T20 cricket has had a
322 delayed yet pertinent effect on the longest format of the game; a suggestion that has been made
323 in previous research (Lenten, 2008). Giving further credence to this is that this was the first or
324 second analysed period following the creation of the major domestic T20 tournaments, the
325 Indian Premier League in 2009, the Big Bash League in 2011, and the Caribbean Premier
326 League in 2013. This study also suggests that the overall boundary percentage has decreased
327 since the introduction of T20. Such findings contrast with older literature which identified the
328 importance of boundary scoring on winning (Moore et al., 2012; Petersen et al., 2008b).
329 Nevertheless, the increase in the percentage of runs scored via sixes in Test cricket is arguably
330 an aspect affected by the introduction of T20 cricket, whereby the use of riskier and aerial shots
331 to score runs quickly is a key characteristic (Moore et al., 2012). Interestingly, research has
332 suggested that six percentage in one-day cricket has a large effect on the match outcome
333 (Petersen et al., 2008b). However, additional studies are needed to determine whether this is
334 the case in Test matches and if so, is this a result of ODI matches, or the emergence of T20s.
335 Furthermore, it was theorised that the increasing importance of boundaries in the T20 format,
336 due to the restricted number of balls which can be bowled, would have elicited a similar
337 increase within Test cricket, especially due to the high player overlap between formats. The
338 results do suggest though that whilst overall boundary percentage is reduced, players are
339 arguably becoming more expansive with their attempt at scoring runs by scoring a greater
340 proportion of runs through sixes and so players/coaching staff ought to consider the above as
341 part of their preparation for, and tactical decision-making during, competitive performance.

342   It is often argued by commentators, media, and other cricketing experts that there has
343 been an increase in the number of runs scored per over within Test cricket since the introduction
344 of international T20. However, the results within the current study found no significant

345 difference in the average number of runs scored per over pre- (3.2) and post-introduction of

346 T20 (ranging between 3.1 and 3.3). Small changes (less than 0.05) were observed between the

347 period pre-T20 and the greatest post T20 run rate; however, the pre-T20 run rate also lies within

348 the post-T20 run rate range. The introduction of T20 cricket has therefore clearly not impacted

349 the speed at which runs are accumulated at the elite level.

350   Interestingly, when the number of runs scored per over was assessed by country, all of

351 Australia's period run rates were lower than their pre-T20 run rate, suggesting that T20 has

352 reduced the speed in which Australia accumulates runs. However, this could be because

353 Australia was consistently ranked number 1 in the ICC Men's Test Team Ranking between

354 2001 and 2009 (ICC, 2021a) and, by virtue of their dominance, may have simply been scoring

355 at an extraordinarily high rate during the pre-T20 period. In contrast, the run rates of New

356 Zealand, South Africa, India, Sri Lanka, Pakistan, and the West Indies generally increased

357 since the introduction of T20 which mirrors previous findings that suggested a higher run rate

358 is expected in Test cricket as T20s become more commonplace within the international cricket

359 calendar (Lenten, 2008). This may further be justified by the comparison of the average number

360 of test matches played per season pre- and post- the introduction of T20 cricket (Table 2). As

361 a result, there appears a need to ensure players are suitably conditioned to cope with the

362 increased higher intensity running demand. In addition, coaches need to be aware of altered

363 run rates in particular teams to positively affect match strategy.

364   Although this might not necessarily be a direct cause and effect of T20 involvement,

365 the various teams are still accumulating runs in a quicker manner, which is a characteristic

366 associated with successful T20 cricket (Moore et al., 2012; Najdan et al., 2014). Research

367 identified an increase in run rates for Test cricket that coincided with increasing ODI run rates,

368 although there appeared to be an approximate 10-year delay (Lentenm 2008). If the suggested

369 minimum 10-year delay is applicable in Test cricket, the effects of the introduction of T20

370 cricket on Test cricket may only be starting to become evident. To add credence to the

371 possibility of a delayed effect, rule changes have been shown to incrementally and slowly effect

372 how basketball (e.g., decrease in three-point accuracy by virtue of the increase in three-point

373 arc distance to the basket; Strumbelj, Vracar, Robnik-Sikonja, Dezman & Erculj, 2013) and

374 rugby league (e.g., 75% reduction in possessions kicked out of play due to the introduction of

375 '40-20' rule; Eaves, Hughes & Lamb, 2008) are played tactically. This may explain why some

376 countries are yet to demonstrate increased run rates throughout their current performances and

377 could also explain why previous studies have found no significant increase at the point of study

378 (Ray, 2019). Coaches, players, and support staff should be cognisant of the potential changes

379   to performance, as evidenced within several teams herein, that might arise in years to come and
380   embed such alterations within their coaching process.
381   Findings of this study contrast with previous literature suggesting that cricket matches
382   continue to last the same length. Previous findings identified an increase in Tests finishing
383   within 4 days from 19.0% to 40.8%, and the number of Tests finishing within 3 days rising to
384   15.3% (from 2.5%; Lenten, 2008). However, the difference in these findings could be due to
385   the periods analysed or the fact that any matches delayed by rain for greater than one day were
386   removed from the sample. Lenten (2008) included Test matches from 1981 to 2007 whilst the
387   current study incorporated matches between 2000 and 2020. Identifying that matches on
388   average continue to day 5 is an important finding as oftentimes suggestions arise for Test
389   cricket to be reduced to 4 days of play (Ammon, 2019). If such a change occurred, the
390   percentage of matches ending with no winner, i.e., a draw, would likely increase, thus
391   negatively impacting spectator interest.
392

393   *Future Recommendations*
394   Cricket grounds are not all uniform, with many different designs and environmental
395   considerations, boundary lengths or propensity to favour the batsman or bowler, among various
396   other differences (e.g., boundary lengths must be between 65 and 90 yards; ICC, 2021b).
397   Therefore, future studies should attempt to establish the additive effect of home advantage on
398   the relationship between T20 and Test cricket. Additionally, establishing whether there have
399   been any changes in the way teams are winning Test matches following the introduction of T20
400   in relation to team quality appears of considerable interest to coaches and players alike. Wider
401   cricket research around 'The Hundred' (the recently introduced 100 ball format) and the
402   strategies utilised within this new short-form tournament by virtue of the rule variations appears
403   widely impactful towards the development and differentiation of in-game tactical strategies.
404   Finally, future research should endeavour to monitor the impact of T20 on ODI cricket to
405   ascertain whether ODI performance metrics have been impacted in a similar manner.
406

407   *Conclusion*
408   This study has provided new and longitudinal insights into the evolution of several performance
409   indicators within Test cricket in relation to the introduction of T20 cricket. Whilst the direct
410   impact of T20 upon Test cricket performance cannot be conclusively known by virtue of the
411   observational nature of the current study, this paper has highlighted interesting changes in

412 performance post T20 introduction. As such, the year of introduction was utilised as a 'line in
413 the sand' whereby changes could be observed and attributed in some manner to the introduction
414 of this shorter, more aggressive, cricket format.

415   Overall, this study highlights to coaches and player alike how the introduction of T20
416 cricket can be associated with an impact on the way in which test cricket is currently played
417 with a decrease in four-percentage, increase in six-percentage, altered run rates for some teams,
418 and a decrease in draw percentage being observed. As a result, improving the ability to strike
419 a greater number of boundaries, increasing the overall run rate, and facilitating strike rotation
420 when batting should be a focus for coaches and players. It will be interesting to observe whether
421 further changes arise in years to come, especially when young players coming into the Test
422 side are potentially those who have been exposed to, and grown up watching and playing, T20
423 cricket.

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