Evolution of Anthropometric and Physical Performance Characteristics of International Male Cricketers from 2014 to 2020 in a World Cup Winning Nation.

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ABSTRACT

The aim of the study was to firstly, present a comprehensive physical profile of international cricketers in a World Cup winning cricket nation. Secondly, to describe changes in physical profiles across seven years. Fifty-two senior international cricketers' physical profiles were retrospectively analysed across seven years. Using linear mixed-modelling, changes in stature, body mass, sum-of-8 skinfolds, sprinting time (10 and 40 m), run-2 time, counter movement jump (CMJ), push and pull strength capacity and the Yo-Yo intermittent recovery test level-1 (Yo-Yo-IR1) were analysed during a seven year period. There were no significant changes in body mass ($p = 0.63$) or stature ($p = 0.99$) during this time. However, there was a significant ($p < 0.001$) mean decrease of ~ 14 mm in the sum-of-8 skinfolds. Distance covered in the Yo-Yo-IR1 also showed a significant ($p = 0.002$) effect of years, with a mean increase of 459 m in 2017 when compared to 2014. A significantly ($p = 0.01$) more balanced push-to-pull strength capacity ratio was also evident across years as a result of a significant ($p < 0.001$) increase in pull strength capacity. Significant ($p < 0.05$) fluctuations in CMJ, sprint and run-2 time were seen, with no obvious trends. International cricketers within our study have gone through a notable physical transformation that has likely resulted in an increase in lean mass and aerobic capacity. The change across time to a more balanced push-to-pull strength capacity may be beneficial for injury prevention.

Key Words: Body Composition, Cricket, Fitness, Sprinting, Player Profile.

INTRODUCTION

International cricketers are exposed to a variety of different physical demands between positions and across the three match formats [1]. Seam bowlers can produce ground reaction forces over eight times body mass at front foot contact during their delivery stride [2] and batters perform in excess of thirty-five 180° turns when scoring a century [3]. In addition, all cricketers need to be able to perform multiple high intensity and explosive movements whilst covering large distances across a match [4]. The high variability in time-motion demands of players from match-to-match also contribute to the complexities of preparing international cricketers for competition [4]. The increase in international match days may also limit the time that can be dedicated to enhancing player's physical capacities [5]. As physical attributes have been associated with critical factors such as ball release speed in seam bowlers [6] and maximum hitting distance among batters [7], understanding the physical profile of international cricketers is essential in assisting practitioners in optimising their preparation.

Little is known about the physical profiles of international cricketers when compared to the abundance of research in sports like soccer and rugby. A few studies have presented physical profiles of professional domestic cricketers [8, 9], with a single study on a top eight international cricket team [10]. The limitation of the research examining the profiles of professional cricketers is that it only provides an overview of a discrete point in time. For practitioners to be able to prepare cricketers effectively for future international competitions it is essential to understand changes across time. However, data only exist on physical performance changes across a single year in county and international cricket [8,11].

An increase in the match-play time-motion demands of players have been shown in team sports such as soccer [12] and international rugby [13]. The expectation would be that physical profiles across sports have improved to meet the enhanced match demands, though there appears to be inconsistent findings with some studies showing improvements [14], no change [15] or even a decrease across years [16] of various physical attributes. With a decrease in available days for physical preparation in international cricket [5] but an increase in professional physical preparation support, it is unknown how the international cricketer's profile has evolved. Literature following the longitudinal physical changes of international sports teams in preparations for major competition is extremely rare.

Consequently, the aim of this study is to describe the evolution of the physical profile of an international cricket nation across a World Cup winning cycle and preparation for the 2019 Ashes series. Given the sensitivity of the international athlete physical profile data, this analysis will offer a unique insight and assist practitioners in identifying optimal future profiles.

METHODS

Participants

Fifty-two senior international male cricketers physical profile data from the England men's team were retrospectively analysed from 2014-2020. All data analysed were collected as a part of routine testing which all players consent to. To be included in the analysis, cricketers must have played in at least one Test-Match, One-Day or Twenty20 international sanctioned match, named in an international squad within the respective year, and be free from injury as determined by the lead physiotherapist. Table 1 shows the number of matches and players included in each year. Ethics was granted retrospectively through St Mary's University ethics committee, in agreement with the Declaration of Helsinki.

Physical Preparation Overview 2014-2020

Development of aerobic capacity and optimisation of body composition were prioritised during this period to support players to withstand the congested fixture demands of international cricket. Due to the low levels of pull strength capacity, there was also a targeted approach towards a more balanced push to pull strength capacity ratio. However, there was a lesser focus on speed development.

Procedures

Stature, body mass, sprint time (10 m and 40 m), countermovement jump height (CMJ), endurance capacity (Yo-Yo intermittent recovery test level 1), strength capacity (supine row and press-ups), sum-of-8 skinfolds and run-2 time were assessed across a seven-year period from 2014 to 2020. Due to changes in preferences of physical tests by the sport science team and lack of opportunity for a full battery of tests in some years, sporadic years are missing from the data set. Depending on the international fixtures, players were occasionally assessed at multiple time points throughout the year. If this did occur, the average result across the year was used, in line with previous research reporting year-to-year changes in physical profiles [17]. All physical tests were conducted at the same venue (National Cricket Performance Centre, Loughborough, UK), proceeded by a group warm-up which was led by the team strength and conditioning coach. The warm-up included sprinting, jumping and 180° turns at the end of a sprint.

Body mass was recorded using SECA 862 Scales (Birmingham, UK). The sum-of-8 skinfold thickness was recorded by two International Society for the Advancement of Kinanthropometry (ISAK) practitioners using Harpenden callipers (British Indicators, Hertfordshire, United Kingdom). The standardised sum-of-8 skinfold sites (bicep, tricep, subscapular, supraspinale, suprailiac, abdomen, mid-thigh and medial calf) and procedures recommended by ISAK were used. This method has been shown to be highly reliable [18].

Counter Movement Jumps

All CMJ's were performed were strictly vertical on a jump mat using flight time (KMS, Fitness Technology, AUS). Cricketers were instructed with hands on hips to "jump as high as they can" and "as they normally would" from a stationary standing position. Three jumps were performed by each cricketer with 1-min separating each jump. The highest jump was recorded for analysis.

Sprints

Three maximal 40 m sprints with 5 min rest between each sprint were also performed. Dual beam timing lights (Brower TC, Brower Timing System, Utah, USA) were placed at 0, 10 and 40 m to record 10 m and 40 m splits. All timing lights were mounted on tripods with the first gate placed at 1 m above the ground and the remaining gates at 1.3 m. Cricketers began from a split stance position set 0.5 m back from the start line. The fastest time was recorded for analysis.

Run-2

For the run-2 test, cricketers were timed running between the wickets (two lines 17.68 m apart). The test is designed to assess the speed of the participants running between the wickets, as they would in a match. The dual beam timing gates were placed on the start line/crease and set at a height of 0.6 m. The run-2 was performed with a cricket bat with the turn assessed off both the right and left side. The test was performed without batting pads and helmet but with a cricket bat. Cricketers started in the split stance position, 0.5 m behind the start line with the cricket bat in hand. Cricketers were instructed to slide the bat over the crease mark at the turn and start/finish, as they would in a match. Two trials, turning off each the right and left side were recorded with the best trial off each side used to calculate an average run-2. All sprints and run-2 tests were performed on the same 60 m indoor cricket training surface as previously described by Ahmun et al. [10].

Push and Pull Strength Capacity Test

The push and pull strength capacity tests are specific tests designed by the England and Wales Cricket Board (ECB revised testing protocols, unpublished). For the push capacity test, cricketers lay in a prone position with hands by their side. The first tester placed a fist on the ground under the cricketer's sternum with the second tester observing from the side and recording the result. Keeping in time with a metronome set at 1 Hz, the cricketer performed continuous maximum press-ups. At the top position of the press-up, the cricketer was instructed to extend their elbows, whilst at the bottom their sternum was required to touch the tester's hand. The test was ceased if the cricketer did not touch the second tester's hand with their sternum, did not lock out their elbows, loss of trunk position or failed to keep time with the metronome. In house test–retest reliability coefficient of variation is 7.6%.

For the pull capacity test, cricketers lay in a supine, crook lying position underneath a loaded Olympic bar in a rack. The bar was set at a height where the cricketer was able to reach it whilst their shoulders are flexed to 90°. The bar was weighted sufficiently so it would not move. The cricketer grasped the bar and then extended their hip, so the pelvis and lower back was off the ground. The first tester observed from the side to monitor upper body and arm position. The second tester observed the lower back and the trunk position. Cricketers performed maximum supine rows keeping in time with a metronome, again set at 1 Hz. The test was ceased if the sternum did not touch the bar in the top position, the elbows did not fully extend at the bottom position, loss of trunk position or failed to keep up with metronome. In house test–retest reliability coefficient of variation is 5.7%. The push-to-pull strength capacity ratio was calculated by dividing the push strength capacity by the pull strength capacity.

Yo-Yo Intermittent Recovery Test Level-1

Between 2014 and 2018, cricketers performed the Yo-Yo Intermittent Recovery Test Level-1 (Yo-Yo-IR1 [19]) to assess endurance capacity. The test consists of running between two lines (shuttle) set 20 m apart. A further cone was placed 5 m back from the start-finish line for the cricketers to walk to during the 10 s active recovery between shuttles. The increasing speed was controlled by an audio beep. The test ended when the cricketer failed to complete two individual shuttles in the required time.

Statistical analyses

Data were analysed using SPSS (version 27.0, Chicago, Illinois, USA). Initially, all dependant variables were visually screened for normality through histograms and Q-Q plots. Homogeneity of variance was assessed with Levene's test. A mixed-linear-modelling (MLM) was used to assess changes in the dependant variables across years (fixed-factor) with individual cricketers assigned as random factors in the model. Where a significant fixed-effect of season was observed, Bonferroni adjusted pairwise comparisons were used to assess difference between seasons with 95% confidence intervals (CI) present to give a range of plausible values. Data is reported as estimated marginal means $\pm$ standard deviation.

RESULTS

There was no significant fixed effect of year on body mass ($p = 0.63$) or stature ($p = 0.99$) (Figure 1). However, there was a significant fixed effect of years on sum-of-8 skinfold thickness ($F_{(5)} = 14.9$; $p < 0.001$) (Figure 1C). Pairwise comparisons showed that skinfolds were significantly lower in 2020, 2019 and 2018 compared to 2015 (2020 Vs 2015; $p < 0.001$; CI 9.9 to 22.9 mm: 2019 Vs 2015; $p < 0.001$; CI 7.9 to 21.5 mm: 2018 Vs 2015 $p < 0.001$; CI 7.5 to 21.0 mm) and 2016 (2020 Vs 2016; $p < 0.001$; CI 3.8 to 16.1 mm: 2019 Vs 2016; $p = 0.003$; CI

1.8 to 14.6 mm: 2018 Vs 2016 p = 0.006; CI 1.4 to 14.2 mm). The skinfolds of the cricketers were also significantly lower in 2017 compared to 2015 (p = 0.003; CI 5.8 to 19.5 mm).

Figure 2 shows changes in Yo-Yo-IR1, CMJ and push and pull strength capacity changes across years. There was no significant change in push strength capacity across the years (p = 0.46). However, pull strength capacity did show a significant fixed effect across time ($F_{(4)} = 13.5$; $p < 0.001$). Significantly more supine rows were performed in 2017 (p = 0.03; CI 0 to 13), 2019 (p < 0.001; CI 5 to 17) and 2020 (p < 0.001; CI 2 to 12) compared to 2014. There were also significantly more supine rows performed in 2017 (p = 0.03; CI 0 to 11), 2019 (p < 0.001; CI 5 to 15) and 2020 (p < 0.001; CI 2 to 10) compared to 2016. There was also a significant fixed effect across years for push-to-pull strength capacity ratio ($F_{(4)} = 4.0$; p = 0.01). The ratio was significantly lower in 2019 compared to 2016 (p = 0.01; CI 0.1 to 0.8). Yo-Yo-IR1 distance showed a significant fixed effect across years ($F_{(3)} = 6.3$; p = 0.002) with cricketers covering a greater distance in 2017 compared 2014 (p = 0.002; CI 149 to 769 m). There was also a significant effect of years on CMJ ($F_{(4)} = 11.6$; p < 0.001). Compared to 2014 (p < 0.001; CI 1.4 to 4.7 cm), 2015 (p < 0.001; CI 1.0 to 4.0 cm), 2017 (p < 0.001; CI 0.9 to 3.7 cm) and 2018 (p = 0.03; CI 0.1 to 3.9 cm), 2016 was significantly lower (Figure 2).

The was a significant fixed effect of years over 10 m sprints ($F_{(4)} = 4.8$; p = 0.002) and 40 m ($F_{(4)} = 4.5$; p = 0.003) (Table 2). Cricketers were significantly quicker over 10m in 2016, 2017, 2019 and 2020 compared to 2018 (p < 0.05). Forty metre times were significantly quicker in 2017 (p = 0.01; CI 0.02 to 0.24 s) and 2016 compared to 2020 (p = 0.02; CI 0.01 to 0.23 s). Finally, there was also a significant fixed effect of years on run-2 time ($F_{(4)} = 6.6$; p < 0.001). Cricketers were significantly quicker in 2019 compared to 2020 (p = 0.001; CI 0.04 to 0.24 s) and 2018 (p = 0.01; CI 0.02 to 0.24 s). Run-2 times were also significantly quicker in 2016 compared to 2020 (p = 0.01; CI 0.02 to 0.27 s).

DISCUSSION

This is a rare data set that presents physical performance changes of an international cricket side in their preparations for the 2019 World Cup and Ashes Series. The main findings from the study were that international cricketers showed a reduction in skinfold thickness across seven years in preparations for the 2019 cricket World Cup and Ashes series. These changes are independent from any changes in stature or body mass over time, suggesting an increase in fat-free mass. The endurance capacity of international cricketers was also shown to improve to comparable levels of other elite endurance team sports. Pull strength capacity increased, which improved the push-to-pull strength capacity ratio and may be beneficial for shoulder health. Changes were apparent in sprint times and run-2 time, though no trends across time were apparent. Given the density of cricket games throughout each year, the data shows meaningful changes can be made with a targeted physical preparation strategy.

This is the first study to examine changes in body mass of international cricketers. Previous research in other sports has shown long-term (~ 60 years [20]) and shorter term (~ 5 years [14]) increases in body mass in international rugby players, that have been largely associated with a change to professional status. Conversely, our study showed no changes in body mass over time within international cricketers. The obvious reasons for the lack of differences in cricket is it is not a collision-based sport where higher body mass is important [21]. As seam bowlers have been shown to cover up to 17 km across a single day of fielding [4], an increase in body mass over time would be detrimental to performance. Supporting this notion, in running dominant positions in rugby (backs) have shown no change in body mass across time [22] and there is also evidence of youth soccer players decreasing in body mass [23] to possibly aid the increase running match demands of soccer over recent years [12]. It should be noted that upper body strength has shown an association with maximum hitting distance [7] and consequently increases in upper body fat free mass may be beneficial for performance in batters.

Even though there was no change in body mass from 2014 to 2020, there was a substantial decrease in skinfold thickness. The data from our study suggests that international cricketers have gone through a drastic alteration in body composition that is likely due to reductions in bodyfat mass. No data exists on longitudinal changes in body composition within cricket and there are only limited data presented in other sports. For example, reductions in skinfold thickness in national level runners [24] and small changes in collegiate sports [25] have been shown. Decreases in skinfold thickness in our study (18%), are far greater than anything reported in the literature and would seem to represent a targeted decrease in body fat by this international team. Given changes in skinfold thickness have been associated with improved running performance, the reduction in skinfold thickness is a vital change in this international cricket team [24]. The 2020 values reported here are, however, comparable to the sum of seven skinfold thickness reported in elite Australian fast bowers in 2007 [26], suggests total skinfold thickness may have differing temporal characteristics in different countries. One of the limitations of our study is that due to the small sample sizes in certain years, we were unable to distinguish between team roles, such as batters and bowlers. Comparisons may therefore be inappropriate between Stuelcken et al. [26] and our study.

Only two studies have reported the distance covered during the Yo-Yo-IR1 in professional cricketers. Veness et al. [9] and Herridge et al. [27] reported mean values of 1892 m and 1960 m in professional county level cricketers. The highest mean values in our study (2426 m in 2017) were greater than all mean values reported in a recent systematic review across several sports, including "top-elite" soccer [28]. This information suggests that international cricketers have high aerobic capacity, comparable to other elite team sport athletes. Other international cricket teams have reported lower fitness targets of 1440 m [29], which would suggest that there are varying standards in aerobic capacity across different international cricket teams and domestic cricket. The diverse findings in aerobic capacity reported, make establishing norm values for cricketers difficult and warrant future research.

There were improvements in the distance covered in the Yo-Yo-IR1 from 2014 to 2017, showing an estimated ~4 $ml \cdot min^{-1} \cdot kg^{-1}$ improvement in $\dot{V}O_{2\ MAX}$. The improvement in endurance capacity appeared to follow similar temporal changes as the decrease in skinfolds thickness. As previously suggested, the decrease in skinfold thickness has been associated with an improvement in running performance [24]. Increases in body mass over similar time periods have also shown to have detrimental effects on endurance capacity in international rugby players [14]. However, the lack of changes in body mass found in our study would suggest that the increase in endurance capacity is not solely a result of a reduction in body fat but reflected an improvement in aerobic metabolism. Anecdotally, these changes reflect a targeted approach to develop 'efficient running cricketers'. Despite the reported increase in game energetics across different sports [13], there is a lack of data that has reported changes in aerobic capacity. In addition to the reduction in average aerobic speed in international rugby players [14], previous work has shown a ~ 2 $ml \cdot min^{-1} \cdot kg^{-1}$ reduction in $\dot{V}O_{2\ MAX}$ in elite male soccer players over 23 years [15], while at the same institute no change was reported in females over 18 years [16]. The increase in aerobic capacity from 2014 to 2017 in our population are large when compared against the magnitude of change in other team sports and reflect a positive impact on performance. Due to a higher skill component of cricket compared to more physiological dominant sports like endurance running, these changes are unlikely to reflect a physiological selection bias from the coaches.

There was an improvement in pull strength capacity and a more balanced push-to-pull ratio across the seven years. The lack of improvement in push strength could possibly be viewed as negative with previous research highlighting the significant positive correlation between upper body muscular pushing strength and maximum hitting distance among elite male cricketers [7]. However, no such relationship between shorter match format (i.e. One-Day and Twenty20) batting average and strike rate and upper body pushing strength was present, which would be more influential to individual and team performance [7]. Furthermore, a more balanced ratio has been proposed to be optimal to minimise injury risk [30]. As around 18% of all injuries in cricket have been reported to be shoulder related [31] and injuries have been associated with match outcome in international cricket [32], a more balanced push pull ratio found in our study is likely to have a greater impact on performance than improving push strength.

Apart from the slower 40 m and run-2 time in 2020 compared to 2016, there were no obvious sustained trends across years, despite some significant changes. There was also little change in CMJ over the seven years. Subjectively, we propose that the slower 40 m and run-2 time in 2020 may have been due to the constrained training regime caused by a global pandemic. The minimal changes pre COVID-19 may also be due to the increasing volume of international cricket, domestic and franchise cricket [5] and thus decreasing the opportunity to focus on explosive qualities (e.g. sprinting, jumping and high velocity movements). In other studies, frequency and duration of aerobic training has shown a negative correlation with strength and power [33]. The high volume of low intensity running associated with cricket matches may also have detrimental effects on explosive power adaptations. International cricketers are exposed to intense, frequent blocks of competition consistently across the whole year, which is likely to diminish any gains in strength and power from targeted strength and conditioning.

However, improvements in power have been shown in aerobic dominated team sports [34]. Other researchers have attributed minimal change in specific physical qualities towards a lack of training focus towards them within an institute [16]. The international side within our study had a focus towards increasing lean body mass and endurance capacity. Consequently, there are multiple reasons for the lack of change or isolated decreases in explosive qualities within this group. It should also be noted that whilst some of these changes are significant, largely these small fluctuations will have minimal impact on cricket performance.

Whilst the strength of this data is the large sample size in one of the best cricketing nations in the world, there are several limitations. The data set is from a single international team's data. Consequently, the changes that have been identified in our study may not apply to other international teams. Whilst all international sides have a dedicated strength and conditioning coach, financial and cultural factors and what the head coach wants will all influence the physical performance changes of the players. Secondly, due to the lower number of cricketers in some years, we were unable to analyse differences between positions.

CONCLUSIONS

The international cricketers within our study have gone through a substantial change in body composition. Without any change in body mass, skinfold thickness has decreased across the seven years, indicating an increase in lean mass. The 19% increase in Yo-Yo-IR1 distance covered shows a large increase in aerobic capacity within this group. Cricketers also showed a more balanced push-to-pull strength capacity ratio which may be beneficial in reducing shoulder related injuries. No obvious improvement in sprint time, CMJ or run-2 time were seen across the seven years, which may be as a result of the frequent long duration aerobic activity which cricketers are exposed to during match play, as well as physical performance focus on increasing lean body mass and aerobic capacity in this team.

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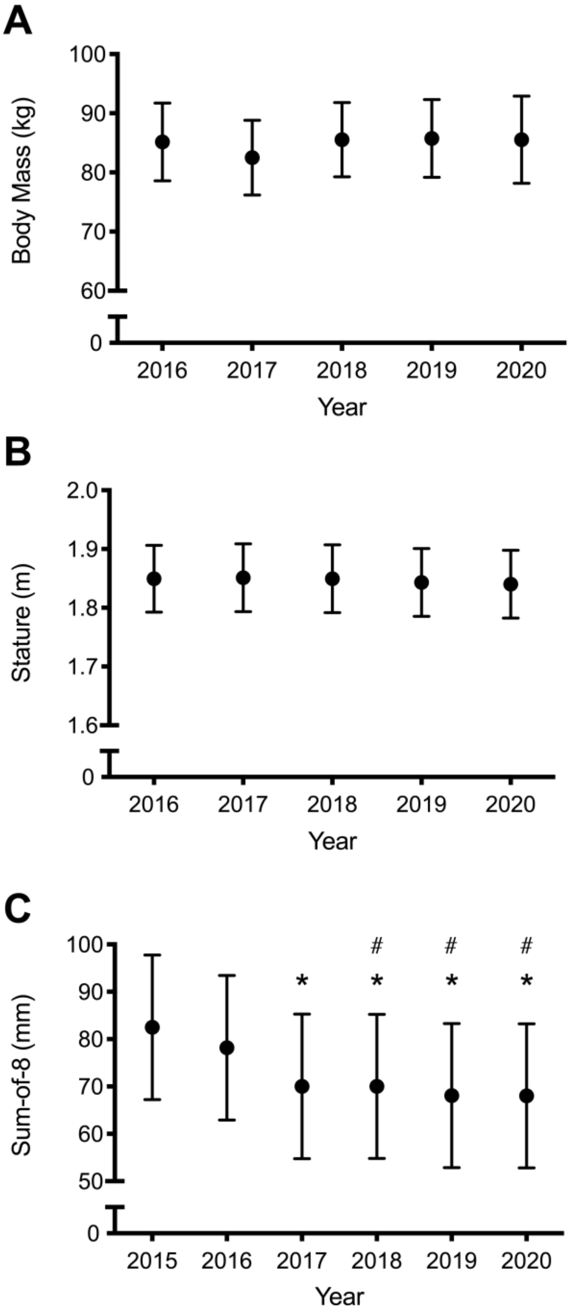

Figure 1. Changes in body mass (A), stature (B) and sum-of-8 skinfolds (C) across different years. *Denotes significant difference from 2015 ($P < 0.05$); $^{\#}$Denotes significant difference from 2016 ($P < 0.05$).

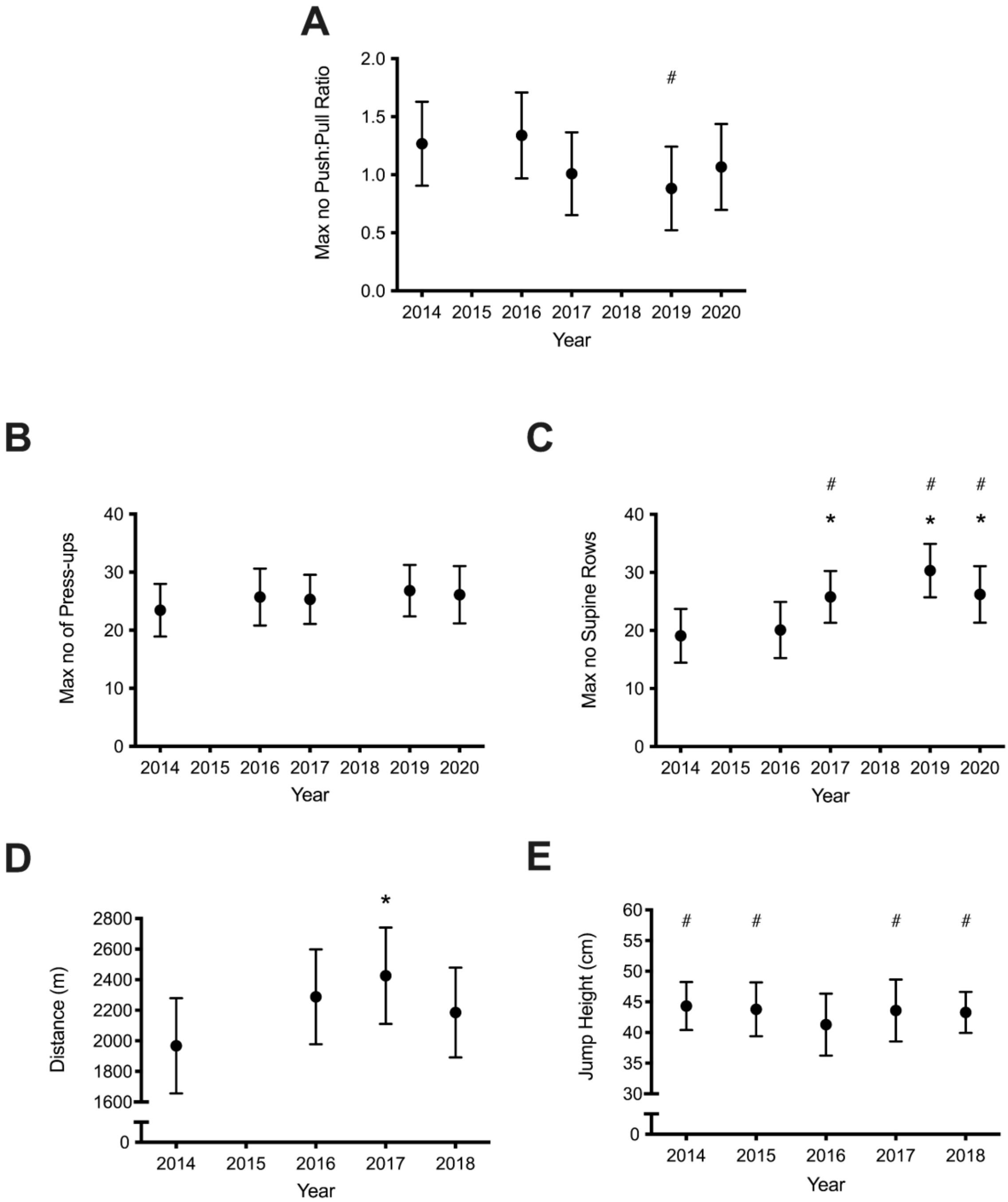

Figure 2. Changes in push-to-pull strength capacity ratio (A), push strength capacity (B) pull strength capacity (C), Yo-Yo intermittent recovery test level-1 (D), countermovement jump (E) across different years. *Denotes significant difference from 2014 ($P < 0.05$); $^{\#}$Denotes significant difference from 2016 ($P < 0.05$).

Table 1. Number of participants and matches across years

Year	Cricketers	Test Matches	One-Day Internationals	Twenty20
2014	14	8	25	12
2015	22	14	26	5
2016	22	17	18	10
2017	18	11	20	7
2018	22	13	24	9
2019	22	12	22	9
2020	35	9	9	12

Table 2. Estimated means ± SD sprint and run-2 time across years.

	2016	2017	2018	2019	2020
10 m (s)	1.71 ± 0.05[$]	1.72 ± 0.05[$]	1.77 ± 0.05	1.70 ± 0.06[$]	1.71 ± 0.07[$]
40 m (s)	5.22 ± 0.15	5.21 ± 0.15	5.31 ± 0.13	5.24 ± 0.16	5.33 ± 0.18[#†]
Run-2 (s)	5.99 ± 0.14	6.06 ± 0.15	6.11 ± 0.12	5.96 ± 0.15[$]	6.10 ± 0.16[¥#]

[#]Denotes significant difference from 2016 (P < 0.05); [†]Denotes significant difference from 2017 (P < 0.05); [$]Denotes significant difference from 2018 (P < 0.05); [¥]Denotes significant difference from 2019 (P < 0.05).