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Effect of physical and physiological parameters on the performance of sub-elite Indian upper order batsmen in T20 matches: a pilot study

Abstract

Scanty studies on physiological demands and movement characteristics to predict batting performance in comparative T20 cricket matches seem to be a fetus of seeds yet to be explored. A pilot study was carried out to explore the relationship between physical and physiological responses with the batting performance of sub elite T20 upper order batsmen and also the effect of batting innings on their performance. Twenty male batsmen who represented at district level (age: 20.0±2.4years, height: 1.68±0.58m, body mass: 63.6±7.6kg) and played in the upper order (1-4) were purposely selected and alienated according to batting innings. Key performance indicators of batting indicate that an individual score is significantly correlated (p=<0.001) with running between the wickets. The study revealed a significant correlation (p=0.02) between the individual score and average heart rate. Also, an 'inverted U' shaped trend line was observed between the individual score (y) and the average heart rate (x) ($y = -0.09x2 + 1.38x + 7.27$ with $R^2 = 0.33$). The moderate to high heart rate (126-157 bpm) zone was found to be effective for scoring at least 30 runs. Batting innings had no significant influence on upper-order batsmen's physical, physiological, and batting performance metrics. During batting, most of the time was spent while standing, most of the distance was covered by walking, and average heart rate of the batsmen was in the moderate to high-intensity zone.

Keywords: cricket, batting innings, heart rate, movement patterns, individual score

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Introduction

Cricket, especially short format cricket, is a highly technical, skill-based game in which players' workloads vary significantly depending on their roles within the game.[1] According to Noakes and Durandt,[2] cricket is a game that requires extreme physical and mental skills, especially the ability to stay focused for long periods of time, which cannot be fully made up for by being just physically fit.[3]

T20 is a shorter version of cricket, a highly unpredictable game,[4] played with a set number of overs in which batting, bowling, and fielding performance have significant impacts on match results.[5] The T20 format has the possibility of inclusion in the Olympic schedule. In the near future, it might be the most significant format. It has been observed many times that the difference between winning and losing has been determined by the performance of a single player. According to Siddiqui & Humphrey,[5] T20 cricket is a fast-paced game, so it is popular with viewers. Many studies have been undertaken over the last decade to explore morphological characteristics,[6] fitness needs,[7] physiological demands,[8] movement patterns,[9] performance indicating factors,[10] and match outcome prediction in cricket,[11] and they have discovered a vast variation in those components depending on match formats.

The primary goal of the batsmen is to score as many runs as possible in the shortest possible number of balls without getting dismissed. The batsman may strike the ball in a 360-degree circle, requiring a diverse repertoire of strokes.[12] The aggressiveness of the batting performance measurements was based on the player's and team's strike rate.[13] The batsmen must be able to programme and execute an adequate response within an extremely short time interval to a ball, which may result in dismissal, depending on the batsmen's visual reaction time and the movement time of the lower extremities and bat.[14] Self-assurance, adequate arousal levels, motivation, attention, ample mental preparation, and efficient body movement are essential for effective performance in any form of cricket, although research on the physical and physiological demands of short-format cricket has been scarce and inadequately documented.[7] Only a little research has been undertaken to investigate the physiological needs of the batsman during a comparative short-format match and very little has been done to predict cricket playing ability in terms of physiological responses.[5] Hence, the present study has attempted to get valuable insights into the physical and physiological needs of batsmen and their relationship in a short-format competitive cricket match in terms of innings variation. Heart rate measurement was used as a parameter for physiological response and run scoring ability was considered as an indicator of physical performance. Besides several physiological factors such as attentional focus, executive skill, sustained level of arousal, sympathovagal modulation (change in heart rate) may also play an essential role on physical performance under competitive demand.

Thus, the present study hypothesized that the run scoring ability of a batsman may be influenced by his concurrent heart rate modulational ability. To our available knowledge till date, the present study is the first to attempt to investigate the role of concurrent heart activity during the time of batting under professional competitive situations. The significance of the findings of the study may offer useful information to physical trainers, coaches, and sports scientists to understand the technical and tactical elements of physiological demand and how to create efficient training modules appropriately.

Materials and methods

Participants: After a brief discussion, twenty districts representing male cricketers of West Bengal filled out informed consent and agreed to participate voluntarily in the study. All the volunteers were upper-order (1-4) batsmen4 who took part in an inter-district T-20 tournament organized by the Cricket Association of Bengal. They were categorized according to their sequence of batting innings (Batting 1st and Batting

2nd) to understand the effect of batting innings on selected physical, physiological, and performance indicators for batsmen. The Ethical Committee of Ramakrishna Mission Vivekananda Educational and Research Institute authorized the study (Table 1).

Table 1 Demographic characteristic of upper-order batsmen

Parameters	Total (n=20)	Batting 1st(n=10)	Batting 2nd (n=10)	P- value
Age (years)	20.0 ±2.4	20.9 ± 2.3	19.2 ± 2.4	0.099
Height (m)	1.68±0.58	1.68±0.67	1.68±0.52	0.495
Body Mass (kg)	63.6±7.6	64.2 ± 6.2	63.1 ± 8.9	0.726
BMI (kg/m2)	22.6±2.4	22.7±2.2	22.4±2.8	0.372

(Data were presented as mean±SD)

Study organization: Basic personal, physical, physiological, and performance data has been collected. During batting, the Polar V800 smart watch (1 Hz) along with the H7 heart rate sensor and chest strap have been used to detect various movement patterns, beat to beat heart rate, and body surface temperature. The validity and reliability of the Polar V800 smart watch in measuring cricket-specific movements were evaluated independently.[15] Batting performance metrics such as runs scored, balls faced, and team scores were also recorded for that batsman.10 During the whole period of data collection, according to the local weather report, the following observations on weather conditions such as ambient temperature (31°C–39°C), humidity (63–88%), and wind speed (4–11 km/h) were made. Batsmen's movements in the crease while batting were classified into three zones, such as low (walking and no movement), moderate (jogging), and high (running and sprinting) intensity zones.3 The researcher had no influence on the venue, field size, match time, pitch, opponent, toss, blowers, fielders, batting order, or match results.

Statistical analysis: The descriptive information was used in the process of analysing each and every piece of data. Due to artifacts in the data set of batting, two heart rate responses were excluded from the final analysis. The Anderson-Darling test was used to understand the distribution pattern of the data. Nonparametric statistical tests were applied because most of the data set did not follow normal distribution patterns. The Spearman's rho (ρ) correlation coefficient was employed as the method of analysis to determine the strength of the rank order association between various physical, physiological parameters and the performance indicators for batting in short-format cricket. In addition to this method, a polynomial regression trend line was also used to explain and predict the performances of batsmen. The Mann-Whitney U test was designed to compare the impact of different batting innings on selected variables. The $p \leq 0.05$ was set as statistically significant. All the data was exported using the polar flow sync programme. Raw data was filtered and sent for additional analysis based on certain batting times. Gnumeric Spreadsheet 1.10.16 was used for data sorting, statistical analysis, and graphical depiction.

Results

To explore how the different factors are related, linear correlations were made between some measures of batting performance and basic movement and physiological factors (Table 2). Duration of batting was found to be significantly associated with peak speed (p=0.03), running between the wickets (p=<0.001) and body surface temperature (p=0.03). Key performance indicator of batting, individual score was significantly correlated with average HR during batting (p= 0.02) as well as with batting specific movement, running between the wickets (p=<0.001). The HR average during batting showed a significant nonlinear association with an individual score. A polynomial regression (R2=0.33) was intended to explore the relationship, and a curvilinear (inverted U type) relationship has been observed. Batting in cricket has an intrinsically higher degree of inexplicable variance because of several elements associated with run-scoring capabilities, such as pitch condition, outfield, bowlers, fielding position, opponent score, weather, ball, and match pressure, etc. For these reasons, the R^2 value might seem to be lower. The projected regression equation showed that a moderate to high average HR (126–157 bpm) was helpful for scoring more than 30 runs (Figure 1).

Table 2 Correlation coefficients between performance indicators and movement characteristics and physiological responses of upper order batsmen in T20 cricket matches

Parameters	Total minutes	Individual score	Strike rate	Adjusted strike rate	% of dot balls
HR average	0.07 (0.78)	-0.39 (0.02)*	0.29 (0.20)	0.33 (0.14)	0.26 (0.25)
Peak speed	0.46 (0.03)*	0.06 (0.81)	-0.26 (0.25)	-0.25 (0.28)	0.59 (0.01)*
Running between the wickets	0.70 (4.07e-4)*	0.64 (1.71e-3)*	0.21 (0.35)	0.13 (0.56)	0.07 (0.78)
Body surface temp	0.48 (0.03)*	0.19 (0.41)	-0.27 (0.24)	-0.31 (0.17)	0.50 (0.02)*

Data were presented as ρ ("rho") (p value), *, significant correlation

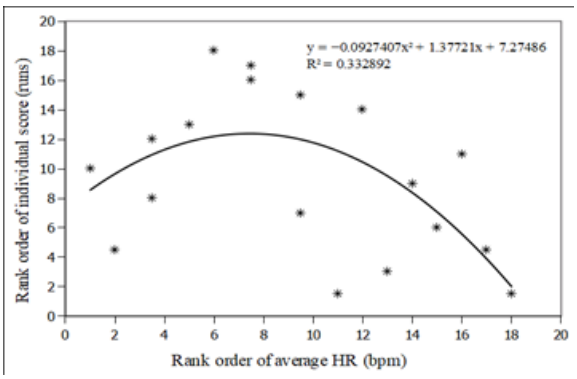

Figure 1 Graphical representation of average HR and individual score, along with polynomial regression line.

The effect of short-format batting innings on physical, physiological, and performance indicators was observed in Table 3, and no statistically significant ($p \leq 0.05$) difference was observed among the parameters. However, the upper order batsmen of the 2nd innings displayed a lower value of HR average as well as body surface temperature, compared to the batsmen of the 1st innings (Table 3). A clear picture of the percentage of time spent in the specified HR reserved zone has been displayed in Figure 2. A significant difference was identified in the HR reserved zone with low intensity (0.032), but not in the HRR zone with moderate intensity (0.726) or the HRR zone with high intensity (0.147). The finding of the study exposes only a trivial difference in the percentage of time spent in different cricket specific movement patterns in the Figure 3. Majority of time during batting upper order cricketers spend in standing position and batsmen covered major distance by walking. There have been no noticeable alterations in the percentage of time spent in different movement

patterns of the batsmen in the top order (standing or no movement (0.820), walking (0.960), jogging (0.435), and running (0.395)).

Table 3 Comparison of performance indicators according to batting innings

Parameters	1st innings	2nd innings	p value
Duration of batting (min)	43.1±18.1	35.0±9.9	0.395
Running between wickets (nos)	16.5±3.5	14.0±4.0	0.177
Individual Score (runs)	34.5±9.5	31.0±6.5	0.342
Strike Rate (nu)	120.8±7.3	121.1±16.7	0.395
Distance covered (m/h)	1211.1±167.9	1219.8±151.1	0.395
HR average (bpm)	147.5±5.5	140.0±9.5	0.051
Max speed (km/h)	13.7±0.9	13.4±1.1	0.453
Body temp (Celsius)	36.3±1.7	35.4±0.6	0.080
Dot balls (%)	44.2±4.4	41.2±11.5	0.294

Data were presented as Median ±Median absolute deviation

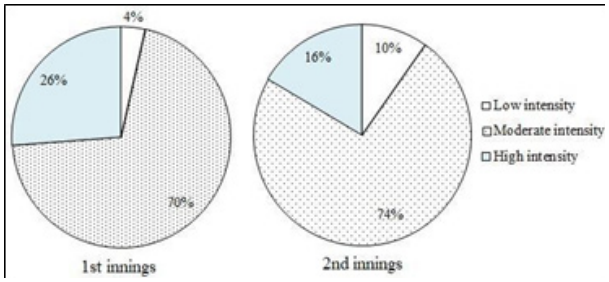

Figure 2 Percentage of time spent in the specified HR reserve zone.

Figure 3 Innings wise percentage of time spends in different cricket specific movements.

Discussion

The purpose of the present study was to discover the links (if any) between certain physical and physiological responses and batting performance in short-format cricket. At the same time, the sequence effects of batting innings on upper order batsmen in a short-format game on some physical, physiological, and performance metrics were also compared. The present study looks critically at how popular measures of batting performance, such as individual runs, strike rate, balls faced, and duration of batting, are related to internal and external load indicators. According to Modekurti &Venkaka,[11] a team's batting in the first or second innings will require distinct team and individual strategies. A team batting in the second innings needs to achieve a targeted run, but the team batting in the first innings must establish a healthy score for chasing. To determine how the toss or sequence of innings affects batsmen in the top order, all batsmen were divided into groups based on their batting innings, and their strike rates were adjusted based on the strike rates of all batsmen in the match.

The observations on the basic physical characteristics of the cricketers are similar; only a trivial difference has been observed in BMI. According to the World Population Review,[16] the average height of Indians is 166.5 cm, which is lower than that of cricketers. The BMI of the cricketers displayed a healthy range which, according to the report "Nutrient Requirements for Indians" published by the Indian Council of Medical Research.[17]

The present study found that the duration of batting is significantly correlated with running between the wickets, peak speed, and body surface temperature. Frequent strike rotation (running between the wickets) and fast singles assist the batsman to minimise mental strain by monitoring the scoreboard. The average heart rate of the batsmen in this study was similar to those reported by Gore et al.,[18] and Christie et al.,[19] who found mean heart rate responses of 144bpm and 138bpm respectively, during matches but in different formats of cricket. It is worth mentioning that an 'inverted U' relationship has been observed for the first time in the analysis for batting performance across all formats of cricket, between individual score and average HR during batting. Literature suggests that the heart rate performance curve (HRPC) can vary depending on the activity type.[20] HRPC is neither linear nor homogenous whereas heart rate increases progressively in an s-shaped manner during incremental task[21] and related to ß1-adrenoceptor sensitivity.[21] A low resting heart rate is frequently indicative of peak physical fitness,[22] however findings of this study tells us that very low or very high average HR values are not suitable for good performance in batting at the upper order. Researchers found that individuals with atypical HRPCs are more likely to experience overload than the individuals with regular HRPCs.[20] Therefore, it is crucial to understand a cricketer's HRPC during real time batting to design future training plans and improve performance. Batting is a manipulative motor activity that requires both gross and fine motor skills. Normally, a substantially higher average heart rate during batting indicates sympathetic hyperactivity and induces nervousness, palpitations, etc.,[23] which has an adverse influence on batting skill execution. It is established that optimal arousal is beneficial to sports performance[24], and arousal is strongly attributable to heart rate.[25] These studies also demonstrated that arousal levels, whether low or high, have a detrimental impact on athletic performance.[24,25]

If a batsman spends more time in the crease while in the moderate to high effort HR zone, core body temperature rises naturally owing to cardiac drift, which also affects body surface temperature (ref). Batting is a skill-oriented intermittent activity,1 and batting success is typically defined by a batsman's ability to score runs at a fast pace.[12] The ultimate expression of the batting performance of a batsman is the runs scored by him or her. However, in T20 cricket, a high strike rate and a low proportion of dot balls are crucial batting success predictors. Optimum technical, tactical, and physical ability are needed to mix with mental prowess to produce a fruitful batting performance.[12] For adaptation to the situation or to gauge the prevailing conditions, opposing teams get very little time in T20s. Most teams, hence, prefer to leverage the experience they get from their opponents' first innings while batting second.[11]

A positive significant link has been found between individual score and running between the wickets, indicating that frequent running between the wickets (singles and doubles) generated a high individual score. The strike rate shows no significant relationship with any physiological reactions, while the modified strike rate has a negative significant link with the low/high movement ratio. By rotating the strike, a batsman may reduce the amount of time spent in the low mobility zone, which includes standing and walking. This can have a knock-on effect on the batsmen's ability to sprint between the wickets.

Generally, most of the time, singles and doubles help in building a healthy strike rate and easing the batter's mind, which makes the task of the bowler in changing the length or the line tougher.

The influence of the sequence of batting innings on selected performance predictors of upper order batsmen was compared, and only a trivial difference has been observed depending on the sequence of batting innings. It has also been observed that batsmen spend more time in the crease while batting first to create a mammoth total than batting in the second while chasing a target. It is a common practice that after getting settled, the batsman will strive to build a good score for the team, which helps in extending the duration of batting. During the second inning, the batsman attempts to finish the game before the last over or as soon as possible. Consequently, batsmen take frequent chances to score quickly, and the rate of dismissal rises. The average individual score was likewise higher among first-inning batters. On the other hand, individual scores did not differ significantly across groups. In the first innings, batsmen strive to comprehend and acclimatise to the pitch's characteristics. Several studies found that batsmen in the first innings scored more runs and spent more time at the crease than batsmen in the second innings,12 maybe because batsmen in the second innings were bound by a certain target5. The top order batsmen in both innings focused on strike rotation to keep the scoreboard running and put the bowlers under pressure. There was no significant difference in strike rate amongst the top order batsmen. However, batsmen in the first innings had a higher strike rate as well as a higher average HR. The HR responses of the batsmen were merely similar to the findings of Webster & Travill.[26] According to the study, the hitter in the second inning had a much lower body surface temperature. During the first innings, batsmen must understand the pitch conditions and play wisely. Consequently, batsmen attempt to adjust by rotating the strike rate to avoid risky strokes. Batsman also tries to exploit the power play field constraints. In response to the situation, sympathetic activity has intensified, increasing heart rate and, consequently, core body temperature. As a result, when batting in the 1st innings, the temperature of the body surface area increases. However, since they were fielding on the ground in the first innings, the batsmen in the second innings had already acclimatized to the environment; their average HR during batting and body surface temperature were relatively lower than the batsmen in the first inning. The "second wind" theory might account for the low average HR while batting in the second inning.

Recommendations

a) Role of heart rate responses on batsmen performance

The appropriate level of arousal and balance between the sympathetic and parasympathetic nervous systems (HR responses during batting) positively affects the execution of complex motor skills such as batting, which is beneficial for scoring runs. HR-guided task-specific simulated training sessions of batting may help to improve run-scoring ability. Controlled breathing techniques might be useful for both strike and not-strike end batsmen during batting for controlling the HR as well as beneficial for reducing psycho physiological match-oriented stress.

b) Role of strike rotation on batsmen performance

Frequent strike rotation reduces match pressure on the batsmen by keeping the scoreboard moving to achieve a good total. It also impedes the bowler from obtaining the ideal line and length, which reduces the risk of dismissal, assists in hitting the boundary, and keeps the fielder under pressure, pushing them to contemplate a mistake. Batsmen might be able to improve their ability to change the strike by working on their speed and agility and participating in running between the wickets' specific small-sided lead-up games.

c) Game of uncertainty (influence of external factors)

Cricket is an unpredictable game, and batting performance is affected by several individual and environmental circumstances. A batsman's ability to score runs is influenced not only by physical ability, psycho physiological state, and batting technique, but also by a variety of uncontrollable independent elements such as opponents, outfields, pitch conditions, weather, match situation, spectators, umpires, and so on. Batsmen have to concentrate more precisely to improve the physical, psycho physiological and batting techniques by which a batsman can cope with any diverse situation.

For psychological boosting of the batsmen, a session with a sports psychologist attached to the team should be held before the start of the game.

Conclusion

The study revealed that, according to the movement pattern of batting, it might be low to moderate intensity activity, but according to HR response, it was moderate to high intensity activity. Performance indicators of batting are significantly linked with selected time motion and physiological parameters. Frequent strike rotation during batting is a key indicator to creating a good individual score. Physiological responses, movement characteristics, and performance indicators of batting were not influenced by batting innings. However, all the decisions and suggestions have been made. As cricket is an uncertain game, the result can be changed by another group or increased numbers of volunteers.

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Conflicts of interest

The authors declare no conflicts of interest for this study.

References

1. Scanlan AT, Berkelmans DM, Vickery WM, et al. A Review of the Internal and External Physiological Demands Associated With Batting in Cricket. *Int J Sports Physiol Perform*. 2016;11(8):987–997.
2. Noakes TD, Durandt JJ. Physiological requirements of cricket. *J Sports Sci*. 2000;18(12):919–929.
3. Sholto-Douglas R, Cook R, Wilkie M, et al. Movement Demands of an Elite Cricket Team during the Big Bash League in Australia. *J Sports Sci Med*. 2020;19(1):59–64.
4. Perera H, Davis J, Swartz TB. Optimal lineups in Twenty20 cricket. *J Stat Comput Simul*. 2016;86(14):2888–2900.
5. Moore A, Turner JD, Johnstone AJ. A preliminary analysis of team performance in English first-class Twenty-Twenty (T20) cricket. *Int J Perform Anal Sport*. 2012;12(1):188–207.
6. Biswas S, Biswas A. Somatotype of Regional Cricketers of West Bengal in India. *Eur J Sport Exerc Sci*. 2021;9(3):11–17.

7. Vickery W, Duffield R, Crowther R, et al. Comparison of the Physical and Technical Demands of Cricket Players During Training and Match-Play. *J strength Cond Res*. 2018;32(3):821–829.
8. Johnstone JA, Ford PA. Physiologic profile of professional cricketers. *J strength Cond Res*. 2010;24(11):2900–2907.
9. Petersen CJ, Pyne DB, Portus MR, et al. Comparison of player movement patterns between 1-day and test cricket. *J strength Cond Res*. 2011;25(5):1368–1373.
10. Irvine S, Kennedy R. Analysis of performance indicators that most significantly affect International Twenty20 cricket. *Int J Perform Anal Sport*. 2017;17(3):350–359.
11. Modekurti DPV. Setting final target score in T-20 cricket match by the team batting first. *J Sport Anal*. 2020;6(3):205–213.
12. Surita Sloane. Analysis of Performance Indicators in IPL Twenty20 Cricket from 2015 to 2017. 2020.
13. Lemmer HH. The single match approach to strike rate adjustments in batting performance measures in cricket. *J Sports Sci Med*. 2011;10(4):630–634.
14. Müller S, Abernethy B, Farrow D. How do world-class cricket batsmen anticipate a bowler's intention? *Q J Exp Psychol (Hove)*. 2006;59(12):2162–2186.
15. Biswas S, Guha S, Bhattacharya R. Validity and Reliability of Polar V800 Smart Watch to Measure Cricket Specific Movements. *Physical Education Theory and Methodology*. 2022;22(3).
16. World Population Review. Average Height by Country. 2022.
17. ICMR-NIN expert group on nutrient requirements for Indians. Recommended Diatory Allowance (RDA) and Estimated Average Requirement (EAR); 2020.
18. Gore CJ, Bourdon PC, Woolford SM, et al. Involuntary dehydration during cricket. *Int J Sports Med*. 1993;14(7):387–395.
19. Christie CJ, Todd AI, King GA. Selected physiological responses during batting in a simulated cricket work bout: A pilot study. *J Sci Med Sport*. 2008;11(6):581–584.
20. Birnbaumer P, Traninger H, Borenich A, et al. Heart Rate Performance Curve Is Dependent on Age, Sex, and Performance. *Front public Heal*. 2020;8:98.
21. Brooke JD, Hamley EJ. The heart-rate--physical work curve analysis for the prediction of exhausting work ability. *Med Sci Sports*. 1972;4(1):23–26.
22. Biswas S. A Study on Resting Heart Rate and Heart Rate Variability of Athletes, Non-athletes and Cricketers. *Am J Sport Sci*. 2020;8(4):95.
23. Dong JG. The role of heart rate variability in sports physiology. *Exp Ther Med*. 2016;11(5):1531–1536.
24. Arent SM, Landers DM. Arousal, anxiety, and performance: a reexamination of the Inverted-U hypothesis. *Res Q Exerc Sport*. 2003;74(4):436–444.
25. Azarbarzin A, Ostrowski M, Hanly P, et al. Relationship between arousal intensity and heart rate response to arousal. *Sleep*. 2014;37(4):645–653.
26. Webster Z, Travill AL. A comparison of the physical demands of a one-day cricket game and the training sessions of provincial cricket players using Global Positioning System tracking software. *South African J Sport Med*. 2018;30(1):1–6.

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