The analysis and competition strategy of the uncrowned king of badminton Lee Chong Wei's key points

Shuzhen Ma, Kim Geok Soh, Salimah Binti Japar, Yang & Yanqi Xu

Published online: 26 Feb 2024.

Submit your article to this journal ↗

Article views: 1075

View related articles ↗

View Crossmark data ↗

SPORT | RESEARCH ARTICLE

The analysis and competition strategy of the uncrowned king of badminton Lee Chong Wei's key points

Shuzhen Ma[a], Kim Geok Soh[a], Salimah Binti Japar[a], Yang[b] and Yanqi Xu[c] (iD)

[a]Department of Sports Studies, Faculty of Educational Studies, Universiti Putra Malaysia, Serdang, Selangor, Malaysia; [b]School of Kinesiology, Shanghai University of Sport, Shanghai, PR China; [c]College of Materials Science and Engineering, Guilin University of Technology, Guilin, PR China

ABSTRACT

The skill and tactical application of key stages of badminton usually show a decisive impact on the competition results. In this research, the skill and tactical performances of Lee Chong Wei in 10 representative matches of the Olympic Games, World Championships and Open in the Quarter, Quarter and Final, respectively, were selected for study. A one-way ANOVA with paired samples t-test was used to analyze the differences of their relevant skill parameters between the ace-shot and misses. Lee Chong Wei is accustomed to serving backhand nets and uses lift shot skills when receiving serves for the first shot on key points, while the mainstream skill of the second shot is drop shot, resulting poor lift shot effect. Furthermore, the multi-shot skill is mainly used to hit the opponent's forecourt backhand area, and the lift shot skill is conducive to scoring, while the picking skill is ineffective.

1. Background

Badminton is an intermittent and dynamic racket sport (i.e. a combination of speed, high-intensity movements, anticipation and rest intervals) where both players must take action and reaction (i.e. interaction of skill, tactics and decision making) during rallies to gain a temporal and positional advantage over their opponents in order to win points (Abián et al., 2014; Barreira et al., 2016; Chow et al., 2014; Laffaye et al., 2015; Phomsoupha & Laffaye, 2015). Badminton requires a variety of skilled postural variations and movements (Malwanage et al., 2022), and is characterized by repetitive effort and high intensity (Cabello Manrique & González-Badillo, 2003). Since its inclusion in the Olympic Games in 1992, badminton has undergone regulatory changes and significant developments, which in turn have generated a great deal of interest in the changing of this sport amongst the Olympic Games (Torres-Luque et al., 2020). In the badminton game, atypical movements and strokes occur frequently (Malwanage et al., 2022). The popularity of the Internet has led to a rapid development in badminton technology, and the competition in the world of men's badminton has become increasingly fierce, with the Skill and tactical gap between male players from different countries narrowing. The rational use of skills and tactics is always a key factor in winning a match, so it is essential to study badminton skills and tactics.

In recent years, the number of Asian players in the world's top 100 has increased significantly to more than 60% (Abián et al., 2021), and Lee Chong Wei is representative one of them. In badminton men's singles, where Lee Chong Wei held the world number one ranking for 825 d in the Badminton World Federation rankings. The current researches on the characteristics of elite badminton matches focus on the analysis of isolated matches (Laffaye et al., 2015), and descriptive data on the performance ability of elite badminton players are scarce (Chin et al., 1995). Many studies have recently been conducted on the timing structure, strokes, footwork and movement of the new badminton system, obtained some rules to make athletes more competitive (21-point system) (Abdullahi & Coetzee, 2017; Abián-Vicén et al., 2018; Gomez et al., 2019; Laffaye et al., 2015; Valldecabres et al., 2020). The analysis of successful players (medalists) is required to update and manage current player performance and its evolution from tournaments to championships if the athletic ability of the players is to be improved (Menescardi et al., 2019). The high-level duels of the best athletes are comprehensive competitions of collective energy, skill, tactics, psychology and intelligence. Due to the improvement of scientific training methods and tools, the growing sophistication of training facilities have led to a general increase in the level of training of athletes from all countries, with minimal differences between the components of competitive ability, making the effective handling of key points even more important for the outcome of the game. Through symbolic analysis and recorded video, the focus was on the different types of shots and winning styles (direct points, unforced errors and forced errors) (Abian-Vicen et al., 2013; Hong & Tong, 2000). The use of data analysis of sporting game information allows for the objective evaluation of important indicators of athletes' game performance, which can be used as an important reference for sport analysis, Skill and tactical evaluation, future training program decisions and pre-game tactics development (Dieu et al., 2020; C.-C. Wang, 2022).

2. Materials and methods

2.1. Definition of key concept

2.1.1. Key points

There are few studies on the 'key points' of badminton, but there are certain studies on the key points of table tennis and tennis. Cheng Xiaopeng defined the key points of table tennis as the key games, rounds and scores of the ball (Abdullahi & Coetzee, 2017), while Huang Fafa defined the key points as the difference between 1 and 2 points in the ending or the score that rose alternately in the middle game is the critical moment (Abdullahi & Coetzee, 2017). When Luo Yijie studied the skill and tactics of the world's outstanding tennis players, the key point was defined as the point that can win the game (Abdullahi & Coetzee, 2017). Wang Hongqun defined the key points of badminton as the score of the game where the players have a stalemate after reaching 17 points, and the score difference does not exceed 6 points (H. Wang, 2017). It is reasonable to define the key score of badminton as one side getting 17 points first, but the score after 15 points in badminton is very critical, and if the score difference
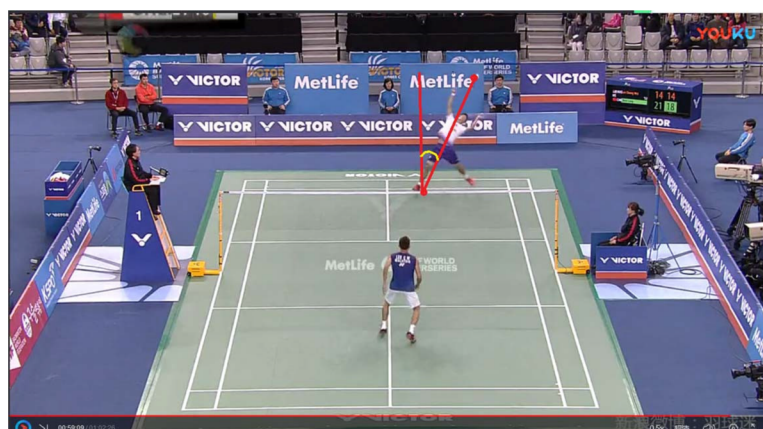

Figure 1. Schematic diagram of the lower declination angle.

is too wide, it may cause the players to give up the game. Therefore, the predecessors' research on the key points of the net confrontation project defines the key points of badminton as: one side scores 16 points first, and the score difference does not exceed 2 points.

2.1.2. Lower declination

The downward declination angle created by Lee Chong Wei's stroke is the angle between the line between the two points of the opponent's catch and the projection point of the opponent's catch onto the net and the horizontal plane (Figure 1).

2.2. Research methods

A comprehensive search of skill and tactical characteristics of various badminton tournaments were summarized from Chinese databases (CNKI, Wan Fang) and web of science databases. The key skill performances of 10 representative matches of Lee Chong Wei from the Olympic Games, Badminton World Championships and Badminton Open during 2016–2018 were selected for investigation (Table 1). All ten of Lee's matches' high-definition video footage was downloaded by the researchers. In order to capture every action in Lee Chong Wei's match footage down to the smallest unit frame, two independent data recorders (MS, XY) use Adobe Premiere. They also meticulously document the different hitting strategies that Lee Chong Wei employs during each stroke of his scoring and missed strokes. The Recorder (YY) makes the final decision in cases where there is disagreement between the two recorders on the identification of skill categories. Following receipt gathering, SPSS is used to compare and analyze the technological application types of Lee Chong Wei's winning and losing points.

3. Results

3.1. Skill and tactical strategies used in first shot of the key point

It is considered that there may be a difference between the Skill use of winning shots and negative shots in critical points, so skill use in critical points is analyzed in two parts: losing shots and scoring shots. The type of serve was divided into five categories: backhand service net, backhand service flat lob, forehand service net, forehand service flat lob and forehand service high. From cross-sectional analysis

Table 1. Statistical table of Lee Chong Wei's matchups to be studied.

Competition name	Opponent	Winning side	Score	Competition time
Rio Olympics Men's Singles Semi-Finals	Lin Dan	Lee Chong Wei	2:1	2016
Malaysia Open Quarter Finals	Anselme	Lee Chong Wei	2:0	2018
Malaysia Open Men's Singles Final	Lin Dan	Lee Chong Wei	2:0	2017
WAF Finals	Anselme	Anselme	2:1	2017
Badminton Asian Championships Men's Singles Semi-Finals	Kento Momota	Kento Momota	2:0	2018
Hong Kong Open Badminton Championships	Chen Long	Lee Chong Wei	2:0	2017
Rio Olympics Men's Singles Final	Chen Long	Chen Long	2:0	2016
Asian Team Championships Quarter Finals	Ng Ka Long	Lee Chong Wei	2:0	2018
All England Open Badminton Championships	Lin Dan	Lin Dan	2:0	2018
Malaysia Open Men's Singles Final	Kento Momota	Lee Chong Wei	2:0	2018

Table 2. Distribution of the average frequency of serve types under different conditions of Lee Chong Wei's key score.

	Score lead	Score tied	Down by a score	F	P
Backhand serve at the net	1.79 ± 1.84	0.57 ± 1.02	1 ± 1.57	2.306	0.113
Flat high backhand serve	0.36 ± 0.633	0.07 ± 0.267	0	3.174	0.053
T	7.493	3.169	5.688	–	–
P	0.011	0.087	0.025	–	–

(Table 2), the frequency of missed balls is greater than that of scored balls when Lee Chong Wei uses the backhand forehand skill in key points, and there is a significant difference at the 0.05 level, indicating he is more likely to miss a point when serving the backhand forehand. The number of balls scored is greater than that of balls conceded when using the backhand lob, indicating that he has a greater chance of scoring with the backhand lob. In longitudinal analysis, the frequency of using the backhand net skill is greater than that of using the backhand flat high ball skill for both missing and scoring balls, suggesting that he has a greater chance of scoring both scoring balls and flat high balls.

There are 10 types of receiving and serving skills: ball rolling, lift shot, fluttering, picking, hooking against the corner, flat draw and quick block, killing, hanging, high ball and splitting and hanging. The frequency of the types of receiving and serving skills for the key points scored and missed by Lee Chong Wei is shown in Table 3. The horizontal analysis shows that there is no significant difference in the use of lift shot, lunge, pick, Crosscourt shot and other skills in the key point serve, indicating that there is no difference in the use of skills in the point serve. In longitudinal analysis, there is a significant difference in the frequency of lift shot, ball picking, ball hooking, other skills, ball fluttering, mainly in the frequency of lift shot and ball fluttering, which means that Lee Chong Wei uses more lift shot skills and less ball fluttering skills in the score ball. There is no significant difference in the frequency of the use of the skills of receiving and serving in the scoring balls, indicating that the use of each skill is relatively even.

The opponent's hitting area reflects Lee Chong Wei's first shot skill and thus his tactical approach to the ball. The frequency distribution of the opponent's hitting zones on the first shot of key scoring shots and missed shots is shown in Table 4. From cross-sectional analysis, there is no significant difference between the frequencies of key point opponent's first racket. In a longitudinal analysis, the frequency of the opponent's first shots when Lee Chong Wei misses a key point ranges from more to less is: forecourt middle area, forecourt backhand area, forecourt forehand area, backcourt forehand area, backhand area, middle court backfield area, other areas and there are significant differences between forecourt middle area and other seven areas, indicating that Lee is more likely to hit the forecourt middle area and less likely to hit the other areas in a missed point. The frequency of the opponent's first shot in a key point missed by Lee Chong Wei can be seen as the middle forecourt area, forecourt backhand area, middle backhand area and forecourt forehand area are equal to backcourt forehand area and backcourt

Table 3. Distribution of the average frequency of the type of serve received under different conditions of Lee Chong Wei's key score.

	Score lead	Score tied	Down by a score	F	P
Lift shot	0.64 ± 0.842 ♦	0.07 ± 0.267	*1.14 ± 1.406*	4.376	0.019
Pick	0.43 ± 0.646	0.50 ± 0.650 $^\vartriangle$	0.50 ± 0.650	0.057	0.945
Crosscourt shot	0.43 ± 0.852	0	0.21 ± 0.579	1.819	0.176
Rush shot	0.07 ± 0.267	0.07 ± 0.267	0.14 ± 0.363	0.260	0.772
Other	0.14 ± 0.363	0.07 ± 0.267	0.29 ± 0.611	1.696	0.197
F	1.860	4.483	3.558	–	–
P	0.128	0.003	0.011	–	–

Note. *, ♦ and $^\vartriangle$ not indicate variability in the magnitude of the values adjacent to each other, the front side of the values indicate horizontal comparisons and the marks on the back side of the values indicate vertical comparisons, as below.

Table 4. Distribution of the average frequency of the opponent's hitting area on the first shot of the key point scored and lost by Lee Chong Wei.

	Goals allowed	Scoring goals	T	P
Forecourt backhand area	1.07 ± 1.269	0.93 ± 1.141	0.268	0.793
Middle area of the forecourt	1.79 ± 1.311 #	1.43 ± 1.158 ♦	0.673	0.513
Front court forehand area	0.86 ± 0.864	0.57 ± 0.756	1.000	0.336
Backhand area in the middle court	0	0.70 ± 0.267	−1.000	0.336
Backhand area	0.36 ± 0.633	0.43 ± 0.646	−3.22	0.752
Middle backfield area	0.07 ± 0.267	0	1.000	0.336
Back court forehand area	0.50 ± 0.760	0.57 ± 0.646	−0.322	0.752
Other	0	0	–	–
F	7.566	5.784	–	–
P	<0.001	<0.001	–	–

Note. #Indicates that there is variability in the magnitude of the values three levels apart and is marked on the larger value, below. ♦Indicates that there is a difference between the values at one level, and is marked on the larger value.

Table 5. Distribution of the average frequency of the first shot of the first Skill stroke line for key points scored and lost by Lee Chong Wei.

	Goals allowed	Scoring goals	T	P
Forehand position	0.93 ± 1.072	1.57 ± 1.158	−1.505	0.156
Middle road	2 ± 1.519	1.5 ± 1.454	0.809	0.433
Backhand position	1.71 ± 1.590	0.86 ± 0.949	2.199	0.047
F	2.161	1.492	–	–
P	0.129	0.238	–	–

Table 6. Distribution of the average frequency of the changes in the first shot of the first game of the key points scored and conceded by Lee Chong Wei.

	Goals allowed	Scoring goals	T	P
Euphoria	0	0.43 ± 0.646	−2.482	0.028
Homogeneous state	4.43 ± 2.065*	3.43 ± 1.869*	1.117	0.284
Inferior state	0.29 ± 0.469	0	2.280	0.040
F	57.544	37.446	–	–
P	<0.001	<0.001	–	–

*Indicates that there is a difference between the adjacent levels of the values, and is marked on the larger value.

backhand area. There is also a significant difference between the frequency of middle front court area and middle back court area, indicating that Lee Chong Wei hits the middle front court area more often than the middle back court area in the missed shots.

The frequency distribution of lines of play for the first shot skill on key points scored and missed by Lee Chong Wei is shown in Table 5. From cross-sectional analysis, there is no significant difference in the distribution of scored and unscored balls among the lines in the key point first shot skill, hitting the line from the forehand position and the middle, which indicates that his forehand position and the middle have no effect on his scored and unscored balls; while in the frequency of hitting the opponent's backhand position, the frequency of unscored balls is greater than the frequency of scoring balls, and there is a significant difference, which indicates that Lee Chong Wei is more likely to lose points when hitting the backhand position in longitudinal analysis, the number of missed balls is higher than the number of points, and there was no significant difference between the number of forehand, middle and backhand balls hit by Lee Chong Wei in the missed and scored shots.

3.2. Effectiveness of skill and tactical strategies used in first shot of the key point

Considering that Lee Chong Wei's first racket skill may rarely produce points in key points, the effect of the first racket skill is measured by the change of posture. If the use of the skill causes to score a point or a trend of scoring, it means that the use of the skill has a superior effect; if the use of the skill is only a transitional skill and does not produce a point or a trend of scoring, it means that the use of the skill has an even effect; The distribution of the first shot of key points scored and lost by Lee is shown in Table 6. From cross-sectional analysis, his first shot in the superior state is a significant difference between the scored balls and the conceded balls, indicating that Lee Chong Wei has a high chance of scoring if first shot is in the superior state, while the conceded balls are greater than the scored balls in the inferior state, indicating that Lee Chong Wei has a high chance of conceding points if first shot is in the inferior state. In the even-state, there is no significant difference between the balls scored and the balls conceded, indicating that the first shot in the even-state has no effect on the points scored and conceded. In longitudinal analysis, it can be seen that the effect of first shot on both scoring and losing balls is greater in the even state than in the superior and inferior states, and is significantly different from the other states, indicating that the effect of first shot is mainly in the even state.

3.3. Skill and tactical strategies used in the second shot of the key point

Skill and tactical strategies used in the second shot of the key point is studied in terms of the types of skills used as well as the landing points and lines. From cross-sectional analysis (Table 7), there is a

Table 7. Distribution of the average frequency of the second shot skill category for key points scored and conceded by Lee Chong Wei.

	Goals allowed	Scoring goals	T	P
Ball rolling	0.07 ± 0.267	0.07 ± 0.267	0	1.000
Rush shot	0	0.07 ± 0.267	−1.000	0.336
Crosscourt shot	0.07 ± 0.267	0.14 ± 0.363	−1.000	0.336
Drop ball	1.43 ± 1.399⊕	0.86 ± 0.949	1.375	0.192
Flat draw fast block	0	0.07 ± 0.267	−1.000	0.336
Catch and kill blocking net	0.29 ± 0.611	0.14 ± 0.363	0.694	0.500
Catch and kill high	0.07 ± 0.267	0.07 ± 0.267	0	1.000
Smash	0.21 ± 0.426	0.57 ± 0.514	−1.794	0.096
Hight clear	0.07 ± 0.267	0.29 ± 0.469	−1.385	0.189
Splitting and lifting	0.50 ± 0.519	0.21 ± 0.426	1.749	0.104
Lift shot	0.71 ± 0.825	0.29 ± 0.611	2.482	0.028
Pick	1.00 ± 0.877	0.71 ± 0.726	0.939	0.365
F	7.122	3.361	–	–
P	<0.001	<0.001	–	–

Note. ⊕Indicates that there is variability in the magnitude of the values four levels apart and is marked on the larger values.

Table 8. Distribution of the average frequency of the opponent's hitting area for the second shot of the key point scored and lost by Lee Chong Wei.

	Goals allowed	Scoring goals	T	P
Forecourt backhand area	1.00 ± 0.961	0.79 ± 0.802	0.611	0.551
Middle area of the forecourt	0.43 ± 0.646	0.36 ± 0.633	0.268	0.793
Front court forehand area	1.36 ± 1.151♦	0.50 ± 0.760	2.917	0.012
Backhand area in the middle court	0.14 ± 0.363	0.21 ± 0.426	−0.563	0.583
Central midfield area	0.14 ± 0.363	0.36 ± 0.633	−1.000	0.336
Forehand area in the middle court	0	0.14 ± 0.363	−1.472	0.165
Backhand area	0.36 ± 0.745	0.36 ± 0.497	0.000	1.000
Middle backfield area	0.14 ± 0.363	0.36 ± 0.633	−1.385	0.189
Back court forehand area	0.64 ± 1.008	0.57 ± 0.514	0.234	0.818
F	5.625	1.435	–	–
P	<0.001	0.189	–	–

♦Indicates that there is a difference between the values at one level, and is marked on the larger value.

Table 9. Distribution of the average frequency of the second shot of the Skill hitting line for the key points scored and lost by Lee Chong Wei.

	Goals allowed	Scoring goals	T	P
Forehand position	2.21 ± 0.975*	2.07 ± 1.328♦	0.285	0.780
Middle road	0.79 ± 0.873	0.93 ± 1.072	−0.366	0.720
Backhand position	1.21 ± 1.369	0.71 ± 0.726	1.165	0.265
F	6.234	6.500	–	–
P	0.004	0.004	–	–

* and ♦ respectively indicate that there is a difference between the adjacent and separated levels between the values, and are marked on the larger values.

significant difference in the frequency of goals conceded and the frequency of goals scored. There is no significant difference between the frequency of balls conceded and the frequency of balls scored in the use of rubbing, fluttering, hooking, hanging, flat draw, quick block, catching and picking, killing, lofting, splitting and picking skills, indicating that Lee Chong Wei uses the lift shot skill more often in the second shot, while there is no difference between the use of other skills in scoring and conceding. In longitudinal analysis, the frequency of each Skill category from most to least in the second racket of the lost ball is hang, pick, release and split. The frequency of using hanging skill is significantly different from the frequency of using skills such as ball rolling and ball fluttering.

Lee Chong Wei's route strategy on the second shot of the key point can be reflected by the hitting zone of his opponent when he hits the ball. The frequency distribution of the opponent's hitting area when using the second shot skill for the key score and the missed score is shown in Table 8. The cross-sectional analysis shows that there is a significant difference in the frequency of his opponent's shots in the forehand area, but not in the other areas, indicating that he is more likely to lose points when he hits his opponent's forecourt area on the second shot, while the other areas are not very

relevant to the points scored and lost. From the longitudinal analysis, the frequency of the opponent's shots in each area when the ball is lost from most to least in forehand area, backhand area, middle court backhand area and middle court forehand area, and the frequency of shots in the forecourt forehand area was different from that in the middle court backhand area and middle court area. There is a significant difference between the areas as well as the middle forehand area, indicating that Lee Chong Wei hits the opponent's forehand area more often in missed balls.

In Lee Chong Wei's key point second shot, his hitting lines were divided into three lines: forehand, backhand and middle. The frequency distribution of the stroke lines used in second shot skill for key point scoring and missing shots is shown in Table 9. The horizontal analysis shows that there is no significant difference between the frequencies of balls scored and balls conceded in each line of his second shot skill, indicating that there is no effect of each line of his shots on the points scored and conceded. In longitudinal analysis, the frequency of forehand shots is greater than the frequency of backhand shots and middle shots in missed shots, and there is a significant difference with the frequency of middle shots, indicating that Lee Chong Wei pays more attention to hitting the opponent's forehand position in missed shots and is less likely to hit the opponent's middle.

3.4. Effectiveness of skill and tactical strategies used in second shot of the key point

Lee Chong Wei's second shot in the key is different from his first shot in that the chance of scoring a point is higher than in the first shot. Therefore, the effectiveness of second key stroke is measured in terms of the change in posture, the number of points scored and lost and the downward deflection angle. The distributions of the potential for the use of the second shot of key score are shown in Table 10. From cross-sectional analysis, there is a significant difference between the number of balls scored and the number of balls conceded after the use of key second shot skill in the superior state, indicating that second shot in the superior state is more likely to be scored. There is no significant difference between the number of balls scored and lost when the second shot is in even or poor form, meaning that the distribution of points scored and conceded is more even when the second shot is in the even state and the bad state. In longitudinal analysis, the frequency of both goals conceded and goals scored is much higher in the even state than in the superior state and the inferior state, and there is a significant difference, indicating that his use of the second racket is dominated by the even state in both goals scored and goals conceded.

The direct effect of Lee Chong Wei's key second shot can be seen in the points scored and lost; however, there are many balls that do not produce a direct score, so the concept of the angle of deflection is introduced. The number of points scored and lost and the frequency of downward deflection for key second shot are shown in Table 11. From cross-sectional analysis, there is no significant difference between the number of points scored and lost in second racket, indicating that the distribution of points scored and lost is relatively even; there is no significant difference between the angle of the lower deflection of the lost balls and the angle of the lower deflection of the scored balls, indicating that Lee

Table 10. Distribution of the average frequency of the change in the second shot potential of the key points scored and conceded by Lee Chong Wei.

	Goals allowed	Scoring goals	T	P
Euphoria	0	0.57±0.646	−2.876	0.013
Homogeneous state	4.14±2.070*	2.86±1.791*	1.540	0.148
Inferior state	0.36±0.633	0	2.110	0.055
F	47.230	26.924	–	–
P	<0.001	<0.001	–	–

*Indicates that there is a difference between the adjacent levels of the values, and is marked on the larger value.

Table 11. Distribution of the average downward deflection angle and average frequency of Lee Chong Wei's key points in the second game.

	Goals allowed	Scoring goals	F	P
Scores and losses	0.36±0.633	0.57±0.646	0.785	0.384
Lower declination	26.78±23.414	24.06±23.856	0.330	0.571

Table 12. Frequency distribution of the Skill categories in which Lee Chong Wei won and lost key points with multiple shots.

	Goals allowed	Scoring goals	T	P
Drop ball	1.71±1.773	1.57±1.869	0.254	0.804
Pick	6.14±4.572^Ω	3.36±1.781	2.424	0.031
Ball rolling	0.86±1.406	0.50±0.650	1.000	0.336
Rush shot	0.57±0.852	0.93±1.592	−1.235	0.239
Crosscourt shot	0.93±1.207	0.71±0.914	0.493	0.630
Flat draw fast block	1.00±1.664	0.86±0.949	0.414	0.686
Catch and kill high	0.14±0.363	0.36±0.633	−1.385	0.189
Hight clear	1.36±1.447	1.07±2.018	0.589	0.566
Splitting and lifting	0.93±1.141	0.29±0.611	2.090	0.057
Smash	2.93±2.841	2.50±3.032	0.501	0.625
Lift shot	5.93±5.370[⊠]	4.57±3.715[⊕]	1.237	0.238
Catch and kill blocking net	2.14±1.875	1.79±1.424	0.548	0.593
F	8.975	7.139	–	–
P	<0.001	<0.001	–	–

Note. ⊕, ⊠ and Ω indicate variability in magnitude at five, six and seven levels apart, respectively, and are marked in front of the larger value.

Table 13. Distribution of the average frequency of the opponent's hitting area in the multi-shot skill for the key points scored and lost by Lee Chong Wei.

	Goals allowed	Scoring goals	T	P
Forecourt backhand area	5.43±3.458[#]	3.21±2.517	2.844	0.014
Middle area of the forecourt	3.14±3.394	2.43±2.065	0.960	0.355
Front court forehand area	4.93±3.362♦	5.07±4.582 No	−0.152	0.881
Backhand area in the middle court	1.36±1.336	1.00±1.109	0.717	0.486
Central midfield area	0.93±1.328	0.93±1.072	0.000	1.000
Forehand area in the middle court	1.14±1.292	1.50±2.279	−5.63	0.583
Backhand area	3.86±3.035	2.07±1.730	1.804	0.094
Middle backfield area	0.50±0.760	0.50±0.760	0.000	1.000
Back court forehand area	2.93±2.731	2.57±2.848	0.701	0.496
F	7.211	4.921	–	–
P	<0.001	0.189	–	–

* and ♦ respectively indicate that there is a difference between the adjacent and separated levels between the values, and are marked on the larger values.

Chong Wei does not tend to press down or rise too high in the scored and lost balls in second racket. There is no significant difference between the frequency distribution of the balls scored and lost and the angle of the downward deflection of the balls scored and lost, indicating that the use of second racket skill as a whole had a transitional effect and that he was not in a hurry to determine the winner.

3.5. Skill and tactical strategies used in multiple shots of the key point

The types of second shot skills used by Lee Chong Wei to score key points are shown in Table 12. It shows that the number of balls conceded is much higher than that of balls scored in the comparison of the scores of key multi-shot skills, which is a significant difference. In cross-sectional analysis, the number of balls conceded in the pick skill was much higher than that of balls scored, with a significant difference at the 0.057 level, indicating that the use of the pick skill was not conducive to scoring. In longitudinal analysis, the frequency of each skill used in lost balls from highest to lowest is pick, release, kill, catch and block, hang, high ball, flat draw quick block, split, then crosscourt shot, roll, float, catch and pick high. The frequency of using the lift shot skill is significantly different from the frequency of using other skills, which means that the use of pick and lift shot skill is high among the lost balls.

To explore the characteristics of Lee Chong Wei's skill and tactical use in key points, skill play is analyzed by exploring opponent's hitting zone when he hits the ball. The frequency distribution of opponent's hitting zone is shown in Table 13. From cross-sectional analysis, the number of balls conceded is greater than that of balls scored in opponent's forecourt backhand area when Lee Chong Wei uses the key point multi-shot skill, and there is a significant difference between the two, indicating that the opponent is more likely to concede points when hitting the opponent's forecourt backhand area. There was no significant

Table 14. Frequency distribution of multi-shot Skill strokes on key points scored and lost by Lee Chong Wei.

	Goals allowed	Scoring goals	T	P
Forehand position	8.57±5.774	6.57±3.589	1.172	0.262
Middle road	4.50±4.485	3.36±2.240	1.333	0.205
Backhand position	10.86±7.814*	8.71±7.279*	1.096	0.293
F	3.803	4.308	–	–
P	0.031	0.020	–	–

*Indicates that there is a difference between the adjacent levels of the values, and is marked on the larger value.

Table 15. Average number of shots scored and conceded by Lee Chong Wei in key games.

	Goals allowed	Scoring goals	T	P
Average	7.964	6.179	1.316	0.211
Standard deviation	4.802	2.6233	–	–

Table 16. Average frequency distribution of Lee Chong Wei's key points scored and conceded in each racket.

	Goals allowed	Scoring goals	T	P
First beat	0.36±0.633	0.36±0.633	0.000	1.000
Second beat	0.36±0.633	0.57±0.646	1.000	0.336
More shots	3.79±1.888♦	3.07±1.542♦	−1.059	0.309
F	37.675	29.909	–	–
P	<0.001	<0.001	–	–

♦Indicates that there is a difference between the values at one level, and is marked on the larger value.

difference between the frequencies of scoring balls and losing balls in other areas. In longitudinal analysis, the frequency of the opponent's hitting zone when dropping the ball from highest to lowest is forecourt backhand area, forecourt forehand area, backcourt backhand area, forecourt middle area, backcourt forehand area, middle court backhand area, middle court middle area, backcourt middle area and forecourt backhand area. There is a significant difference between middle court backhand area, middle court middle area, middle court forehand area and backcourt middle area, indicating that Lee Chong Wei focuses more on hitting his opponent's forecourt backhand area in missed shots; The frequency of his opponent's hitting areas on scoring shots from most to least is forecourt forehand area, forecourt backhand area and backcourt forehand area. There is a significant difference between the frequency of shots in the forehand zone of the forecourt and those in the middle backhand, middle and middle backcourt areas, suggesting that Lee Chong Wei focuses more on hitting the opponent's forehand area.

In multiple shots, the routes are divided into three routes: forehand, backhand and middle. The frequency distribution of the hitting routes for his key point-scoring shots and missed shots using multiple skills is shown in Table 14. The horizontal analysis shows that there is no significant difference between the frequencies of balls scored and balls conceded in each line of play, which means that his line of play has a relatively even effect on the number of points scored and conceded. In longitudinal analysis, the frequency of missed shots from most to least is backhand, forehand and center court, with a significant difference between the frequency of backhand shots and center court, while the frequency of scoring shots from most to least is backhand, forehand and centre court and there is also a significant difference between the frequency of backhand shots and middle of the court. Hitting the opponent's backhand position is the main focus.

3.6. Effectiveness of skill and tactical strategies used in multiple shots of the key point

The effectiveness of Lee Chong Wei's multiple shots is measured in terms of the average number of shots scored and lost and the number of points scored and lost. The effectiveness of multiple shots is compared by the numbers of shots scored and lost in key points. The distribution of key points is shown in Table 15. The number of key points scored is lower than that of points conceded, and there is no significant difference between the two. It can be seen that the majority of key points are scored at 6 strokes and the majority of missed points are scored at 8 strokes. Lee Chong Wei's rhythm slows down after 6 strokes and he is unable to keep up with his opponent's rhythm, therefore his concentration on the game is reduced. In this regard, Lee Chong Wei should find a breakthrough before 6 strokes as much as possible, as long strokes are not conducive to his scoring.

The trend of the concentration of Lee Chong Wei's key points is investigated by exploring the points scored and lost on the first, second and multiple shots. The frequency distributions of key scores on the first, second and multiple shots are shown in Table 16. The cross-sectional analysis shows that there is no significant difference between the frequencies of scoring and conceding balls in each racket of the key score, indicating that the distribution between scoring and conceding balls in each racket is relatively even. In longitudinal analysis, the frequency of multi-tempo shots is higher than that of first and second shots in both scoring and conceding shots, and there is a significant difference.

4. Discussion

Although it is common in all sports to experience loss, little research has been done on the subject (Kee et al., 2016). Studying the skill play of well-known Malaysian athlete Lee Chong Wei, who has won three silver medals for his country, will benefit other athletes. This study compares and contrasts the points that Lee Chong Wei wins and losses in the game to identify how different technologies are used. This information will help players who play similarly to Lee Chong Wei think more strategically.

Lee Chong Wei performed well on the backhand flat lob at critical junctures, poorly on the backhand in front of the net, and poorly on the backhand position of the opponent. Consequently, Lee Chong Wei should increase the frequency of attacks on the oe of technology when making the opening stroke in the crucial stages. When Lee Chong Opponent's backhand high ball service, decrease the impact on the opponent's backhand position, pay attention to the change in service types, and strengthen the stability of his use hit the second beat in the crucial stage, the opponent's forehand area was poorly hit, the shot's line had little bearing on the score, and the lift shot method was poorly used. As such, Lee Chong Wei should suitably minimize his usage of defensive net technology and his strategies and tactics to smash the opponent's front forehand while he is in the second beat of the crucial point. The majority of Lee Chong Wei's score was concentrated in six beats, after which the scoring trend declined as the number of beats increase. Additionally, there was little impact from using the pick technique to strike the opponent's backhand area in front court. In order for Lee Chong Wei to win the match, it would be advantageous for him to employ fewer defensive and moderate picking strategies during the multi-stroke playing stage, to hit less in the opponent's front backhand area, and to end the match as quickly as feasible.

Prior research indicates that the majority of studies concentrated on comparing the opponents' and competitors' skill usage (Adnan, 2018; Hu et al., 2006; J. Wang & Liu, 2016). The disparities in technology utilization between a player's winning and losing points has not been the subject of many researches. This study will offer fresh perspectives and ideas for future badminton research, as well as new skills and tactics for coaches to teach badminton players.

5. Conclusion

In summary, Lee Chong Wei is used to serving backhand net shots and focuses on using release skills when receiving serves, mainly controlling his opponent's middle forecourt area and backhand area. He used more aggressive lift shot skills in the lead, while his style was relatively gentle in the tiebreak, with his first shots mostly producing an even-strength effect, mainly losing points based on his opponent's backhand position. The lower deflection angle was not a key Skill parameter affecting the points scored and loss of Lee Chong Wei, whose dominant skill on the second racket was the drop shot, and the points lost were concentrated in the forehand area, while the forecourt backhand was high scoring. Lee Chong Wei's key points are scored in the multi-shot phase with a high percentage of points scored around 6 shots, and then a decreasing trend as the number of shots increases. He mainly hits his opponent's backhand in the forecourt area, and the lift shot skill is good for scoring.

Disclosure statement

About the authors

Shuzhen Ma was born in Yucheng, Shandong, P.R. China, in 1995. He received his bachelor's degree from Tianjin Sports University and his master's degree from Guangxi Normal University, P.R. China. Now, he studies in Faculty of Educational Studies, Universiti Putra Malaysia. His research interest include sports teaching, sports training and sports sociology. E-mail: mashuzhen@glut.edu.cn

Dr. Kim Geok Soh is a Professor in Faculty of Educational Studies, Department of Sports Studies at Universiti Putra Malaysia. She received her PhD degree from University Malaya, Malaysia, in 2004. Her current research interests focus on the physical education, exercise science, sports science and health. E-mail: kims@upm.edu.my

Dr. Salimah Binti Japar is a lecturer in Faculty of Medicine and Health Sciences, Department of Nursing at Universiti Putra Malaysia. She received her Master degree from Griffith University, Australia, in 2012. Her current research is focused on the public health, general and surgical nursing. E-mail: j_salimah@upm.edu.my

Yang born in Guiyang, Guizhou, China in 1995, received his bachelor's degree in Education from Beijing Sport University and his master's degree from Guangxi Normal University. Now he is studying for his PhD in Shanghai University of Sport. His research interests include exercise and health promotion, exercise and skeletal muscle glucose and lipid metabolism. Email: 416330321@qq.com

Yanqi Xu received her PhD degree from Beijing University of Chemical Technology. She worked as an associate professor at Guilin University of Technology. Her research interests focus on clay-based materials, electrocatalysts and photocatalysts for fine chemicals and environmental applications. E-mail: xuyanqi@glut.edu.cn

Author contribution statement

Conceptualization and design: Shuzhen Ma and Yang Yang, Kim Geok Soh and Salimah Binti Japar
    Data analysis and interpretation: Shuzhen Ma and Yang Yang
    Drafting and revising: Shuzhen Ma and Yanqi Xu
    Approval: Shuzhen Ma, Yang Yang, Yanqi Xu, Kim Geok Soh and Salimah Binti Japar
    All authors agree to be accountable for all aspects of the work.

Funding

ORCID

Yanqi Xu http://orcid.org/0000-0001-7244-9980

Data availability statement

The data that support the findings of this study are available from the first author [Shuzhen Ma] upon reasonable request.

References

Abdullahi, Y., & Coetzee, B. (2017). Notational singles match analysis of male badminton players who participated in the African Badminton Championships. *International Journal of Performance Analysis in Sport*, *17*(1–2), 1–13. https://doi.org/10.1080/24748668.2017.1303955

Abian-Vicen, J., Castanedo, A., Abian, P., & Sampedro, J. (2013). Temporal and notational comparison of badminton matches between men's singles and women's singles. *International Journal of Performance Analysis in Sport*, *13*(2), 310–320. https://doi.org/10.1080/24748668.2013.11868650

Abián-Vicén, J., Sánchez, L., & Abián, P. (2018). Performance structure analysis of the men's and women's badminton doubles matches in the Olympic Games from 2008 to 2016 during playoffs stage. *International Journal of Performance Analysis in Sport*, *18*(4), 633–644. https://doi.org/10.1080/24748668.2018.1502975

Abián, P., Castanedo, A., Feng, X. Q., Sampedro, J., & Abian-Vicen, J. (2014). Notational comparison of men's singles badminton matches between Olympic Games in Beijing and London. *International Journal of Performance Analysis in Sport*, *14*(1), 42–53. https://doi.org/10.1080/24748668.2014.11868701

Abián, P., Simón-Chico, L., Bravo-Sánchez, A., & Abián-Vicén, J. (2021). Elite badminton is getting older: Ages of the top 100 ranked badminton players from 1994 to 2020. *International Journal of Environmental Research and Public Health*, *18*(22), 11779. https://doi.org/10.3390/ijerph182211779

Adnan, M. F. (2018). Analysis of shot, unforced error, number of shot and duration of the match between Shi Yuqi and Lee Chong Wei in All England 2017.

Barreira, J., Chiminazzo, J. G. C., & Fernandes, P. T. (2016). Analysis of point difference established by winners and losers in games of badminton. *International Journal of Performance Analysis in Sport*, *16*(2), 687–694. https://doi.org/10.1080/24748668.2016.11868916

Cabello Manrique, D., & González-Badillo, J. J. (2003). Analysis of the characteristics of competitive badminton. *British Journal of Sports Medicine*, *37*(1), 62–66. https://doi.org/10.1136/bjsm.37.1.62

Chin, M. K., Wong, A. S., So, R. C., Siu, O. T., Steininger, K., & Lo, D. T. (1995). Sport specific fitness testing of elite badminton players. *British Journal of Sports Medicine*, *29*(3), 153–157.https://doi.org/10.1136/bjsm.29.3.153

Chow, J. Y., Seifert, L., Hérault, R., Chia, S. J. Y., & Lee, M. C. Y. (2014). A dynamical system perspective to understanding badminton singles game play. *Human Movement Science*, *33*, 70–84. https://doi.org/10.1016/j.humov.2013.07.016

Dieu, O., Schnitzler, C., Llena, C., & Potdevin, F. (2020). Complementing subjective with objective data in analysing expertise: A machine-learning approach applied to badminton. *Journal of Sports Sciences*, *38*(17), 1943–1952. https://doi.org/10.1080/02640414.2020.1764812

Gomez, M. Á., Rivas, F., Connor, J. D., & Leicht, A. S. (2019). Performance differences of temporal parameters and point outcome between elite men's and women's badminton players according to match-related contexts. *International Journal of Environmental Research and Public Health*, *16*(21), 4057. https://doi.org/10.3390/ijerph16214057

Hong, Y., & Tong, Y. (2000). The playing pattern of the world's top single badminton players in competition-a notation analysis. *Journal of Human Movement Studies*, *38*(4), 185–200.

Hu, F., Li, F., Dai, J., Zhang, H., & Guan, Y. (2006). *The application of data mining in technique and tactic analysis of badminton single matches* [Paper presentation]. Paper Presented at the Proceedings of 1st Joint International Pre-Olympic Conference of Sports Science & Sports Engineering.

Kee, Y. H., Fry, J. M., Wang, J. C. K., Chong, Y. W., & Li, C. (2016). Silver lining in winning silver: an exploratory study of supporters' reactions and coping on the social media towards Lee Chong Wei's London Olympics defeat. *Asia Pacific Journal of Sport and Social Science*, *5*(1), 1–15. https://doi.org/10.1080/21640599.2016.1145938

Laffaye, G., Phomsoupha, M., & Dor, F. (2015). Changes in the game characteristics of a badminton match: A longitudinal study through the olympic game finals analysis in men's singles. *Journal of Sports Science & Medicine*, *14*(3), 584–590.

Liu, C. Sport communication report: Samsung communication Campaign for Rio Olympic games. *Journal of Consumer and Marketing Research,* *1*(2), 1–9. https://doi.org/10.55375/jcmr.2022.2.1

Malwanage, K. T., Senadheera, V. V., & Dassanayake, T. L. (2022). Effect of balance training on footwork performance in badminton: An interventional study. *PLoS One*, *17*(11), e0277775. https://doi.org/10.1371/journal.pone.0277775

Menescardi, C., Falco, C., Ros, C., Morales-Sánchez, V., & Hernández-Mendo, A. (2019). Technical-tactical actions used to score in taekwondo: An analysis of two medalists in two olympic championships. *Frontiers in Psychology*, *10*, 2708. https://doi.org/10.3389/fpsyg.2019.02708

Phomsoupha, M., & Laffaye, G. (2015). The science of badminton: Game characteristics, anthropometry, physiology, visual fitness and biomechanics. *Sports Medicine (Auckland, N.Z.)*, *45*(4), 473–495. https://doi.org/10.1007/s40279-014-0287-2

Torres-Luque, G., Carlos Blanca-Torres, J., Cabello-Manrique, D., & Kondric, M. (2020). Statistical comparison of singles badminton matches at the London 2012 and Rio De Janeiro 2016 olympic games. *Journal of Human Kinetics*, *75*(1), 177–184. https://doi.org/10.2478/hukin-2020-0046

Valldecabres, R., Casal, C. A., Chiminazzo, J. G. C., & de Benito, A. M. (2020). Players' on-court movements and contextual variables in badminton world championship. *Frontiers in Psychology*, *11*, 1567. https://doi.org/10.3389/fpsyg.2020.01567

Wang, C. C. (2022). A binary-entropy analysis of the relationship between scoring structure and match outcome in badminton. *Frontiers in Psychology*, *13*, 799293. https://doi.org/10.3389/fpsyg.2022.799293

Wang, H. (2017). *Statistical analysis of the "key points" stage techniques and tactics of Ma Lin, an excellent badminton singles player (Master)*. Chengdu Institute of Physical Education

Wang, J., & Liu, Y. (2016 *Factors and Causes Affecting the Development of Badminton in Xinjiang. Paper presented at the* [Paper presentation].2nd International Conference on Arts, Design and Contemporary Education. https://doi.org/10.2991/icadce-16.2016.294