Int. j. racket sports sci. vol. 5(1), 2023, xx eISSN: 2695-4508
Original Investigation DOI: 10.30827/---

Double Analysis During High-Level Badminton Matches: Different Activities Within The Pair?

Análisis de dobles durante partidos de bádminton de alto nivel: ¿diferentes actividades dentro de la pareja?

Yann Le Mansec[1], Martin Boiveau[1], Julie Doron[1, 2] and Marc Jubeau [1]*

1 Laboratory Movement, Interactions, Performance (EA4334), Faculty of Sport Sciences, University of Nantes, France
2 Laboratory of Sport, Expertise and Performance (EA7370), French National Institute of Sport, Expertise and Performance, Research Department, Paris, France

Received: 04-01-2023

Accepted: 07-08-2023

Abstract

The main aims of the present study were i) to examine the different demands (temporal and muscular data) between different types of events in badminton (part 1) and ii) to compare the real activity (areas distribution and strokes distribution) between the two players who composed the pair during the three types of doubles that occur in badminton (part 2). Seven matches were analyzed for both men's and women's singles and for men's, women's and mixed doubles during European Championship. In Part 1, both timing structure (match duration, number of points, rally duration, rest time, effective playing time and shot frequency) and specific movements (jumps and lunges) were compared between the five types of events. In Part 2, after dividing the court into four zones, we compared the activity of the two players within the same pair in each of these zones. The distribution of technical variables and specific movements was also analysed. For Part 1, male and mixed doubles showed the shortest rally duration (~-45%), the longest rest between two rallies (~+18%), as well as the highest shot frequency (~+24%) when compared to male and female singles and female doubles. Male and female singles showed the highest number of jumps (+40% when compared to doubles) and lunges (+250% when compared to doubles). Male and female singles showed the highest number of jumps (+40% when compared to doubles) and lunges (+250% when compared to doubles). For Part 2, we observed that spatial and notational distribution between players of the pair is largely dependent on the type of double considered. This study demonstrated that the constraints of a badminton game are specific and related to the type of event played (males or females and/or singles or doubles).

Keywords: *physical demand, smash, racket sports, jump, effort.*

Resumen

Los principales objetivos del presente estudio fueron i) examinar las diferentes demandas (datos temporales y musculares) entre los distintos tipos de eventos en bádminton (Parte 1) y ii) comparar la actividad real (distribución de áreas y distribución de golpes) entre los dos jugadores que componían la pareja durante los tres tipos de dobles que se dan en bádminton (Parte 2). Se analizaron siete partidos de individuales masculinos y femeninos y de dobles masculinos, femeninos y mixtos durante el Campeonato Europeo. En la Parte 1, se compararon la estructura temporal (duración del partido, número de puntos, duración del peloteo, tiempo de descanso, tiempo efectivo de juego y frecuencia de golpeo) y los movimientos específicos (saltos y estocadas) entre los cinco tipos de eventos. En la Parte 2, tras dividir la cancha en cuatro zonas, se comparó la actividad de los dos jugadores de una misma pareja en cada una de estas zonas. También se

Corresponding author: Marc Jubeau, marc.jubeau@univ-nantes.fr

Cite this article as:
Le Mansec, Y., Boiveau, M., Doron, J., & Jubeau, M. (2023). Double Analysis During High-Level Badminton Matches: Different Activities Within The Pair?. *International Journal of Racket Sports Science*, *5*(1), xxx.

analizó la distribución de las variables técnicas y los movimientos específicos. En la Parte 1, los dobles masculinos y mixtos mostraron la menor duración de peloteo (~-45 %), el mayor descanso entre dos peloteos (~+18 %), y la mayor frecuencia de golpes (~+24 %) en comparación con los individuales masculinos y femeninos y los dobles femeninos. Los individuales masculinos y femeninos mostraron el mayor número de saltos (+40 % en comparación con los dobles) y estocadas (+250 % en comparación con los dobles). En la Parte 2, observamos que la distribución espacial y notacional entre los jugadores de la pareja depende en gran medida del tipo de dobles considerado. Este estudio demostró que las limitaciones de un partido de bádminton son específicas y están relacionadas con el tipo de prueba disputada (masculino, femenino, individuales, dobles).

Palabras clave: *demanda física, remate, deportes de raqueta, salto, esfuerzo.*

INTRODUCTION

During high-level badminton matches, periods of moderate- to high-intensity effort are interspersed with periods of recovery (Abian-Vicen, Castanedo, Abián, & Sampedro, 2013; Phomsoupha, & Laffaye, 2015). This results in a specific temporal structure that coaches should consider when planning training sessions that replicate the demands of a match (Abián, Castanedo, Feng, Sampedro, & Abian-Vicen, 2014; Abian-Vicen et al., 2013; Phomsoupha, & Laffaye, 2015).

Badminton has five types of events, men's and women's singles, men's and women's doubles and mixed doubles. Each of these events requires specific physical and technical skills (Abian-Vicen et al., 2013; Phomsoupha, & Laffaye, 2015). While numerous studies have paid attention to the singles matches (Torres-Luque, Fernández-Garcia, Blanca-Torres, Kondric, & Cabello-Manrique, 2019), the amount of data regarding the doubles is low, especially when women's doubles and mixed doubles are considered (Torres-Luque et al., 2019). The literature classically reported differences in timing structure (e.g. rally duration) and/or physiological (e.g. heart rate) or psychological (e.g. difference personality between single and double athletes) parameters between singles and doubles matches (Alcock & Cable, 2009; Jung Hoon, & Hak-Kyun, 2020; Liddle, Murphy, & Bleakley, 1996; Widyaningsih, Handayani, & Hidayah, 2018). For instance, some studies reported a significant difference in rally duration between singles and doubles, i.e., shorter rallies during doubles than during singles (for the men's doubles and the mixed doubles but not the women's doubles) (Gawin, Beyer, & Seidler, 2015). Nevertheless, there is a consensus on the fact that the speed of the game (shot frequency) is significantly greater during doubles matches (for the men's doubles and mixed doubles but not the women's doubles), highlighting the high intensity during doubles (Alcock & Cable, 2009; Gawin et al., 2015). Authors also highlighted some differences between men and women: women's doubles had longer real times played, effective playing times, rally times, and work densities, whereas men who played in doubles matches showed greater intensity (i.e., shot frequency) (Abián-Vicen, Sánchez, & Abián, 2018). Thus, these results suggest that singles and doubles are disciplines that differ in terms of conditional or technical qualities. This is partially supported by the fact that no elite athlete is highly ranked in both single and double at the same time (Torres-Luque et al., 2019).

Surprisingly, no previous study examined if the demand differs between players that play together in a double (i.e. within the pair). This is important as players behave differently on the court: for instance, during an offensive situation, players usually take different positions on the court, i.e. one player (often the same) close to the net and the other on the rear court. This could probably imply physical, technical and tactical discrepancies such as different displacements and different strokes. To the best of our knowledge, only the study of Sobko et al. has tried to rationalize the edification of a pair of young players (Sobko, Zharkova, Vitsko, Zhukov, & Tsapko, 2020). The authors proposed two ways of forming pairs, that are similarity (for men's and women's doubles) and compensation (for mixed doubles). To date, this assumption has not been verified. A better understanding of the real distribution of the tasks within a pair could be relevant in order to adjust the training program for each player.

The main purposes of the present study were (i) to verify the different demands (temporal and muscular data) between different types of events (singles and doubles, men's, women's, and mixed) (= part 1) and (ii) to compare the real activity between the two players who composed the pair during the three types of doubles that occur in badminton, i.e. men's doubles, women's doubles and mixed doubles (= part2).

METHODS

Design and procedures

Seven matches from the 2016 European Badminton Championship (Mouilleron-le-Captif, France) were analyzed for each of the following events: men's singles (MS), women's singles (WS), men's doubles (MD), women's doubles (WD), and mixed doubles (XD). To be representative of the very high European level of play (Abián-Vicen et al., 2018) and to take into account the significant differences between the group phase and the elimination phase with regard to physiological demands (Chiminazzo, Barreira, Luz, Saraiva, & Cayres, 2018; Torres-Luque et al. 2019), only the matches of the final phases were used in the analysis (quarter-finals, semi-finals, and finals). At the time of the study, players were ranked from 4^{th}-51^{th} (men's singles), 1^{st}-61^{th} (women's singles), 9^{th}-58^{th} (men's doubles), 5^{th}-43^{rd} (women's doubles), and 4^{th}-50^{th} (mixed doubles) of the world ranking.

Analysis

All matches were recorded with a video camera (AHD-H12 VAZ2S, Aiptek®, Willich, Germany). The camera was placed behind one side of a court (8m) on a platform located 5m above the court, allowing us to analyze all the players. The viewings were analyzed with VLC media player software (V3.0.4, VideoLan, Paris, France). Analyses were performed by one experimenter alone, who was an expert badminton specialist.

Part 1

Timing structure analysis

Timing structure analysis data were gathered using a digital stopwatch. The match duration was defined as the time elapsed between the first service and the time at which the last point was awarded. The rally time was considered the time elapsed between the racket–shuttlecock contact during the service and the time at which the shuttlecock touched either the ground (in or out) or the net. The rest duration was defined as the time elapsed between the awarding of the previous rally and the service of the following one. We calculated the effective playing time as the sum of the rally durations expressed in percentage of the total playing time. The total playing time was calculated as the sum of both the rally durations and rest durations. The shot frequency was calculated as the number of shots divided by the effective playing time (shots per second) (Gawin et al., 2015). Reliability of this methodology was proven to be good in a previous study from our research team (Le Mansec, Sève, & Jubeau, 2017).

Specific movements

The number of vertical jumps (when both feet were lifted off the floor) and lunges performed by each player, i.e., two specific movements (Kuntze, Mansfield, & Sellers, 2010; Lin, Blazevich, Abbiss, Wilkie, & Nosaka, 2023; Phomsoupha, & Laffaye, 2015), were counted. To ensure that the counts of occurrences were unambiguous, each match was viewed four times.

Part 2

To compare the activity between the two players within the pair, it was necessary to assign a role to each player, with respect to their position on the court when they strike the shuttlecock. For all doubles, we decided to label "player A" the player who played the greater number of shuttlecocks in the rear part of the court (e.g. the man was called "player A" and the woman was called "player B" in XD). Based on this, the names "player A" and "player B" remained consistent for all variables. The court was divided into 4 zones: net (the part between the net and the short service line, i.e. 198 cm), front (the part between the short service line and the center of the court, i.e. 198 cm), middle (the part between the center of the court and the long doubles service line, i.e. 198 cm) and rear (the part between the long doubles service line and the base line, i.e., 76 cm) (Figure 1). A stroke was counted in the net zone when at least one foot was located on the line of the short service line or in front of this line. A stroke was counted in the rear when at least one foot was located on the line of the long doubles service line or behind this line or when the player landed on this zone after performing a jump. We also compared the distribution of typical badminton strokes, such as smash, kill and net.

Statistical analysis

Part 1. All data are expressed as the mean ± SD. After checking for normality (Shapiro-Wilk test), a one-way analysis of variance (ANOVA) was used to test between disciplines differences in timing structure data (match duration, number of points, rally time, rest time, effective playing time, and shot frequency) and specific movements (number of jumps, number of lunges).

Part 2. All data were normalized and expressed as the mean ± SD. "Player A" 's values corresponding to the ratio as follow: ((A*100/(A+B)). "Player B"'s values corresponding to the ratio as follow: ((B*100/(A+B)). After checking for normality (Shapiro-Wilk test), a one-way ANOVA (6 between-subjects factors) was used to test for differences in the distribution in the four zones previously described (net, front, middle and rear) and notational data (number of jumps, lunges, smashes, nets and kills) between each player.

In both parts, the level of significance was set at $p<.05$, and post hoc analyses were performed when appropriate using HSD (honestly significant difference) Tukey correction for multiple comparisons. For the main effects of the ANOVAs, partial eta squared (η_p^2) are reported, with small, moderate and large effects considered for $\eta_p^2 \geq .01$ (ranged from .010 to .069), ≥.07 (ranged from .070 to .139) and ≥.14, respectively. For the follow-up tests, Cohen effect sizes (d) are reported, with small, moderate, and large effects considered for $d>.2$ (ranged from .2 to .49), >.5 (ranged from .5 to .79), and>.8, respectively (Cohen, 2013).

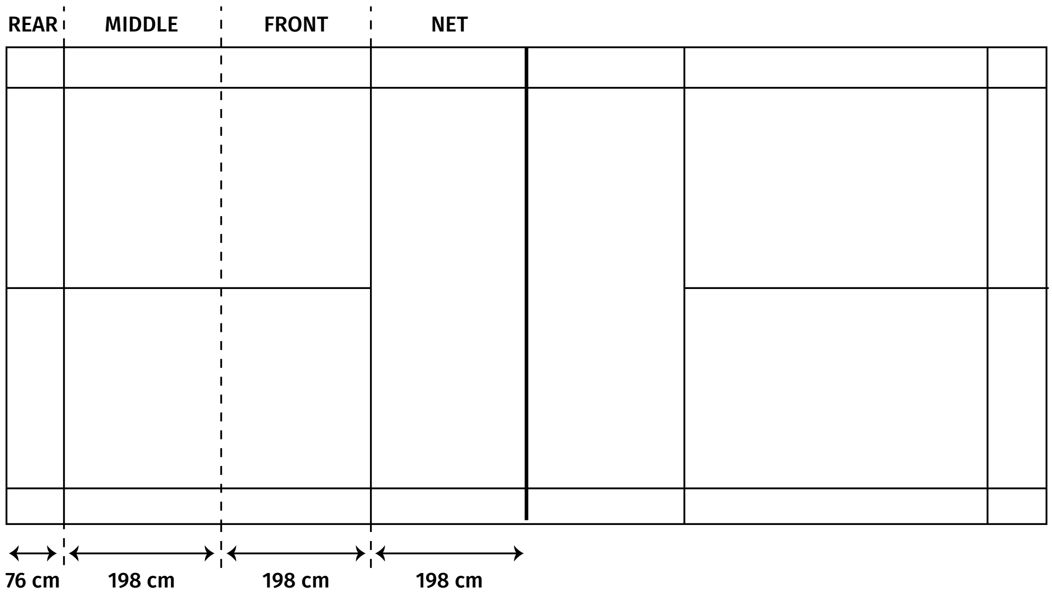

Figure 1. Top view of the four zones (rear, middle, front and net) used to divide the court.

RESULTS

Part 1

Timing structure analysis

All results are shown in Table 1. There was no significant main effect of the group on the duration of the match (average: 42.0±11.6 min). A significant effect of the group was observed for all the other variables (η_p^2 ranged from .345 to .942, p<.05)

Rally duration

For rally duration, XD was shorter than MS (*p*<.05, *d*=2.24) and WD (*p*<.05, *d*=1.60). MD was shorter than MS (*p*<.05, *d*=2.80) and WD (*p*<.05, d=1.76).

Rest time

For rest time between two rallies, XD was longer than WD (*p*<.05, *d*=1.92).

Effective playing time

For the effective playing time, WD was significantly greater than all of the other groups (for all, *p*<.05, d ranged from 2.79 to 5.25). Both XD and MD were significantly lower than both MS and WS (*p*<.05, d ranged from 1.85 to 3.17).

Shot frequency

For shot frequency, WS was significantly lower when compared with all of the groups (*p*<.05, *d* ranged from 3.91 to 8.86). Both XD and MD were significantly greater than MS and WD (*p*<.05, d ranged from 5.33 to 6.54). MD was significantly greater when compared with XD (*p*<.05, *d*=2.64).

Specific movements

Jumps and lunges

There was a significant effect of the group on the number of jumps and lunges performed during a match. The number of jumps was significantly greater for MS than XD (*p*<.05, *d*=2.69) and WD (*p*<.05, 1.59). The number of jumps for WS was significantly greater than XD (*p*<.05, *d*=2.27). The number of lunges was significantly greater for both MS and WS when compared with all other groups (*p*<.05, *d* ranged from 2.94 to 3.58).

Part 2

Distribution ("Player A" vs "Player B") depending on the zone

All results are shown in Figure 2 and table 2. A significant effect of the group was observed for the distribution in each zone (η_p^2 ranged from .502 to .680, *p*<.001)

Rear zone

As expected, "Player A" played significantly a greater proportion of shuttlecocks than "Player B" for all types of doubles in the rear zone (*p*<.001, panel A).

Middle zone

"Player A" played significantly a greater proportion of shuttlecocks than "Player B" for both MD and

XD ($p<.001$, panel B) in the middle zone. Moreover, “Player A” played significantly a greater proportion of shuttlecocks during XD than MD ($p<.01$, d=1.463) and WD ($p<.01$, d=2.300).

Front zone

“Player A” played significantly a lesser proportion of shuttlecocks than “Player B” for both MD and WD in the front zone ($p<.01$, panel C) while “Player A” played significantly a greater proportion of shuttlecocks than “Player B” for XD ($p<.001$). Moreover, “Player A” played significantly a greater proportion of shuttlecocks during XD than MD ($p<.001$, d=3.111) and WD ($p<.001$, d=4.000).

Net zone

“Player A” played significantly a lesser proportion of shuttlecocks than “Player B” for both MD and WD ($p<.001$, panel D) in the net zone. No difference was found between “Player A” and “Player B” for XD.

Distribution (“Player A” vs “Player B”) depending on the type of action

All results are shown in Figure 3 and table 3. Except for kills ($\eta_p^2=.142$, $p>.05$, panel E), a significant effect of the group was observed for the distribution of all variables (η_p^2 ranged from .400 to .759, $p<.001$).

Jumps

“Player A” performed a greater proportion of jumps than “Player B” for both MD and XD ($p<.01$, panel A). Moreover, “Player A” performed significantly a greater proportion of jumps during XD than MD ($p<.01$, d=1.643) and WD ($p<.01$, d=1.972).

Lunges

“Player A” performed a greater proportion of lunges than “Player B” for XD ($p<.001$, panel B). Moreover, “Player A” performed significantly a greater proportion of lunges during XD when compared to MD ($p<.001$, d=2.055).

Smashes

“Player A” performed a greater proportion of smashes than “Player B” for all types of doubles ($p<.05$ for all doubles, panel C). Moreover, “Player A” performed significantly a greater proportion of smashes during XD than MD ($p<.01$, d=1.475) and WD ($p<.01$, d=3.259).

Nets

“Player A” performed a lesser proportion of nets than “Player B” for both MD and XD ($p<.01$, panel D). No difference was found between “Player A” and “Player B” for WD.

Table 1.

Comparative results of the timing structure of a badminton game for male single, female single, male double, female double and mixed double. Data are expressed as mean ± SD.

	Male Single	**Female Single**	**Male Double**	**Female Double**	**Mixed Double**	**p value**	**η_p^2**
Match Duration (min)	43.0 ± 12.1	41.5 ± 10.5	40.5 ± 12.4	40.2 ± 12.3	44.9 ± 13.3	0.95	0.023
Number of Points	81.0 ± 19.1	79.0 ± 18.9	86.0 ± 20.5	89.4 ± 23.7	90.6 ± 21.7	0.79	0.052
Rally Duration (s)	8.9 ± 1.0*#	8.4 ± 1.1	6.1 ± 1.0	$9.7 \pm 2.7^{**\#\#}$	6.3 ± 1.3	< 0.001	0.501
Rest Time (s)	21.0 ± 1.7	19.7 ± 3.2	23.5 ± 4.8	$18.7 \pm 3.3^{\#}$	24.6 ± 2.8	0.010	0.345
EPT (%)	$27.8 \pm 2.0^{**\#\#\#\dagger\dagger\dagger}$	$26.7 \pm 2.7^{**\#\#\dagger\dagger\dagger}$	$21.6 \pm 1.9^{\dagger\dagger\dagger}$	$35.1 \pm 3.1^{***\#\#\#}$	$21.3 \pm 3.1^{\dagger\dagger\dagger}$	< 0.001	0.808
ShotFrequency (shots.s^{-1})	$1.09 \pm 0.02^{***\#\#\#\S\S\S}$	$0.94 \pm 0.04^{***\#\#\#\dagger\dagger\dagger}$	1.45 ± 0.07	$1.11 \pm 0.03^{***\#\#\#}$	$1.30 \pm 0.03^{***}$	< 0.001	0.942
Number of jumps	$71.0 \pm 22.3^{\#\#\#\dagger}$	$57.6 \pm 18.1^{\#}$	45.0 ± 23.2	41.9 ± 12.9	26.6 ± 6.7	< 0.001	0.454
Number of lunges	$158.3 \pm 50.4^{***\#\#\#\dagger\dagger\dagger}$	$174.9 \pm 47.9^{***\#\#\#\dagger\dagger\dagger}$	46.6 ± 18.4	47.3 ± 16.8	50.7 ± 10.7	< 0.001	0.780

*, ** and *** significantly different from Male Double ($p<.05$, $p<.01$ and $p<.001$ respectively). $^{\#}$, $^{\#\#}$ and $^{\#\#\#}$ significantly different from Mixed Double ($p<.05$, $p<.01$ and $p<.001$ respectively). † and ††† significantly different from Female Double ($p<.05$ and $p<.001$ respectively). §§§, significantly different from Female Single ($p<.001$). EPT: effective playing time ; η_p^2 = partial eta squared. p values represent the results of the one-way analysis of variance (ANOVA) for each parameter.

Table 2.
Distribution of areas distribution (number of occurrences, absolute values) between players "A" and players "B" for male double, female double and mixed double. Data are expressed as mean ± SD.

	Male Double		**Female Double**		**Mixed Double**		**p value**	**ηp2**
	Player A	**Player B**	**Player A**	**Player B**	**Player A**	**Player B**		
Rear	19.2 ± 8.9	9.6 ± 5.5	44.2 ± 22.8	31.7 ± 21.4	22.9 ± 10.1	13.9 ± 8.6	< 0.001	0.509
Middle	60.8 ± 16.8	49.0 ± 20.0	83.9 ± 32.1	75.9 ± 32.3	64.1 ± 20.0	31.6 ± 14.6**	< 0.001	0.462
Front	66.6 ± 21.0	75.0 ± 25.6	66.8 ± 21.4	73.5 ± 17.4	80.5 ± 25.4	57.1 ±18.6**	0.006	0.216
Net	38.1 ± 14.7	49.9 ± 15.5	38.7 ± 14.4	41.8 ± 13.8	36.0 ± 12.1	53.6 ± 19.3**	0.001	0.255
TOTAL	184.7 ± 52.7	183.6 ± 54.4	233.6 ± 75.4	222.9 ± 68.4	203.5 ± 57.2	156.2 ± 47.9	< 0.001	0.269

** significantly different from Player "A" in the same double ($p < .01$).η_p^2 = partial eta squared. p values represent the results of the one-way analysis of variance (ANOVA) for each parameter.

Table 3
Distribution of the actions (absolute values) between players "A" and players "B" for male double, female double and mixed double. Data are expressed as mean ± SD.

	Male Double		**Female Double**		**Mixed Double**		**p value**	**ηp2**
	Player A	**Player B**	**Player A**	**Player B**	**Player A**	**Player B**		
Jumps	49.2 ±23.7	42.0 ±23.9	44.4 ±18.3	39.9 ±17.2	35.4 ±15.1	18.0 ±5.6	< 0.001	0.239
Lunges	45.3 ±19.3	48.6 ±18.2	51.4 ±23.6	43.6 ±16.4	62.6 ±16.6	40.0 ±11.6*	0.026	0.147
Smashes	24.6 ±10.8	16.5 ±8.0	35.5 ±20.1	30.4 ±19.4	26.9 ±10.2	10.1 ±4.7*	< 0.001	0.299
Nets	10.6 ±3.8	18.3 ±8.2*	13.6 ±6.2	15.3 ±5.3	14.4 ±4.5	21.4 ±7.5*	< 0.001	0.255
Kills	6.6 ± 4.5	8.1 ± 4.2	5.6 ± 2.7	8.4 ± 4.5	6.3 ± 2.6	9.2 ± 5.1	0.157	0.095

* significantly different from Player "A" in the same double ($p < 0.05$). η_p^2 = partial eta squared. P values represent the results of the one-way analysis of variance (ANOVA) for each parameter.

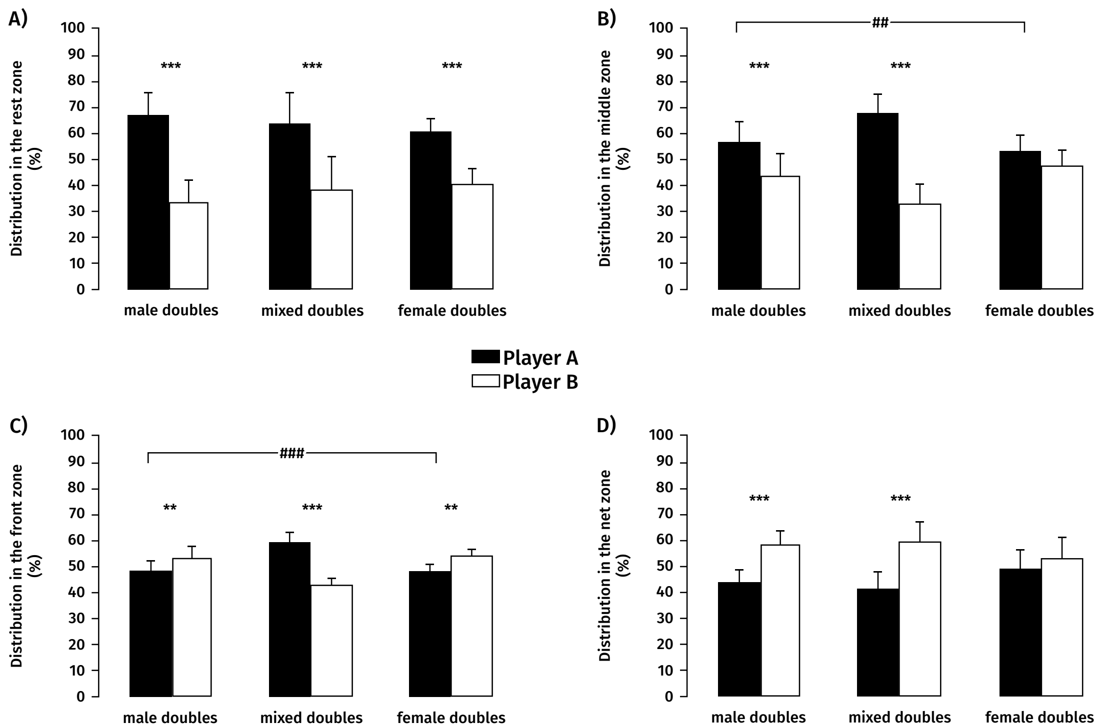

Figure 2. Comparison of the distribution ("Player A" vs "Player B") depending on the zone: rear zone (panel A), middle zone (panel B), front zone (panel C) and net zone (panel D). ** and *** significant difference between "Player A" and "Player B" (p<.01 and p<.001 respectively). ## and ###, significant difference between the mixed doubles for "Player A" (p<.01 and p<.001 respectively). Data are presented as means ± SD. The value of 50% indicates the same distribution between the two players.

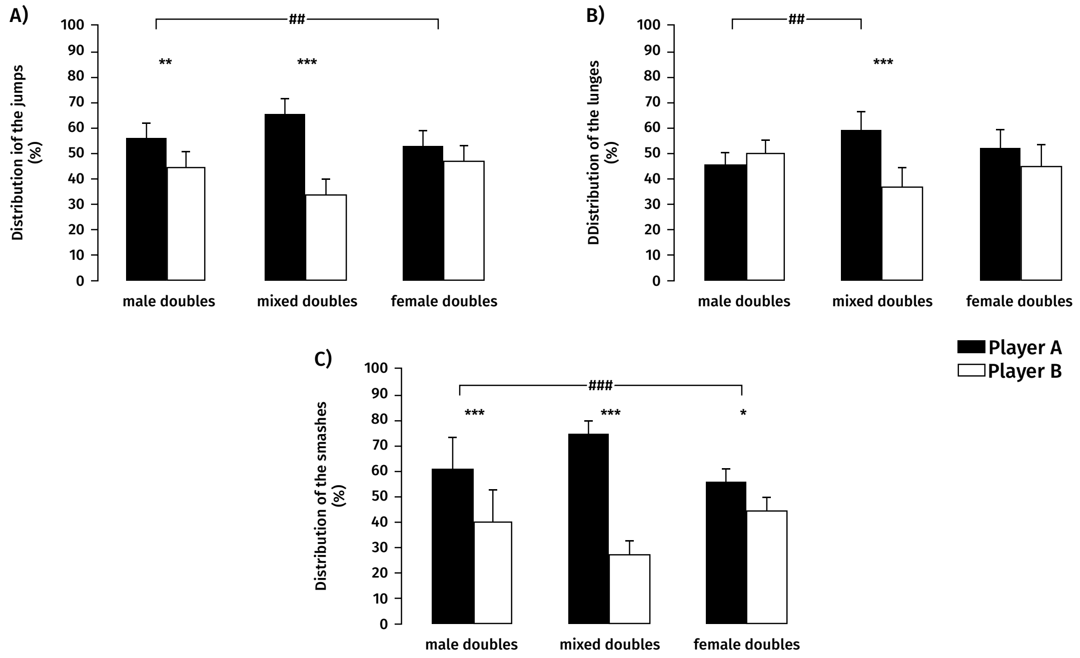

Figure 3. Comparison of the distribution ("Player A" vs "Player B") for the jumps (panel A), lunges (panel B) and smashes (panel C). *, ** and *** significant difference between "Player A" and "Player B" ($p<.05$, $p<.01$ and $p<.001$ respectively). ## and ###, significant difference between the mixed doubles for "Player A" ($p<.01$ and $p<.001$ respectively). Data are presented as means ± SD. The value of 50% indicates the same distribution between the two players.

DISCUSSION

The present study showed that the characteristics of doubles games were highly related to the presence or absence of male players. Specifically, we observed that the effective playing time was significantly less during men's and mixed doubles and the shot frequency was the greatest during these two events. We also found that specific movements, i.e., the number of jumps and number of lunges, were greater during singles play than in doubles play. Furthermore, we found that the activity of the two players performing in the same pair is largely dependent on the type of double considered.

Part 1: Differences between doubles and singles and among different types of doubles

The results of the present study show that the timing structure of a doubles game is largely dependent on the type of doubles. Consequently, the differences between doubles games may vary depending on the presence or absence of a male player in the configuration of the double. Indeed, among the five types of events analyzed, we found that the shortest rallies were observed during men's and mixed doubles and the longest rallies were observed during women's doubles. In spite of this, the longest rest time between two rallies was observed during men's and mixed doubles and the shortest rest time was observed during women's doubles. However, some results support the idea of specialization between singles and doubles training (Gawin et al., 2015). Indeed, when considered the male players, the effective playing time was significantly greater during men's singles games than men's and mixed doubles games. We also observed different muscular demands, i.e. greater jumps (+40%) and lunges (+250%) performed during singles compared with doubles matches. Thus, the current study confirms the high muscular demand during a singles match (Lin et al., 2023), particularly when compared to a doubles match. Moreover, males aiming to play in doubles matches must be able to develop specific technical skills, such as short serve and return (Gawin, Beyer, Hasse, & Büsch, 2013) and offensive moves (e.g., smash) (Rusdiana et al., 2020), and a great variety of strokes (Alcock, & Cable, 2009), as well as psychological skills to perform under intense mental pressure. As previously observed (Gawin et al., 2015), results are less clear when female players are considered. Indeed, all temporal data show that a women's doubles game is the most demanding activity involving female players (i.e., in terms of rally duration, rest time, and effective playing time), whereas the characteristics of the mixed doubles game appear to be more similar to the men's doubles (i.e., low rally duration and a long rest between two rallies). As previously suggested (Gawin et al., 2015), it is likely that the duration of the rally during women's doubles could be attributable to a lesser speed of the shuttlecock during the offensive strokes, while the defensive skills are equal.

Our results confirm that the shot frequency is greater during doubles games than during singles games (Gawin et al., 2015). Thus, both male and female players wishing to specialize in playing doubles should adapt their training programs by including high shotfrequency sequences to control the technical and psychological constraints of the high-speed game.

Taken as a whole, these results suggest that a high temporal pressure associated with shot frequency requires longer recovery. It could be speculated that greater mental effort is required in double compared to single plays.

Part 2: Differences between two players within the same pair.

To the best of our knowledge, the current study was the first to compare the role of the players within the same pair. Sobko et al. study previously proposed two ways of forming pairs depending on the type of doubles, that were similarity for both men's doubles and women's doubles (i.e., identical roles between players) and compensation for mixed doubles (i.e., different roles between players) (Sobko et al., 2020). Our results only partly confirmed this hypothesis.

Distribution related to the space

Men's doubles (MD)

Interestingly, we observed significant differences between the two players in all the zones considered (Fig.2). More precisely, it is noteworthy that the closer from the net, the lesser the "Player A" is involved. As regards the rear zone, "Player A" hits the shuttlecock twice as often as "Player B", while "Player B" hits the shuttlecock 33% more than "Player A" when the shuttlecock is close to the net. This result highlights that the pair actively seeks a preferential position when attacking, thus allowing "Player A" to produce powerful strokes, such as smash, in order to maintain an offensive strategy. This tactical choice has consequences on physical and technical parameters. Thus, "Player A" performed significantly more jumps (+23%) and smashes (+48%) than "Player B" while the opposite has been observed for the net strokes. It has been previously shown that the jump smash is an efficient stroke widely used by the players during doubles matches, requiring several various qualities, such as timing, power and control (Rusdiana et al., 2020). As regards the net stroke, this stroke is usually performed by completing a lunge, which has been thought to be linked to muscular fatigue (Lin et al., 2023). Hence, our results showed that the training programs must take into account the specificity of each player. Contrary to the suggestions of Sobko et al. (2020), it appears that, due to task specificity, compensation principle is more relevant than similarity when re-pairing men's doubles teams.

Women's doubles (WD)

Our results showed a different strategy in WD than that observed during MD. Indeed, although significant difference was observed regarding the rear zone, the distribution between A and B is fairly balanced in all other areas of the court. Thus, it appears that during WD, there is no clearly defined role. The pair relies instead a constant adaptation to the specific situation. This aspect is also visible when comparing the specific movements and strokes. Indeed, no difference was found for any parameter, revealing that the two players have the same tasks. Hence, when compared to men's doubles players, it appears that there is no need to individualize the training programs when coaching WD, as no specific tasks were found between the two players for both tactical and technical skills. Our results confirm the similarity principle proposed by Sobko et al. (2020) for WD.

Mixed doubles (XD)

As the mixed double is the only pair composed by both male and female player, one may expect a different strategy than those observed during MD and WD. Our results confirm this hypothesis by showing that XD is the most unbalanced type of double when comparing the spatial distribution of the shuttlecocks played by the players. Thus, "Player A" is largely predominant on the rear half of the court (both the rear and the middle zones). Indeed, "Player A" hits the shuttlecock twice as often as "Player B" in the middle zone. Moreover, the mixed doubles is the only type of doubles in which the "Player A" played significantly more shuttlecocks than his partner in the front zone. Interestingly, "Player A" also played a greater significant distribution of shuttlecocks than "Player B" in the mixed doubles in the central zone, i.e. front and middle zones, when compared to MD and WD. Thus, it appears that during mixed doubles, the female player mainly tries to intercept the shuttlecock in one side of the court close to the net in order to conclude the rally. Consequently, the male player is supposed to cover the rest of the court, included the front zone and sometimes even the net zone. This unbalanced distribution of shuttlecocks is also visible through the actions performed by the players, since the number of jumps, lunges or smashes is largely greater for the male player. The differences of distribution also reach the significance when the "Player A" are compared between XD and MD. Finally, during XD, the female player is predominant to perform decisive actions close to the net, i.e. kills and nets. In the light of these elements, the compensation principle suggested by Sobko et al. (2020) seems to be relevant regarding the mixed doubles.

PRACTICAL APPLICATIONS

Our results allow to highlight reliable skill profiles for training and detection based on muscular and timing structure data. Indeed, while male and female players who aim to play during single competitions must develop both muscular and cardiorespiratory fitness, doubles generally request more explosive qualities. Moreover, as regards men's and mixed doubles players, we also showed that there is a need for individualization training program due to specific roles on the court. For women's doubles players, as the contributions are quite similar, it is important that both players control a large amount of technical skills. Consequently, the training program of both players could be identical. Lastly, due to the characteristics of the different events (especially muscular constraints), we also suggested that muscular fatigue is likely to occur during both male and female singles and doubles. Therefore, coaches and physical trainers should adapt their training programs to counteract the deleterious effects of fatigue (Le Mansec, Perez, Rouault, Doron, & Jubeau, 2020).

LIMITATIONS

Some limitations may be addressed. First, it has to keep in mind that the current study dealt with European players. As the badminton is currently dominated by Asian players, it could be interesting to compare the results observed herein with those observed during Asian and/or world championships. Secondly, as we focused on adult players, future studies are needed to apply the same methodology with young players to detect possible differences. Lastly, to be representative of the European top-level, we chose to analyze only the final phases of the competition. Thus, only seven matches were analyzed for each event. Further studies could confirm the robustness of our results with a large sample of matches.

CONCLUSIONS

This study demonstrated that the constraints of a badminton game are specific and related to the type of event played. More specifically, our results showed that the characteristics of doubles games were highly related to the presence or absence of male players. This information is highly relevant for coaches and physical trainers to tailor the training programs.

REFERENCES

Abián, P., Castanedo, A., Feng, X. Q., Sampedro, J., & Abian-Vicen, P. (2014). Notational comparison of men's singles badminton matches between Olympic Games in Beijing and London. *Int J Perform Anal Sport, 14*(1), 42-53.

Abian-Vicen, J., Castanedo, A., Abián, P., & Sampedro, J. (2013). Temporal and notational comparison of badminton matches between men's singles and women's singles. *Int J Perform Anal Sport, 13*(2), 310-320.

Abián-Vicen, A., 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. *Int J Perform Analysis Sport, 18*(4), 633-644.

Alcock, A., & Cable, T. (2009). A comparison of singles and doubles badminton: heart rate response, player profiles and game characteristics. *Int J Perform Analysis Spor, 9*(2), 228-237.

Chiminazzo, J. G. C., Barreira, J., Luz, L. S. M., Saraiva, W. C., & Cayres, J. T. C. (2018). Technical and timing characteristics of badminton men's singles: comparison between groups and play-offs stages in 2016 Rio Olympic Games. *Int J Perf Anal Sport, 18*(2),245-254.

Cohen, J. (2013). *Statistical Power Analysis for the Behavioral Sciences*. New York, NY: Academic Press.

Gawin, W., Beyer, C., Hasse, H., & Büsch, D. (2013). How to attack the service: an empirical contribution to rally opening in world-class badminton doubles. *Int J Perform Analysis Sport, 13*(3), 860-871.

Gawin, W., Beyer, C., & Seidler, M. (2015). A competition analysis of the single and double disciplines in world-class badminton. *Int J Perform Analysis Sport, 15*(3), 997-1006.

Jung Hoon, C., & Hak-Kyun, K. (2020). Physical fitness and characteristic analysis of Korean national prospective badminton team members stratified by gender and game type. *Korean J Sports Med, 38*(2),95-100.

Kuntze, G., Mansfield, N., & Sellers, W. (2010). A biomechanical analysis of common lunge tasks in badminton. *J Sports Sci, 28*(2),183-191.

Le Mansec, Y., Perez, J., Rouault, Q., Doron, J., & Jubeau, M. (2020). Impaired performance of the smash stroke in badminton induced by muscle fatigue. *Int J Sports Physiol Perfor, 15*(1),52-59.

Le Mansec, Y., Sève, C., & Jubeau, M. (2017). Neuromuscular fatigue and time motion analysis during a table tennis competition. *J Sports Med Phys Fitness, 57*(4), 353-361.

Liddle, S. D., Murphy, M. H., & Bleakley, W. (1996). A comparison of the demands of singles and doubles badminton among elite male players: a heart rate and time/motion analysis. *J Hum Mov Stud, 29*(4), 159-176.

Lin, Z., Blazevich, A. J., Abbiss, C. R, Wilkie, J. C, & Nosaka, K. (2023). Neuromuscular fatigue and muscle damage following a simulated singles badminton match. *Eur J Appl Physiol, 123*, 1229-1240.

Phomsoupha, M., & Laffaye, G. (2015). The science of badminton: game characteristics, anthropometry, physiology, visual fitnessand biomechanics. *Sports Med, 45*(4), 473-495.

Rusdiana, A., Subarjah, H., Imanudin, I., Kusdinar, Y., Syahid, A. M., & Kurniawan, T. (2020). Effect of fatigue on biomechanical variable changes in overhead badminton jump smash. *Ann Appl Sport Sci, 8*(3), 1-9.

Sobko, I., Zharkova, Y., Vitsko, S., Zhukov, V., & Tsapko, A. (2020). Formation of doubles and mixed categories in badminton using multivariate analysis methods. *J Phys Education and Sport, 20*(6), 3138-3145.

Torres-Luque, G., Fernández-Garcia, A. I., Blanca-Torres, J. C., Kondric, M., & Cabello-Manrique, D. (2019). Statistical differences in set analysis in badminton at the Rio 2016 Olympic Games. *Front Psychol, 731.*

Widyaningsih, W. W., Handayani, O. W. K., & Hidayah, T. (2018). The relationship between personality of single and double athletes of badminton toward achievement level in PB. Djarum. *J Phys Education and Sports, 7*(1), 1-6.