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Match load & technique differences in winning and losing female youth tennis players on clay courts

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ABSTRACT

The aim of the study was to analyse the differences in match load and technique between winners and losers in female youth tennis competitions on clay courts. Ten female youth tennis players (age 15.80 ± 0.42 years), all ranked in the singles ranking in International Tennis Federation (ITF) Junior. A simulated clay court competition using standard rules was the setting for the study. Technical data was scrutinized using Dartfish and the matched load was evaluated and contrasted by utilizing Banister's, Edward's, and Rating of Perceived Exertion–based Training Impulse (RPE TRIMP). The results found that the second set has a statistically significant lower load than the first set up $p \leq .05$. Pearson correlation indicated that the Backhand and Smash Technique has a strong relationship with training impulse (TRIMP) in all winners, but mostly TRIMP tends to have a negative relationship with many techniques in the losers group. It appears that winning youth players have lower competition loads than losing players and are more efficient in their technique in competition. The importance of proper match load analysis and competition technique together may be a guideline to increase the chance of winning in youth tennis competitions on clay courts.

KEYWORDS

Match Load; Technical; TRIMP; RPE; Sport Analysis Performance

1. INTRODUCTION

Tennis is a competitive sport that requires a combination of skill and anaerobic energy, such as speed, agility, and power, as well as a high level of aerobic capacity and a high work rate. The physical stress of a high work rate intermittently leads to a high degree of fatigue and can decrease hitting accuracy (Kovacs, 2007). More than 75% of the loads during competition are low, and 25% are medium and high loads. Therefore, those with high anaerobic combined energy competence can maintain a good level of competition. (Baiget et al., 2015). During match, highly intermittent combine complex movements pattern consumes relatively high energy and effort to play (Fernandez et al., 2006; Gomes et al., 2016), maintaining both technical and physical fitness is crucial to achieving good results. Winners tend to have more mobility in competition and thus have a lower physiological response, in contrast to those who lose in the competition have a higher physiological response (Roldán-Márquez et al., 2022). Different load intensities in a match can be caused by the player's serve game, movement characteristics, experience, playing style, and court surfaces (Fernandez et al., 2006; Kilit & Arslan, 2017; Martin et al., 2011) which affects the competition.

The skills players use in matches come in many combinations to match the techniques and tactics used in matches. Training must, therefore, focus on training that can be adapted to the physiological needs of the game in order for the physical to adapt to the game as well (Gomes et al., 2016) by expressing a style of technique and tactics in play, competitive technical competence is essential for performance in young tennis players (Kolman et al., 2021) Decisions made to use specific techniques or tactics during a game affect the score and may result in losing or winning the match. The importance of technique and tactics, along with the level of physical ability, is, therefore, an essential factor in determining the performance of a player (Kolman et al., 2019); training sessions should examine the demands of competition by determining training load as well as training techniques and tactics that will help athletes prepare for competition (Murphy et al., 2014a, 2016; Reid et al., 2008).

Another critical factor that affects a tennis player's performance is the court surface. Previous studies have shown that the physical responds more physiologically when training or competing on clay courts than hard courts (Reid et al., 2013). This high physiological response is achieved during competition when movements performed on clay courts are more challenging than on hard courts, making the physical work during play longer and more complex, resulting in 22% longer rallies during play than on the hard court, resulting in more extended playtime on clay courts than on the hard court (Fleming et al., 2023). Due to these causes and factors, playing on clay courts may pose a risk of injury that can occur in less experienced players (Starbuck et al., 2016), especially among high-level athletes. Younger than highly experienced players.

The difference in match load that occurs during clay court competition creates a higher level of competition that directly impacts the ultimate ability of these athletes, creating a greater burden than competing on a hard court. The preparation of players with technical training and physical fitness strategies that are appropriate for the competition environment is crucial for increasing their chances of success in competition. Therefore, this study attempts to analyse and compare the load and techniques of tennis matches between winners and losers in youth women's tennis matches on clay courts in order to lead to the analysis of coaches' planning.

2. METHODS

2.1. Participants

Ten female tennis players (age 15.80 ± 0.42 years; body mass 63.00 ± 4.16 kg.; height 164.20 ± 2.94 cm. and experience 4.02 ± 0.51) (Table 1). All participants were purposive sampling where they received a single ranking in International Tennis Federation Junior (ITF Junior) had tennis training and performed at least 6 training sessions per week and competition background for at least 3 years. To participate, all participants must give written informed consent.

This study was approved for ethical human research by the Committee on Ethics in Human Research from the research and social innovation encouragement, Thaksin University (TSU2022_75) which is conducted in the Declaration of Helsinki, The Belmont Report, CIOMS Guideline, International Conference on Harmonization in Good Clinical Practice.

Table 1. The physical characteristics of players (N=10)

Physical Characteristics	**Mean ± SD**
Age (years)	15.80 ± 0.42
Body mass (kg.)	63.00 ± 4.16
Height (cm.)	164.20 ± 2.94
BMI	23.37 ± 1.36
Experience	4.02 ± 0.51

2.2. Simulation Game

The simulated competition on a clay court used the rules of The International Tennis Federation (ITF) and 2 out of 3 sets from the standard game. All participants were randomly selected for the simulated competition to avoid advantages and disadvantages and ensure fairness in the simulated matches and results. The simulation competition utilizes indoor clay courts. The match will start at the same time every day for all matches, and the competition will be finished within a week to avoid temperature differences at different times of the day.

2.3. Testing Methods

2.3.1. Physiological measured

Polar H10 (Polar H10, Kempele, Finland) was used to record the heart rate during the competition, and Polar team software (Polar Electro, Kempele, Finland) was used to record the heart rate zone.

2.3.2. Technical analysis

The technical analysis was a video recorded by a Sony Handycam (HDR PJ670) with a resolution of 1920 x 1080/60p from the baseline on both sides of the court. The Forehand, Backhand, Volley, and Smash Techniques were analyzed using Dartfish V.9. Technical analysis uses experts with experience in tennis coaching to identify the techniques used in competition.

2.3.3. Match load calculates

The calculation of the match load between the winner (WG) and loser (LG) by using absolute load and a relative load from the formula of Banister’s TRIMP, Edward’s TRIMP, and RPE TRIMP.

Banister’s TRIMP (BnTRIMP) based on the exponential weighting factor the Banister’s TRIMP method (Banister, 1991); Banister’s TRIMP = D x HRR x 0.64 x e (1.92 x HRR), when D is the duration of exercise (minute), and HRr is the Heart rate reserve. Calculated to the following equation (HRex – HRrest) / (HRmax – HRrest) by determining HRex is the average of heart rate exercise, HRrest is the heart rate rest, and HRmax is the maximum.

Edward’s TRIMP (EwTRIMP): (Edwards, 1993) was calculated by multiplying the duration of the exercise by the HR zones coefficient [Edward’s TRIMP = Duration x HR Zone (50–60% = 1; 60–70% = 2; 70–80% = 3; 80–90% = 4; And 90–100% = 5)].

sRPE TRIMP (RpeTRIMP) was calculated by multiplying duration by the sRPE scale (RPE TRIMP = Duration x sRPE (1-10)).

The relative TRIMP of Banister's TRIMP (BnR TRIMP), Edward's TRIMP (EwR TRIMP), and RPE TRIMP (RpeR TRIMP) were calculated by dividing the minutes of competition in each set.

2.4. Statistical Analysis

The statistical analysis is performed using SPSS version 26 (IBM, Chicago, Illinois, United States of America) and the means and standard deviations (SDs) are represented by the Shapiro-Wilk test for regularities of the distribution data. Two-way repeated-measures MANOVA analysis (TWO-way MANOVA with repeated measures) was performed for all TRIMP variables to compare the interaction between the group (winner and loser) and the period (first set and second set). The correlation between TRIMP and technique is analyzed by Pearson correlation statistics. The Bonferroni test was used to determine which measures had a significant difference and was set at $p \leq .05$.

3. RESULTS

The main effect of the study found that had interaction between group x period (p =. 002) only BnR TRIMP had significantly $p = .034$; in All periods the BnR TRIMP showed WG lower load than LG had significantly $p \leq .05$. The affected the group found that WG had BnTRIMP, EwTRIMP, and RpeTRIMP lower than LG all $p \leq .05$. Effected of the period; the BnTRIMP, BnR TRIMP, EwR TRIMP, and RpeR TRIMP of WG lower load than LG had significantly all $p \leq .05$. All data is shown in Table 2 and the figure illustrates the differences between groups, sets, and interactions of different TRIMP load assessment methods in Figure 1.

Table 2. Two-way MANOVA with repeated measure analysis for interaction analyze

Load Variable	Between Group		Set 1	Set 2	Group x Set
			Mean ± SD	Mean ± SD	
Banister's TRIMP	**Win**	0.023*	316.032 ± 175.83	223.55 ± 141.82	0.145
	Lose		416.302 ± 67.99	397.09 ± 130.85	
	Within Group		0.032*		
Relative Banister's TRIMP	**Win**	0.017*	8.564 ± 4.48	6.99 ± 4.06	0.034*
	Lose		11.522 ± 2.51	12.94 ± 4.80	
	Within Group		0.907		
Edward's TRIMP	**Win**	0.094	95.488 ± 22.04	81.80 ± 20.36	0.428
	Lose		108.852 ± 8.84	93.60 ± 7.32	
	Within Group		.001**		
Relative Edward's TRIMP	**Win**	0.027*	2.598 ± 0.51	2.60 ± 0.52	0.103
	Lose		2.976 ± 0.04	3.00 ± 0.00	
	Within Group		0.058		
RPE TRIMP	**Win**	0.10	227.4 ± 51.06	200.80 ± 43.73	0.336
	Lose		249.6 ± 41.04	236.60 ± 17.91	
	Within Group		0.010*		
Relative RPE TRIMP	**Win**	0.025*	6.2 ± 1.23	6.40 ± 1.07	0.162
	Lose		6.8 ± 0.79	7.60 ± 0.52	

Within Group	0.026*

Note. *$^{*}p \le .05$, $^{**}p \le .01$*

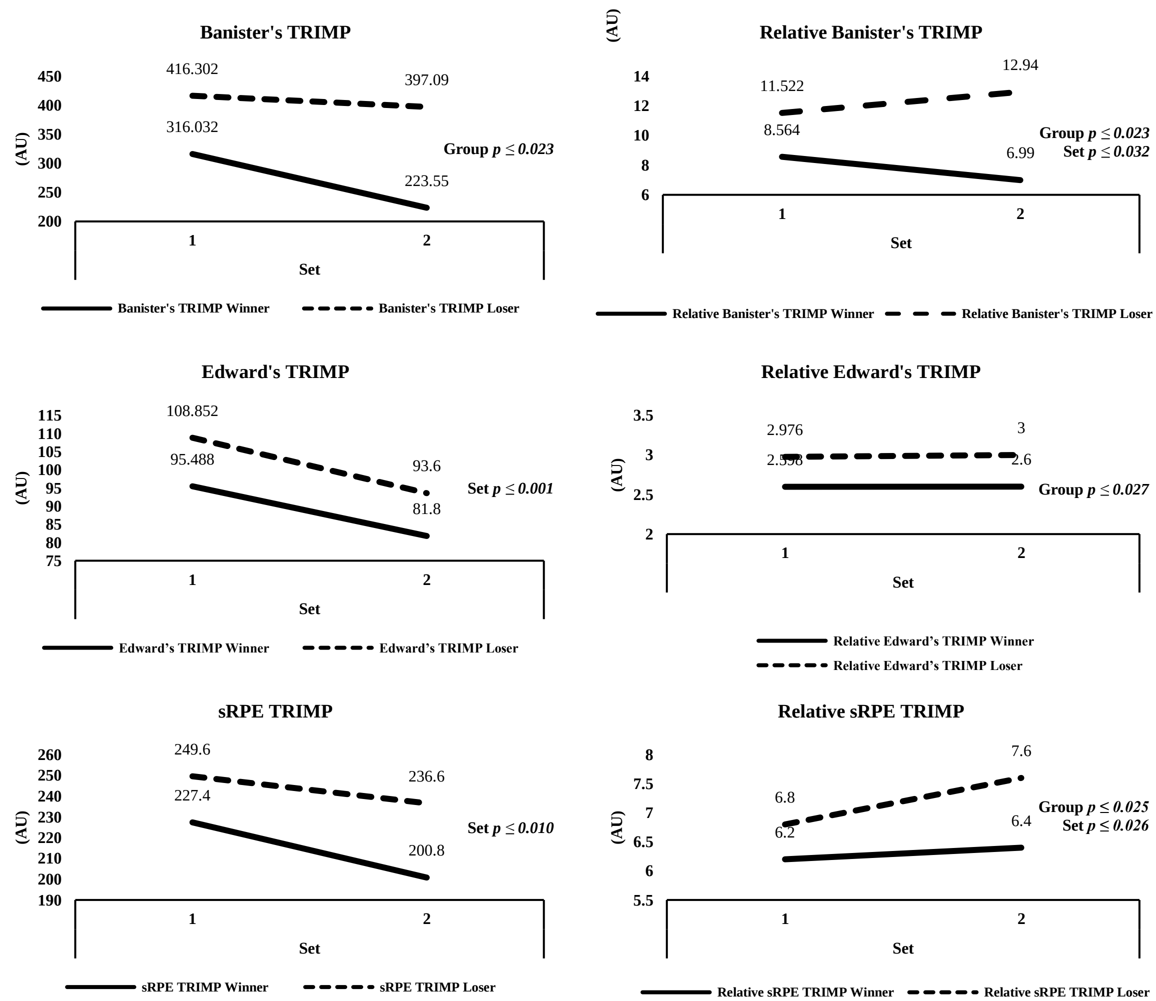

Figure 1. Differences in mean TRIMP values between winners and losers across sets and TRIMP formats

The Pearson correlation for the winner group found that BnTRIMP, EwTRIMP, and RpeTRIMP high positive correlation with Backhand Technique and Smash Technique had significant $p < .05$ (BnTRIMP; $r = .097$ and $r = .092$, EwTRIMP; $r = .771$ and $r = .874$, and RpeTRIMP; $r = .841$ and .897 respectively.). The loser group found that BnTRIMP, EwTRIMP, and RpeTRIMP had a high negative correlation with Volley Technique and Smash Technique had significant (BnTRIMP vs Volley Technique $r = -.915$, EwTRIMP vs Smash Technique $r = -.891$, and RpeTRIMP vs Smash Technique $r = -.708$ respectively.) All data is shown in Table 3.

Table 3. Pearson correlation results between technique and TRIMP method for each group

Group	Variable	Forehand Technique	Backhand Technique	Volley Technique	Smash Technique
Winner	Banister's	.380	.907**	.324	.902**
	Edward’s	-.155	.771**	.571	.874**
	RPE	.222	.841**	.235	.897**
Loser	Banister's	-.129	-.435	-.915**	.203
	Edward’s	.068	-.254	.435	-.891**
	RPE	-.091	.109	.471	-.708*

Note. *The Pearson correlation (r)* $^{*}p \leq .05$, $^{**}p \leq .01$

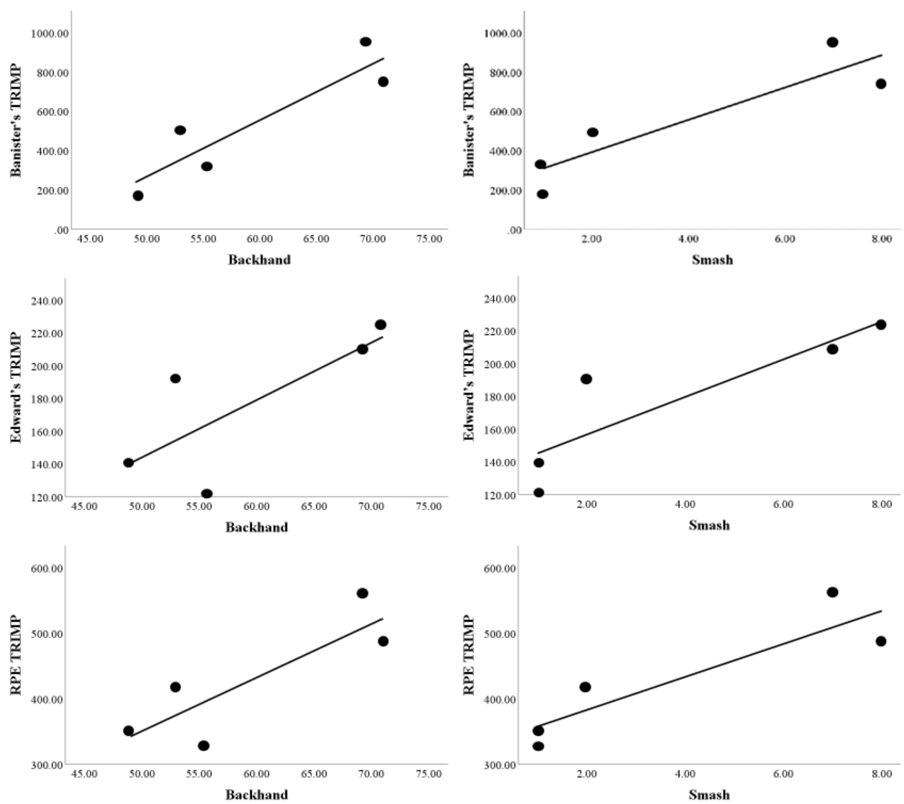

Figure 2. Illustration of the correlation between the techniques and TRIMP of the winner

4. DISCUSSIONS

According to the study, it was found that when using the load estimation method using Banister TRIMP, Edward TRIMP, or RPE TRIMP to calculate the match load of the competition, it can be seen that the winner will have a lower TRIMP than the loser. Players who are performing at a higher level may have a lower physiological load than those who are defeated in competition, which is a clear indication of a competitive advantage. The level of internal load can be significantly impacted by psychological stress or a weaker nervous system, which can lead to losers having greater physiological responses than winners (Roldán-Márquez et al., 2022).

Although the game time on clay courts in particular is longer than other types of courts and the surface is different from other types of courts, it stimulates a higher physiological response than normal matches (Björklund et al., 2020). Therefore, coaches must pay attention to how each type of on-court training affects the level of training load of athletes, which is an important factor in considering the physiology of training or competition (Martin et al., 2011). These things have a significant impact on athletes' performance during competition if they are not trained properly and in line with real competition situations.

It appears using RPE or heart rate data to estimate workload is a suitable method of training, providing an easy-to-use tool for monitoring tennis training or competition, these load estimation methods can be used interchangeably because they have a high level of reliability (Haddad et al., 2012). especially training that is high-intensity training (Hadžić et al., 2021; Murphy et al., 2016; Tibana et al., 2018), as well as for assessment of the match load in female players (Filipcic et al., 2023), is coupled with training. These methods may help to assess training load appropriately and efficiently and may have a greater impact on competition.

The appropriate proportions of technical and physical fitness training are necessary for competition purposes (Turner et al., 2023). Coaches should therefore consider more appropriate training load and techniques that are used in competitions, as well as methods for tracking and calculating appropriate loads by applying data from competitions to training (Gomes et al., 2016; Murphy et al., 2016). Most training sessions for competitions may not have a duration that corresponds to the actual competition due to the greater duration difference than is normal in competition on clay court, which may contribute to the buildup of fatigue in competition (Fleming et al., 2023; Reid et al., 2013) and directly affects the technique and performance of players (Carboch et al., 2019; Martin et al., 2011). Training that is consistent with the competition will aid athletes in improving their performances, particularly for young athletes (Kovalchik & Reid, 2017).

The relationship between technique during a match and performance in tennis should be evaluated (Kolman et al., 2019), as the technical characteristics of youth athletes are important for the development of future athlete abilities (Kolman et al., 2021). Situations that use more techniques or rally shots in a match are associated with a higher load and may lead to fatigue on the physical (Murphy et al., 2014b), it affects the player who has altered their performance level. Elite players are more likely to efficiently use their techniques during matches, which gives them a chance to win (Aoki et al., 2018; Kolman et al., 2019; Thongthanapat & Khamros, 2024).

In particular, the use of precision techniques such as forehand or backhand techniques are skills that require precision and speed, and are frequently used in competition.(Muhamad et al., 2011; Sangkaew et al., 2024; Wang et al., 2010). Those with a lower level of technique will have less efficiency in their technique and will not be able to control the pace of the competition, requiring more effort to compete. As a result, the physiological stress levels are higher than those of the winner. This is some basic information that a coach can put into practice. Coaches who understand the load can help assess training load and reduce the athlete's risk of injury (Murphy et al., 2014a), as well as assess performance in a competitive environment, especially on the court, this can lead to differences in the techniques used and the performance levels of athletes. (Carboch et al., 2019; Martin et al., 2011).

5. CONCLUSIONS

The results of this study showed that the use of TRIMP in youth tennis players is another method that can be used to assess the match load in competition on clay courts. This study also found that winners tended to have TRIMP, whether Banister's TRIMP, Edward’s TRIMP, or sRPE TRIMP, at a lower level than losers. In addition to being a simple method, the results of this study that led to the application of the technique in competition display also found that the Backhand Technique and Smash Technique were the techniques that had a positive relationship and were more consistent with the use of TRIMP for assessing the load in competition among winners than losers who had a more negative relationship. This may be an important strategy for training and competition that helps to approximate competitive physiology, based on data on winners and losers in competition to training. In the future, technology should be used to analyze data to obtain more diverse dimensions.

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All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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