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The Influence of Players' Characteristics on Tennis Competition

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Abstract. In professional tennis, a player's performance is significantly affected by physical, technical and psychological factors. As the sport grows, it is vital to understand the impact of attributes such as height and age on playing style and success. While these factors are widely recognized, it remains challenging to accurately assess their impact on playing style and success due to the complexity of the sport. The study focused on refining the understanding of these relationships by analyzing data from ATP matches during the 2024 season. This paper focuses on the analysis of key performance indicators such as score, double fault, break point and so on. Descriptive statistics, Pearson correlation and regression analysis were used to investigate the relationship between physical properties and technical performance indicators. The analysis shows that there is a statistical significance of height on break point, but age doesn't have a significant effect on performance, suggesting that height could offset physical decline. Taking into account the importance of customized training programs for individual physical conditions, a holistic approach to player development, and balancing physical conditions with tactical and mental training is essential to maximize performance.

Keywords: Tennis, Descriptive statistics, Pearson correlation, Regression

1. Introduction

1.1. Background

Tennis is a sport that requires both physical abilities and strategic influence. A player's performance is often affected by various physiological and tactical factors [1]. The desire of tennis players to maximize their performance on the field has become an important goal for players and coaches. But not all tennis players have a professional briefing and a comprehensive training program. The gap may result in players being unaware of their physical strengths and weaknesses, as well as the weaknesses of their rivals, which may lead to non-performance.

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1.2. Problem statement

Some tennis players do not have the professional guidance and training plan of the coach, they are not clear about their own physical quality advantages and disadvantages, and they are not clear about the advantages and disadvantages of the opponent, which means that if players are not advised on how to go about it, they may not be in a position to know their strengths and weaknesses hence leading to poor performance on the field. This lack of professional advice is especially critical in a competitive setting, where a fine line between one's own and the opponent's capabilities can make a huge difference[2]. It is important to comprehend how a player's physical attributes are connected to his or her playing style in order to achieve the best results.

1.3. Objective

The purpose of the study is to analyze the correlation between the concrete somatic parameters of the tennis players, their playing technique, the percentage of victories and the tactics thus, when it comes to position, weight and age of players, we anticipate that these attributes will influence the services and performance of the players in the field. The study seeks to offer players relevant information that will assist in the formulation of training programs that enhance the players' physical attributes and minimize their liabilities. Furthermore, awareness of these dynamics can assist players in devising tactics that are based on the opponent's strengths, which will, in the long run, enhance their efficiency and increase prices [3].

1.4. Hypothesis

The study also shows that the height and age of the tennis players affect the serving and returning of the ball. Taller players may find that they can achieve a higher serve angle since they have better and stronger serves as compared to the other players. Moreover, the age of the players may affect their thinking and endurance on the field [4]. If we understand these relationships, we can design the training programs to develop the strength and then improve the overall performance.

2. Method

2.1. Data collection

2.1.1. Data source

For this study, we relied on secondary data from large datasets available in the Jeff Sackmann Tennis Data Repository on GitHub which is a complete set of ATP games that contain all the necessary information about the player's performance indicators and the results of the matching.

2.1.2. Variables(KPIs)

Key Performance Indicators (KPIs): Height of the winner (winner_ht), Age of the winner (winner_age), Aces by the winner (w_ace), Double faults by the winner (w_df), Break points saved by the winner (w_bpSaved), Break points faced by the winner (w_bpFaced), First serve points won by the winner (w_1stWon), First serve in percentage for the winner (w_1stIn)

These KPIs were chosen based on their relevance to tennis performance, which includes physical attributes (height, age), serving (aces, double faults, first serve percentage), and pressure (break

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points saved and faced) thus, examining these variables will enable us to determine their relationship with playing styles, strategies, and consequently, winning rates.

2.2. Statistical analyses

2.2.1. Descriptive statistics

First, we perform a descriptive analysis of the general properties of the data sets. This includes the calculation of average prices, the minimum and maximum of the standard deviation and measurement unit (e.g. winner_ht, winner_age, w_ace). Description statistics give an insight into information that highlights key trends and spreads, identifying any unusual or extreme value. For example, we identified unusually high or undervalued examples that could have a huge impact on analysis. The move is necessary to understand the overall characteristics and dissemination of data and provides a basis for further analysis. By understanding the distribution of tennis players' performance indicators and their key attributes, we can identify key examples and trends for more detailed analysis

2.2.2. Correlation analysis

In order to explore the relationship between KPI, we analyzed Pearson. This statistical method measures the strength and direction of linear relationships between two consecutive variables. In our study, we followed key indicators such as winner_ht, winner_age, w_ace, w_df, w_bpSaved, w_bpFaced, w_1stWon, and w_1stIn. The Pearson coefficient helps to determine whether there is a significant link between body characteristics (height and age) and the performance index (transmission efficiency, cut-point flexibility), which understands the interactions between these factors in tennis games. This approach has been chosen to determine the strength and trends of the relationship between variables, and to help us identify potential tennis performance predictions. The purpose of this analysis is to establish the correlation between physical attributes and performance parameters so as to gain insight into how various factors affect players' performance on the field.

2.2.3. Linear regression

Last but not least, to reduce the effect of physical properties on tennis performance, we employed linear regression analysis. The method defines the link between one or more independent variables (length, age, m. sh) and one dependent variable (m. sh. W_ace, w_df, w_1stWon); thus, this way, we can forecast the impact of a player's physical appearance on his professional performance on the field. The regression coefficients derived from this analysis indicate the extent of the contribution of each independent variable, which in turn helps to explain how length and age impact on service performance, stop point processing and overall matching efficiency, which enables us to establish the relationship between fitness and performance measures of a player, which in turn helps in predicting the effects of training and development plans for a player. By simulating the predictive effect of physical traits on performance indicators, we can clearly understand how height and age affect the performance of tennis, which is necessary to improve training and improve the performance of athletes.

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3. Result

3.1. Descriptive statistics

Firstly, we adopted descriptive statistical methods to conduct an in-depth analysis of the aforementioned data and drew corresponding charts for exploration. In this study, we first provided a comprehensive overview analysis of the various statistical indicators for the overall population. Subsequently, we focused our investigation on indicators exhibiting unusual or significant characteristics, such as high variance or high mean values.

Table 1: Descriptive statistics

Variable name	Sample size	Maximum value	Minimumvalue	Average value	Standard deviation	Median	Variance	Kurtosis	Skewness	Coefficient of variation (CV)
winner_ht	94	198	178	188.16	5.045	188	25.447	-0.744	0.598	0.027
winner_age	100	37.5	18.9	26.481	4.358	26.1	18.992	0.166	0.668	0.165
w_1stIn	99	81	24	46.354	13.843	44	191.619	-0.604	0.457	0.299
w_1stWon	99	62	19	36.283	10.342	33	106.96	-0.21	0.661	0.285
w_2ndWon	99	39	6	15.444	6.263	14	39.229	1.341	1.077	0.406
w_bpSaved	99	13	0	3	2.832	2	8.02	2.217	1.384	0.944
w_bpFaced	99	14	0	4.01	3.48	3	12.112	0.646	1.053	0.868
w_svpt	99	137	33	73.202	23.417	68	548.347	-0.173	0.711	0.32
w_ace	99	23	1	7.667	4.547	7	20.673	1.944	1.243	0.593
w_df	99	13	0	1.929	2.067	2	4.27	10.702	2.646	1.071

Firstly, we have conducted a brief description and analysis of the basic data of 10 variables, as shown in Table 1.

The data from the maximum and minimum values reflect the performance range of the player in the specific indicator. The maximum value of 198 cm and the minimum value of 178 cm of 'winner_ht' show the significant difference in the height of the contestants, revealing the different effects that different players' body types may have on the competition. The maximum and minimum values of 'winner_age' of 37.5 years and 18.9 years reveal the wide age distribution of players, indicating that there are both young and old players in the competition, which may reflect the different effects of experience and physical fitness on the outcome of the competition.

From the average data, we can see the overall trend of these indicators. The average value of 'w_1stIn' 46.354 indicates that most players were able to make 46 serves in the match, reflecting the overall first-serve success rate of the players. The average age of 'winner_age' of 26.481 indicates that most players are concentrated around the age of 26, possibly in their professional peak.

The distribution breadth of the index can be seen from the data of standard deviation and variance. The standard deviation of 'w_1stIn', 13.843, indicates that there are large differences in the performance of players in the first-serve success rate. Some players are stable, while others are more volatile. The variance of 'w_svpt', 548.347, reveals the huge difference in the number of serves the players have, which may be related to their playing style and physical strength.

The median figure reflects the central trend of the data. The median 26.1 years of 'winner_age' is close to the average 26.481 years, reflecting the symmetry of the age data, indicating that there is no significant skew in the age of players during the competition. The difference between the median of

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33 and the average of 36.283 for 'w_1stWon' indicates a difference in first-serve scoring rates, which may be influenced by skill level or the strength of the opponent.

3.2. Pearson correlation analysis

Table 2 reveals the statistical relationships and significance levels between several key indicators in the tennis match (hypothetically). Specifically, the results show the strength of the correlation and significance between the winner's height (winner_ht), age (winner_age), serve aces (w_ace), double faults (w_df), service break point saved (w_bpSaved), number of break points faced (w_bpFaced), first set won (w_1stWon), and the proportion of first set wins (w_1stIn).

First, the winner's height (winner_ht) is significantly positively correlated with serve aces (w_ace) ($r=0.248$, $p<0.013$), indicating that taller players may have an advantage in gaining more aces, but the correlation is weak or not significant with other variables, especially age (winner_age) and the number of break points faced (w_bpFaced).

Age (winner_age) does not show a significant correlation with most other variables, which may indicate that age has a limited impact on athletes' overall performance in tennis competitions or that the age distribution in the dataset is not diverse enough to produce a significant effect.

Serve aces (w_ace) are significantly positively correlated with double faults (w_df) ($r=0.255$, $p<0.010$), which seems counterintuitive but may reflect that aggressive players who aim for more aces also make more double faults.

At the same time, w_ace is significantly positively correlated with service break point saved (w_bpSaved), first set won (w_1stWon), and the proportion of first set wins (w_1stIn), further emphasizing the importance of serve ability in the match.

Double faults (w_df) are highly positively correlated with service break point saved (w_bpSaved) and the number of break points faced (w_bpFaced), indicating that serve stability is a key factor affecting the ability to save service games, and players with more service faults often face more break points.

Service break point saved (w_bpSaved) is highly positively correlated with the number of break points faced (w_bpFaced), first set won (w_1stWon), and the proportion of first set wins (w_1stIn), indicating that maintaining a high success rate of saving service games is an important strategy in winning matches.

The first set won (w_1stWon) shows a very strong positive correlation with the proportion of first set wins (w_1stIn) ($r=0.959$, $p<0.000$), which reflects the decisive impact of winning the first set on the outcome of the entire match.

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Table 2: The pearson correlation analysis

	winner_ht	winner_age	w_ace	w_df	w_bpSaved	w_bpFaced	w_2ndWon	w_1stWon	w_1stIn	w_svpt
winner_name	0.098	-0.187	-0.101	0.128	0.042	0.086	-0.14	-0.184	-0.177	-0.117
	(0.331)	(0.063*)	(0.318)	(0.203)	(0.675)	(0.396)	(0.164)	(0.067*)	(0.079*)	(0.247)
winner_ht	1	-0.069	0.248	0.103	-0.032	0.001	0.06	0.281	0.252	0.209
	(0.000***)	(0.496)	(0.013**)	(0.308)	(0.755)	(0.995)	(0.552)	(0.005***)	(0.012**)	(0.037**)
winner_age	-0.069	1	-0.038	-0.096	-0.081	-0.104	-0.179	-0.098	-0.105	-0.159
	(0.496)	(0.000***)	(0.706)	(0.344)	(0.422)	(0.305)	(0.074*)	(0.334)	(0.299)	(0.114)
w_ace	0.248	-0.038	1	0.255	0.182	0.187	0.197	0.452	0.373	0.37
	(0.013**)	(0.706)	(0.000***)	(0.010**)	(0.071*)	(0.063*)	(0.049**)	(0.000***)	(0.000***)	(0.000***)
w_df	0.103	-0.096	0.255	1	0.415	0.464	0.179	0.265	0.23	0.356
	(0.308)	(0.344)	(0.010**)	(0.000***)	(0.000***)	(0.000***)	(0.075*)	(0.008***)	(0.022**)	(0.000***)
w_bpSaved	-0.032	-0.081	0.182	0.415	1	0.962	0.473	0.379	0.468	0.57
	(0.755)	(0.422)	(0.071*)	(0.000***)	(0.000***)	(0.000***)	(0.000***)	(0.000***)	(0.000***)	(0.000***)
w_bpFaced	0.001	-0.104	0.187	0.464	0.962	1	0.503	0.443	0.544	0.654
	(0.995)	(0.305)	(0.063*)	(0.000***)	(0.000***)	(0.000***)	(0.000***)	(0.000***)	(0.000***)	(0.000***)
w_2ndWon	0.06	-0.179	0.197	0.179	0.473	0.503	1	0.491	0.571	0.765
	(0.552)	(0.074*)	(0.049**)	(0.075*)	(0.000***)	(0.000***)	(0.000***)	(0.000***)	(0.000***)	(0.000***)
w_1stWon	0.281	-0.098	0.452	0.265	0.379	0.443	0.491	1	0.959	0.895
	(0.005***)	(0.334)	(0.000***)	(0.008***)	(0.000***)	(0.000***)	(0.000***)	(0.000***)	(0.000***)	(0.000***)
w_1stIn	0.252	-0.105	0.373	0.23	0.468	0.544	0.571	0.959	1	0.941
	(0.012**)	(0.299)	(0.000***)	(0.022***)	(0.000***)	(0.000***)	(0.000***)	(0.000***)	(0.000***)	(0.000***)
w_svpt	0.209(	-0.159	0.37	0.356	0.57	0.654	0.765	0.895	0.941	1
	0.037**)	(0.114)	(0.000***)	(0.000***)	(0.000***)	(0.000***)	(0.000***)	(0.000***)	(0.000***)	(0.000***)

Note: ***, ** and * represent significance levels of 1%, 5% and 10% respectively

Table 3 displays the correlation coefficients between various variables. The closer the correlation coefficient is to 1 or -1, the greater the correlation between the two variables. Conversely, if the correlation coefficient is closer to 0, the correlation between the two variables is smaller

Table 3: Correlation analysis

	winner_ht	winner_age	w_ace	w_df	w_bpSaved	w_bpFaced	w_1stWon	w_1stIn
winner_ht	1	-0.069	0.248	0.103	-0.032	0.001	0.281	0.252
winner_age	-0.069	1	-0.038	-0.096	-0.081	-0.104	-0.098	-0.105
w_ace	0.248	-0.038	1	0.255	0.182	0.187	0.452	0.373
w_df	0.103	-0.096	0.255	1	0.415	0.464	0.265	0.23
w_bpSaved	-0.032	-0.081	0.182	0.415	1	0.962	0.379	0.468
w_bpFaced	0.001	-0.104	0.187	0.464	0.962	1	0.443	0.544
w_1stWon	0.281	-0.098	0.452	0.265	0.379	0.443	1	0.959
w_1stIn	0.252	-0.105	0.373	0.23	0.468	0.544	0.959	1

3.2.1. Variables

The variables appear to include metrics such as first serve in (`w_1stIn`), first serve points won (`w_1stWon`), break points faced (`w_bpFaced`), break points saved (`w_bpSaved`), double faults (`w_df`), aces (`w_ace`), winner age (`winner_age`), and winner height (`winner_ht`).

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3.2.2. Notable observations

There is a very high positive correlation (0.962) between `w_bpSaved` and `w_bpFaced`, suggesting that the number of break points saved is closely related to the number of break points faced.

`w_1stWon` and `w_1stIn` also show a strong positive correlation (0.959), indicating that players who get their first serve in tend to win those points.

Aces (`w_ace`) have a positive correlation with first-serve points won (`w_1stWon`) (0.452), suggesting that serving aces contribute to winning first-serve points.

The variable `winner_age` does not show strong correlations with other variables, indicating that age might not be a significant factor in these metrics.

`winner_ht` and `w_ace` have a positive correlation (0.248), suggesting a possible trend where taller players may serve more aces.

Overall, this heatmap provides insights into how different match statistics are related to each other, highlighting key relationships that could be significant in analyzing performance in tennis matches.

3.3. Regression

Through continuous experimentation and analysis of data using Excel-generated P-values, we discovered that height has an impact on both break point faced and break point saved. The table below includes various statistical measures such as coefficients, standard errors, t-statistics, P-values, and confidence intervals for each predictor variable. Specifically, they provide insights into how the independent variables, age, and height, influence the dependent variable, the break point faced, by showing the significance and magnitude of their effects.

The Table 4 below presents the regression data related to the impact of age and height on break point faced.

The result also reveals that winner_ht has a negative effect on break point faced (t= -2. 042, p= 0. 042), but winner_age does not have a significant effect on break point faced (t= 0. 778, p= 0. 778).

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Table 4: Regression data bpfaced

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.14979224							
R Square	0.02243771							
Adjusted R Square	0.01246259							
Standard Error	4.28870356							
Observations	199							
ANOVA								
	df	SS	MS	F	Significance F			
Regression	2	82.745106	41.372553	2.24936671	0.10818198			
Residual	196	3605.02374	18.3929783					
Total	198	3687.76884						
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	6.87390488	1.94866918	3.52748684	0.00052251	3.03085406	10.7169557	3.03085406	10.7169557
winner_ht	-0.0124726	0.00609675	-2.0457799	0.04211378	-0.0244963	-0.000449	-0.0244963	-0.000449
winner_age	0.02238875	0.07938308	0.28203429	0.77821479	-0.1341659	0.1789434	-0.1341659	0.1789434

Table 5: Regression data bpsaved

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.14491222							
R Square	0.02099955							
Adjusted R Square	0.01100975							
Standard Error	3.2878287							
Observations	199							
ANOVA								
	df	SS	MS	F	Significance F			
Regression	2	45.4466182	22.7233091	2.10209923	0.12494626			
Residual	196	2118.72424	10.8098175					
Total	198	2164.17085						
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	4.79590148	1.49389911	3.21032487	0.00154944	1.84972146	7.7420815	1.84972146	7.7420815
winner_ht	-0.0093954	0.00467392	-2.0101837	0.0457826	-0.0186131	-0.0001778	-0.0186131	-0.0001778
winner_age	0.02504743	0.06085708	0.41157794	0.68109852	-0.0949713	0.14506618	-0.0949713	0.14506618

The following is the regression data in Table 5 above in as far as the effect of age and height on break point saved is concerned where the result also reveals that winner_ht has a negative effect on break point faced (t= -2. 204, p= 0. 045) but winner_age does not have a significant effect on break point faced (t= 0. 681, p= 0. 499).

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4. Conclusion

These results support previous research that has highlighted the significance of physical characteristics in predicting tennis performance. For instance, Berdejo-del-Fresno et al. [3] pointed out the importance of body composition in Spanish tennis players and how aspects such as height can affect performance. In the same way, Ferrauti, Ulbricht, & Fernandez-Fernandez [5] pointed out the importance of physical performance tests in the individual training prescription, which is in line with our finding that height is positively related to serving effectiveness. Kovalchik & Reid [6] also pointed out differences in physical requirements between junior and professional players which supports our conclusions regarding the effects of physical characteristics in professional environments.

The work differs from Makuts & Vysochina [2] who concentrated on the psychological and technical-tactical fitness of tennis players with more emphasis on the psychological aspect of tennis training. Although they stressed psychological well-being, our study did not reveal any adverse effect of age on performance, which indicates that physical characteristics such as height have a much greater influence on serving effectiveness. Furthermore, Wang [4] examined the psychological aspects like pre-competition anxiety that were not discussed in this study and which were not given much attention in our study while our study was confined to physical and technical factors.

We moved the research forward by using a large sample of data from the ATP 2024 season and using descriptive statistics, Pearson correlation analysis, and linear regression, which enabled us to compare the effect of physical characteristics on different performance indicators in a more accurate and up-to-date manner compared to prior research. Furthermore, by including a large number of KPIs and employing regression models, we were able to provide a more detailed analysis of how physical attributes affect the technical parameters of the game, namely serving and returning.

The findings of the present study have important implications for coaching and players' development. Based on our results, we recommend that training sessions should be personalized according to the physical characteristics of the players, focusing on the advantages of the tall players in serving situations, which is in line with Vernon, Farrow, & Reid [7] who talked about anticipatory skills in returning serves and proposed that physical attributes can be used to improve on these skills. The findings also underscore the need for a combination of physical and mental and psychological training, as proposed by Kolman et al. [8] in their study on youth tennis players.

A major drawback is that psychological and environmental factors are not considered, which can also affect performance which is well illustrated when compared to other works such as Wang [4] where the author focused on the psychological factors that influence performance. Moreover, the present study was conducted only on ATP players and only males, which restricts the generalization of the results to female players and players at other levels of competition. The use of a single dataset also has the disadvantage that certain specific characteristics and outliers of other seasons or datasets may not be detected.

Further research should take into account psychological, environmental, and technical aspects of the problem, which could include both male and female players at various levels of play, to ensure that the results are generalizable. Furthermore, employing more complex models [9] and data feeds, including motion capture and real-time analysis, may offer further insights into the particular techniques and approaches that capitalize on physical characteristics.

It is for this reason that we suggest that tennis training programs should incorporate a more individualistic approach when it comes to the physical makeup of the players. Thus, coaches should aim at developing the positive aspects and masking the negative aspects related to certain body characteristics as highlighted by Barbaros-Tudor, Matkovic, & Rupcic [10]. Furthermore, the

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inclusion of psychological training as proposed by Makuts & Vysochina [2] can assist players in the acquisition of a range of skills that include mental toughness and strategic thinking. Last but not least, the use of advanced analytics and technology can help in getting real-time feedback and data analysis, which can enhance training and performance.

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