ORIGINAL ARTICLE

Comparison of match-play characteristics of junior and professional tennis players

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ABSTRACT

The main purpose of this study was to compare the match-play characteristics of junior and professional tennis players on clay, grass, and hard courts. The match-play characteristics of players who competed and won the matches in the first-round singles main draws of the 2022 French Open, Wimbledon, and US Open Tournaments were obtained from the official web pages. A total of 576 matches (junior = 192, professional = 384) consisting of 288 males and 288 females were analysed. The results of the study indicated that professional players demonstrated significantly higher average set duration and ace per set than juniors on each of the court surfaces. Junior boys had significantly higher return points won on grass and hard courts than professionals. Professional female players performed significantly higher first serve points won and total points won on grass court than junior girls. It was observed that in professional males the variables of first serve points won, ace per set, and double faults per set were significantly higher on grass and hard courts, compared to clay court. Moreover, females performed significantly higher unforced errors per set than males on each of the courts.

Keywords: Performance analysis, Grand slams, Racket sports, Match-play outcomes, Court surface, Match analysis.

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INTRODUCTION

Sport performance is influenced by a multitude of interconnected factors that encompass physiological, psychological, and environmental dimensions (Bali, 2015). Physiologically, an athlete's fitness level, including their fatigue, muscular strength, and flexibility, significantly impacts their performance (Paul et al., 2016; Verschueren et al., 2020). Additionally, nutrition plays a crucial role, as optimal fuelling and hydration contribute to sustained energy levels and enhanced endurance (Malsagova et al., 2021). From a psychological perspective, an athlete's mindset, self-confidence, motivation, and ability to manage stress directly influence their performance outcomes (Murphy, 2012). Moreover, environmental factors such as weather conditions, altitude, and facilities' accessibility can either bolster or impede performance (Davids & Baker, 2007; Brocherie et al., 2015; Bishop & Girard, 2013). The complex interaction among these factors underscores the need for a holistic approach when considering strategies for enhancing sports performance (Bali, 2015; Gomez-Ruano et al., 2020).

The utilization of performance analysis in sports has arisen as a crucial method for improving athletes' and teams' results, as it offers a data-centred structure to enhance training, tactics, and decision-making processes (Hughes & Franks, 2004). Therefore, computerized systems for sports analysis were developed to document athletes' movements and technical manoeuvres, leading to subsequent explorations through descriptive investigations across diverse sports (McGarry et al., 2002). The analysis of match and training performances seeks to uncover both the strengths and areas that require improvement of the players, with the goal of detecting the important training priorities (Lames & McGarry, 2007).

Notational analysts focus on enhancing and assessing sports performance, relying heavily on video analysis and related technology (Hughes & Bartlett, 2002). With increasing technological accessibility to athletes in various sports, the field of performance analysis has advanced over recent years, demonstrating its crucial role in athlete growth, coaching methods, and a substantial edge in competition (Krizkova et al., 2021). During the past few years, a growing body of literature on sports sciences is focused on performance analysis of racket sports such as tennis, table tennis, and squash (Lees, 2003). Technological progress, encompassing visual tracking systems and wearable sensors, has simplified the analysis of the specific requirements in tennis (Pluim et al., 2023). With the similar purpose of the present study, Martin & Prioux (2016) also analysed the match-play statistics of tennis competitions. The present study investigated three different questions of: (1) Are there any differences between junior and professional tennis players in terms of match-play variables on different court surfaces? (2) Are there any court surface related differences in match-play characteristics for both junior and professional players? (3) Are there any differences between male and female tennis players in terms of match-play characteristics on different court surfaces? With the purpose of investigation of these three questions, the present study is different from the study of Martin & Prioux (2016). In addition, the included matches that played on the hard court took place in Australian Open Tournament, while the matches played on the hard court surface in the present study was in the US Open Tournament.

METHOD

The match-play characteristics of players who competed and won the matches in the first-round singles main draws of the 2022 French Open, Wimbledon, and US Open Tournaments were obtained from the official web pages. A total of 192 junior (girls = 96, boys = 96) and 384 professional (women = 192, men = 192) matches (192 matches from each tournament) for each tournament) were analysed. No missing matches or injured players who could not complete their matches were found in tournaments.

The data were collected from the official websites of the three included tournaments. Then, collected data were manually transferred to Microsoft Excel (Microsoft Corp., Version 2016) software. The entire data were double-checked by the authors. Subsequently, the data were transferred to SPSS 27 (IBM Corp., 2020) software to conduct the statistical analysis. Prior to statistical analyses, the normality of the data was checked for each of the analyses. The only non-normal distributed data were males' ace and unforced error variables. However, according to Ghasemi and Zahediasl (2012), violation of normality of data could not cause biased estimations with a sample size larger than 30 or 40. As a result, non-normality of these variables was ignored. One way analysis of variance (ANOVA) was used to measure the effects of court surface. An independent samples t-test was used to analyse the gender and competitive level differences. To measure the effect size in t-tests, Cohen's d (Cohen, 1988) was used and classified as: 4.0 (extremely large) effect sizes (Hopkins et al., 2009). Besides, eta squared (η^2) was calculated in ANOVA as: $\eta^2 = 0.01$ (small), $\eta^2 = 0.06$ (medium), $\eta^2 = 0.14$ or higher (large) (Cohen, 1988).

RESULTS

Table 1 represents the descriptive statistics of female players by court surface and t-test results. Three statistically significant differences in match-play characteristics were found in matches played on grass court. Results indicated that professional female players showed a significantly ($p < .05$, d = -0.50) higher percentage of winning first serve points, compared to juniors. Moreover, junior female players performed significantly ($p < .01$, d = 1.27) more unforced errors per set than professional female players. Moreover, professional female players performed significantly ($p < .05$, d = 0.43) higher total points when compared to junior players. No statistically significant differences observed among the other match-play characteristics on grass court. The results demonstrated not statistically significant ($p > .05$) differences between junior and professional players in any of the match-play characteristics on clay court. Since there were no data of winner per set, unforced error per set, net points won and total points won for junior players on the official website of Rolland Garros Tournament, comparison could not be made. On hard court, the results revealed that professional female players had significantly ($p < .05$, d = -0.62) higher average set duration than juniors. Furthermore, junior female play performed significantly ($p < .05$, d = 0.53) higher return points won than professionals. The other characteristics were observed to be similar ($p > .05$).

The descriptive statistics of male players by court surface and t-test results are given in Table 2. The results showed that professional players obtained a significantly ($p < .05$, d = -0.50) higher average set duration than juniors on grass court. In addition, aces per set of professional players was significantly ($p < .05$, d = -0.46) higher than junior players. Junior players performed significantly ($p < .01$, d = 0.86) higher percentage of return points won. Professional players won significantly ($p < .01$, d = -1.87) higher total points than juniors. The reason for this difference may be that professional matches are played over 5 sets. The other match-play characteristics on grass court were similar ($p > .05$). On clay court, professional players performed significantly ($p < .05$, d = -0.50) higher average set duration, compared to juniors. Additionally, they performed significantly ($p < .05$, d = -0.53) higher aces per set. Junior players were observed to have significantly ($p < .01$, d = 0.61) higher double fault per set, compared to professionals. No other significant differences were found on clay court. Additionally, no data were found on winner per set, unforced error per set, net points won and total point won were found on the official website of Roland Garros Tournament. Thus, comparison was not possible for these characteristics. On hard court, professionals performed significantly ($p < .05$, d = -5.52) higher average set duration than juniors. They also performed significantly ($p < .05$, d = -0.61) higher aces per set. Junior players were observed to have a significantly higher percentage of break points ($p < .05$, d = 0.56) and return points won ($p < .01$, d = 0.70). Professional players acquired significantly ($p < .01$, d = -1.94) higher total points won, compared to juniors. This difference may have been caused by the fact that

the matches of professionals are played over 5 sets. The other match-play characteristics on hard court were similar ($p > .05$).

Table 1. Descriptive statistics of female players by court surface and t-test results.

Match-play characteristics	Junior	Professional	*t*	*p*	*d*
Grass court					
1st serve (%)	59.78 ± 7.06	62.47 ± 7.30	-1.720	.089	*0.37*
1st serve points won (%)	68.94 ± 7.31	72.68 ± 7.70	-2.286	.024	*-0.50*
2nd serve points won (%)	48.97 ± 12.25	53.02 ± 11.25	-1.613	.110	*-0.35*
Average set duration (min)	40.95 ± 6.57	40.05 ± 8.84	-0.507	.613	*0.11*
Aces per set (#)	1.04 ± 1.03	1.28 ± 1.22	-0.974	.332	*-0.21*
Double faults per set (#)	1.83 ± 1.19	1.52 ± 1.13	1.269	.207	*0.28*
Winner per set (#)	9.90 ± 4.26	9.38 ± 2.95	0.692	.491	*0.15*
Unforced error per set (#)	14.76 ± 4.29	9.92 ± 3.57	5.853	.001	*1.27*
Net points won (%)	61.75 ± 17.68	65.10 ± 17.44	-0.886	.378	*-0.19*
Break points won (%)	50.47 ± 19.44	55.17 ± 18.47	-1.156	.251	*-0.25*
Return points won (%)	48.69 ± 6.22	47.47 ± 6.43	0.884	.379	*0.19*
Total points won	83.44 ± 19.33	75.50 ± 17.80	2.001	.048	*0.43*
Clay court					
1st serve (%)	61.31 ± 7.23	63.05 ± 8.73	-0.969	.335	*-0.21*
1st serve points won (%)	64.50 ± 8.11	67.84 ± 9.25	-1.737	.086	*-0.38*
2nd serve points won (%)	50.5 ± 11.95	51.72 ± 11.95	-0.495	.621	*-0,11*
Average set duration (min)	42.19 ± 7.07	42.44 ± 8.00	-0.155	.877	*-0.03*
Aces per set (#)	0.83 ± 0.91	1.14 ± 1.04	-1.456	.149	*0.31*
Double faults per set (#)	1.64 ± 1.36	1.35 ± 0.99	1.153	.252	*0,25*
Winner per set (#)	-	10.70 ± 3.59	-	-	-
Unforced error per set (#)	-	10.67 ± 3.62	-	-	-
Net points won (%)	-	69.56 ± 17.63	-	-	-
Break points won (%)	51.63 ± 13.79	50.92 ± 13.79	0.237	.813	*0,05*
Return points won (%)	49.75 ± 5.69	50.42 ± 5.69	-0.504	.615	*-0,11*
Total points won	-	-	-	-	-
Hard court					
1st serve (%)	60.66 ± 6.53	62.47 ± 7.74	-1.137	.258	*-0.25*
1st serve points won (%)	68.16 ± 10.76	71.58 ± 8.57	-1.690	.094	*-0.37*
2nd serve points won (%)	54.44 ± 13.25	51.81 ± 10.95	1.031	.305	*0.22*
Average set duration (min)	39.22 ± 9.42	44.46 ± 7.96	-2.859	.005	*-0.62*
Aces per set (#)	1.17 ± 0.95	1.65 ± 1.47	-1.666	.099	*-0.36*
Double faults per set (#)	1.60 ± 0.95	1.68 ± 1.10	-0.353	.725	*-0.08*
Winner per set (#)	9.64 ± 3.52	10.19 ± 3.56	-0.712	.478	*-0,15*
Unforced error per set (#)	13.15 ± 7.40	11.05 ± 4.22	1.766	.081	*0.38*
Net points won (%)	65.25 ± 19.81	69.48 ± 15.93	-1.130	.261	*-0.25*
Break points won (%)	49.19 ± 18.11	54.89 ± 17.08	-1.511	.134	*-0.33*
Return points won (%)	51.25 ± 7.65	47.47 ± 6.89	2.444	.016	*0.53*
Total points won	76.53 ± 16.75	76.72 ± 14.77	-0.056	.955	-0.01

Note. # - number.

The ANOVA results for the effects of playing surface in junior and professional players are given in Table 3. No statistically significant ($p > .05$) effect of court surface on any match-play characteristics was observed in junior girls. In addition, there was a lack of data on characteristics of winner per set, unforced error per set, net points won and total points won in the official website of Roland Garros Tournament. Therefore, comparison was not made. In professional female players, court surface was found to be significantly effective in terms of percentage of first serve points won ($p < .05$, $\eta^2 = 0.06$), average set duration ($p < .05$, $\eta^2 = 0.05$) and return points won ($p < .05$, $\eta^2 = 0.04$). Post hoc results revealed that professional female

players performed significantly higher percentage of first serve points won on grass and hard courts, than on clay court.

Table 2. Descriptive statistics of male players by court surface and t-test results.

Match-play characteristics	Junior	Professional	*t*	*p*	*d*
Grass court					
1st serve (%)	62.59 ± 8.82	62.64 ± 6.27	-0.030	.976	*-0.01*
1st serve points won (%)	78.59 ± 7.87	77.13 ± 6.66	0.958	.340	*0.21*
2nd serve points won (%)	55.28 ± 11.71	56.80 ± 7.57	-0.765	.446	*-0.17*
Average set duration (min)	36.80 ± 6.91	40.51 ± 7.68	-2.304	.023	*-0.50*
Aces per set (#)	2.09 ± 1.40	2.89 ± 1.89	-2.113	.037	*-0.46*
Double faults per set (#)	1.14 ± 0.66	1.18 ± 0.73	-0.273	.785	*-0.06*
Winner per set (#)	10.25 ± 2.83	10.96 ± 3.15	-1.079	.283	*-0.23*
Unforced error per set (#)	9.78 ± 3.91	8.74 ± 2.90	1.465	.146	*0.32*
Net points won (%)	71.66 ± 10.11	69.33 ± 8.08	1.222	.225	*0.26*
Break points won (%)	54.97 ± 21.17	47.88 ± 18.78	1.672	.098	*0.36*
Return points won (%)	45.56 ± 6.58	40.27 ± 5.93	3.975	.001	*0.86*
Total points won	72.59 ± 15.31	122.89 ± 31.00	-8.651	.001	*-1.87*
Clay court					
1st serve (%)	62.97 ± 7.60	63.95 ± 6.04	-0.690	.492	*-0.15*
1st serve points won (%)	71.63 ± 7.38	72.59 ± 7.65	-0.592	.556	*-0.13*
2nd serve points won (%)	55.78 ± 10.39	56.20 ± 9.89	-0.194	.847	*-0.04*
Average set duration (min)	39.67 ± 7.98	43.66 ± 8.00	-2.302	.024	*-0.50*
Aces per set (#)	0.99 ± 1.01	1.72 ± 1.51	-2.452	.016	*-0.53*
Double faults per set (#)	1.17 ± 0.85	0.77 ± 0.55	2.829	.006	*0.61*
Winner per set (#)	-	10.48 ± 3.26	-	-	-
Unforced error per set (#)	-	8.61 ± 2.69	-	-	-
Net points won (%)	-	71.88 ± 9.25	-	-	-
Break points won (%)	52.38 ± 16.67	47.19 ± 15.58	1.502	.136	*0.33*
Return points won (%)	46.41 ± 8.23	44.16 ± 6.91	1.410	.162	*0.31*
Total points won	-	-	-	-	-
Hard court					
1st serve (%)	60.16 ± 6.67	60.28 ± 6.17	-0.091	.928	*-0.02*
1st serve points won (%)	77.03 ± 7.40	76.98 ± 6.89	0.031	.976	*0,01*
2nd serve points won (%)	55.69 ± 11.52	55.59 ± 8.98	0.044	.965	*0.01*
Average set duration (min)	39.35 ± 10.79	43.70 ± 7.01	-2.378	.019	*-0.52*
Aces per set (#)	2.06 ± 1.60	3.01 ± 1.56	-2.778	.007	*-0.61*
Double faults per set (#)	1.32 ± 0.95	1.33 ± 0.94	-0.019	.985	*-0.01*
Winner per set (#)	9.28 ± 2.49	10.50 ± 3.25	-1.862	.066	*-0.40*
Unforced error per set (#)	9.41 ± 3.27	9.22 ± 3.10	0.232	.817	*0.05*
Net points won (%)	67.94 ± 14.07	70.61 ± 15.46	-0.822	.413	*-0.18*
Break points won (%)	57.88 ± 20.41	48.20 ± 15.44	2.591	.011	*0.56*
Return points won (%)	46.31 ± 8.29	41.55 ± 5.87	3.253	.002	*0.70*
Total points won	72.13 ± 17.62	120.23 ± 27.64	-8.964	.001	-1.94

Note. # - number.

Average set duration of females was significantly higher on hard court than grass court. Additionally, percentage of return points won on clay court surface was significantly higher than on grass and hard courts. There were no data on total points won on official website of Roland Garros Tournament. Therefore, it was not possible to compare these characteristics. The other match-play characteristics were not significantly (p > .05) different. On the other side, the percentage of first serve points (p < .01, η^2 = 0.14) and aces per set (p < .05, η^2 = 0.13) were found to be significantly affected by court surface in junior boys. Besides, they performed significantly higher percentage of first serve points won on grass court, compared to clay court.

Table 3. ANOVA results for the effects of playing surface in junior and professional players.

Match-play characteristics	***F***	***p***	***η²***	***Post hoc***
Girls				
1st serve (%)	0.391	.677	0.01	-
1st serve points won (%)	2.292	.107	0.05	-
2nd serve points won (%)	1.631	.201	0.03	-
Average set duration (min)	1.172	.314	0.03	-
Aces per set (#)	1.042	.357	0.02	-
Double faults per set (#)	0.365	.695	0.01	-
Winner per set (#)	-	-	-	-
Unforced error per set (#)	-	-	-	-
Net points won (%)	-	-	-	-
Break points won (%)	0.159	.853	0.01	-
Return points won (%)	1.227	.298	0.03	-
Total points won	-	-	-	-
Professional female players				
1st serve (%)	0.113	.893	0.01	-
1st serve points won (%)	5.662	.004	0.06	*C < G, H; G = H*
2nd serve points won (%)	0.272	.762	0.01	-
Average set duration (min)	4.558	.012	0.05	*H > G; C = G*
Aces per set (#)	2.763	.066	0.03	-
Double faults per set (#)	1.467	.233	0.02	-
Winner per set (#)	2.469	.087	0.03	-
Unforced error per set (#)	1.454	.236	0.02	-
Net points won (%)	1.436	.241	0.02	-
Break points won (%)	1.323	.269	0.01	-
Return points won (%)	4.313	.015	0.04	*C > G, H; G = H*
Total points won	-	-	-	-
Boys				
1st serve (%)	1.244	.293	0.03	-
1st serve points won (%)	7.5	.001	0.14	*G > C; G = H*
2nd serve points won (%)	0.018	.982	0.01	-
Average set duration (min)	1.045	.356	0.02	-
Aces per set (#)	6.832	.002	0.13	*C < G, H; G = H*
Double faults per set (#)	0.460	.633	0.01	-
Winner per set (#)	-	-	-	-
Unforced error per set (#)	-	-	-	-
Net points won (%)	-	-	-	-
Break points won (%)	0.636	.532	0.01	-
Return points won (%)	0.114	.892	0.01	-
Total points won	-	-	-	-
Professional male players				
1st serve (%)	5.842	.003	0.06	*C > H; G = C, H*
1st serve points won (%)	8.474	.001	0.08	*C < H, G; C = H*
2nd serve points won (%)	0.295	.745	0.01	-
Average set duration (min)	3.738	.026	0.04	-
Aces per set (#)	11.818	.001	0.11	*C < G, H; G = H*
Double faults per set (#)	9.47	.001	0.09	*C < G, H; G = H*
Winner per set (#)	0.461	.631	0.01	-
Unforced error per set (#)	0.648	.524	0.01	-
Net points won (%)	0.798	.452	0.01	-
Break points won (%)	0.062	.94	0.01	-
Return points won (%)	6.431	.002	0.06	*C > G; H = C, G*
Total points won	-	-	-	-

Note. # - number, G = Grass, H = Hard, C = Clay.

They also had significantly higher aces per set on grass and hard courts than on clay court. There were no data on winner per set, unforced error per set, net points won, and total points won on the official website of Roland Garros Tournament. Thus, comparison was not possible. The other characteristics were insignificant ($p > .05$). The results revealed that percentage of first serve ($p < .05$, $\eta^2 = 0.06$), percentage of first serve points won ($p < .01$, $\eta^2 = 0.08$), average set duration ($p < .05$, $\eta^2 = 0.04$), aces per set ($p < .01$, $\eta^2 = 0.11$), double faults per set ($p < .01$, $\eta^2 = 0.09$) and percentage of return points won ($p < .01$, $\eta^2 = 0.06$) were significantly affected by court surface in professional male players. Post hoc results showed that males had significantly higher percentage of first serve points won, aces per set, and double faults per set on grass and hard courts than on clay court surface. In contrast, they had significantly higher percentage of first serve on clay court than on hard court. Although there was a significant effect of court surface on average set duration, no significant differences were observed in the post hoc results. There were no data on total points won on the official website of Roland Garros Tournament. The other characteristics were found to be similar ($p > .05$).

Table 4. Gender differences by court surface.

Match-play characteristics	Grass			Clay			Hard		
	t	*p*	*d*	*t*	*p*	*d*	*t*	*p*	*d*
Juniors									
1st serve (%)	-1.409	.164	-0.35	-0.893	.375	-0.22	0.303	.763	*0.08*
1st serve points won (%)	-5.082	.001	-1.27	-3.677	.001	-0.92	-3.845	.001	*-0.96*
2nd serve points won (%)	-2.106	.039	-0.53	-1.887	.064	0.47	-0.403	.689	*-0.1*
Average set duration (min)	2.463	.017	0.62	1.334	.187	0.33	-0.051	.959	*-0.01*
Aces per set (#)	-3.455	.001	-0.86	-0.696	.489	-0.17	-2.713	.009	*-0.68*
Double faults per set (#)	2.91	.005	0.73	1.633	.108	0.41	1.163	.249	*0.29*
Winner per set (#)	-0.392	.697	-0.1	-	-	-	0.471	.639	*0.12*
Unforced error per set (#)	4.863	.001	1.22	-	-	-	2.616	.011	*0.65*
Net points won (%)	-2.752	.008	-0.69	-	-	-	-0.626	.534	*-0.16*
Break points won (%)	-0.886	.379	-0.22	-0.196	.845	-0.05	-1.801	.077	*-0.45*
Return points won (%)	1.95	.056	0.49	1.89	.063	0.47	2.475	.016	*0.62*
Total points won	2.487	.016	0.62	-	-	-	1.025	.309	*0.26*
Professionals									
1st serve (%)	-0.143	.887	-0.03	-0.683	.496	-0.12	1.769	.079	*0.31*
1st serve points won (%)	-3.488	.001	-0.62	-3.165	.002	-0.56	-3.932	.001	*-0.7*
2nd serve points won (%)	-2.231	.027	-0.39	-2.418	.017	-0.43	-2.137	.035	*-0.38*
Average set duration (min)	-0.311	.756	-0.06	-0.857	-.393	-0.15	0.579	.564	*0.1*
Aces per set (#)	-5.717	.001	-1.01	-2.508	.013	-0.44	-5.074	.001	*-0.90*
Double faults per set (#)	2.029	.045	0.36	4.169	.001	0.74	1.953	.053	*0.35*
Winner per set (#)	-2.93	.004	-0.52	0.36	.719	0.06	-0.517	.606	*-0.09*
Unforced error per set (#)	2.057	.042	0.36	3.661	.001	0.65	2.55	.012	*0.45*
Net points won (%)	-1.756	.082	-0.31	-0.929	.355	-0.16	-0.405	.686	*-0.07*
Break points won (%)	2.216	.028	0.39	1.441	.152	0.26	2.323	.022	*0.41*
Return points won (%)	6.586	.001	1.16	5.333	.001	0.94	5.235	.001	*0.93*
Total points won	10.606	.001	-1.88	-	-	-	11.108	.001	-1.96

Note. # - number.

Table 4 shows gender differences by court surface. The results showed that junior boys performed significantly higher percentage of first serve points won on grass ($p < .01$, d = -1.27), clay ($p < .01$, d = -0.92) and hard ($p < .01$, d = - 0.96) courts. Gender difference in average set duration was present only on grass court. Junior girls performed significantly higher average set duration ($p < .05$, d = 0.62) on grass court. Junior boys performed significantly higher aces per set on grass ($p < .01$, d = -0.86) and hard ($p < .01$, d = -0.68) courts. Double faults per set were significantly higher in junior girls ($p < .01$, d = 0.73) on grass court. Gender

difference in double faults per set was not significantly ($p > .05$) present on clay and hard courts. Junior girls were observed to have significantly higher unforced errors per set on grass ($p < .01$, d = 1.22) and hard (p < .05, d = 0.65) courts. Junior boys performed significantly higher percentage of net points won on grass court ($p < .01$, d = -069). Gender difference in percentage of return points won was observed on clay ($p < .05$, d = 0.47) and hard ($p < .05$, d = 0.62) courts. Junior females performed significantly higher percentage of return points won. Only gender difference in total points won was observed to be on grass court ($p < .05$, d = 0.62). Junior females performed significantly higher total points won on grass court.

There was no significant ($p > .05$) gender difference observed in match-play characteristics of second serve points won, winner per set and break points won in any of the courts. Additionally, there was no data on winner per set, unforced error per set, net points won and total points won in the official website of Roland Garros Tournament. This caused the comparison was not made. In professional players, gender difference in match-play characteristics of percentage of first serve points won, percentage of second serve points won, unforced error per set and return points won was significantly present on grass, clay and hard courts. Professional male players performed significantly higher percentage of first serve points won on grass ($p < .01$, d = -0.62), clay ($p < .01$, d = -0.56) and hard ($p < .01$, d = -0.70) courts, compared to females. Males performed significantly higher percentage of second serve points won on grass ($p < .05$, d = -0.39), clay ($p < .05$, d = -0.43) and hard ($p < .05$, d = - 0.38) courts. Gender was significantly effective in aces per set in three courts. Males performed significantly higher aces per set on grass ($p < .01$, d = -1.01), clay ($p < .05$, d = -0.44) and hard ($p < .01$, d = -0.90) courts. Females performed significantly higher double faults per set on grass ($p < .05$, d = 0.36) and clay ($p < .05$, d = 0.74) courts. Grass court was the only court that gender difference in winner per set was present. On grass court, males performed significantly higher winner per set than females ($p < .01$, d = -0.52). Gender was significantly effective in unforced error per set in each three courts. Females performed significantly higher unforced error per set on grass ($p < .05$, d = 0.36) clay ($p < .01$, d = 0.74) and hard ($p < .05$, d = 0.35) courts. Females performed significantly higher percentage of break points won on hard court ($p < .05$, d = 0.41). Gender difference in percentage of return points won was observed to be in three courts. Females performed significantly higher percentage of return points won on grass ($p < .01$, d = 1.16), clay ($p < .01$, d = 0.96) and hard ($p < .01$, d = 0.93) courts. At the same time, gender was significantly effective in terms of total points won on grass ($p < .01$, d = -1.88) and hard ($p < .01$, d = -1.96) courts. No data on total points won on clay court was found in the official website of Roland Garros Tournament. Accordingly, no comparison was made. No significant ($p > .05$) gender difference was found in percentage of first serve, average set duration and net points won in any of court surfaces.

DISCUSSION

The main purpose of this study was to examine the match-play characteristics of match-winning tennis players and compare these characteristics of junior and elite players. It was also aimed in this study to observe the influence of court surface and gender on match-play characteristics. The findings of the study revealed that on each of the court surfaces, professional players exhibited notably longer average set durations and a higher number of aces per set compared to junior players. When compared to junior girls, boys demonstrated significantly higher return points won on grass and hard-court surfaces. Professional females performed significantly higher unforced errors per set than males, regardless of the court surface. Court surface had a significant effect on professional males. The variables of first serve points won, ace per set, and double faults per set were significantly lower on clay court, compared to grass and hard surfaces in males.

Regardless of court surface, aces per set were significantly higher in professional males when compared to junior boys. Additionally, professional females were significantly better at winning first serve points than junior girls. These findings were consistent with the findings of Fernández-García et al. (2020). Kovalchik & Reid (2017) indicated that professional males had significantly higher first serve points won than junior boys but there were no significant differences for females. On the contrary, it was observed in the results of this study that females had significantly higher first serve points than juniors on clay, grass, and hard court surfaces. This inconsistency may be caused by the by the reason that Kovalchik & Reid (2017) included the match data of different year intervals (from 2000 to 2015), while this study included only Grand Slam Tournaments that took place in the year 2022. Furthermore, no data on Australian Open Tournament were included in the present study.

This study reported that there were significantly higher aces and double faults on grass and hard courts than on clay court in the professional males' category. Similarly, Söğüt (2019) investigated a total of 5138 (clay = 1631, grass = 527, hard = 2980) ATP matches in males' singles category and observed that significantly more aces and double faults were performed on grass court surface than on both other courts. In relation to this difference, Martin & Prioux (2016) stated that court surface have influence on players' playing style, while these differences of match-play characteristics were caused by two main factors as coefficient of friction and coefficient of restitution of different court surfaces. Thus, it may be concluded from these studies that professional male players tend to perform more aces and double faults as type of court surface gets faster.

Gale-Ansodi et al. (2017) investigated gender-related match-play characteristics with a total of 98 (female = 49, male = 49) high-ranked tennis players with a mean age of 14.0 ± 2.9. According to the results of the study, males performed significantly higher distance covered, maximum speed, and average speed than females. Another study (Breznik, 2013) was conducted to examine the advantages and disadvantages of being right-handed or left-handed in males and females. It was observed in the results that only in males' category, it was significantly more advantageous to be left-handed in players. It can be deducted from these results that when comparing genders and handedness, being a left-handed male is the greatest advantage in terms of demonstrating a better match performance in tennis.

There were several limitations of this study. The first limitation was that there were no data available on match-play characteristics of 2022 Australian Open Tournament on the official website of the tournament. Thus, the inclusion of matches played on 2022 Australian Open was not possible. However, same as Australian Open, US Open Tournament is played on hard court surface as well. Eventually, data of matches played on hard court were able to be reached. The second limitation was that no data of junior players on variables of winner per set, unforced error per set, and net points won were found in the official website of Rolland Garros Tournament. Additionally, total points won were not accessible for both juniors' and professionals' categories. This study investigated match-play characteristics of Wimbledon, US Open and Rolland Garros Tournaments that took place in the year 2022. Future research may focus on long-term comparison of these characteristics to provide non-exceptional results and prevent coincidental findings.

These findings highlight the importance of proper training programs for each age and court surface. There are several suggested practical implications of this study for coaches and athletes. Firstly, when training a tennis athlete, more importance should be given on court-based long-term and short-term training methods to improve the athletes' surface-related performance. Secondly, coaches should take into account the statistical match-play differences between junior and professional players to obtain more accurate information on what causes these differences. Furthermore, gender- based training on different court surfaces should be

applied on both junior and professional athletes. Longitudinal studies are required to have a deeper understanding on athletes' match-play performance and various facets of training methods.

CONCLUSION

This study examined the differences of match-play characteristics of junior and professional tennis players on clay, grass and hard-court surfaces. Professional players exhibited notably greater average set duration and aces per set compared to junior players across all court surfaces. There were notably higher return points won on grass and hard courts in junior boys than on professionals. Professional females displayed notably higher rates of first serve points won and total points won on grass courts. It was evident that among professional male players, metrics such as first serve points won, aces per set, and double faults per set were significantly elevated on grass and hard courts when contrasted with clay courts. Junior boys showcased a significantly higher percentage of first serve points won in comparison to junior girls on grass, clay, and hard courts. In professional male players, there were notably higher levels of first serve points won and aces per set when compared to their female counterparts across all three court types. This study may be a guideline for coaches and players, in terms of training methods. Further longitudinal studies are required to obtain new perspectives related to well-shaped training programs.

AUTHOR CONTRIBUTIONS

Ulusoy, İ.T.: Conception and design; analysis and interpretation of the data; article writing; review of the article final text. Söğüt, M.: Conception and design; analysis and interpretation of the data; revising it critically for intellectual content.

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