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How did Top 100 Women's Tennis Association (WTA) Players Succeed: an Analysis of Player Rankings

Abstract

Achieving a Top 100 Women's Tennis Association (WTA) ranking is one of the most important markers in professional tennis. The financial benefits of having a ranking inside the Top 100 are considerable compared to individuals who do not achieve this ranking threshold. Sport governing bodies, sports agencies, parents and coaches spend significant resources on the development of professional talent and having a better understanding of the pathway to succeed will aid in decision making along the journey. The data was collected from WTA online source for ranking information in 2014. The individuals were ranked in the Top 100 were analyzed to determine different ranking statistics from the beginning of their professional career. Descriptive statistics, ratio analysis and regression analysis were used to analyze the data and compare the pathways of the different individuals. The average age of the population was 25.21 years ($\pm$ 4.12), height 174.08cm ($\pm$ 6.93), weight 63.75kg ($\pm$ 5.25). The age when first reached Top 1000 was 15.91 ($\pm$ 0.95); Top 500 16.84 ($\pm$ 1.10); Top 300 17.64 ($\pm$ 1.23); Top 200 18.60 ($\pm$ 1.57); Top 100 19.75 ($\pm$ 1.90). Differences were seen in the age when achieved the first Top 100 between the Top 10 compared to the Top 100. It takes an average of approximately four years for a female professional tennis player to progress to the Top 100 in the world. The top 10 players in the world have a significantly different pathway to achieve a Top 100 ranking.

Keywords: benchmark; player development; pathway.

Introduction

Achieving a Top 100 Women's Tennis Association (WTA) ranking is one of the most important markers in professional tennis. This allows players to have direct entry into the four major Grand Slam tournaments and to be able to play a top level professional schedule. The financial benefits of having a ranking inside the Top 100 are considerable compared to individuals who do not achieve this threshold. Sport governing bodies, sports executives, sports agencies, parents and coaches spend significant resources on the development of professional talent and having a better understanding of the pathway to succeed will aid in decision making along the journey. The WTA ranking system has been in effect since 1975 and the ranking system is a highly transparent and measurable scale that can be utilized for a number of important decisions. Over the past few decades the game of tennis at the professional level

has changed significantly.[1] Most of the major national governing bodies and sports federation ns evaluate the tennis strength of a country by the number of players in the top 100 and is believed to provide an insight into the professional tennis depth of that Federation/country.[2] The financial investments to develop elite level tennis athletes is considerable. Many of the major tennis nations spend millions of dollars per year on athlete/player development programs. For example in 2013 the Lawn Tennis Association of Great Britain spent over £12 million [3] and in 2012 Tennis Australia spent AUS$24 million [4] on athlete and player development. Other major countries like the United States and France also spend significant funds on the current and future development of top professional tennis players. Developing a professional tennis player has been calculated to cost between $121,000-$197,000 per year.

(5) These fees include coaching, travel, equipment, training expenses etc. It is not realistic (or in many cases financially feasible) for sports governing bodies and tennis federations to financially support all the best juniors for a 10 year development period. Therefore, it is important to use the best available data to determine how best to allocate the finite financial and human (coaches/ trainers/ medical, etc) capital for the greatest long term success. Just like all the major professional sports teams (American football, baseball, soccer, basketball etc) use different metrics to determine how best to allocate resources to have the best teams on the field - so must tennis federations and leaders in the industry.

Hundreds of studies now exists in nearly every sport designed to help teams, coaches and sports federations to make more informed and educated decisions about how best to select athletes during the development years and how certain metrics may correlate with future sports success.[6] Similar data has been also used to determine/evaluate career decrease in performance (which helps teams to have a better idea about when to release/cut a player.[7,8] Over the past decade a number of very beneficial studies have been performed looking at the tennis careers of tennis players over multi-decade periods.[9] However, the majority of these studies have focused on the male tennis player and more studies are needed looking at the female tennis athlete data. This type of information is very beneficial to look at long term changes in career paths, win/loss ratios and ranking type information over an extended period of time with a large dataset. One of the most critical periods for a prospective professional tennis player is the transition period between junior tennis and the minor leagues of professional tennis. The transition between junior and professional competition has been modelled using linear regression, and has found junior ranking to be a statistically significant, although minor, (5 and 13% of variance explained for boys and girls, respectively), predictor of senior ranking for girls [10] and boys.[11] The relationship between junior success and the resultant performance in professional competition may have some predictive relationships, it is no definitive.[12] A study that looked at benchmark data for the Top 100 in male professional tennis was conducted on data back in 2009 and mean age of 21.5 (+ 2.6 years of age) and 29 athletes entered the Top 100 as teenagers.[13] The need exists for more current data and also data looking at similar variables in the female professional tennis player. The challenge in tennis, is that the game has changed rather dramatically over the past decade that historically data may not be that beneficial for making decisions today and into the future. Therefore, the purpose of this study was to evaluate the current Top 100 WTA Professionals in 2014 and highlight ranking and performance milestones to highlight how they have achieved career success in professional tennis.

Methods

Data used in this study were obtained from the public domain at the official WTA Online Ranking Database. [14] The 100 names, countries and date of birth information of players ranked 1-100 in the WTA rankings were extracted for the rankings listed on July 28th, 2014.[15] The year-end professional rankings of these players were tracked from the date that they first reached a Top 1000 WTA ranking to the July 28th, 2014 ranking. Age data was used for all calculations related to ranking and age milestones. A random sample of 20 athletes (20%) was selected and manually checked for accuracy. 100% of these data were verified to be accurate. Rankings for athletes who were not ranked in the Top 100 at the time of the analysis were not otherwise considered. A series of key "milestones" in the careers of elite tennis athletes were determined. Five major ranking milestones were determined based on the age when the athlete first reached the following ranking milestone: Top 1000, Top 500, Top 300, Top 200 and Top 100. Another milestone of interest was titled "Tennis Evolution Time" or "TET" defined as the first time the athlete achieves a ranking inside the Top 1000 to the athlete first being ranked inside the Top 100.

Statistical Analysis

Selected variables were subjected to descriptive statistical analyses, ratio analysis and regression analysis were used to evolve a working profile of the players. All statistical computations and analyses were done using the R statistical platform (R Core Team, Vienna, Austria, 2014).[16] To facilitate comparisons and contrasts as a function of ranking, a new variable was introduced. This variable, ranking level, created three ranking bands: Top 10, Top 11-50 and Top 51-100. This division into three parts, which has been used in previous studies,[17] represents a slight departure from the usual top 10, top 50 and top 100 breakdown. From the standpoint of statistics it has the advantage of providing three independent subsets. Benchmark age variables (e.g., age at which top 100 ranking was achieved) were checked for normality using the Shapiro-Wilk Normality test as well as graphically. Ordinary Regression Analyses (ORA) were conducted between selected variables to check for associations that might exceed random chance. To compare the effects on players of being within different ranking bands, ANOVA analyses were performed where appropriate (i.e., data pass normality test) or T-tests.

Table 1
Demographic, physical, ranking and status variables analyzed

Demographic	Physical	Ranking Milestones	Status Milestones
Name	Height	Year Turned Pro	Current Ranking
Country	Weight	Age Ranked Top 1000	Career Best Ranking
Region	Handedness	Age Ranked Top 500	Weeks Top 100
Current Age		Age Ranked Top 300	Weeks Top 50
Date of Birth		Age Ranked Top 200	
Year of Birth		Age Ranked Top 100	

Results

The average age of the Top 100 professional female tennis players was 25.21 years and the average number of years that the individuals in the current Top 100 have had a professional ranking has been approximately 10 years. However, the average age the players first entered the Top 100 was 19.75. The current top 10 players (18.20 + 1.60) achieved the Top 100 ranking 1.55 years sooner than the entire Top 100 (19.75 +1.90) (Figure 2). The average height is rather consistent, but a non-significant trend is seen for the higher ranked players to be slightly taller (Table 2). In the sample analyzed the average career high ranking of the entire Top 100 was 30.54 (+ 23.6). Only 8% (8/100) of the players are left handed.

Table 2
Statistical comparison of top 10, 11-50 and top 100 rankings on age, height, weight

Current Age					
X – Y	p-value	df	t	Mean x	Mean y
Top 10 – Top 11-50	0.5042	13.018	0.687	26.60	25.65
Top 10 – Top 51-100	0.1738	14.028	1.433	26.60	24.58
Top 11-50 - Top 51-100	0.2154	87.987	1.2479	25.65	24.58
Top 10 – Top 100	0.3163	11.043	-1.0497	26.60	25.21
Top 11-50 – Top 100	0.5362	81.355	-0.6213	25.65	25.21
Top 51-100 – Top 100	0.4088	91.165	0.8299	24.58	25.21

Height (cm)					
X – Y	p-value	df	t	Mean x	Mean y
Top 10 – Top 11-50	0.1613	16.972	1.4646	176.9	173.5
Top 10 – Top 51-100	0.1994	13.094	1.3516	176.90	173.97
Top 11-50 - Top 51-100	0.7552	74.355	-0.3129	173.50	173.97
Top 10 – Top 100	0.2024	11.414	-1.3526	176.90	174.08
Top 11-50 – Top 100	0.6844	65.209	0.4082	173.50	174.08
Top 51-100 – Top 100	0.9295	104.558	0.0886	173.98	174.08

Weight (kg)					
X – Y	p-value	df	t	Mean x	Mean y
Top 10 – Top 11-50	0.966	14.797	0.0433	63.70	63.62
Top 10 – Top 51-100	0.9238	12.454	-0.0977	63.70	63.88
Top 11-50 -Top 51-100	0.8222	77.615	-0.2255	63.62	63.88
Top 10 – Top 100	0.9758	10.888	0.0311	63.70	63.75
Top 11-50 – Top 100	0.8968	66.969	0.1302	63.62	63.75
Top 51-100 – Top 100	0.8899	101.095	0.1388	63.88	63.75

Table 3
Comparison of age at top 1000, top 500, top 300, top 200 and top 100

Age Achieved Top 1000 Ranking					
X – Y	p-value	df	t	Mean x	Mean y
Top 10 – Top 11-50	0.3784	13.232	0.9113	16.0	15.7
Top 10 – Top 51-100	0.8584	13.364	-0.1819	16.00	16.06
Top 11-50 -Top 51-100	0.07323	87.073	-1.8133	15.70	16.06
Top 10 – Top 100	0.7791	10.929	-0.2875	16.0	15.91
Top 11-50 – Top 100	0.2181	77.33	1.2418	16.00	15.91
Top 51-100 – Top 100	0.3809	94.291	-0.8803	15.70	15.91

Age Achieved Top 500 Ranking					
X – Y	p-value	df	t	Mean x	Mean y
Top 10 – Top 11-50	0.5687	14.033	-0.5836	16.4	16.6
Top 10 – Top 51-100	0.05616	14.839	-2.0716	16.40	17.12
Top 11-50 -Top 51-100	0.02442	87.791	-2.29	16.60	17.12
Top 10 – Top 100	0.2017	11.503	1.354	16.4	16.84
Top 11-50 – Top 100	0.2119	80.577	1.2585	16.40	16.84
Top 51-100 – Top 100	0.1634	93.335	-1.4048	16.60	16.84

Age Achieved Top 300 Ranking					
X – Y	p-value	df	t	Mean x	Mean y
Top 10 – Top 11-50	0.4736	15.159	-0.735	17.20	17.48
Top 10 – Top 51-100	0.09859	15.425	-1.7579	17.20	17.86
Top 11-50 - Top 51-100	0.1423	87.131	-1.4806	17.48	17.86
Top 10 – Top 100	0.2321	11.737	1.2601	17.20	17.64
Top 11-50 – Top 100	0.4564	76.57	0.7487	17.20	17.64
Top 51-100 – Top 100	0.3256	93.169	-0.9883	17.48	17.64

Age Achieved Top 200 Ranking					
X - Y	p-value	df	t	Mean x	Mean y
Top 10 – Top 11-50	0.4202	11.289	-0.8365	17.80	18.33
Top 10 – Top 51-100	0.08869	11.945	-1.8533	17.80	18.98
Top 11-50 -Top 51-100	0.03839	87.998	-2.1022	18.33	18.98
Top 10 – Top 100	0.2204	10.325	1.3044	17.80	18.6
Top 11-50 – Top 100	0.294	86.354	1.0557	17.80	18.6
Top 51-100 – Top 100	0.1805	94.685	-1.3492	18.33	18.6

Age Achieved Top 100 Ranking					
X - Y	p-value	df	t	Mean x	Mean y
Top 10 – Top 11-50	0.05377	13.445	-2.1136	18.20	19.45
Top 10 – Top 51-100	0.00347	14.395	-3.4894	18.2	20.3
Top 11-50 -Top 51-100	0.02713	87.936	-2.2472	19.45	20.30
Top 10 – Top 100	0.01876	11.437	2.7363	18.20	19.75
Top 11-50 – Top 100	0.3497	84.313	0.9404	18.2	19.75
Top 51-100 – Top 100	0.1069	95.326	-1.6276	19.45	19.75

Figure 1
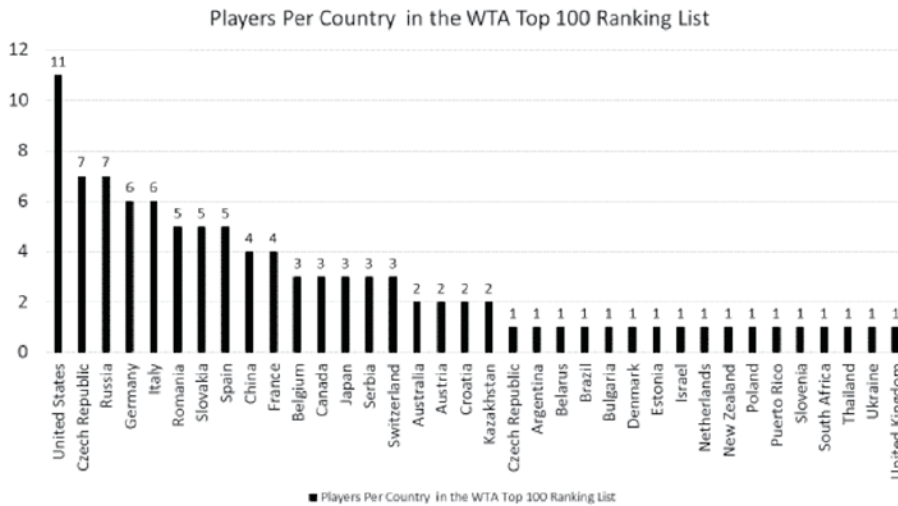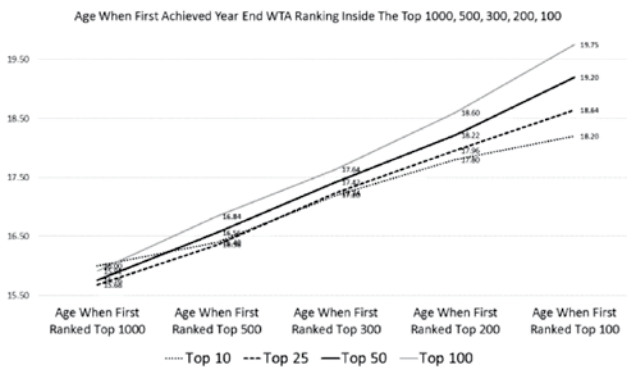**Players per country in the women's tennis association (wta) top 100 ranking list**

Players Per Country in the WTA Top 100 Ranking List

Figure 2
Age when first achieved year end wta ranking inside the top 1000, 500, 300, 200, 100

Age When First Achieved Year End WTA Ranking Inside The Top 1000, 500, 300, 200, 100

Discussion

Professional women's tennis has undergone significant change since the mid-1980s, [18,19] Perhaps the most influential has been the development of racket and string material technologies as well as the off-court physical training and sport science services [19] provided to players compared to 20-30 years prior.[18] Also, the sport has become significantly more global (due in part to tennis being included as an Olympic sport) and at the time of this analysis 36 different countries had at least one representative in the Top 100 ranking list (Figure 1).

The United States had the most players in the Top 100 with 11, followed by the Czech Republic and Russia who both had 7 (Figure 1). With the addition of more countries represented and putting significant resources to developing tennis players, the number of lower level professional tournaments has also expanded.[20] This increases opportunities for more individuals to achieve a professional ranking thereby increasing the opportunity for developing athletes to compete. However, this increase in tournaments has increased the number of individuals

with a professional ranking at the lower levels (<1000 ranking), but the data does not seem to support that this has made a significant impact on the higher ranking levels. For example, such countries as Mexico or Turkey have a large number of tournaments throughout the year, but neither country has a player in the Top 100.

As much of the published ranking data studies have been performed on the men's side of tennis it is useful to look at some of this data. In a very unique study looking at pooled ranking data since the beginning of official ATP rankings (1973 to 31 December 2010) the mean ± standard deviations for an athlete to go from his first point till Top 100 was 134.0 ± 57.2, 209.5 ± 96.8 and 285.1 ± 129.2 weeks for Top 10, Top 11–50 and Top 51–100 athletes, respectively.[17] Our data for the TET (199.68 weeks + 98.80) to go from the Top 1000 ranking to a Top 100 ranking) for the current Top 100 players. This approximate fours year average timeline is rather similar to the same analysis recently performed on the men's professional circuit over the same time period and using the same methodology. The TET in male professional tennis players were 205.92 weeks + 154.96. When comparing this data to other men's professional tennis data that has been published it was found that 4.5 (+ 2.1) years for an athlete to achieve their first ranking point until reaching a Top 100 ranking using data back in 2009.[13] However, in that study they looked at when an athlete first achieved their first ranking points until the athlete achieved a Top 100 and this was just looking at men's data. Our study on the female data is the only one of its kind available in the literature and provides a unique insight into the timeline and ages needed to achieve professional success. Also, this data highlights that it takes significantly more time to progress through the rankings compared to the historical male data analysis.[17] Multiple reasons exists why the Top 1000 is a better marker for starting a professional career when determining milestone related data. Achieving a Top 1000 ranking requires approximately 9 WTA ranking points in 2014. This can take between one-six tournaments at the minor leagues were the athlete is able to win at least one match. This is an important differential to other measures that may just use the time point where an athlete achieved their first ranking point.[17] The negative with using the first ranking point is that there could be 3-18 months of time before the athlete then reaches the Top 1000 threshold. This is a result of many of these players competing predominantly at the national or international junior level and not playing enough tournaments to gain the points necessary. Therefore, the time periods are somewhat mixed depending on the tournament schedule chosen by the player/coach/federation. Therefore it is more appropriate to measure the TET from Top 1000 to Top 100 which should highlight a more consistent representation of the pathway.

Entry age and the time taken to transition to the top 100 appear unrelated in a study looking at male professional players.[13] The data from this study supports this contention (Figure 2). The age at ranking milestones of Top 300, Top 200 and Top 100 all show statistically significant differences (Table 3) based on the ranking groups within the top 100 (Figure 2). The pathway or ranking progression for the individuals in the Top 10 ranking group was significantly different than the other groups and achieved a Top 100 ranking earlier as well (Figure 2). This age differential is even more pronounced when the athletes first reaches a Top 100 ranking. The individuals who are currently in the Top 10 in the world achieve this ranking milestone 1.55 years sooner than the average for the entire Top 100 players (Figure 2). This information is relevant and important for understand the progression toward a top 100 tennis athlete.

Conclusion

The data analyzed in this study was performed to evaluate the current Top 100 WTA Professionals in 2014 and highlight ranking and performance milestones to better understand how they have achieved career success in professional tennis. The objective ranking data allows for an unemotional analysis of the career pathway of current and future tennis players. This information is highly valuable for tennis executives, sports agencies, talent and player development specialists, coaches, researchers, parents and players. Although many factors contribute to ultimate tennis success, utilizing an unbiased measure such as rankings can provide valuable information along the journey to career success in professional tennis. The major findings highlight that the age an athlete achieves a Top 1000 ranking is not a solid predictor of a high WTA ranking within the Top 100. However, the age when an athlete achieves a Top 300, Top 200 ranking does provide some insights for when an athlete may reach the Top 100. This data highlights that the Top 100 pathway of Top 10 players differs significantly from the entire Top 100. This information may be used in better decision making in multiple areas: 1) decision to become a professional tennis before attending college based on where the athlete is ranked at her 17th and 18th birthdates, 2) appropriate sports national governing body and tennis federation funding for individuals based on how well they are progressing at different age markers, 3) tournament scheduling and training scheduling to help improve times to focus on tournament play to increase ranking and/or time to focus on training time. This information should be used by national sports federations, tennis associations, sport science and medical professionals, athlete agencies, parents, coaches and players to better plan tournament/training schedules, be more realistic about goal setting and results at different age groups.

Conflicts of Interest: none declared.

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References

1. Kovacs MS. Tennis physiology: training the competitive athlete. *Sports Med* 2007;37(3):189-198.

2. De Bosscher V, De Knop P, Heynelds B. Comparing tennis success among countries. *Int Sports Studies* 2003;25:49-68.

3. LTA. Lawn Tennis Association (LTA): British Annual Review. 2013;2014:http://www.lta.org.uk/Footer/about-us/Structure-and-Vision/LTA-Annual-Reports/. Accessed 12/29/2014.

4. TA. Tennis Australia Annual Report. *http://assets.tennis.com.au/annual_report/e-brochures/2011-2012/*. 2012. Accessed 12/29/2014.

5. Quinlan G. *The lay of the land: prize-money in professional tennis*. Paris: International Tennis Federation;2012.

6. Pyne DB, Gardner AS, Sheehan K, et al. Fitness testing and career progression in AFL football. *J Sci Med Sport* 2005;8:321-332.

7. Witnauer W, Rogers R, Saint Onge J. Major league baseball career length in the 20th century. *Population Research and Policy Review*. 2007;26:371-386.

8. Ducking J. The effects of minimum salaries on career length: Evidence from the National Football League. *http://economics.appstate.edu/sites/economics.appstate.edu/files/Ducking.pdf*. 2012. http://economics.appstate.edu/sites/economics.appstate.edu/files/Ducking.pdf. Accessed 12/29/2014.

9. Guillaume M, Lens S, Tafflet M, et al. Success and decline: top 10 tennis players follow a biphasic course. *Med Sci Sports Exerc* 2011;43:2148-2154.

10. Reid M, Crespo M, Santilli L. Importance of the ITF junior girls' circuit in the development of women professional tennis players. *J Sports Sci* 2009;27:1443-1448.

11. Reid M, Crespo M, Santilli L, et al. The importance of the International Tennis Federation's junior boys' circuit in the development of professional tennis players. *J Sports Sci* 2007;25:667-672.

12. Brouwers J, De Bosscher V, Sotiriadou P. An examination of the importance of performance in youth and junior competition as an indicator of later success in tennis. *Sport Management Rev* 2012;15:461-475.

13. Reid M, Morris C. Ranking benchmarks of top 100 players in men's professional tennis. *Eur J Sport Sci* 2013;13(4):350-355.

14. WTA. Women's Tennis Association (WTA) Singles Database. *http://www.wtatennis.com/rankings*. 2014.

15. ATP. Singles Ranking Database. *http://www.atpworldtour.com/Rankings/Singles.aspx*. 2014.

16. Core R. A language and environment for statistical computing. *http://www.R-project.org/*. 2014. http://www.R-project.org/.

17. Bane MK, Reid M, Morgan S. Has player development in men's tennis really changed? an historical rankings perspective. *J Sports Sci* 2014;32(15):1477-1484.

18. Lees A. Science and the major racket sports: a review. *J Sports Sci* 2003;21(9):707-732.

19. Kovacs M. Applied physiology of tennis performance. *Br J Sports Med* 2006;40:381-386.

20. ITF. International Tennis Federation (ITF) Women's Tennis Pro Circuit History *http://www.itftennis.com/procircuit/about-pro-circuit/women%27s-history.aspx* 2014.

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