Abstract:

The constant improvement of the tennis racquet has accelerated the pace of tennis to where 130 mph serves are commonplace. Height has given an edge to the top players who are adapting to this new speed, implementing the serve as a critical part of their game. The purpose of this study was to determine the effect of body height on several performance factors in elite male tennis players. The data used contains all recorded ATP matches from 1968 to 2021. The data set contains crucial performance factors such as 1st serve in, 1st serve won, breakpoints faced, breakpoints saved, etc.. To analyze the data, I used data sets, graphing, and statistical analyses. The results indicated that ranking and serve related match outcomes that exhibit considerable variation according to players' stature and court surface.

1. Introduction

The constant improvement of the tennis racquet has accelerated the pace of tennis to where 130 mph serves are commonplace (Cross and Bower, 2006). Players have developed new strategies to take advantage of faster pace (Abrams et al., 2011). With the increase in speed the serve became a key factor to winning a point (Martin et al., 2013). Hitting the serve with fast pace and good placement can significantly increase your chances of winning by reducing your opponents time to react (Vaverka and Cernosek, 2016). And the taller the player the easier it is to hit down on the ball, giving the serve more speed (Vaverka and Cernosek, 2013; Söğüt, 2018). It would seem that being taller would be an advantage. However, there is a general consensus within the tennis community that being taller is an advantage but only up to a certain point. For example, there has never been a player taller than 193cm to reach rank 1 in tennis.

Over the past few years, there have been many studies that have shown height as a major factor in serve speed and aces (eg., Matteo, et al., 2015; Frantisek et al., 2005; Vaverka and Cernosek, 2013; Vaverka and Cernosek, 2016; Wong et al., 2014). Serve speed and aces do in fact contribute to the deciding factor of the game (Mecheri et al., 2016; Vaverka and Cernosek, 2013; Vaverka and Cernosek, 2016; Söğüt, 2016). However, there are also other variables affecting performance that we should not ignore. The main objective of this paper is to explore the relationship between body height and tennis performance.

Findings of this research can give us valuable information about the effects of height in tennis. Possibly allowing us to better see the future of tennis and predict trends. It can also allow coaches and players to better understand certain advantages or disadvantages to improve their training or game.

2. Literature review

Height is a crucial variable in almost all sports. In tennis, being taller provides a major advantage when serving (Vaverka and Cernosek, 2013; Söğüt, 2019). The taller the professional male tennis player is the higher the probability of winning when the height discrepancy is higher between opponents (Ovaska and Sumell, 2014). If a player is able to win all of their serves then there is no way for the opponent to win, as seen in the longest tennis match to date, where both players refused to lose on their serve. Top tennis players are able to maintain the temporal pattern of their serve technique, in spite of muscular fatigue (Martin et al.,

2016). Tall players seem to have an overarching advantage, since the serve is now the deciding factor to a game (Martin et al., 2013).

Earlier studies have linked height to serve speed, aces, and first point won (eg., Matteo, et al., 2015; Frantisek et al., 2005; Vaverka and Cernosek, 2013; Vaverka and Cernosek, 2016; Wong et al., 2014). Through previous research we can conclude that height significantly influences the speed of the serve and therefore the amount of aces hit (Vaverka and Cernosek, 2013; Söğüt, 2016). However it seems the effect of height varies across different court types (Hughes & Clarke, 1995; O'Donoghue & Ingram, 2001; Takahashi et al., 2006; Takahashi, Wada, Maeda, Kodama, & Nishizono, 2009).

Most of tennis is played on either grass, clay, or hard surfaces (Barnett & Pollard, 2007). And studies have shown substantial variation in game strategy based on court surface (Hughes & Clarke, 1995; O'Donoghue & Ingram, 2001; Takahashi et al., 2006; Takahashi, Wada, Maeda, Kodama, & Nishizono, 2009; Unierzyski & Wieczorek, 2004). Variations in court surface can be attributed to the interactions between the court surface and ball, deciding the court speed(Brody, Cross, & Lindsey, 2002; Cross, 2003; Cross & Lindsey, 2005; Miller, 2006). Grass courts have lower friction, hence the fastest court, while clay has higher friction, hence the slowest court, and hard surfaces are in between (Cross, 2003; Martin & Prioux, 2016). We suspect that height will provide more of an advantage in grass courts since the ball can maintain more speed (Martin & Prioux, 2016). And that height will give less of an advantage in clay courts where the speed of serves decrease by a lot (Martin & Prioux, 2016). This means that taller players will be able to use their advantage to the fullest when playing on grass courts, where their most important performance variables like aces will be the highest. However, this also means that taller players will find it more difficult to dominate on clay courts, where their aces are lowest.

We also need to consider other performance variables since the serve is not the only advantage of a player with tall stature. Taller players have longer arms and legs, giving them the ability to cross a larger distance in a single step and the ability to cover more area with their reach. They are also in a better position to receive certain shots like overheads and lobs due to their height and reach. With longer limbs they can generate more power when hitting the ball. In this study, we will be exploring the correlation of height and a number of performance variables to see what impact a player's height has on tennis.

3. Research method

The data used in this research come from a dataset provided by JeffSackmann (2022), which contains all recorded ATP matches from 1968 to 2021. The dataset includes performance indicators like 1st serve in, 1st serve won, breakpoints saved, etc.. Note that some early ATP match records did not have sufficient data. Matches with incomplete data were excluded from our analysis. The dataset was then reorganized into more convenient formats suitable for data analysis.

The dataset (Top 8) contains match data that are either quarter finals, semi finals, or finals of top tournaments from 1968 to 2021. Top tournaments include: Grand Slams, Masters 1000s, and other tour-level events. There are a total of 28214 matches in this dataset.

In the following Data analysis section, we use a series of line charts and scatter plots to show the relationship between player height and major performance indicators. We will further discuss the implications of the findings.

4. Data analysis

As we established, height plays an important role in tennis. However, from figure 1 we see that there are a substantial number of players around 185 cm, with less players as height deviates more from 185cm. It seems that most players who dominate the top of tennis are around 185cm, with almost no player under 170cm or above 200cm.

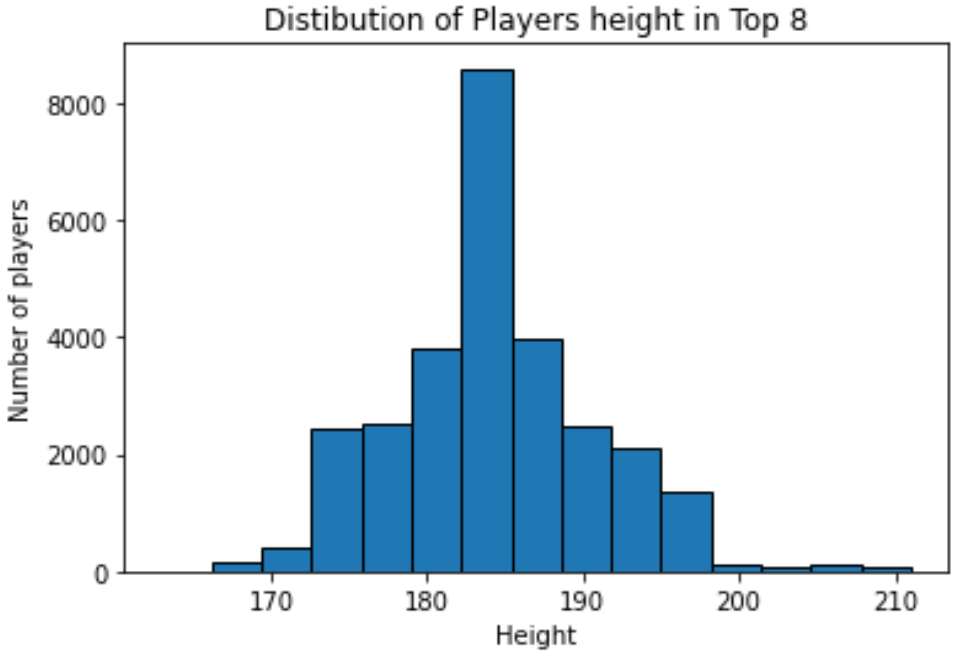

Figure 1: The height of players in Top 8

We examined the height of winners over the years. Based on figure 2, we have seen a constant increase to the height of the players starting from around 1975. This upward trend goes to show that tennis has evolved to depend more and more on the height of the players to compete and win at the highest level. This could be the result of the game becoming more dependent on serves, giving those who are taller a natural advantage.

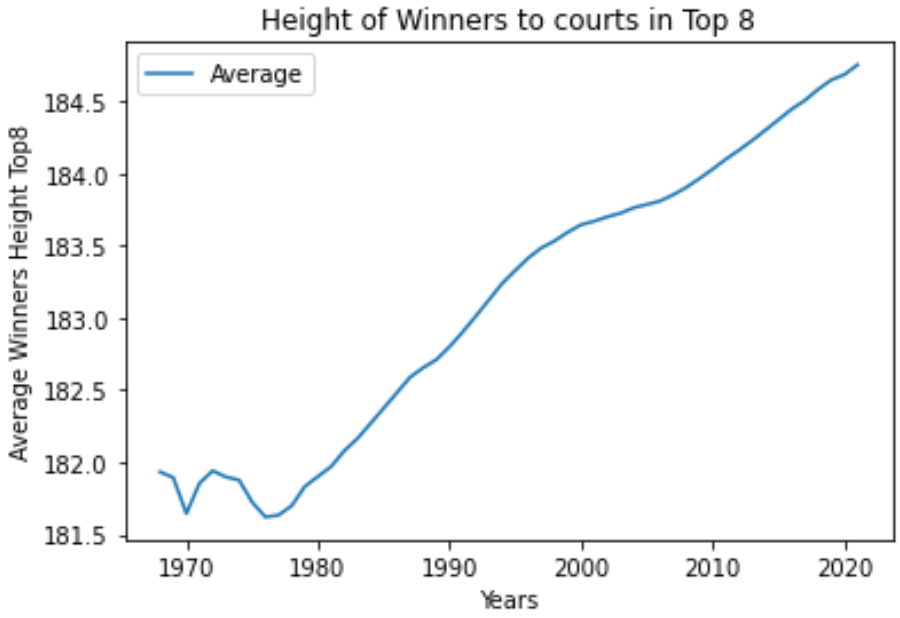

Figure 2: Average height of winners over the years

We then examined the height of winners over the years on three separate court types, hard, grass, and clay. In figure 3, ignoring the abnormality of hardsurface before 1970, the hard surface and grass courts have winners of equal heights, meaning neither of them gives more of an advantage to players in terms of height. The average height of winners on clay courts are around 2 inches shorter than both hard and grass courts. This shows that clay courts do not give as much of an advantage to taller players than hard and grass courts.

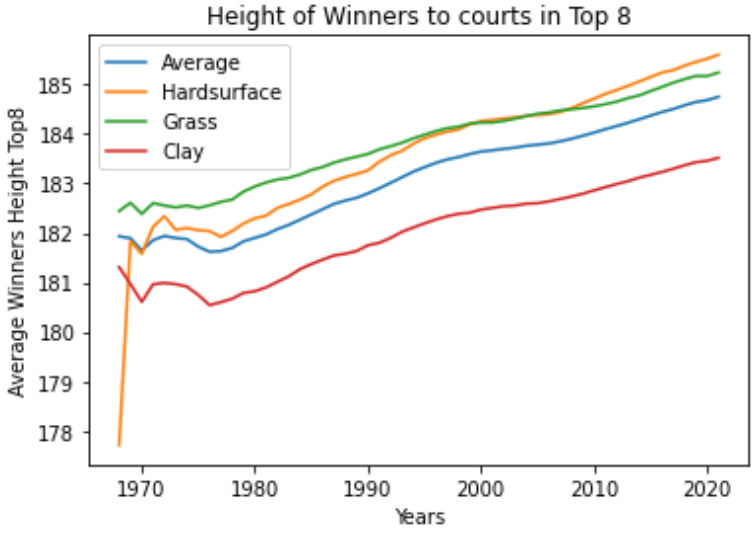

Figure 3: Average height of winners for different courts over the years

3.1 Height and Aces

Here in figure 4, we examine the height of winners compared to their average number of aces per match. As the average height of winners increases, the average aces per match also increases. This shows that winners that are taller have an advantage when serving aces. The

number of aces increases constantly till around 183.3 where the increase drastically slows down. This means that at a certain height, further increase would not lead to much more aces.

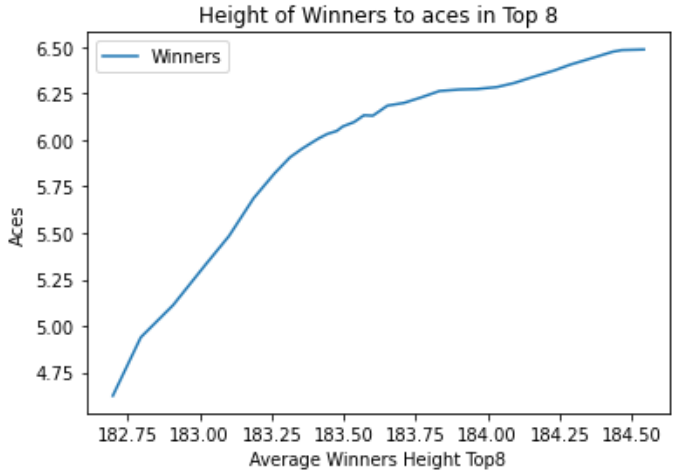

Figure 4: Average height of winners and aces

Next we look at the aces of the three court types separately. The first thing to notice in figure 5 is that all three have a different range of heights for their winners as seen in figure 3. We see that grass courts have more aces than hard courts even though the range in height is about the same. We also see that the clay court winners are significantly shorter and have average less aces than both of the other courts. This shows that being taller does not yield a significant advantage when serving on clay courts.

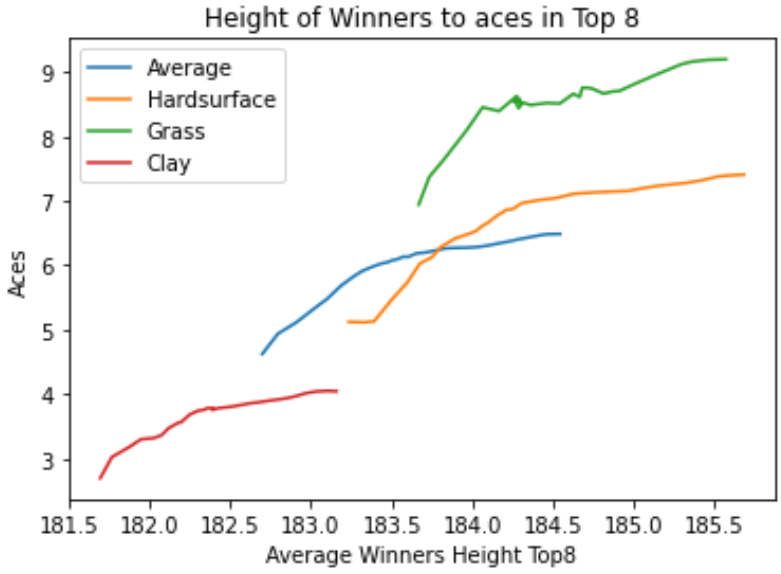

Figure 5: Average height of winners and aces on different court types

3.2 Height and Double faults

After examining aces we look at the effect of height on double faults. Interestingly enough, figure 6 shows that double faults do not favor those who are taller. Even though taller

players would theoretically have a higher serve percentage due to their better net clearance. This could be the result of taller players going for risker serves while the shorter players are going with much safer serves. However there seems to be an anomaly where the players with slightly below average height have much more double faults than both taller and shorter players.

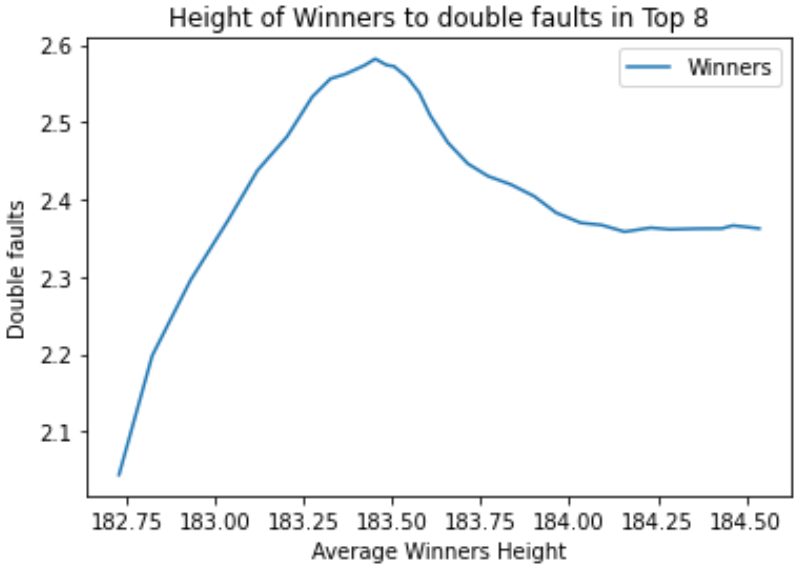

Figure 6: Average height of winners and double faults

Looking at the effect of height on double faults on different courts in figure 7, we see again that double faults do not favor those who are taller. Grass courts seem to have a lot more double faults than both hard and clay. This is due to the fact that players are going for risker serves since on grass the ball keeps more speed and they have a higher chance of hitting an ace. For all three courts the amount of double faults peak at around 183.75cm, the height around 183.75cm seems to be an awkward height to serve at.

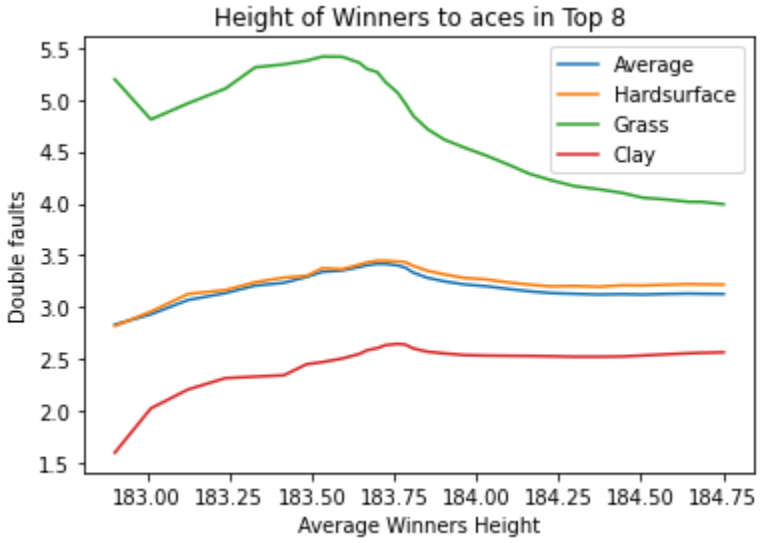

Figure 7: Average height of winners and double faults on different court types

3.3 Height and break points faced

Another important factor is the number of break points per match. In figure 8, we see that the number of break points faced is minimized when height is taller. And the opposite is true for the shorter players. Surprisingly the players with height from about 183.50 to 183.75 have the same number of break points as the shorter players.

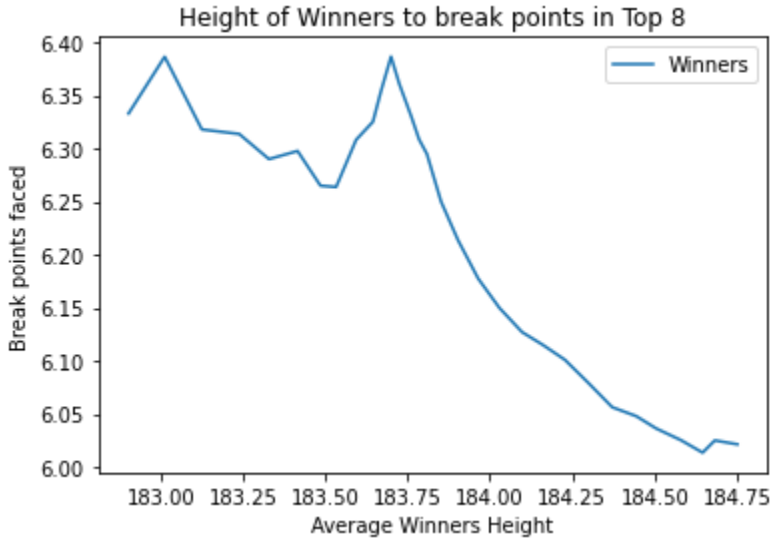

Figure 8: Average height of winners and break points faced

Looking at the number of break points faced per match on different court types in figure 8, we see that the number of break points faced is minimized when height is taller. And the opposite is true for the shorter players. Surprisingly the players with average height have the same number of break points as the shorter players.

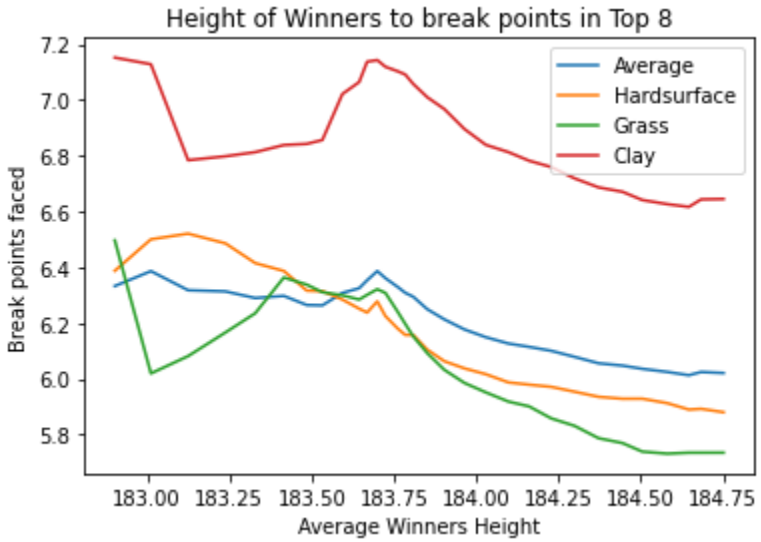

Figure 9: Average height of winners and break points faced on different court types

3.4 Height and break points saved

In figure 10, the height of winners is compared to their average number of break points saved per match. The figure exhibits a similar trend to figure 8, where the number of break points faced is minimized when height is tallest. However, there is a spike in break points saved at the same interval as figure 8.

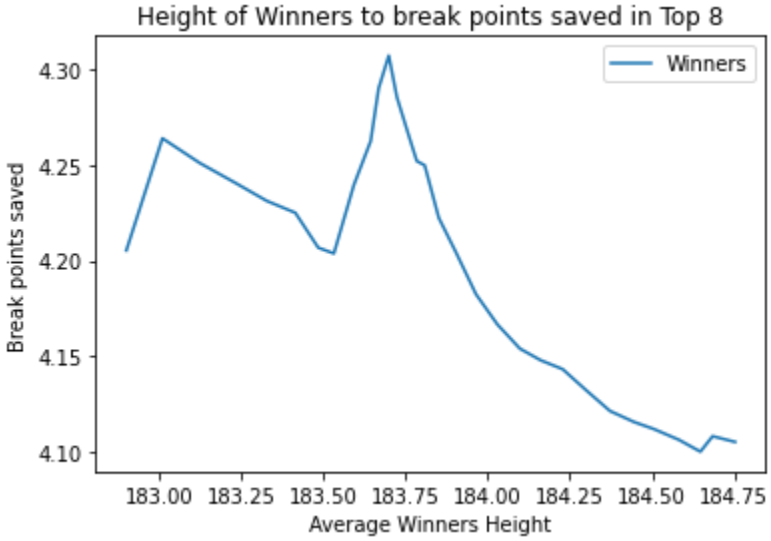

Figure 10: Average height of winners and break points saved

In figure 11, the height of winners is compared to their average number of break points saved per match. The figure reveals a similar trend to figure 9, where the number of breakpoints faced is minimized when height is taller.

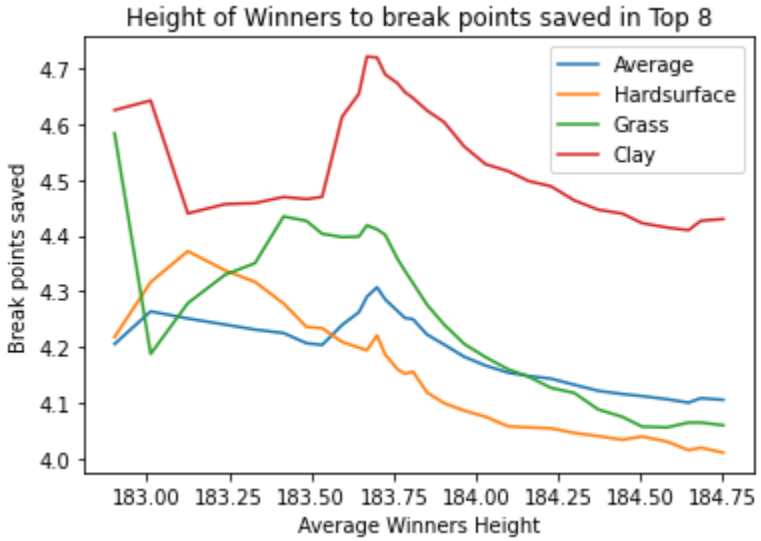

Figure 11: Average height of winners and break points saved on different court types

3.5 Height and match length

The time it takes to complete a match can usually indicate the intensity of the match. Where shorter matches are wipeouts and longer ones are stalemates. In figure 12, we compare the height of winners to their average length of the matches in minutes. We see that at both ends of the graph the average match length is around 122 minutes. However, there is an anomaly around 183.50cm where the length of the match decreases substantially by around 10 minutes.

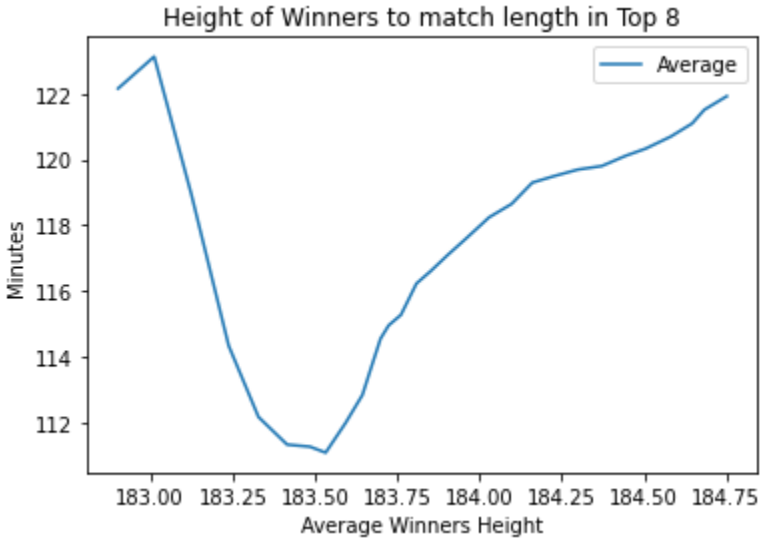

Figure 12: Average height of winners and match length

Looking at figure 13, we compare the height of winners to their average length of the matches in minutes. The grass courts seem to take longer than both hard and clay. However, at around 183.50cm they all exhibit a similar trend where the average match length decreases about 10 minutes resulting in the lowest average match length.

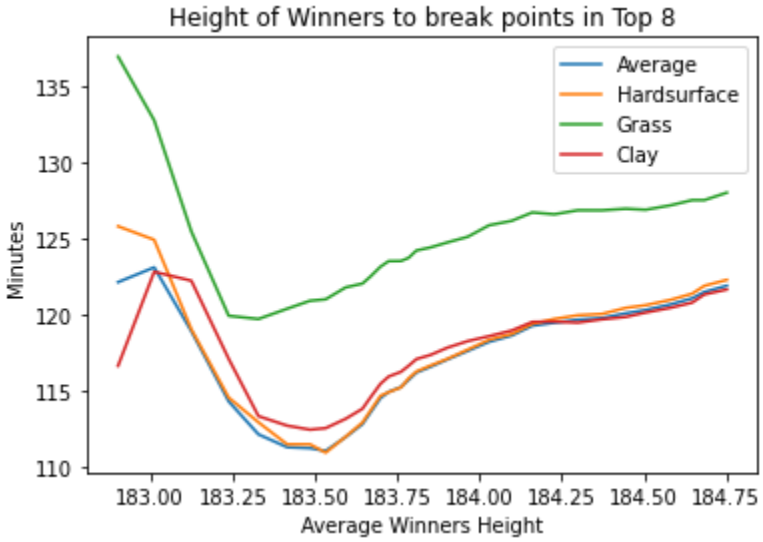

Figure 13: Average height of winners and match length on different court types

5. Discussion

When we think of the advantage of height in sports, most would think the taller the better, especially in a sport like tennis. Surprisingly that's not the case, as the descriptive results revealed, the majority of top tennis players are around 185cm in height. Also, the average height of elite tennis players is increasing every year at a steady rate, with the current average at around 184.7cm, and on course for 185cm in 1-3 years. There are also next to zero top tennis players below 170cm or above 200cm, though there are rare exceptions, they are not consistent and have never got into the top 10 in rankings.

The aim of this research was to examine the effects of body height on different performance aspects of elite male tennis players. We analyze the dataset provided by JeffSackmann (2022), which contains all recorded ATP matches from 1968 to 2021. We find that the relation of average height to average aces is a factor of logistic growth. As height increases the amount of aces also increases but at a decreasing rate. From the three different court surfaces, grass yields the highest height to ace ratio, making it the most ideal surface for taller players to hit aces, while the opposite is true for clay. There is an overall increase in double faults on grass, and a decrease for clay. On grass taller players double fault less than shooter players, while the opposite is true for clay. Players average more break points faced on clay courts since they hold less advantage on serve. Unsurprisingly, taller players average fewer break points faced than shooter players because of their dominance in serves. However, taller players also average less break points saved, likely due to their weakness in returns when receiving. While shorter players average move break points saved, likely due to their strategies focused around returns and rallies. Looking at the data, height related match outcomes seem to be largely influenced by court surface. Taller players produced significantly more aces on grass and hard courts than clay. While going for aces increases the chances of doubling faulting, it is rare for top tennis players to double fault, especially taller ones. The advantage from their serves can also be seen from their low number of break points faced. Without giving break points to their opponent, they can turn the game with a single break. It seems that being taller doesn’t give much of an advantage on clay, to the point it could even be considered a disadvantage. However, taller players have a decent advantage on hard courts, and a significant advantage on grass courts. Considering ATP tournament courts are 56% hard, 33% clay, and 11% grass, with 67% of ATP tournament courts being hard and grass courts, it seems to be greatly favoring taller players.

For practical application, the findings of this paper can be used by players, coaches, recruiters and others as reference. For example, coaches can strategize with their players more effectively by weighing the pros and cons of height in relation to court surface to develop in-game tactics and training routines.

The paper attempted to provide insight into performance of top male tennis players through using publicly available data. The results indicated that ranking and serve related match outcomes exhibit considerable variation according to players’ stature and court surface. Since this research is based on top male tennis players, it may not apply to female players. A future study would be meaningful to expand the current research to include female players. Due to limited publicly available data on tennis games in general, especially in past years, our data analysis is limited by this data that could potentially point to more critical information. Because of this limitation, future research on this topic can consider using higher quality and more abundant data collected from recent years and onwards. By doing this, future research may be

able to find more crucial data and correlations. And at some point we may even be able to predict the winner of a match just by their historical matches and stats.

References

Abrams, G. D., Sheets, A. L., Andriacchi, T. P., Safran, M. R. (2011). Review of tennis serve motion analysis and the biomechanics of three serve types with implications for injury. Sports Biomechanics, 10(4), 378-390.

Barnett, T., & Pollard, G. (2007). How the tennis court surface affects player performance and injuries. Medicine and Science in Tennis, 12(1), 34–37.

Bonato, M., Maggioni, M., Rossi, C., Rampichini, S., La Torre, A., & Merati, G. (2015). Relationship between anthropometric or functional characteristics and maximal serve velocity. J Sport Med Phys Fitness, 55(10), 1157-65.

Brody, H., Cross, R., & Lindsey, C. (2002). The physics and technology of tennis. Vista: Racquet Tech Publishing.

Cross, R. (2003). Measurements of the horizontal and vertical speeds of tennis courts. Sports Engineering, 6(2), 95–111.

Cross, R., & Lindsey, C. (2005). Technical tennis: racquets, strings, balls, courts, spin, and bounce. Vista: Racquet Tech Publishing.

Cross, R., Bower, R. (2006). Effects of swing-weight on swing speed and racket power. Journal of Sports Sciences, 24(1), 23-30.

Frantisek Vaverka & Miroslav Cernosek (2013) Association between body height and serve speed in elite tennis players, Sports Biomechanics, 12:1, 30-37, DOI: 10.1080/14763141.2012.670664

Hughes, M. D., & Clarke, S. (1995). Surface effect on patterns of play of elite tennis players. In T. Reilly, M. D. Hughes & A. Lees (Eds.), Science and Racket Sports (pp. 272–278). London: E & FN Spon.

Martin, C., Kulpa, R., Delamarche, P., Bideau, B. (2013). Professional tennis players' serve: correlation between segmental angular momentums and ball velocity. Sports Biomechanics, 12(1), 2-14.

Martin, C., & Prioux, J. (2016). Tennis playing surfaces: The effects on performance and injuries. Journal of Medicine and Science in Tennis, 21(1), 11–19.

Miller, S. (2006). Modern tennis rackets, balls, and surfaces. British Journal of Sports Medicine, 40(5), 401–405.

O'Donoghue, P., & Ingram, B. (2001). A notational analysis of elite tennis strategy. Journal of Sports Sciences, 19(2), 107–115.

Söğüt, M. Height- and surface-related variations in match-play outcomes and rankings in professional men's tennis. Ger J Exerc Sport Res 49, 332–338 (2019).

Söğüt, M. (2018). Stature: Does it really make a difference in match-play outcomes among professional tennis players? International Journal of Performance Analysis in Sport, 18(2), 255–261

Takahashi, H., Wada, T., Maeda, A., Kodama, M., Nishizono, H., & Kurata, H. (2006). The relationship between court surface and tactics in tennis using a computerized scorebook. International Journal of Performance Analysis in Sport, 6(2), 15–25.

Takahashi, H., Wada, T., Maeda, A., Kodama, M., & Nishizono, H. (2009). An analysis of time factors in elite male tennis players using the computerised scorebookfortennis. InternationalJournalof Performance Analysis in Sport, 9(3), 314–319.

Unierzyski, P., & Wieczorek, A. (2004). Comparison of tactical solutions and game patterns in the finals of two grand slam tournaments in tennis. In A. Lees, J. Kahn & I. Maynard (Eds.), Science and racket sports III (pp. 200–205). London: Routledge.

Vaverka, F., Cernosek, M. (2016). Quantitative assessment of the serve speed in tennis. Sports Biomechanics, DOI:10.1080/14763141.2015.1123763.

Vaverka, F., Cernosek, M., Tesarova, K., & Elfmark, M. (2005). The influence of body height on the serve in tennis. In ISBS-Conference Proceedings Archive.