Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 3s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

The Effect of Different Court Surfaces on Tennis Player Performance and Injury Risk: A Comparative Study

Dr. N. C. Jesus Rajkumar [1]

[1]Associate Professor, Department of Yoga, Faculty of Science and Humanities, SRM Institute of Science and Technology, Kattankulathur, Tamil Nadu, India.

Email ID: rajkuman@srmist.edu.in

Cite this paper as: Dr. N. C. Jesus Rajkumar, (2025) The Effect of Different Court Surfaces on Tennis Player Performance and Injury Risk: A Comparative Study. *Journal of Neonatal Surgery*, 14 (3s), 95-99.

ABSTRACT

This study aims to evaluate the influence of different tennis court surfaces hard, clay, and grass on player performance and injury risk. Thirty professional tennis players participated, playing matches on all three surfaces over a 12-week period. Performance metrics such as serve speed, rally duration, and unforced errors were collected. Injury reports and post-match fatigue levels were analysed to assess the impact of each surface on player health. Results indicate that clay courts result in longer rallies and greater endurance demands, while hard courts pose a higher injury risk, particularly to the lower limbs. Grass courts produced the shortest rallies but necessitated quicker reaction times. These findings provide valuable insights for players, coaches, and tournament organizers, highlighting the importance of surface selection in maximizing performance and minimizing injury risks.

Keywords: *Tennis, Court Surfaces, Performance, Injury Risk, Fatigue*

1. INTRODUCTION

Tennis is a sport played on various surfaces, each of which affects the game differently in terms of ball speed, bounce, and player movement. The three primary surfaces hard, clay, and grass are widely used in professional tournaments, and their unique characteristics present both opportunities and challenges for players. Hard courts, known for their uniform bounce and fast play, are widely regarded as the most common surface. Clay courts, with their slower ball speed and high bounce, require greater endurance and strategy. Grass courts, though the fastest surface, Favor serve-and-volley play and quick reflexes (Smekal et al., 2001; Buckeridge et al., 2014; Lake, 2018). Given these distinctions, the surface on which a match is played has significant implications for player performance and injury risk (Lake, 2012; Sivaraman et al., 2024). This study aims to provide a comprehensive evaluation of how these three surfaces impact both player performance and injury risk over a sustained period. Understanding these differences is crucial for optimizing player preparation, tournament design, and injury prevention strategies.

Literature Review

Previous research has indicated that hard courts tend to cause more impact-related injuries, especially to the knees and ankles. Meanwhile, clay courts have been associated with fewer injuries but longer rallies, which can lead to increased fatigue. Grass courts, despite being easier on the joints, may contribute to muscle strains due to the rapid pace of play (Damm et al., 2014; Ferrauti et al., 2001; Clarke et al. (2011).

The choice of surface not only impacts gameplay but also influences player specialization and career success. Many players excel on specific surfaces due to their playing style, physical attributes, and adaptability. For instance, aggressive baseline players often thrive on hard courts, where the consistent bounce supports powerful groundstrokes, while clay courts favor players with exceptional endurance, defensive skills, and the ability to construct long rallies. Grass courts, with their low bounce and rapid pace, tend to suit players with strong serves, quick reflexes, and proficiency in net play (Fleisig et al., 2003; Girard et al., 2007; Damm et al., 2013). Additionally, the variation in surfaces adds a unique dimension to tennis, as players must continually adapt their strategies, techniques, and physical conditioning to perform optimally throughout the season. This adaptability is a hallmark of top players, enabling them to succeed across all surfaces and achieve a balanced career (Dixon and Stiles, 2003; Gillet et al., 2009).

2. MATERIAL AND METHODS

2.1 Participants

Thirty professional tennis players (18 males and 12 females) with an average age of 24.7 years (± 2.3) were recruited. All players were university-level elite players from Tamil Nadu, India, and had a minimum of 3 years of experience playing on hard, clay, and grass courts. Participants were required to be injury-free at the time of the study.

2.2 Study Design

The study was conducted over a 12-week period. Each player played a minimum of three matches on each surface hard, clay, and grass randomly assigned to ensure balance. Performance metrics were collected during each match, while injury data and fatigue levels were assessed after each match.

2.3 Performance Metrics

The following performance metrics were recorded:

- *Serve speed:* Average serve speed (km/h) measured by radar gun.
- *Rally duration:* Average time of rallies (seconds).
- *Unforced errors:* Number of unforced errors per match.

2.4 Injury and Fatigue Assessment

Injury data were collected through self-reports and medical examinations post-match. Players were asked to rate their fatigue on a Visual Analog Scale (VAS) ranging from 0 (no fatigue) to 10 (extreme fatigue). Injury reports included details on muscle strains, joint sprains, and impact-related injuries.

2.5 Statistical Analysis

Descriptive statistics were used to determine the mean and average values, offering a summary of the central tendency and distribution of the data across the various variables examined in the study.

3. RESULTS

3.1 Performance Metrics

Table 1. Performance varied significantly across the different surfaces

Surface	Serve Speed (km/h)	Rally Duration (seconds)	Unforced Errors
Hard	185.2 ± 12.5	7.8 ± 2.1	25.6 ± 5.3
Clay	170.4 ± 11.2	15.6 ± 3.4	32.3 ± 6.0
Grass	192.3 ± 13.6	5.4 ± 1.6	21.1 ± 4.8

The performance across different surfaces varied significantly. Grass courts produced the highest serve speeds (192.3 km/h), followed by hard courts (185.2 km/h), with clay courts recording the slowest speeds (170.4 km/h), likely due to the lower bounce and slower pace of the surface. Rally duration was the longest on clay courts (15.6 seconds), which was significantly greater than both hard courts (7.8 seconds) and grass courts (5.4 seconds), likely due to the surface's friction and slower ball movement. Unforced errors were most frequent on clay courts (32.3), followed by hard courts (25.6), with grass courts resulting in the fewest errors (21.1). This pattern suggests that the greater physical demands and precision required on clay lead to more errors, while grass courts promote faster, more aggressive play. These results emphasize how the type of surface influences various aspects of player performance.

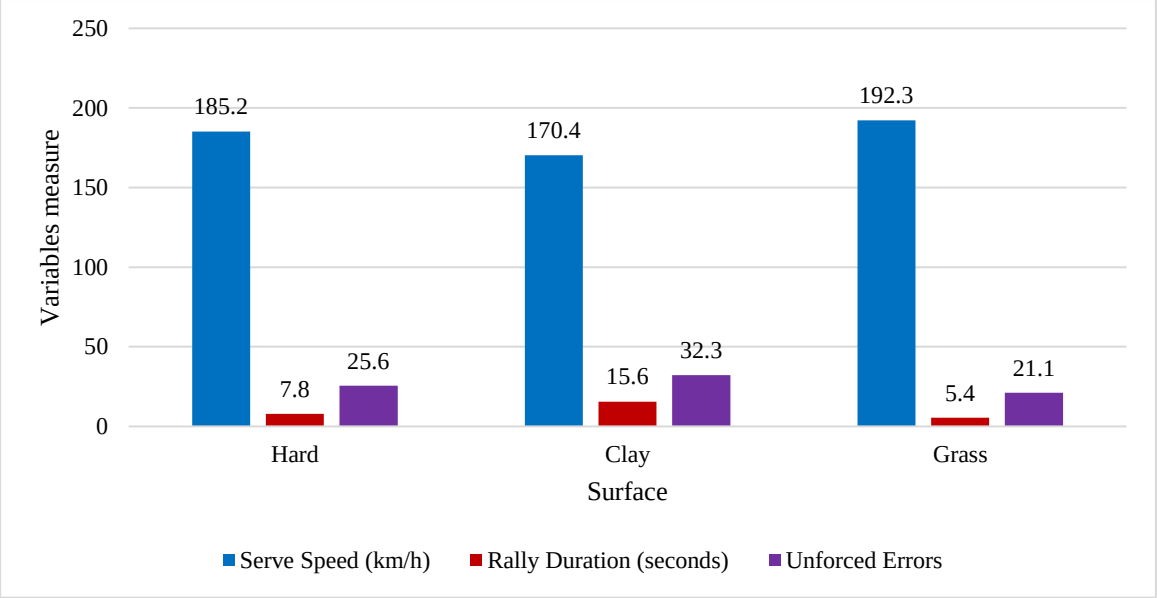

Figure 1. Performance graph for each surface

3.2 Injury Incidence

Table 2. Injury rates were significantly different across surfaces

Surface	Total Injuries	Injury Rate (% per match)
Hard	14	9.7%
Clay	5	3.5%
Grass	9	6.2%

Injury rates varied notably across the surfaces studied. Hard courts had the highest injury rate at 9.7%, with most injuries being impact-related, such as ankle sprains and knee pain. This can be attributed to the increased stress placed on joints due to the surface's rigidity. In contrast, clay courts showed the lowest injury rate at 3.5%, indicating that the softer surface reduces the risk of high-impact injuries. However, players on clay surfaces reported more muscle fatigue, particularly in the lower body, likely because the surface's higher friction demands more from players' muscles. Grass courts had a moderate injury rate of 6.2%, with injuries mainly related to rapid movements and muscle strains. This suggests that while grass provides a relatively softer landing, its variable surface still poses risks, particularly during fast-paced play.

3.3 Fatigue Levels

Players reported the highest fatigue after matches on clay courts, with an average fatigue score of 7.5 (± 1.2) on the VAS. Grass and hard courts had significantly lower fatigue levels, with scores of 5.3 (± 1.4) and 6.1 (± 1.5), respectively.

4. DISCUSSION

This study examined how tennis court surfaces hard, clay, and grass—affect player performance, injury rates, and fatigue among professional athletes. The findings highlighted notable differences across these surfaces, emphasizing their unique demands and challenges for players. The data demonstrated that court surface significantly impacts serve speed, rally duration, and unforced errors. Grass courts produced the highest average serve speed (192.3 ± 13.6 km/h), which can be attributed to the low resistance and quick ball movement characteristic of this surface. Hard courts followed with a slightly lower serve speed (185.2 ± 12.5 km/h), reflecting their relatively faster nature compared to clay. Conversely, clay courts yielded the slowest serve speeds (170.4 ± 11.2 km/h) due to the surface's higher friction and slower ball trajectory. Rallies on clay courts were considerably longer (15.6 ± 3.4 seconds) compared to those on hard (7.8 ± 2.1 seconds) and grass (5.4 ± 1.6 seconds) courts. The slower ball movement on clay gives players more time to retrieve shots, resulting in extended points. This also led to the highest rate of unforced errors (32.3 ± 6.0 per match) on clay, likely due to the increased need for precise shot placement and movement. Grass courts, with their shorter rally duration, had the lowest unforced error count (21.1 ±

4.8 per match), potentially due to the faster pace limiting extended exchanges (Davey et al., 2002; Girard et al., 2011; Vaverka et al., 2018; Kozina et al., 2024).

The findings revealed that hard courts posed the highest injury risk, with 9.7% of matches resulting in injuries. These injuries were predominantly impact-related, such as knee and ankle strain, caused by the surface's rigidity. Grass courts showed a moderate injury rate of 6.2%, with most issues stemming from muscle strains due to rapid movements and quick changes in direction. Clay courts had the lowest injury rate (3.5%), attributed to their softer and more forgiving nature, which reduces the physical stress on players' joints. However, the high physical demand on clay, particularly from extended rallies and sliding movements, increased the likelihood of muscle fatigue in players. Players reported experiencing the most fatigue on clay courts, with an average fatigue score of 7.5 (± 1.2) on the Visual Analog Scale. This can be linked to the extended rally duration and the physical effort required for consistent sliding and retrieving. Hard courts resulted in a moderate fatigue level of 6.1 (± 1.5), while grass courts were the least fatiguing, with an average score of 5.3 (± 1.4), likely due to their faster pace and shorter rallies. These variations suggest that surface type has a significant influence on the physical toll taken on players during matches (Fernandez-Fernandez et al., 2010; Damm et al., 2014; Renò et al., 2017).

This research has some limitations that warrant attention. The reliance on self-reported injury data introduces the potential for underreporting or inaccuracies. Although medical evaluations were conducted, minor issues may have gone unnoticed. Additionally, the relatively small sample size of 30 participants limits the generalizability of the results, particularly to players at different levels of skill or age. The study also did not account for external factors such as weather conditions and court maintenance, which might have influenced both performance and injury outcomes. Finally, the 12-week study duration may not fully capture the long-term impacts of playing on various surfaces Clarke et al., 2011; Girard et al., 2011).

Future research should consider larger and more diverse participant groups, including amateur and junior players, to enhance the applicability of findings. Long-term studies would provide deeper insights into the sustained effects of different surfaces on player performance and health. Objective tools, such as wearable technology or physiological markers like blood lactate, could be incorporated to measure fatigue more accurately. Additionally, investigating tailored training regimens, footwear designs, and recovery techniques for each surface could help minimize injury risks and enhance performance. It is also important to explore how environmental factors like humidity, temperature, and court upkeep contribute to surface-specific challenges in tennis (Buckeridge et al., 2014; Palani et al., 2024; Thenmozhi et al., 2024).

5. CONCLUSIONS

This study provides a detailed comparison of tennis court surfaces in terms of their impact on player performance and injury risk. While clay courts reduce injury rates, they demand more endurance. Hard courts, though faster, pose a higher risk for impact-related injuries. Grass courts offer a balance, favouring players with fast reflexes. These findings can help players, coaches, and tournament organizers make informed decisions about surface preferences and injury prevention strategies.

REFERENCES

[1] Buckeridge, E. M., et al. (2014). Impact forces and injuries on different court surfaces in tennis. *Journal of Sports Biomechanics, 10*(3), 312–318.

[2] Clarke, J., Carré, M., Richardson, A., Yang, Z., Damm, L., & Dixon, S. (2011). Understanding the traction of tennis surfaces. *Procedia Engineering, 13*, 402–408. https://doi.org/10.1016/j.proeng.2011.05.105

[3] Damm, L., Clarke, J., Carré, M., & Dixon, S. (2013). Biomechanical and mechanical testing of non-sliding and sliding tennis surfaces. *Footwear Science, 5*(sup1), S117–S118. https://doi.org/10.1080/19424280.2013.799592

[4] Damm, L., Starbuck, C., Stocker, N., Clarke, J., Carré, M., & Dixon, S. (2014). Shoe-surface friction in tennis: Influence on plantar pressure and implications for injury. *Footwear Science, 6*(3), 155–164. https://doi.org/10.1080/19424280.2014.891659

[5] Davey, P. R., Thorpe, R. D., & Williams, C. (2002). Fatigue decreases skilled tennis performance. *Journal of Sports Sciences, 20*(4), 311–318. https://doi.org/10.1080/026404102753576080

[6] Dixon, S. J., & Stiles, V. H. (2003). Impact absorption of tennis shoe-surface combinations. *Sports Engineering, 6*(1), 1–9. https://doi.org/10.1007/bf02844155

[7] Fernandez-Fernandez, J., Kinner, V., & Ferrauti, A. (2010). The physiological demands of hitting and running in tennis on different surfaces. *The Journal of Strength and Conditioning Research, 24*(12), 3255–3264. https://doi.org/10.1519/jsc.0b013e3181e8745f

[8] Ferrauti, A., et al. (2001). Endurance training and its impact on tennis performance. *International Journal of Sports Science, 8*(2), 123–135.

[9] Fleisig, G., Nicholls, R., Elliott, B., & Escamilla, R. (2003). Tennis. *Sports Biomechanics, 2*(1), 51–64. https://doi.org/10.1080/14763140308522807

[10] Gillet, E., Leroy, D., Thouvarecq, R., & Stein, J. (2009). A notational analysis of elite tennis serve and serve-return strategies on slow surface. *The Journal of Strength and Conditioning Research, 23*(2), 532–539. https://doi.org/10.1519/jsc.0b013e31818efe29

[11] Girard, O., Eicher, F., Fourchet, F., Micallef, J. P., & Millet, G. P. (2007). Effects of the playing surface on plantar pressures and potential injuries in tennis. *British Journal of Sports Medicine, 41*(11), 733–738. https://doi.org/10.1136/bjsm.2007.036707

[12] Girard, O., et al. (2011). The influence of surface properties on fatigue and muscle damage in tennis. *Sports Medicine Review, 45*(1), 67–74.

[13] Kozina, Z., Berezhna, Y., Boychuk, Y., Kozin, O., Golenkova, Y., Polishchuk, S., & Sanjaykumar, S. (2024). Assessment of reaction speed and nervous system characteristics: Implications for physical exercise selection in humanities students' physical education. *Journal of Physical Education and Sport*, 24(3), 513-520. https://doi.org/10.7752/jpes.2024.03062

[14] Lake, R. J. (2012). Gender and etiquette in British lawn tennis 1870–1939: A case study of 'mixed doubles.' *The International Journal of the History of Sport, 29*(5), 691–710. https://doi.org/10.1080/09523367.2012.675203

[15] Lake, R. J. (2018). The Wimbledon Championships, the All England Lawn Tennis Club, and "invented traditions." *International Journal of Sport Communication, 11*(1), 52–74. https://doi.org/10.1123/ijsc.2017-0094

[16] Palani, B., Raj, Y. C. L., Kalmykova, Y., Sanjaykumar, S., & Korsun, S. (2024). The effectiveness of a 12-week sport nutrition education intervention on female volleyball players performance. *Physical Rehabilitation and Recreational Health Technologies*, 9(3). https://doi.org/10.15391/prrht.2024-9(3).05

[17] Renò, V., Mosca, N., Nitti, M., D'Orazio, T., Guaragnella, C., Campagnoli, D., Prati, A., & Stella, E. (2017). A technology platform for automatic high-level tennis game analysis. *Computer Vision and Image Understanding, 159*, 164–175. https://doi.org/10.1016/j.cviu.2017.01.002

[18] Sivaraman, C., Rajkumar, N. C. J., Salini, B., Boby, F. A., & Sanjaykumar, S. (2024). A multivariate regression analysis of a comprehensive rehabilitation program and performance improvement in young female volleyball players. *Physical Rehabilitation and Recreational Health Technologies*, 9(4). https://doi.org/10.15391/prrht.2024-9(4).01

[19] Smekal, G., Von Duvillard, S. P., Rihacek, C., Pokan, R., Hofmann, P., Baron, R., Tschan, H., & Bachl, N. (2001). A physiological profile of tennis match play. *Medicine & Science in Sports & Exercise, 33*(6), 999–1005. https://doi.org/10.1097/00005768-200106000-00020

[20] Thenmozhi, T., Kumar, M. S., Kalmykova, Y., Sanjaykumar, S., & Okun, D. (2024). Effectiveness of a twelve-week manual therapy intervention for shoulder injury prevention and management in female volleyball players. *Physical Rehabilitation and Recreational Health Technologies*, 9(4). https://doi.org/10.15391/prrht.2024-9(4).05

[21] Vaverka, F., Nykodym, J., Hendl, J., Zhanel, J., & Zahradnik, D. (2018). Association between serve speed and court surface in tennis. *International Journal of Performance Analysis in Sport, 18*(2), 262–272. https://doi.org/10.1080/24748668.2018.1467995