

ELEVATING ATHLETE SUPPORT IN WHEELCHAIR TENNIS THROUGH COMPREHENSIVE SCREENING

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In the dynamic world of wheelchair tennis, where risk and performance are ever evolving, the need for comprehensive athlete screening has never been more crucial. Understanding the intricate balance between health, performance, and readiness is essential for players aiming to excel on the court. Understanding the measurement frequency of periodic screening and high frequency monitoring sets the stage for a nuanced understanding of the athlete's journey. Like a compass guiding through uncharted waters, screening offers periodic glimpses into the athlete's inner workings, identifying potential pitfalls and opportunities for growth. Meanwhile, monitoring serves as a constant beacon, shedding light on the ever-changing landscape of adaptation and recovery¹.

Together, these approaches form the cornerstone of athlete support, navigating the twists and turns of athletic endeavour with precision and purpose.

WHEELCHAIR TENNIS DEMANDS

Wheelchair tennis presents unique challenges for players, on and off the court. On-court demands require players to master the physical and technical aspects of the game, including stroke technique, court movement, and shot selection. Adaptation to the specific challenges of playing in a wheelchair is crucial, involving manoeuvring the chair, hitting shots from various positions, and reacting swiftly to opponents' moves. Furthermore, movement demands such as agility, speed, and balance are essential for effective on-

court performance². Off-court demands encompass training, recovery, travel, and managing daily life activities.

Beyond the physical realm, wheelchair tennis players face psychological and physiological hurdles. Psychological stressors like performance pressure, injury management, and competition anxiety and depression can impact players' mental well-being. Physiological challenges include regulating body temperature, managing pain, and combating fatigue, which is especially relevant for those with spinal cord-related disorders.

Weight management poses a common hurdle, particularly for players with spinal cord-related disorders, who may contend with reduced mobility and metabolic changes. Moreover, the diverse



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range of physical impairments among players necessitates tailored training programs and injury prevention strategies. Daily physical demands, for example, transferring in and out of the chair and navigating between venues, contribute to players' overall load, underscoring the importance of rest periods and training volume adjustments.

Despite their challenges, wheelchair tennis players often exhibit remarkable strength, attributed to the need to manoeuvre their body weight, and adapt to various assistive devices. It is common to find areas of great strength contrasted with inactive, very weak musculoskeletal systems, highlighting the importance of addressing muscular imbalances to mitigate injury risks. Additionally, players who start wheelchair tennis later in life may have a low training age despite their chronological age, necessitating tailored physical program prescriptions suitable for beginners.

Understanding the specific impairments faced by wheelchair tennis players allows

for targeted interventions to address their unique needs and challenges, ultimately enhancing their participation and enjoyment of the sport.

Mason et al.³ conducted a comprehensive study on the demands of elite wheelchair tennis, revealing intriguing insights into players' activity profiles and performance dynamics in different divisions. The study highlighted that activity profile variations were linked to individual players' absolute physical capacity, with internal workload and technical performance levels remaining similar across divisions. Interestingly, the research emphasized that technical proficiency often outweighed physical prowess across all divisions, underscoring the importance of skill and strategy in wheelchair tennis.

Key findings from the study shed light on specific gameplay dynamics within the men's elite division. Only 10% of balls were struck on the second bounce, indicating the fast-paced nature of matches. Men also exhibited a higher frequency of volleys

than female or quad divisions, suggesting differences in playing style and strategy. Moreover, the study noted that matches where players lost sets were characterized by more high-speed accelerations, indicating moments of decreased control and increased effort in chasing down balls.

Rotational velocity during turning emerged as a crucial factor in predicting tennis performance in wheelchair players, emphasizing the significance of rotational movement ability in gameplay. Furthermore, a specific analysis of backhand strokes⁵ revealed notable changes in trunk rotation and shoulder dynamics between wheelchair and standing conditions. In the wheelchair condition, players demonstrated greater angular excursion, velocity, and acceleration during shoulder flexion, as well as higher values for shoulder abduction and adduction. Interestingly, lower racket vibration was observed in the wheelchair condition, suggesting potential differences in stroke mechanics or equipment interaction.

An in-depth understanding of the sport provides valuable insights into the nuanced demands and performance characteristics of elite wheelchair tennis, highlighting the intricate interplay between physical capacity, technical proficiency, and gameplay dynamics. These findings underscore the importance of tailored training and screening protocols to optimize player performance and enhance their competitive edge in the sport.

Screening is therefore necessary to ensure safety and well-being during sports participation, offering a vital opportunity to assess players' health status, detect underlying conditions, and monitor changes over time. This comprehensive approach is particularly crucial in elite wheelchair tennis, where the effects of aging and prolonged athletic activity can impact players' health and performance over the span of their careers.

SCREENING OF WHEELCHAIR TENNIS PLAYERS: WHAT IS IT?

An organization, coach, or player typically requests screening for the following purposes:

- Injury and disease prevention
- Health and well-being monitoring
- Early disease detection/injury prevention
- Performance optimization
- Compliance and safety
- Educational opportunities

The process can further be categorised into medical screening and performance monitoring. Both involve assessing

individuals' health status but differ in focus, objectives, and methods. A multi-layered approach to screening should be adopted, incorporating a team of inter-disciplinary professionals to gain objective, global insight into the player. Through comprehensive screening processes and prioritizing player screening, we can ensure wheelchair tennis players receive the support they need to excel in their sport while safeguarding their overall well-being.

Every tennis player presents a unique set of abilities, and the Individualisation principle is important for all players, but within a wheelchair tennis context, this tops the priority list. These players present unique mechanical, physiological, and psychological abilities to the extent that there may not be anything in common between two players competing in this sport. This takes the individualized approach to another level. The general guidelines for screening, treating, or training non-disabled athletes are often not sufficient for wheelchair tennis players, and a think-out-of-the-box approach is required.

Wheelchair tennis is organized into two main divisions: the Open division, featuring separate draws for men and women, and the Quad division, which includes a mixed draw. Diagnostic groups are divided into two primary categories to effectively assess and classify players, following recommendations from the Para sport translation of the IOC consensus on recording and reporting data for injury and illness⁴.

The first category comprises neurological

impairments, which encompass a range of conditions affecting the nervous system. Neurological conditions found among wheelchair tennis players can be further divided into brain disorders, spinal cord-related disorders and neuromuscular disorders. Neuromuscular disorders are stable or progressive, and screening health care professionals must remember this. Stable disorders could include post-polio or peripheral nerve impairments. Progressive conditions include motor neuron disease, muscular dystrophy or myopathy, which are degenerative by nature and need monitoring over time.

The second category involves musculoskeletal impairments, which affect the structure and function of the musculoskeletal system. This category includes conditions like limb deficiency, short stature, leg length differences, and impaired passive range of motion in joints. These musculoskeletal impairments can significantly impact a player's mobility, strength, and coordination, affecting their performance on the tennis court.

WHAT SHOULD BE SCREENED AND HOW?

A few factors will influence the best screening protocol for the individual player.

- The nature of the player's physical impairment
- The interdisciplinary team that is consistently available to that player
- Budget
- Competitive level of the player
- Validity and sensitivity of tests used.



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TABLE 1

<i>Medical Doctor</i>	<i>Trainer / Strength & Conditioning practitioner / Sport Scientist</i>	<i>Physiotherapist</i>	<i>Psychologist</i>
<i>Screening/ monitoring role in the team</i>			
<ul style="list-style-type: none"> • Cardiovascular assessment (ECG, and echocardiogram if indicated) • Medical and injury history (questionnaire) • General medical and musculoskeletal examination • Laboratory testing (blood markers) • Sleep quantity and quality • Lifestyle habits • Vaccinations 	<ul style="list-style-type: none"> • Performance marker testing (serve velocity, speed, endurance capacity) • Biomechanical movement efficiency • Acute and chronic training load • Growth and maturation influences • Scheduling of travel, training, competition, follow up assessments, interdisciplinary engagements • Nutrition 	<ul style="list-style-type: none"> • Functional tests such as joint range of movement, proprioception, balance, and some strength tests (“Aspetar - Athletes Screening Article”) 	<ul style="list-style-type: none"> • Well-being status • Goal setting • Life demands • Game readiness
<i>Recommended frequency of the screen</i>			
<i>Annually</i>	<i>Daily - Quarterly</i>	<i>Bi-annually</i>	<i>Weekly - Monthly</i>

Legends: ECG = Electrocardiogram

Table 1: Example of the screening and monitoring roles of an interdisciplinary team.

The screening process in wheelchair tennis encompasses a thorough examination of both physical and psychological aspects, recognizing their interconnectedness and profound influence on a player’s performance. By identifying and addressing any barriers or limitations in these domains, coaches and practitioners can develop more effective training and strategic plans tailored to each player’s unique needs. Understanding the physical impairment of the player, including endurance capacity, strength, power, speed, flexibility, and mobility, is crucial for optimizing technical skills and executing tactical manoeuvres on the court. Simultaneously, delving into the psychological realm, such as assessing mindset, confidence levels, and coping mechanisms, can uncover hidden obstacles that may hinder performance. By zooming in on these key areas during screening, coaches, and support staff can gain invaluable insights into the holistic development of the player, fostering a comprehensive approach to tennis planning strategy that maximizes potential and enhances overall success.

Building the screening plan, an interdisciplinary team should assess the following areas (see Table 1): health, well-being, injury history, physical capacities, lifestyle, life demands, training details and schedules, competition schedules and player goals. One should liken this to an artist painting a picture. Only once they have layered the different painting techniques and covered the whole canvas can you interpret the meaning of the piece.

Medical Screening

A Periodic Health Evaluation (PHE) conducted by a medical doctor is recommended for players regularly. This PHE includes basic medical screening as well as special investigation(s).

The basic medical screen encompasses:

1. a thorough evaluation of personal and medical histories,
2. a history on sleep, nutritional and lifestyle habits of the player, and
3. a physical examination which includes a systematic evaluation of all the organ systems (cardiovascular, respiratory,

nervous, skin, musculoskeletal, digestive, endocrine, urinary and reproductive).

Special investigations, including essential non-invasive tests [e.g., electrocardiograms (ECGs)], which provide insights into the heart’s electrical activity and spirometry, assessing lung function and capacity, are suggested. Additional diagnostic measures, such as echocardiography and exercise tests, may be employed based on clinical necessity. Blood samples can be used to screen for disease prevention, check for haematological conditions, or as a monitoring tool.

Neurological assessments, including evaluations of sensation, reflexes, and motor function, are essential for detecting or managing any neurological impairments. Many reliable functional screening tests are available to screen players for neuromuscular function, soft tissue health and overall movement competency, which inform muscle contraction and/or joint biomechanics. This usually depends on the player’s choice of practitioner to perform

the tests and the background of that practitioner, but it is commonly performed by a medical doctor or physiotherapist^{6,7}. Urological screening, specifically for players with spinal cord-related disorders is a crucial step that can often be overlooked.

Limb deficiency is another common physical impairment seen in wheelchair tennis. A comprehensive examination of musculoskeletal and dermatological health and function needs to be conducted on these players to ensure their functioning limbs can cope with their altered movement mechanics and that the skin-prosthesis interface is well-fitted and maintained. It is worth considering the individual's day to day locomotion as some players may only use a wheelchair while playing tennis. Musculoskeletal radiology services, including X-rays, ultrasound scans can be utilized if indicated, and magnetic resonance imaging (MRI), ensuring a thorough and tailored approach to screening.

A truly holistic screen should also incorporate an interdisciplinary approach to assess the player's visual, dental, psychological, and nutritional health.

Psychological Screen

A player's psychological state plays a pivotal role in their overall readiness and performance, often serving as the linchpin that can either enhance or hinder their physical and mental capabilities. While screening for health, wellness, and readiness covers important aspects of a player's preparation, overlooking their psychological well-being can undermine all other efforts. A player may possess optimal physical fitness, technical skills, and tactical knowledge, but if their psychological state is compromised, it can neutralize these advantages instantly.

Psychological factors such as confidence, focus, motivation, resilience, and emotional stability profoundly impact a player's ability to perform under pressure, adapt to challenges, and sustain long-term success. Issues such as performance anxiety, lack of self-belief, stress, or burnout can manifest unexpectedly, significantly impacting performance outcomes and overall well-being.

Therefore, comprehensive screening should encompass psychological assessments and interventions to identify and address underlying issues that impede a player's mental readiness. This may involve cognitive-behavioural



interventions, mindfulness practices, goal-setting strategies, and stress management techniques tailored to the individual player's needs.

By recognizing the pivotal role of psychological factors in athletic performance and incorporating psychological screening into player assessments, coaches and practitioners can better support players in achieving holistic readiness and peak performance.

Performance Monitoring

Implementing a dual strategy that combines daily monitoring of relevant biomarkers and performance metrics with periodic health assessments can offer comprehensive insight into the player's well-being and

readiness to perform. In optimizing the timing and execution of these strategies, it's crucial to have a deep understanding of the player's training and competition schedule¹, which can be obtained through regular interactions with the coach and sports scientist. While a snapshot of markers collected during a medical screening may provide some value, continuous player monitoring can provide the context needed to derive the greatest insights from the medical screening process.

The comprehensive evaluation of a player's readiness to perform in wheelchair tennis encompasses different tests and assessments to gauge various aspects of physical fitness and performance. Utilizing tools such as using speed gates or IMUs

(Inertial Measurement Units) to assess speed and manoeuvrability⁸, along with the 30-15 intermittent fitness test for court sports, provides reliable tools for monitoring a player's readiness to perform in wheelchair tennis. These tests offer insights into a player's aerobic fitness levels and anaerobic explosiveness, which are crucial for maintaining peak performance amidst the travel demands and competition schedules inherent in tennis. Additionally, the Wingate arm ergometer test and supine or seated overhead medicine ball throw test⁶ are valuable indicators of power, freshness, and readiness to compete for both non-disabled and wheelchair tennis players. Grip strength using an isometric dynamometer can also be used as a quick and reliable measure of the ability to produce maximal force and is a tool that players can travel with and use as an objective measure of preparedness⁶. While measuring serve velocity with radar guns or video methods may be less feasible for lower-level players, it remains a pivotal predictor of tennis performance, particularly in junior players. Thus, incorporating these monitoring tools into screening processes enables coaches and practitioners to make informed decisions about a player's readiness to compete and tailor training programs accordingly.

CONCLUSION

A comprehensive screening approach in wheelchair tennis is not merely a routine task but a fundamental aspect of player management, essential for safeguarding health, enhancing performance, and promoting overall well-being. The timing of the screening and thorough understanding of the unique demands of wheelchair tennis and the individual need to be tailored to the player's impairment, which is key to making this process valuable. Medical doctors and performance support staff can be pivotal in optimizing player readiness and success. Adopting a multi-layered approach to screening and incorporating an interdisciplinary team of professionals ensures a holistic understanding of the player, safeguarding that players receive the comprehensive support they need to excel in their sport while prioritizing their health and safety, on and off the court. It is beyond the scope of this article to delve into the detail of every possible scenario that wheelchair tennis players could present, as each player will require a detailed

understanding of their unique impairments and the appropriate net of screening tools specific to the individual, the options given above should provoke further investigation into the most suitable practitioner to provide a thorough screening network for the player.

References

1. Pedlar CR, Newell J, Lewis NA. Blood biomarker profiling and monitoring for high-performance physiology and nutrition: current perspectives, limitations and recommendations. *Sports Med.* 2019;49(Suppl 2):185-198.
2. Derman W, Badenhorst M, Blauwet C, et al. Para sport translation of the IOC consensus on recording and reporting of data for injury and illness in sport. *Br J Sports Med.* 2021;55:1068-1076.
3. Mason BS, van der Slikke RMA, Hutchinson MJ, Goosey-Tolfrey VL. Division, result and score margin alter the physical and technical performance of elite wheelchair tennis players. *J Sports Sci.* 2020;38:937-944.
4. Sindall P. Physiological demands and court-movement patterns of wheelchair tennis [PhD thesis]. Loughborough University; 2016.
5. Ju YY, Chu WT, Shieh WY, Cheng HK. Sensors for wheelchair tennis: measuring trunk and shoulder biomechanics and upper extremity vibration during backhand stroke. *Sensors.* 2021;21:6576.
6. Reiman MP, Manske RC. *Functional Testing in Human Performance.* Champaign IL: Human Kinetics Publishers; 2009.
7. Mayrhuber L, Rietveld T, de Vries W, van der Woude LHV, de Groot S, Vegter RJK. A scoping review on shoulder injuries of wheelchair tennis players: potential risk-factors and musculoskeletal adaptations. *Front Rehabil Sci.* 2022;3:862233.
8. Rietveld T, Vegter RJK, van der Slikke RMA, Hoekstra AE, van der Woude LHV, de Groot S. Wheelchair mobility performance of elite wheelchair tennis players during four field tests: Inter-trial reliability and construct validity. *PLoS One.* 2019;14(6):e0217514.

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