

INPLASY PROTOCOL

To cite: McCormick et al. The Physical Demands of Wheelchair Tennis - a Systematic Review. Inplasy protocol 202330060. doi: 10.37766/inplasy2023.3.0060

Received: 17 March 2023

Published: 17 March 2023

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Support: Nil.

Review Stage at time of this submission: Data extraction.

Conflicts of interest:
None declared.

The Physical Demands of Wheelchair Tennis - a Systematic Review

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Review question / Objective: Our aim was to describe and synthesise the physical demands of wheelchair tennis. We reviewed the data across different playing surfaces, performance levels and sex of tennis players.

Eligibility criteria: Studies had to meet the criteria below to be included in the review: i. The paper reported on participants playing singles or doubles wheelchair tennis matches (all ages, performance levels, quad or open category and court surfaces). ii. The data collected was related to the duration of play (e.g. length of match, effective playing time), on-court movement characteristics (e.g. distance covered, moving speed, accelerations), stroke characteristics (e.g. first serve %, count, frequency) or physiological response to match play (e.g. heart rate, oxygen uptake, energy expenditure) of wheelchair tennis.

INPLASY registration number: This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 17 March 2023 and was last updated on 17 March 2023 (registration number INPLASY202330060).

INTRODUCTION

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Rationale: The physical demands of sport vary between disciplines and are

dependent on activity patterns and the body's perceived physiological response. Dynamic sports require great aerobic and anaerobic fitness which is reliant on the cardiovascular and respiratory systems' ability to perfuse contracting skeletal muscle with adequate oxygen (9). Wheelchair tennis involves intermittent periods of high intensity exercise with periods of rest in between. During a tennis match, average oxygen uptake is

approximately 50-60% of the maximum oxygen uptake (VO₂-max), with oxygen uptake exceeding 80% VO₂-max during intense rallies. Hence tennis players must be able to utilise energy stores from both aerobic and anaerobic processes (10). Physical strength is important in sport and athletes target their training to those muscles that are dominant within their discipline. In tennis, the serve is the most powerful shot and it is important for players to strengthen their scapular, rotator cuff (shoulder), fibularis longus, tibialis anterior, core and grip strength muscles to deliver a powerful serve movement (3, 11). Different sports require different degrees of flexibility. The range of motion in the glenohumeral joint is particularly important in tennis players as shots can require great lateral or overhead reach (11). Nutrition, sleep and psychological wellbeing also have an important role in maximising the performance and recovery of athletes (12, 13). Tennis players use tactics and their cognitive ability and depth-perception to win rallies (14).

Engaging in regular exercise is essential to maintain a healthy lifestyle and physical activity is prescribed as a lifestyle measure by clinicians in preventing non-communicable diseases and alleviating psychiatric conditions (15, 16). Understanding the demands of physical activity is therefore important in prescribing exercise, including tennis, appropriately to the public to treat these diseases. Additionally, understanding the physical demands of tennis is important to maximise elite sports performance. This knowledge can be used to identify people with the ideal physiology for a particular sport, individualise training programmes, guide tapering for competition and aid injury surveillance and injury recovery (17, 18). Moreover, nutrition and supplementation of athletes can enhance performance through understanding the physical requirements of athletes (19). Thus, detailed analysis of wheelchair tennis matches will allow athletes to perfect their training regime and enhance performance as well as optimise exercise prescription for the general population. This is the first systematic review and meta-analysis

undertaken into the physical demands of wheelchair tennis.

Condition being studied: Physical demands of wheelchair tennis.

METHODS

Search strategy: Data Sources and Searches - A systematic literature search was performed in the bibliographic databases Medline, Embase and Web of Science from inception to 12th January 2023. The search syntax was designed by SM following consultation from a medical subject librarian (RF). Search terms included both controlled terms and free-text terms; the terms used included 'wheelchair tennis' and 'athletic performance' (including synonyms and closely related words). Duplicate articles were excluded and a backward citation search was conducted.

Participant or population: Wheelchair tennis participants.

Intervention: N/A.

Comparator: N/A.

Study designs to be included: Studies had to meet the criteria below to be included in the review:i. The paper reported on participants playing singles or doubles wheelchair tennis matches (all ages, performance levels, quad or open category and court surfaces).ii. The data collected was related to the duration of play (e.g. length of match, effective playing time), on-court movement characteristics (e.g. distance covered, moving speed, accelerations), stroke characteristics (e.g. first serve %, count, frequency) or physiological response to match play (e.g. heart rate, oxygen uptake, energy expenditure) of wheelchair tennis.

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Information sources: A systematic literature search was performed in the bibliographic databases Medline, Embase and Web of Science from inception to 12th January 2023.

Main outcome(s): The outcomes include duration of play measurements, on-court movement characteristics, stroke characteristics and physiological characteristics for singles matches and doubles matches, open category and quad category, different playing surfaces and different performance levels.

Data management: Reviewer SM extracted data related to the following characteristic from each of the appropriate studies. This was double-checked by NH. Characteristics included; name of first author, year of publication, location of study, study design and aim, population, sample size, age, sex, performance level, assessment tool, overview of outcome measures. Data related to the outcome measures was extracted for later analysis.

- i. Duration: match duration expressed in minutes, rally duration expressed in seconds and number of strokes, effective playing time as a percentage of total time, work-to-rest ratio defined as the ratio between rally duration and rest periods between rallies, points per game/set/match were expressed by numbers, games per set/match were expressed by numbers and sets per match were expressed by numbers.
- ii. On- court Movement characteristics: acceleration and deceleration expressed in m/s^2 , changes in direction expressed as number per match or rally, distance covered expressed in metres per point/game/set/match/minute/hour and peak

moving speeds expressed in m/s.

- iii. Stroke characteristics: stroke counts expressed as a number per/game/set/match/second, stroke speed expressed in km/h and type of stroke was subdivided into forehands, backhands, serves, volleys and overheads and were expressed as numbers.

- iv. Physiological Variables: peak heart rate and average heart rate expressed in bpm, oxygen uptake expressed as ml/kg/min and energy expenditure expressed in kcal.

Quality assessment / Risk of bias analysis: Reviewers SM and NH independently assessed the methodological quality of all appropriate studies using the Joanna Briggs Institute Checklist for Analytical Cross-Sectional Studies. SM and NH discussed any unclear questions until a consensus was reached and a third reviewer was available for any disputes. This assessment was not used to determine study inclusion or perform subgroup analysis based on methodological quality due to risk of bias.

Strategy of data synthesis: The outcomes were analysed based on overall categories as follows:

- i. Sex
- ii. Open vs Quad category
- iii. Single vs doubles match
- iv. Performance levels
- v. Playing surface

For quantitative statistical analysis, mean differences were calculated and confidence intervals were set to 95% to determine significance.

Qualitative Synthesis

The descriptive characteristics of each study were summarised. A table comprised of this information can be found in the appendix.

Subgroup analysis: The descriptive characteristics of each study were summarised. The impact of the different court surfaces (hard/grass/clay) was considered.

Sensitivity analysis: Sensitivity analysis is planned on the results.

Language restriction: Papers need to be available in English.

Country(ies) involved: UK.

Keywords: Tennis; wheelchair; physical demands.

Dissemination plans: Appropriate publications and presentation of data as well as sharing the results with relevant tennis bodies.

Contributions of each author:

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