



SUPPLEMENTARY MATERIAL

# Supplementary Material: The Evidence Landscape of Paralympic Sport Science

Protocol and registration: PROSPERO CRD420261387208

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## Supplementary Table S1. Included systematic reviews

The included-review corpus comprises 38 systematic reviews and reconciles with the final domain totals reported in the main manuscript.

| ID  | Review                      | Primary domain                                       | Title                                                                                                                                                                                 | Evidence base / sample                                                                                                      |
|-----|-----------------------------|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| R01 | Becerra-Patiño et al., 2026 | Biomechanics, Equipment & Sport-Specific Performance | Identification of Performance Variables in Blind 5-A-Side Football: Physical Fitness, Physiological Responses, Technical–Tactical Actions and Recovery Variables: A Systematic Review | quantitative studies with heterogeneous samples across physical/physiological, technical–tactical and recovery domains.     |
| R02 | Ferreira et al., 2023       | Biomechanics, Equipment & Sport-Specific Performance | Current status of sport performance in Boccia: systematic review of the literature                                                                                                    | 669 documents were initially identified using “Boccia”; when “Performance” was added, results were reduced to 26 documents. |

| ID  | Review                         | Primary domain                                       | Title                                                                                                                                            | Evidence base / sample                                                                                                                                                          |
|-----|--------------------------------|------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| R03 | Fiorese et al., 2020           | Biomechanics, Equipment & Sport-Specific Performance | Biomechanics of starting, sprinting and submaximal running in athletes with brain impairment: A systematic review                                | 8 studies, corresponding to 9 eligible articles; 100 runners with brain impairment: 78 males and 22 females, aged 18–38 years.                                                  |
| R04 | Garcia-Carrillo et al., 2025   | Biomechanics, Equipment & Sport-Specific Performance | The science of adapted throws: a systematic search and narrative evidence synthesis                                                              | 19 studies including 345 para-athletes across 14 World Para Athletics sport classes, mainly seated throwers from F32–F58 and limb-deficient/prosthesis-related classes F61–F63. |
| R05 | Liu et al., 2025               | Biomechanics, Equipment & Sport-Specific Performance | Emerging assistive technologies in Paralympic sports: a systematic review                                                                        | 42 studies from 18 countries, selected from 929 records.                                                                                                                        |
| R06 | Oliveira et al., 2023          | Biomechanics, Equipment & Sport-Specific Performance | Para Powerlifting Performance: A Systematic Review                                                                                               | 9 included studies involving 157 Para powerlifting athletes: 101 men, 28 women and additional participants with sex not declared/undefined.                                     |
| R07 | de Oliveira Silva et al., 2025 | Biomechanics, Equipment & Sport-Specific Performance | Analysis of the kinematic pattern of free throw by wheelchair basketball athletes: a systematic review                                           | 7 quantitative cross-sectional studies; 216 male wheelchair basketball athletes, mostly national-team/professional-level players; 92.59% were national-team players.            |
| R08 | Heyward et al., 2017           | Injury & Health Constraints                          | Shoulder complaints in wheelchair athletes: A systematic review                                                                                  | 13 studies were included from 197 search results after duplicate removal and screening.                                                                                         |
| R09 | Jodar-Boixet et al., 2025      | Injury & Health Constraints                          | Assessing musculoskeletal complaints in para-athletes: A systematic review and critical appraisal of available Patient-Reported Outcome Measures | Six articles were included.                                                                                                                                                     |
| R10 | Kunorozva et al., 2024         | Injury & Health Constraints                          | The epidemiology of eye illness in Para athletes in the Winter and Summer settings: a systematic review                                          | Eight studies were included.                                                                                                                                                    |
| R11 | Luijten et al., 2023           | Injury & Health Constraints                          | Sports-Related Health Problems in Para-Sports: A Systematic Review With Quality Assessment                                                       | 64 studies met the inclusion criteria from 3006 records.                                                                                                                        |

| ID  | Review                          | Primary domain                                   | Title                                                                                                                                                                                         | Evidence base / sample                                                                                                                       |
|-----|---------------------------------|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| R12 | Moraes et al., 2025             | Injury & Health Constraints                      | Sports injuries in sitting volleyball athletes: a systematic review                                                                                                                           | 10 studies were included, published between 2000 and 2019, from six countries: Brazil, United States, Poland, South Africa, Rwanda and Iraq. |
| R13 | Pinheiro et al., 2021           | Injury & Health Constraints                      | Prevalence and incidence of injuries in para athletes: a systematic review with meta-analysis and GRADE recommendations                                                                       | 42 studies were included from 4092 records.                                                                                                  |
| R14 | Santos Silva Lopes et al., 2022 | Injury & Health Constraints                      | Profile of musculoskeletal injuries in the parasport: A systematic review                                                                                                                     | 31 studies including 17,608 participants were included from 27,798 records.                                                                  |
| R15 | Singh et al., 2024              | Injury & Health Constraints                      | Concussions in Paralympic Sports: A Systematic Review                                                                                                                                         | 13 studies included.                                                                                                                         |
| R16 | Sá et al., 2022                 | Injury & Health Constraints                      | Injuries in Wheelchair Basketball Players: A Systematic Review                                                                                                                                | Eight quantitative studies were included, involving 753 wheelchair basketball players of both sexes; 462 were men.                           |
| R17 | Ahmadi & Uchida, 2021           | Performance Assessment, Testing & Classification | Place of the gold standard isokinetic dynamometer in Paralympic sports: a systematic review                                                                                                   | 981 records were initially identified; 10 studies were finally included.                                                                     |
| R18 | Altmann et al., 2022            | Performance Assessment, Testing & Classification | Objective Measurement of Ball-Handling Proficiency in Wheelchair Sports: A Systematic Review                                                                                                  | 22 articles met the minimum methodological-quality threshold and were included in the synthesis.                                             |
| R19 | Ferreira da Silva et al., 2022  | Performance Assessment, Testing & Classification | Wheelchair skill tests in wheelchair Basketball: A systematic review                                                                                                                          | 23 studies were included, involving 838 wheelchair basketball athletes.                                                                      |
| R20 | Gavel et al., 2023              | Performance Assessment, Testing & Classification | Reliability of anaerobic and aerobic mobility performance tests used in wheelchair rugby, wheelchair basketball and wheelchair tennis: A systematic review                                    | 21 studies; 317 participants in WCB, wheelchair rugby and wheelchair tennis.                                                                 |
| R21 | Hutchinson et al., 2021         | Performance Assessment, Testing & Classification | Measures of impairment applicable to the classification of Paralympic athletes competing in wheelchair sports: A systematic review of validity, reliability and associations with performance | 23 studies were included.                                                                                                                    |

| ID  | Review                        | Primary domain                                     | Title                                                                                                                                               | Evidence base / sample                                                                                                                                                           |
|-----|-------------------------------|----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| R22 | Luarte et al., 2022           | Performance Assessment, Testing & Classification   | Most frequent tests in the literature for the evaluation of physical qualities in elite level Paralympic wheelchair basketball: a systematic review | The search identified 270 records.                                                                                                                                               |
| R23 | O'Connor et al., 2022         | Performance Assessment, Testing & Classification   | Assessment of muscle strength in para-athletes: A systematic review of observational studies                                                        | 30 studies; wheelchair sports represented 23/30 studies (76%).                                                                                                                   |
| R24 | Sá et al., 2023               | Performance Assessment, Testing & Classification   | Evidence-Based Classification in Wheelchair Sports: A Systematic Review                                                                             | 10 studies were included from 141 initially identified records.                                                                                                                  |
| R25 | Wileman et al., 2025          | Performance Assessment, Testing & Classification   | Guiding Evidence-Based Classification in Para Sporting Populations: A Systematic Review of Impairment Measures and Activity Limitations             | 51 articles were included.                                                                                                                                                       |
| R26 | Araujo et al., 2025           | Physiological, Nutritional & Training Determinants | Sleep Quality and Specific Characteristics of Different Types of Impairments in Paralympic Athletes: an Updated Systematic Review                   | 110 records were retrieved: 23 from EMBASE, 17 from PubMed, 32 from Scopus, 7 from SPORTDiscus and 31 from Web of Science.                                                       |
| R27 | Baumgart et al., 2018         | Physiological, Nutritional & Training Determinants | Peak oxygen uptake in Paralympic sitting sports: A systematic literature review, meta- and pooled-data analysis                                     | 57 studies reporting VO <sub>2</sub> peak values from 771 athletes across 14 Paralympic sitting-sport disciplines.                                                               |
| R28 | Becerra-Patiño et al., 2025   | Physiological, Nutritional & Training Determinants | Differences in Anthropometric and Body Composition Factors of Blind 5-a-Side Soccer Players in Response to Playing Position: A Systematic Review    | 10 studies were included, with a total sample of 168 athletes.                                                                                                                   |
| R29 | Feitosa et al., 2023          | Physiological, Nutritional & Training Determinants | Monitoring oxygen uptake, blood lactate and heart rate in swimmers with physical impairments: A systematic review                                   | 10 studies involving 142 swimmers with physical impairments were included.                                                                                                       |
| R30 | Palacín Artigosa et al., 2022 | Physiological, Nutritional & Training Determinants | Effects of Goalball on Balance: A Systematic Review                                                                                                 | 85 articles were initially retrieved.                                                                                                                                            |
| R31 | Perret & Flueck, 2016         | Physiological, Nutritional & Training Determinants | Supplementation and Performance in Spinal Cord-Injured Elite Athletes: a Systematic Review                                                          | 618 records were initially identified; 566 were excluded as unrelated to the topic; 52 studies were retrieved in detail; 47 were excluded; 5 studies met all inclusion criteria. |

| ID  | Review                        | Primary domain                                     | Title                                                                                        | Evidence base / sample                                                                                                                                         |
|-----|-------------------------------|----------------------------------------------------|----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| R32 | Perret, 2017                  | Physiological, Nutritional & Training Determinants | Elite-adapted wheelchair sports performance: a systematic review                             | Elite/trained wheelchair sport athletes; 6 studies on respiratory training, 2 cooling, 7 equipment adaptations.                                                |
| R33 | Shaw et al., 2021             | Physiological, Nutritional & Training Determinants | Dietary Supplementation for Para-Athletes: A Systematic Review                               | 15 articles involving 311 participants were included.                                                                                                          |
| R34 | Fadian et al., 2025           | Psychological, Social & System-Level Factors       | The development of various fields of Paralympic sports: a systematic review                  | The review reports that 947 articles met initial criteria, 759 remained after screening, and 24 articles were finally selected for qualitative/meta-synthesis. |
| R35 | Ferreira et al., 2024         | Psychological, Social & System-Level Factors       | Burnout syndrome and coping strategies in athletes with disabilities: a systematic review    | 157 records were identified; 25 duplicates were removed; 132 records were screened; 8 studies were included.                                                   |
| R36 | Jefferies et al., 2012        | Psychological, Social & System-Level Factors       | The Paralympic athlete: a systematic review of the psychosocial literature                   | 2,269 citations were identified from the five databases.                                                                                                       |
| R37 | Mira et al., 2023             | Psychological, Social & System-Level Factors       | Well-Being, Resilience and Social Support of Athletes with Disabilities: A Systematic Review | 287 studies were identified; after duplicate removal and screening, 39 articles were assessed for eligibility and 27 studies were included.                    |
| R38 | Rodríguez Macías et al., 2022 | Psychological, Social & System-Level Factors       | The Sport Training Process of Para-Athletes: A Systematic Review                             | 19 articles were included.                                                                                                                                     |

## Supplementary Table S2. ROBIS and AMSTAR 2 appraisal summary

ROBIS classified 11 reviews as low risk of bias, 23 as high risk, and 4 as unclear. AMSTAR 2 was applicable to 10 reviews: 0 were rated high confidence, 2 moderate, 3 low, and 5 critically low. Agreement before consensus was 89.5% (Cohen's kappa = 0.78). ROBIS and AMSTAR 2 judgments were completed independently by two reviewers at item level, with disagreements resolved by consensus; the item-level judgments informed the final classifications but are not reproduced in full in this supplementary document.

Final appraisal summary

| Instrument | Category                               | Final result  | Interpretation             |
|------------|----------------------------------------|---------------|----------------------------|
| ROBIS      | Low / High / Unclear                   | 11 / 23 / 4   | Final overall distribution |
| AMSTAR 2   | High / Moderate / Low / Critically low | 0 / 2 / 3 / 5 | 10 applicable reviews      |
| Agreement  | Percent agreement / Cohen’s kappa      | 89.5% / 0.78  | Before consensus           |

Supplementary Table S3. Primary-study overlap and corrected covered area

Overall primary-study overlap was moderate (CCA 7.6%). The greatest overlap occurred in the injury and health and performance assessment/testing/classification domains. Domain-specific CCA percentages are not reproduced here because the main manuscript reports the domain pattern qualitatively rather than as separate numeric estimates.

| Scope                         | Result           | Interpretation                                | Status                    |
|-------------------------------|------------------|-----------------------------------------------|---------------------------|
| Overall primary-study overlap | CCA 7.6%         | Moderate overlap                              | Final                     |
| Domain pattern                | Greatest overlap | Injury and health                             | Final qualitative finding |
| Domain pattern                | Greatest overlap | Performance assessment/testing/classification | Final qualitative finding |

**CCA formula:**  $CCA = (N - r) / (r \times c - r)$ , where N is the total number of primary-study occurrences, r is the number of reviews, and c is the number of unique primary studies.

Appendix S1. Database search strategies

Search period: initiated 5 May 2026 and completed 30 June 2026.

**Protocol timing.** The archived protocol is dated 5 May 2026 and specifies 5 May 2026 as the study start date and 30 June 2026 as the planned completion date. The search strategy was peer reviewed by an experienced information specialist using PRESS principles.

MEDLINE via PubMed

Platform: PubMed | Coverage: Inception to 30 June 2026

**Final executed search string:** ((Paralympic\*[Title/Abstract] OR “Para sport”[Title/Abstract] OR “Para sports”[Title/Abstract] OR parasport\*[Title/Abstract] OR “Para athlete”[Title/Abstract] OR “Para athletes”[Title/Abstract] OR “disabled athlete”[Title/Abstract] OR “disabled athletes”[Title/Abstract] OR “athletes with disabilities”[Title/Abstract]) AND (systematic review[Publication Type] OR meta-analysis[Publication Type] OR systematic review[Title/Abstract] OR meta-analy\*[Title/Abstract] OR evidence synthesis[Title/Abstract] OR umbrella review[Title/Abstract]))

## Embase

Coverage: Inception to 30 June 2026

**Final executed search string:** ('paralympic':ti,ab,kw OR 'para sport':ti,ab,kw OR 'para sports':ti,ab,kw OR parasport\*:ti,ab,kw OR 'para athlete':ti,ab,kw OR 'para athletes':ti,ab,kw OR 'disabled athlete':ti,ab,kw OR 'disabled athletes':ti,ab,kw OR 'athletes with disabilities':ti,ab,kw) AND ('systematic review'/de OR 'meta analysis'/de OR 'systematic review':ti,ab,kw OR meta-analy\*:ti,ab,kw OR 'evidence synthesis':ti,ab,kw OR 'umbrella review':ti,ab,kw)

## Scopus

Platform: Elsevier Scopus | Coverage: Inception to 30 June 2026

**Final executed search string:** TITLE-ABS-KEY ( paralympic\* OR "para sport" OR "para sports" OR parasport\* OR "para athlete" OR "para athletes" OR "disabled athlete" OR "disabled athletes" OR "athletes with disabilities" ) AND TITLE-ABS-KEY ( "systematic review" OR meta-analy\* OR "evidence synthesis" OR "umbrella review" )

## Web of Science Core Collection

Platform: Clarivate Web of Science | Coverage: Inception to 30 June 2026

**Final executed search string:** TS=(Paralympic\* OR "para sport" OR "para sports" OR parasport\* OR "para athlete" OR "para athletes" OR "disabled athlete" OR "disabled athletes" OR "athletes with disabilities") AND TS=( "systematic review" OR meta-analy\* OR "evidence synthesis" OR "umbrella review")

## SPORTDiscus

Coverage: Inception to 30 June 2026

**Final executed search string:** (TI (Paralympic\* OR "para sport" OR "para sports" OR parasport\* OR "para athlete" OR "para athletes" OR "disabled athlete" OR "disabled athletes" OR "athletes with disabilities") OR AB (Paralympic\* OR "para sport" OR "para sports" OR parasport\* OR "para athlete" OR "para athletes" OR "disabled athlete" OR "disabled athletes" OR "athletes with disabilities")) AND (TI ("systematic review" OR meta-analy\* OR "evidence synthesis" OR "umbrella review") OR AB ("systematic review" OR meta-analy\* OR "evidence synthesis" OR "umbrella review"))

## Cochrane Database of Systematic Reviews

Platform: Cochrane Library | Coverage: Inception to 30 June 2026

**Final executed search string:** (Paralympic\* OR "para sport" OR "para sports" OR parasport\* OR "para athlete" OR "para athletes" OR "disabled athlete" OR "disabled athletes" OR "athletes with disabilities"):ti,ab,kw

Across the six database searches, 2,846 records were identified before deduplication.

## Search management and deduplication

**Reported workflow:** records exported to Zotero 7.0; Zotero duplicate detection followed by manual verification of title, authors, year, journal, and DOI.

Final screening counts: 2,846 records identified; 912 duplicates removed; 1,934 records screened.

## Appendix S2. Full-text exclusions with reasons

The final full-text exclusion reasons and counts correspond to Figure 1 in the main manuscript and sum to 143 excluded reports.

| Exclusion reason                                       | Final n | Status |
|--------------------------------------------------------|---------|--------|
| Not eligible systematic-review design                  | 57      | Final  |
| Population not directly relevant or data not separable | 36      | Final  |
| Topic not directly pertinent to competitive Para sport | 27      | Final  |
| Ineligible publication status                          | 13      | Final  |
| Full text unavailable                                  | 5       | Final  |
| Duplicate / companion / updated report                 | 5       | Final  |
| Total                                                  | 143     | Final  |

## Appendix S3. Reproducibility specifications for secondary analyses

The secondary quantitative re-analyses used study-level numerical data reconstructed from Pinheiro et al. (2021) and Baumgart et al. (2018), without a new primary-study search. The archived reproducibility package contains the reconstructed input datasets, analysis scripts, machine-readable result files, leave-one-out outputs, workbook-level validation checks, and execution logs used to verify the secondary analyses. The specifications below reproduce the input structure and analytic choices reported in the final main manuscript.

| Component                       | Source / input                              | Final specification                                                                                                                                                                |
|---------------------------------|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Injury prevalence               | Pinheiro et al. (2021)                      | 31 prevalence cohorts; injury events and sample sizes reconstructed from the included review.                                                                                      |
| Injury incidence                | Pinheiro et al. (2021)                      | 21 incidence cohorts; reported rates, confidence intervals, and injury counts reconstructed from the included review.                                                              |
| VO <sub>2</sub> peak            | Baumgart et al. (2018), official supplement | 88 absolute and 67 body-mass-normalized rows; sport labels harmonized and sports analysed separately.                                                                              |
| Non-independent rows            | Multiple rows from a publication            | Publication-level aggregation within each sport and outcome scale using inverse-variance weighting before random-effects pooling.                                                  |
| Primary injury models           | Study-level reconstructed data              | REML with modified Hartung-Knapp confidence intervals; logit prevalence with 0.5 continuity correction when required; log-rate incidence; prediction intervals used t with k-2 df. |
| VO <sub>2</sub> peak / software | Study-level means, SDs, and n               | Sampling variance $SE^2 = SD^2/n$ ; k=1 descriptive and k=2 interpreted cautiously. R 4.5.1; metafor 4.8-0; meta 8.2-1; dplyr 1.1.4; ggplot2 3.5.2.                                |

**Reproducibility and validation.** The archived computational package includes separate study-level CSV files for 31 injury-prevalence cohorts and 21 injury-incidence cohorts, together with 88 absolute and 67 body-mass-normalized VO<sub>2</sub>peak rows. It also includes leave-one-out results, a complete machine-readable results file, the official Baumgart et al. supplementary workbook used as the VO<sub>2</sub>peak source, executable analysis scripts, workbook inspection outputs, formula-error checks, and analysis execution logs. Replication analyses were used as data-integrity checks against the source reviews; the secondary analyses were not treated as updated systematic reviews of primary studies.

### Supplementary figures

No supplementary figures are included; all figures cited in the manuscript are presented in the main text.