

Physical Fitness Assessment Across the Disability Spectrum in Multiple Sclerosis

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BACKGROUND

- Appropriate assessment of physical fitness (i.e., aerobic capacity and muscular strength) is necessary to the design and evaluation of exercise training in multiple sclerosis (MS).
- One of the primary limitations in evaluating fitness across the disability spectrum is physical inaccessibility of traditional testing modes (e.g., walking on a treadmill). Traditional tests further lack sensitivity and accuracy in determining maximal physical capacity.
- This restricts the capacity for well-designed clinical trials of exercise training across the MS disability spectrum.

AIMS

We conducted a comparative evaluation of traditional and alternative modes for measuring fitness across the disability spectrum in MS. We compared arm ergometry and manual muscle testing (MMT) (i.e., traditional modes) to recumbent stepping and quantitative dynamometry (i.e., alternative modes), respectively, to determine:

1. If the response to cardiorespiratory and muscular fitness testing differed between traditional and alternative testing modes.
2. If the exercise response in persons with MS differed by disability level.
3. If physical fitness, assessed by alternative testing modes, had a stronger association with clinical, functional, symptomatic, and participatory measures, compared to physical fitness assessed by traditional testing modes.

METHODS

• Fitness outcomes:

| | Traditional Mode | Alternative Mode |
|-------------------|--|--------------------|
| Aerobic capacity | Arm ergometer | Recumbent stepper |
| Muscular strength | Manual muscle testing (MMT) with hand-held dynamometer | Seated dynamometer |

• Other outcomes:

- Disability:** clinically-administered Expanded Disability Status Scale (EDSS)
- Walking speed:** Timed 25-foot walk (T25FW)
- Walking endurance:** 6-minute walk (6MW)
- Cognition:** Symbol digit modalities test (SDMT)
- Fatigue:** Modified Fatigue Impact Scale (MFIS)
- Health-related quality of life:** Multiple Sclerosis Impact Scale (MSIS-29)
- Activities of daily living:** Late Life-Function and Disability Inventory (LL-FDI)

- Protocol: Participants completed two testing sessions separated by ~one week. At each session, participants completed one aerobic and one muscular strength test, administered in a counterbalanced order across testing sessions. The remaining outcomes were distributed between the two sessions in an order that minimized patient fatigue.

TABLE 1: Participant characteristics.

| Characteristic | Total MS (n=64) | Mild (n=21) | Moderate (n=22) | Severe (n=21) |
|--------------------------|-----------------|--------------|-----------------|---------------|
| Age (years) | 52.0 (7.8) | 49.7 (9.4) | 51.8 (6.9) | 54.6 (6.4) |
| Sex (% female) | 71.9% | 61.9% | 72.7% | 81.0% |
| Height (cm) | 169.9 (10.2) | 173.1 (12.3) | 170.4 (7.9) | 166.1 (9.1) |
| Weight (kg) | 80.1 (20.9) | 78.8 (15.2) | 81.1 (19.6) | 74.5 (23.9) |
| EDSS, mdn (IQR) | 4.25 (2.5) | 3.0 (1.5) | 4.25 (0.5) | 6.5 (0.5) |
| Disease duration (years) | 13.2 (8.8) | 8.9 (6.3) | 14.5 (8.9) | 16.0 (9.5) |
| Disease course (% RRMS) | 77.4% | 100% | 86.4% | 47.6% |

FIGURE 1: Comparison of (A) VO_{2peak} and (B) peak torque assessed by traditional and alternative testing modes by level of disability.

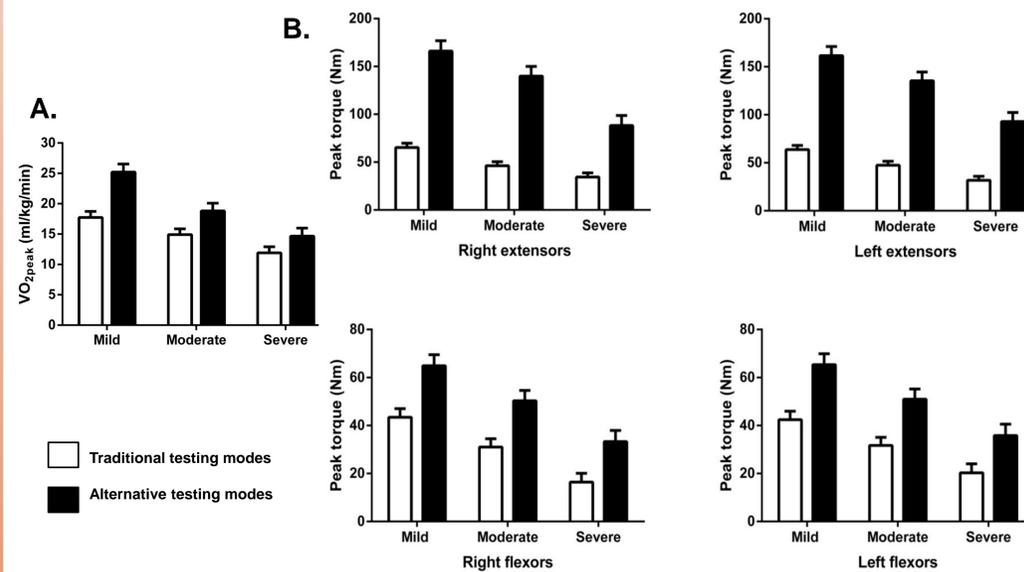


FIGURE 2: Bland-Altman plots assessing agreement between (A) VO_{2peak} and (B) peak torque measured by traditional and alternative testing modes.

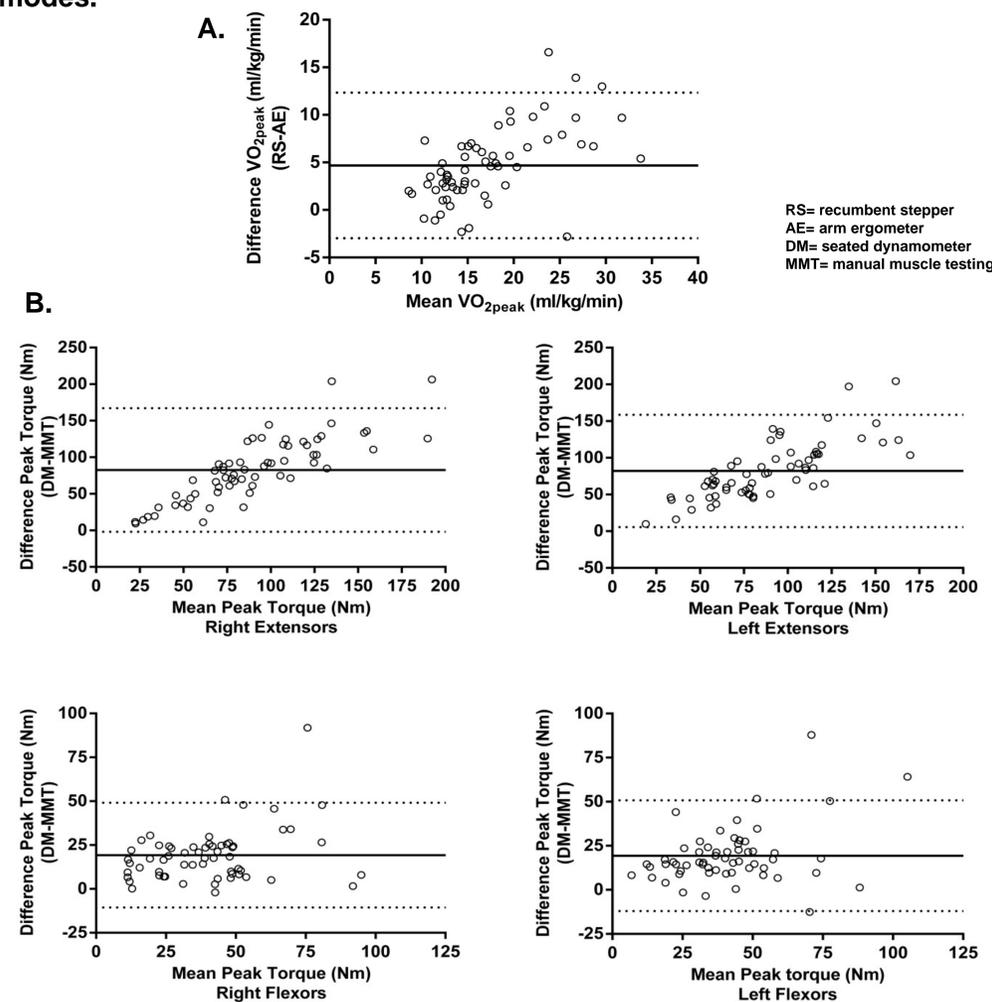


TABLE 2: Reliability of cardiorespiratory and muscular fitness tests in the overall sample and by disability level.

| Test | Intraclass Correlation Coefficients | | | |
|--------------------------|-------------------------------------|---------|-------------|-----------|
| | Total MS | Mild MS | Moderate MS | Severe MS |
| Aerobic capacity | .891 | .875 | .882 | .905 |
| Muscular strength | | | | |
| KE Right | .675 | .627 | .495 | .680 |
| KE Left | .676 | .575 | .635 | .497 |
| KF Right | .858 | .721 | .772 | .893 |
| KF Left | .822 | .687 | .820 | .836 |

TABLE 3: Correlation coefficients between fitness and other outcomes in the overall MS sample.

| Outcome | Fitness parameter | | | | | | | | | |
|----------------|--------------------------|-------|---------|-------|-------|----------------------|-------|---------|-------|-------|
| | VO_{2peak} (ml/kg/min) | | | | | Muscle strength (Nm) | | | | |
| | Extensors | | Flexors | | | Extensors | | Flexors | | |
| | AE | RS | MMT | DM | MMT | DM | MMT | DM | MMT | DM |
| EDSS | -.51* | -.63* | -.55* | -.58* | -.59* | -.60* | -.59* | -.61* | -.54* | -.56* |
| T25FW | -.48* | -.54* | -.45* | -.49* | -.55* | -.61* | -.52* | -.54* | -.50* | -.59* |
| 6MW | .60* | .72* | .58* | .65* | .62* | .62* | .63* | .66* | .57* | .66* |
| SDMT | .47* | .49* | .46* | .44* | .37* | .36* | .45* | .46* | .36* | .37* |
| MFIS | -.50* | -.66* | -.46* | -.45* | -.43* | -.49* | -.50* | -.43* | -.39* | -.51* |
| MSIS-29 phys. | -.51* | -.65* | -.49* | -.55* | -.48* | -.56* | -.55* | -.56* | -.45* | -.54* |
| MSIS-29 psych. | -.46* | -.59* | -.44* | -.44* | -.36* | -.43* | -.42* | -.42* | -.40* | -.41* |
| LL-FDI | .54* | .71* | .55* | .63* | .57* | .63* | .58* | .62* | .50* | .59* |

*Correlation coefficient statistically significant at $p < 0.05$.

CONCLUSIONS

- Overall, peak aerobic capacity and peak torque were 32% and ~170% greater, respectively, based on alternative testing modes (i.e., recumbent stepper and seated dynamometer).
- The assessment of fitness and prescription of exercise training in MS should be based on alternative testing modalities to provide the most appropriate stimulus for training adaptations.
- There was moderate-to-good reliability for the fitness tests, although there was a lack of agreement in peak fitness between testing modalities; peak fitness was underestimated using traditional modes.
- There were not differences in the associations between physical fitness and other outcomes between the traditional and alternative modalities.
- There continues to be an important association between physical fitness and other outcomes in MS, regardless of assessment modality.

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