

# Lower Extremity Motor Score (LEMS)

## Assessment Overview

### Assessment Area

**ICF Domain:**

Body Function

**Subcategory:**

Neuromusculoskeletal &  
Movement-related Functions and  
Structures

### You Will Need

**Length:**

10 locations (myotomes) (5 each  
side of the body):

- L2 – hip flexors
- L3 – knee extensors
- L4 – ankle dorsiflexors
- L5 – long toe extensors
- S1 – ankle plantarflexors

**Scoring:**

Each myotome is rated from 0 to  
5:

- Grade 0 = Total paralysis
- Grade 1 = Palpable or visible  
contraction
- Grade 2 = Active movement,  
full range of motion (ROM)  
with gravity eliminated
- Grade 3 = Active movement,  
full ROM against gravity
- Grade 4 = Active movement,  
full ROM against gravity and  
moderate resistance in a  
muscle specific position
- Grade 5 = (Normal) active  
movement, full ROM against  
gravity and full resistance in a  
functional muscle position  
expected from an otherwise  
unimpaired person

The maximum score is 50.

**Training:**

Training is mandatory. The  
International Standards Training  
e-Learning Program (InSTeP) is a  
five-module course (including  
basic anatomy, sensory  
examination, motor examination,  
anorectal examination, and

### Summary

The lower extremity motor score (LEMS) is a subscale of the  
International Standards for Neurological Classification of Spinal Cord  
Injury (ISNCSCI) that assesses lower extremity muscle strength.

Previous research suggests that individual UEMS or LEMS scores alone  
(rather than total ISNCSCI scores) better predicts upper limb or lower  
limb function (Marino & Graves, 2004; Graves, 2006).

The score range is 0–5 for each of 5 key muscles (hip flexors, knee  
extensors, ankle dorsi-flexors, long toe extensors and ankle plantar  
flexors) of each leg, with maximum score of 50.

The LEMS, along with the ISNCSCI exam should be performed in the  
supine position (except for the rectal examination that can be  
performed side-lying) to ensure scores collected are standard and  
comparable.

During each myotome / muscle group testing, the assessor should start  
the assessment in “grade 3” by default. Depending on the performance  
of the patient in each test, then the assessor will move forward to Grade  
4-5 or Grade 0-2. Please, refer to the worksheet to see the patient  
positions and testing procedures for each muscle group and grade.

### Availability

**Motor Exam Guide from:** [http://asia-spinalinjury.org/wp-content/uploads/2016/02/Motor\\_Exam\\_Guide.pdf](http://asia-spinalinjury.org/wp-content/uploads/2016/02/Motor_Exam_Guide.pdf)

**Scoring Diagram and Worksheet:** [https://asia-spinalinjury.org/wp-content/uploads/2023/12/ASIA-ISCOS-Worksheet-Sides-12\\_12\\_4\\_2023.pdf](https://asia-spinalinjury.org/wp-content/uploads/2023/12/ASIA-ISCOS-Worksheet-Sides-12_12_4_2023.pdf)

**Online ISNCSCI calculator:** [www.isncscialgorithm.com](http://www.isncscialgorithm.com)

**Video:** <https://www.youtube.com/watch?v=PpgGzlhCpul>

**Languages:** ISNCSCI Worksheet is available in many languages:  
<https://asia-spinalinjury.org/isncsci-worksheet-now-available-in-other-languages/>

scoring, scaling, and the AIS classification) designed to enable clinicians to perform accurate and consistent SCI neurological examinations of individuals with SCI.

**Equipment:**  
N/A

## Assessment Interpretability

### Minimal Clinically Important Difference

#### MID by Injury Level and Severity:

Cervical B = 2.35  
Cervical C = 2.45  
Cervical D = 1.5  
Thoracic A = 0.44  
Thoracic B = 1.75  
Thoracic C = 2.12  
Thoracic D = 1.31  
Lumbar A = 2.26  
Lumbar B = 2.08  
Lumbar C = 1.73  
Lumbar D = 1.71

#### Effect size-based estimate for small/large changes in LEMS scores:

Cervical B = 0/0  
Cervical C = 2.36/5.9  
Cervical D = 1.84/4.6  
Thoracic A/B = 0/0  
Thoracic C = 1.72/4.3  
Thoracic D = 1.44/3.6  
Lumbar A = 1.92/4.8  
Lumbar B = 1.88/4.7  
Lumbar C = 1.58/3.95  
Lumbar D = 1.52/3.8

(Scivoletto et al. 2013; n=661; 440 males; mean age: 50.35 years; 233 ASIA A, 67 ASIA B, 158 ASIA C, 142 ASIA D; mean (SD) time since injury = 51.6(36.8) days)

### Statistical Error

#### Minimal Detectable Change:

Not established in SCI

#### Standard Error of Measurement:

Not established in SCI

#### Smallest Real Difference:

1.3

(Tester et al. 2016; n=72, 57 males, 15 females; mean age: 36 years; median time since injury: 0.7 years; ASIA A-D)

### Typical Values

#### Mean (SD) LEMS scores

##### Admission to Discharge:

Cervical B = 0(0) to 11.5(16.6)  
Cervical C = 19.4(11.8) to 37.3(12.7)  
Cervical D = 39.2(9.2) to 44.8(6.5)  
Thoracic A = 0(0) to 0.76(3.1)  
Thoracic B = 0(0) to 10.3(12.4)  
Thoracic C = 14.6(8.6) to 27.4(12.3)  
Thoracic D = 34.6(7.2) to 40.8(5.8)  
Lumbar A = 6.6(9.6) to 11.9(12.8)  
Lumbar B = 6.9(9.4) to 14.4(11.3)  
Lumbar C = 16.3(7.9) to 28.7(9.4)  
Lumbar D = 36.6(7.6) to 41.6(9.4)

(Scivoletto et al. 2013; n=661; 440 males; mean age: 50.35 years; 233 ASIA A, 67 ASIA B, 158 ASIA C, 142 ASIA D; mean (SD) time since injury = 51.6(36.8) days)

## Measurement Properties

### Validity – **Moderate** to **High**

#### **High** correlation with the Walking Index for Spinal Cord Injury (WISCI) in people with SCI:

3 months:  $r = 0.85$

6 months:  $r = 0.85$

12 months:  $r = 0.88$

(Ditunno et al. 2007; N = 146 (114M, 32F); Mean age = 32 years (range 16 – 69 years); Incomplete spinal cord injury patients who had a Functional Independence Measure locomotor score for walking of < 4 on entry.)

#### **Moderate** correlation with the Gait Deviation Index for Spinal Cord Injury (SCI-GDI):

$r = 0.638$

(Sinovas-Alonso et al. 2023; n=85, 50 participants without SCI, 35 adults with incomplete SCI)

#### **Moderate** correlation with SCIM mobility subscore:

$r = 0.666$ ,  $p < 0.001$

(Lena et al. 2021; n=140, 92 males, 48 females; mean (SD) age: 60 (16) years; 30 cervical, 78 thoracic, 32 lumbar; ASIA A-D)

#### **High** correlation with 6 Minute Walk Test (6MWT):

$r = 0.7$  (0.64-0.76)

#### **High** correlation with 10 Meter Walk Test (10MWT):

$r = 0.69$  (0.63-0.75)

#### **High** correlation with the Modified Functional Reach:

$r = 0.81$  (0.77-0.85)

#### **High** correlation with Berg Balance Scale:

$r = 0.79$  (0.74-0.85)

#### **High** correlation with the Neuromuscular Recovery Scale (NRS) Overall Phase and Summary Score:

$r = 0.70$ -0.80

(Harkema et al. 2016; n=152; 123 male; mean age: 36 years; 43 ASIA A, 21 ASIA B, 39 ASIA C, 49 ASIA D; median (range) time post-SCI: 0.9 (0.1-45.2) years)

#### **Moderate** to **High** correlations with self-selected WISCI level, self-selected WISCI speed, max WISCI level, and max WISCI speed:

$r = 0.509$ -0.717 ( $p < 0.05$ )

(Burns et al. 2011; n=41, tetraplegia; ASIA A-D; chronic SCI)

(Morganti et al. 2005; n=200; 184 males; mean age: 50.4 years; 84 ASIA A, 19 ASIA B, 129 ASIA C, 52 ASIA D; mean (SD) time since injury: 56.9(43.9) days)

**Number of studies reporting validity data: 18**

### Reliability – **High**

#### **High** Inter-rater Reliability:

$r = 0.986$  (0.974-0.993)

(Lena et al. 2021; n=140, 92 males, 48 females; mean (SD) age: 60 (16) years; 30 cervical, 78 thoracic, 32 lumbar; ASIA A-D)

ICC = 0.98

(Marino et al. 2008; n=16; 16 examiners; 10 males; 5 complete tetraplegia, 5 motor incomplete tetraplegia, 5 complete paraplegia, 1 motor incomplete paraplegia; only test performed in incomplete SCI)

#### **High** Internal Consistency:

Cronbach's  $\alpha = 0.995$  (0.993-0.996)

(Lena et al. 2021; n=140, 92 males, 48 females; mean (SD) age: 60 (16) years; 30 cervical, 78 thoracic, 32 lumbar; ASIA A-D)

**Number of studies reporting reliability data: 2**

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## Responsiveness

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**Floor/Ceiling Effect:**

53% of participants at floor (score 0)

(Marino & Graves 2004; n=4338, 3443 males; 854 complete tetraplegia, 1464 incomplete tetraplegia, 1195 complete paraplegia, 825 incomplete paraplegia, 2049 ASIA A, 511 ASIA B, 655 ASIA C, 1123 ASIA D; median (IQR) time since injury = 15 (9-28) days)

**Effect Size:**

Not established in SCI

**Standardized Response Means:**

LEMS Standardized Response Means after Locomotor Training:

- All individuals: 0.23
- AIS-A/B: -0.10
- AIS-C: 0.72
- AIS-D: 0.16

(Harkema et al. 2016; n=152; 123 male; mean age: 36 years; 43 ASIA A, 21 ASIA B, 39 ASIA C, 49 ASIA D; median (range) time post-SCI: 0.9 (0.1-45.2) years)

**Number of studies reporting responsiveness data: 2**