

Development of a Modified Lumbar Stiffness Disability Index (mLSDI) Incorporating Lumbar and Hip Flexion

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Disclosures: Nothing to declare for all authors. This study was approved by the local Ethics Committee.

INTRODUCTION: We previously reported that the Lumbar Stiffness Disability Index (LSDI)¹ (Table 1) correlates more strongly with the combined forward flexion capacity of the lumbar spine and hip joints (TrunkA: Figure 1) than with lumbar flexion alone. This suggests that many daily activities require not only lumbar but also hip flexibility. However, the original LSDI was developed based solely on lumbar mobility and does not sufficiently account for hip contribution, potentially limiting its sensitivity. Therefore, the objective of this study was to develop a modified Lumbar Stiffness Disability Index (mLSDI) that better reflects stiffness-related disability in activities of daily living (ADL) by incorporating clinical and radiographic parameters of both lumbar and hip function.

METHODS: In this prospective, cross-sectional multicenter study, 147 patients with a history of lumbar spinal surgery were enrolled between June 2023 and December 2024. The mean age of participants was 74.1 years, and 49.7% were female. A panel of orthopedic surgeons, rehabilitation specialists, and epidemiologists revised the original LSDI using a modified Delphi method, adding six candidate items focused on ADLs involving hip flexion (Table 1). After two Delphi rounds, ten final items were selected (Table 1). Radiographic data in maximum seated flexion were used to calculate TrunkA, the sum of pelvic incidence minus lumbar lordosis (PI-LL) and pelvic femoral angle (PFA) (Figure 1). Pearson's correlation and multiple linear regression were used to assess associations between mLSDI, TrunkA, number of fused segments, and other clinical variables.

RESULTS SECTION: The response rates and score distributions for the LSDI and the new items are shown in Table 2. The mLSDI showed stronger correlation with both TrunkA ($r = -0.57, p < 0.001$) (Figure 2) and number of fused segments ($r = 0.47, p < 0.001$) than the original LSDI. Multiple regression identified TrunkA, fusion extent, and Oswestry Disability Index (ODI) as significant predictors. ROC analyses revealed that TrunkA values around 130° were consistent thresholds for functional limitation (Score 3 or 4) across high-difficulty ADLs (LSDI item 5 and new items 3, 4, and 5).

DISCUSSION: The mLSDI more accurately captures functional impairment due to lumbar-hip stiffness than the original LSDI. It may serve as a more sensitive tool for evaluating postoperative outcomes and informing surgical goals tailored to individual patient needs.

SIGNIFICANCE/CLINICAL RELEVANCE: The modified Lumbar Stiffness Disability Index (mLSDI) provides a more accurate assessment of stiffness-related disability by incorporating both lumbar and hip flexion. This tool can aid spine surgeons in setting personalized surgical goals and improving patient-centered outcomes in spinal fusion procedures.

REFERENCES:

- Hart RA, Gundle KR, Pro SL, Marshall LM. Lumbar Stiffness Disability Index: pilot testing of consistency, reliability, and validity. *The spine journal : official journal of the North American Spine Society*. 2013;13(2):157-161. doi:[10.1016/J.SPINEE.2012.12.001](https://doi.org/10.1016/J.SPINEE.2012.12.001)

IMAGES AND TABLES

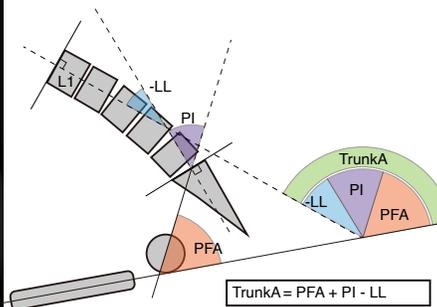


Figure 1. Measurement of lumbar and hip flexion angles in the maximum flexed seated position.

Table1. Selected 10 items of modified LSDI score

- Original LSDI questionnaire
- ① Bend to your feet to put on your underwear and pants while dressing independently
 - ② Bend through your waist to put on your socks and shoes
 - ~~3. Drive a motor vehicle.~~
 - ④ Perform personal hygiene functions after toileting
 - ⑤ Bend forward to pick up a small object off the floor
 - ~~6. Get in and out of bed.~~
 - ⑦ Get in and out of a chair
 - ~~8. Bathe the lower half of your body.~~
 - ⑨ Get in and out of an automobile
 - ~~10. Engage in sexual intercourse.~~

— Deleted items
 ○ Selected items

New candidate items

- ① Sit on a sofa or low chair and get up
- ~~2. Sit on a high chair and get up.~~
- ③ Cut the nails of the feet and take care of them
- ④ Sit on the floor or ground
- ⑤ Get up from a sitting position on the floor or ground
- ~~6. Go up and down the stairs.~~

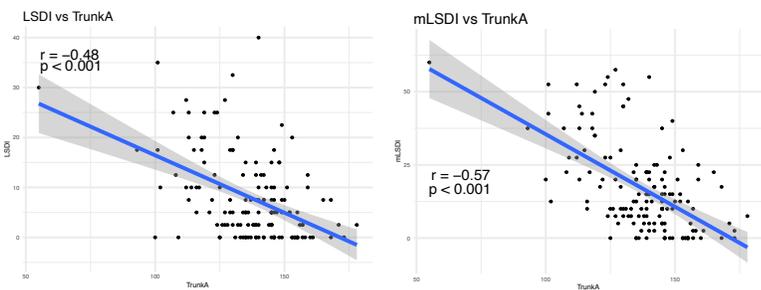


Figure 2. Scatter plots showing the relationships between LSDI and TrunkA, and between mLSDI and TrunkA.

Table 2 Distribution of answers to each question

Original LSDI	Severely disabled				Response
	0	1	2	4	
LSDI 1	78	57	12	0	147
LSDI 2	69	58	19	1	147
LSDI 3	68	3	0	0	71
LSDI 4	118	23	5	0	146
LSDI 5	76	55	10	3	146
LSDI 6	106	36	3	0	145
LSDI 7	125	19	1	0	145
LSDI 8	105	41	1	0	147
LSDI 9	107	36	2	2	147
LSDI 10	8	3	0	0	11
The new items for this research					
New item 1	73	50	20	2	145
New item 2	124	16	3	1	144
New item 3	47	47	27	12	146
New item 4	49	55	25	6	144
New item 5	39	57	29	9	145
New item 6	91	44	10	0	146