ORIGINAL ARTICLE

Arch AHS

Archives of Allied Health Sciences 2021; 33(3): 9-15.

Discriminative ability of the Spinal Cord Independence Measure III on levels of independence among ambulatory individuals with spinal cord injury

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KEYWORDS
Clinical tool;
Rehabilitation;
Neurology;
Mobility;
Burden of care.

ABSTRACT

Spinal Cord Independence Measure (SCIM) III has been proposed as a test battery to discriminate independence of individuals with spinal cord injury (SCI). However, there is no clear evidence to support this claim. This study compared the SCIM III scores among 45 ambulatory individuals with SCI who had different levels of independence. Eligible participants were assessed for their demographics, SCI characteristics, and SCIM III scores (Thai version). The requirement of external assistance and/or devices while completing the tasks of SCIM III were used to categorize the participants into three groups (15 participants/group), including need assistance, modified independence (MoID), and independence (ID).The differences among the groups were compared using the Kruskal-Wallis test.The findings indicated significant differences in the total and subscale SCIM III scores among the three groups (p-value < 0.05), except the respiration and sphincter management between the MoID and ID participants (p-value > 0.05). The current findings clearly confirmed the use of SCIM III scores to discriminate and monitor independence among ambulatory individuals of SCI.

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Received: 21 February 2021/ Revised: 9 May 2021/ Accepted: 14 June 2021

Introduction

Injury to the spinal cord commonly distorts the neural conduction, i.e., sensorimotor and autonomic functions, across the lesion sites according to the severity and the levels of injury[1,2]. Consequently, individuals with spinal cord injury (SCI) suffer from myriad consequences, including self-care, respiration, bowel and bladder control, and mobility that subsequently increase health care cost and burden of care from family members[3,4]. Therefore, apart from the development of rehabilitation treatments, the use of an effective measure is important for data transferring, communication, and periodic follow-up for the change over time of these individuals.

The Spinal Cord Independence Measure (SCIM) has been claimed as a thorough, comprehensive test battery to indicate independence of individuals with both tetraplegia and paraplegia, as well as those with complete and incomplete SCI. After development, the tool has been gradually modified to the third version, as the so-called the SCIM III. It is divided into three subscales with the total of 19 items, including self-care (six items; range from 0-20 scores), respiration and sphincter management (four items; range from 0-40 scores), and mobility (nine items; range from 0-40scores). Thus, the total SCIM III scores range from 0 to 100, with a higher score inferring the requirement of little assistance or fewer aids to complete basic daily activities and life support activities[5-8]. However, to the best of the researchers' knowledge, there was no clear evidence to confirm the discriminative ability of SCIM III scores on the independence of individuals with SCI. Therefore, this study compared the SCIM III scores (discriminative ability) among ambulatory individuals with SCI who had different levels of independence as determined using external assistance and devices required while completing daily activities.

Materials and methods

Subjects

This study was cross-sectionally conducted in ambulatory individuals with SCI who were consecutively admitted to a tertiary rehabilitation center. The inclusion criteria were age at least 18 years old, having motor incomplete SCI as determined using criteria from the American Spinal Injury Association (ASIA) Impairment Scale (AIS) C and D from traumatic or non-progressive causes, and being at a sub-acute or chronic stage of injury[1,9]. Individuals with SCI were excluded if they presented with any conditions that might affect outcomes of the study or participation in this study, such as having unstable medical conditions, brain involvement, visual deficits, deformity in the joints, leg length discrepancy, pain in the musculoskeletal system with the visual analog scale more than 5 out of 10, and other medical conditions that might affect participation in the study.The sample size calculation (using pilot data of SCIM III scores, 15 participants, with a standard deviation of 4.93 and effect size of 3.06, with set a power of test at 0.8 and an alpha level of 0.05) indicated that the study required at least 14 participants/group. The research protocol was approved by the institutional this committee for human research (HE611371). A written informed consent form was obtained from all participants prior to participation in the study.

Research protocols

Participants were interviewed and assessed for their demographics (i.e., bodyweight, height, sex, age, underlying disease, if any), and SCI characteristics (i.e., post-injury time, causes, levels and severity of injury using criteria from the ASIA impairment scale (AIS C or D)[9].Subsequently, participants were assessed for their SCIM III scores (Thai version) via interview and observation by an experience rater who had excellent reliability in using the SCIM III (Thai version) (intraclass correlation coefficients > 0.9) with the confirmation from their care givers (Figure 1). Their ability and the requirement of external assistance and/or devices while completing the tasks of SCIM III were used to arrange the participants into three independent levels [9,10] including

- Assistance (ASST) referred to those who required external assistance to perform daily movements.

- Modified independence (MoID) inferred to those who were able to execute daily movements independently with external devices.
- Independence (ID) referred to those who were able to complete daily movements independently without external assistance and devices.

Figure 1 Data collection for the SCIM III scores using interview and observation.

Statistical analysis

Descriptive statistics were applied to explain demographics and SCI characteristics. With non-normal distribution, data among the groups were compared using the Kruskal-Wallis test. Then every pairwise comparison was further analysed using the Mann-whitney U test. A level of statistical significance was set at p-value < 0.05.

Results

Forty-five ambulatory individuals with SCI completed this study (15 participants/group). Most of them were middle-aged (53.6 ± 13.8 years) female (69%), being at a chronic stage (n = 34, average post-time injury of nearly 5 years, Table 1). All participants could breathe independently using room air. All ID participants were paraplegia with AIS D, whereas some ASST participants were tetraplegia and most of them had AIS C (p-value < 0.05, Table 1). However, other demographics and SCI characteristics showed no significant differences among the groups (p-value > 0.05, Table 1). The findings indicated that ID participants had the highest SCIM III scores, both total and all subscales, followed by those with MoID, and ASST individuals, respectively (Figures 1A-D). The ID participants had the total SCIM III of nearly 96 scores whereas ASST individuals had the total SCIM III of approximately 46 scores (Figure 2D). The findings indicated significant differences among the groups, both the total and all subscale scores (p-value < 0.05, Figures 2A-D), except the respiration and sphincter management domain between MoID and ID participants (p-value > 0.05, Figure 2B).

Table 1 Demographics and spinal cord injury (SCI) characteristics of the participants

Variable	Level of independence (n=45)			*p*-value
	Assistance (n=15)	Modified ID (n=15)	ID (n=15)	
Age (year)[a]	56.7 ± 10.8 (50.7-62.7)	51.6 ± 15.6 (42.9-60.2)	52.6 ± 14.8 (49.5-57.8)	0.572
Body mass index (kg/m^2)[a]	23.0 ± 4.4 (20.5-25.4)	23.6 ± 4.2 (21.2-26.0)	22.5 ± 3.5 (20.6-24.5)	0.770
Post time injury (month)[a]	57.9 ± 80.4 (13.3-102.4)	88.1 ± 85.4 (40.8-135.4)	49.6 ± 51.6 (21.0-78.2)	0.335
Gender (n; %)[b]				
- Female	12 (80)	10 (67)	9 (60)	0.484
- Male	3 (20)	5 (33)	6 (40)	
Cause of SCI (n; %)[b]				
- Traumatic	7 (47)	8 (53)	11 (73)	0.306
- Non-traumatic	8 (53)	7 (47)	4 (27)	
Level of injury (n; %)[b]				
- Cervical (C3-5)	7 (46)	5 (33)	0	0.012*
- Thoracic (T1-10)	4 (27)	2 (13)	1 (7)	
- Lumbar (L1-5)	4 (27)	4 (27)	7 (47)	
- Cauda equina	0	4 (27)	7 (47)	
Severity of SCI (n; %)[b]				
- AIS C	11 (90)	1 (7)	0	< 0.001*
- AIS D	4 (10)	14 (93)	15 (100)	

Note: The data are presented using [a] mean ± standard deviation (95% confidence interval) and [b] number (%). *Indicate significant difference between groups. ID, independence; AIS, American Spinal Injury Association (ASIA) Impairment Scale; AIS C: more than half of the key muscles below the neurological level of injury have muscle grade < 3; AIS D: more than half of the key muscles below the neurological level of injury have muscle grade ≥ 3.

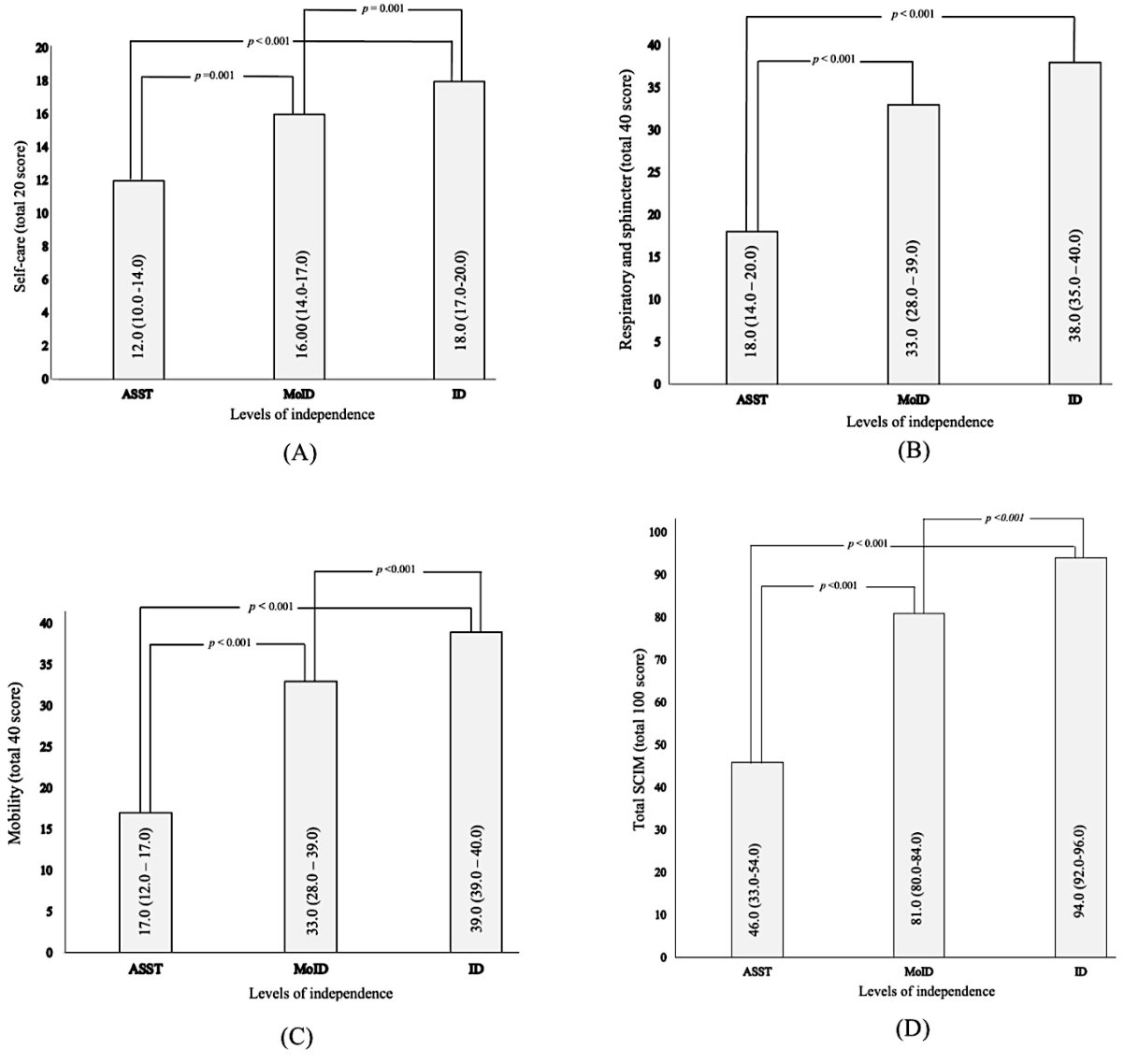

Figure 2 Spinal Cord Independence Measure (SCIM) III scores of participants with different levels of independence for
A: Self-care subscale
B: Respiration and sphincter management subscale
C: Mobility subscale
D: Total SCIM III scores

Note: Data among the groups were compared using the Kruskal-Wallis test and every pairwise comparison was analyzed using the Mann-Whitney U test. ASST, need assistance; MoID, modified independence; ID, independence.

Discussion

Without clear evidence to confirm the use of SCIM III to indicate independence in ambulatory individuals with SCI, this study compared the SCIM III scores among individuals with different levels of independence. The finding clearly indicated that the SCIM III scores, both total and in all subscales, could significantly discriminate ambulatory

individuals with SCI who had different levels of independence (p-value < 0.05), except the respiration and sphincter management subscale between MoID and ID participants (p-value > 0.05, Figure 2B).

The significant differences found for the levels and the severity of injury among the groups (Table 1) represented normal characteristics of those with different potential of independence[7,11], and appropriateness of standard criteria used to verify discriminative ability of the SCIM III scores. A large proportion of ASST participants were those with tetraplegia and AIS C (Table 1). Thus, these participants needed external assistance to execute their self-care, respiration and sphincter management, and mobility; and they had the lowest total SCIM III scores (approximately 46 scores, Figure 2D). On the contrary, all ID participants had paraplegia and mild lesion severity (AIS D). Consequently, these participants could complete their daily activities independently without assistance from persons and devices. The findings indicated that these participants had nearly total scores possible (96 out of 100 scores, Figure 2D). The findings were coherent with the previous reports[6,12] that reported the discriminative ability of the SCIM III scores in individuals with complete and incomplete SCI, and those with different degrees of lesion severity (AIS A-D). The present findings further confirm the discriminative ability of the SCIM III scores among ambulatory individuals with SCI who had different independence in daily activities especially.

The non-significant differences in the respiration and sphincter management subscale between MoID and ID participants may reflect characteristics of participants and defect in the SCIM III items. All participants in this study could breathe independently using room air; thus they had a full score that suggests the ceiling effects of this item. On the contrary, individuals with SCI commonly experience bladder and bowel control, even in ID individuals. Thus, the findings indicated the non-significant differences in the respiration and sphincter management subscale between MoID and ID participants (p-value > 0.05, Figure 2B). Ackerman et al. (2010) also reported that the respiration item of the SCIM III scores has ceiling effects, whereby individuals with SCI who were discharged from a post-acute rehabilitation program achieved the highest score possible in this item[13].

The present findings confirm the discriminative ability of the SCIM III scores among ambulatory individuals with SCI with different independence. Thus, individuals with the different SCIM III scores could reflect those with different independence in their daily living. However, the findings were derived from only ambulatory individuals with SCI with three levels of independence. In addition, this study cross-sectionally gathered the data; thus the findings may not clearly confirm the use of SCIM III score to monitor independence of individuals with SCI overtime. Further study in a large number of participants with data analysis separately for wheelchair-bounded and ambulatory individuals with various degrees of independence and the use of SCIM III scores to monitor independence of these individual overtime would further provide clinical benefit of the SCIM III scores for individuals with SCI.

Conclusion

The current findings clearly confirmed the discriminative ability of the SCIM III scores for independence among ambulatory individuals with SCI, whereby the individuals with the different SCIM III scores reflect those with different independence in their daily living.

Take home messages

The SCIM III is a comprehensive disability test battery for individuals with SCI. The different SCIM III scores reflect those with different independence in their daily living.

Conflicts of interest

The authors declare no conflict of interest.

Acknowledgements

The researchers sincerely thank for funding support from Graduate School and the Improvement of Physical Performance and Quality of Life (IPQ) research group, Khon Kaen University, Khon Kaen, Thailand.

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