Journal of Associated Medical Sciences 2024; 57(3): 83-89

JAMS
Journal of Associated Medical Sciences

Scopus Indexed & Thai-Journal Citation Index Centre (TCI)

Journal of Associated Medical Sciences

Journal homepage: https://www.tci-thaijo.org/index.php/bulletinAMS/index



Factors associated with musculoskeletal pain in ambulatory individuals with spinal cord injury

Narongsak Khamnon[1,2] Sugalya Amatachaya[2,3] Thiwabhorn Thaweewannakij[2,3] Lugkana Mato[2,3*]

[1]Department of Physical Therapy, School of Integrative Medicine, Mae Fah Luang University, Chiang Rai Province, Thailand.
[2]Improvement of Physical Performance and Quality of Life (IPQ) Research Group, Khon Kaen University, Khon Kaen Province, Thailand.
[3]School of Physical Therapy, Faculty of Associated Medical Sciences, Khon Kaen University, Khon Kaen Province, Thailand.

ARTICLE INFO

Article history:
Received 14 March 2024
Accepted as revised 3 July 2024
Available online 7 July 2024

Keywords:
Musculoskeletal disorders, factors, pain, neurological deficits.

ABSTRACT

Background: Such myriad consequences of musculoskeletal pain were common and distorted the level of functioning after spinal cord injury (SCI). No known data identifies pain-related factors in ambulatory individuals with SCI.

Objective: To examine the risk factors for musculoskeletal pain in ambulatory patients with SCI.

Materials and methods: A total of 138 ambulatory participants with SCI were interviewed and evaluated for their demographics, SCI traits, levels of locomotor disability (Functional Independence Measure-Locomotor), and data on musculoskeletal pain, including area, cause, and severity of pain using a body chart diagram and Visual Analogue Scale. Then, logistic regression was used to analyze risk factors associated with musculoskeletal pain.

Results: Precisely, 55.07% of the 138 ambulatory individuals with SCI reported musculoskeletal pain. The common top three areas of pain include the lower back (27%), hip (23%) and shoulder (15%). Factors associated with musculoskeletal pain include being a man and FIM-L 6 in which males had OR=3.56 (95% CI, 1.62-7.84; p=0.002) and FIM-L 6 had OR=2.57 (95% CI, 1.08-6.10; p=0.032).

Conclusion: The present findings revealed that musculoskeletal pain is highly prevalent in ambulatory individuals with SCI. Ambulatory individuals with SCI who are males and able to walk at least 50 meters while using gait devices are most concerned about musculoskeletal pain problems.

Introduction

Spinal cord injury (SCI) directly results in permanent sensorimotor and autonomic deterioration.[1] In addition, an increasing number of coronaviruses in 2019 (COVID-19) affected adaptation to the new normal medical services model, which limited the number of people admitted to rehabilitation care.[2] Therefore, ambulation with disabilities without health care follow-up after SCI may increase complications.[3]

Musculoskeletal pain is a chronic condition commonly reported in individuals with SCI.[4] It is characterized by injury related to the overuse, strain, and wear and tear of the musculoskeletal structure.[5] It usually gets worse with movement and better with rest.[5] A previous study showed that musculoskeletal pain frequently occurred in individuals with SCI in the first 5 years after injury[4]. Another study reported that 68 of 100 individuals with SCI experienced musculoskeletal pain.[5] The problem with pain significantly

* **Corresponding contributor.**
Author's Address: *School of Physical Therapy, Faculty of Associated Medical Sciences, Khon Kaen University, Khon Kaen Province, Thailand.*
E-mail address: yui@kku.ac.th
doi: 10.12982/JAMS.2024.050
E-ISSN: 2539-6056

interfered with mental and physical health, which led to a significant increase in the rate of hospitalization and cost of care, as well as a decline in quality of life.[5-8] Despite evidence that musculoskeletal pain is a common problem for individuals with SCI, the various factors associated with the development of musculoskeletal pain in SCI among ambulatory individuals are unknown.

Regarding concerns about advancing age, which declines in the musculoskeletal system, daring behaviors in males, having an excessive BMI, experiencing high levels of locomotor disability, as well as the cause, level, severity, and stage of the injury, are most likely to be associated with pain. However, existing evidence has not yet supported these hypotheses in ambulatory individuals with SCI.[5-14] The data regarding factors associated with musculoskeletal pain could provide for ambulatory individuals with SCI who have a high risk of developing this issue. Therefore, the study aimed to investigate risk factors associated with musculoskeletal pain in ambulatory individuals with SCI.

Materials and methods

Participants

Ambulatory individuals with SCI who visited community hospitals and tertiary rehabilitation centers were invited to participate in this study. The inclusion criteria were ambulatory individuals with SCI, both traumatic and non-traumatic causes, aged at least 18 years, and capable of walking independently, with or without a walking device, for at least 15 meters.[15,16] Participants were excluded if they had joint or extremity deformities, had present medical conditions that might limit walking ability, could not understand and follow commands, and had any underlying diseases that caused pain.[14] The ethical committee (HE 591462) authorized the trial, and eligible subjects provided written informed permission before participating in the study.

Protocol

Participants were interviewed and assessed by one physiotherapist for their demographic information (including gender, age, body weight, and height) and SCI features, such as post-injury duration, cause, severity, and levels of SCI diagnosis using the International Standards for Neurological Classification of SCI (ISNCSCI).[17] Subsequently, the physiotherapist assessed participants present level of musculoskeletal pain using dichotomous variables (yes /no pain), areas of pain using a body chart diagram, and intensity of pain using the Visual Analogue Scale (VAS), ranging from 0 to 10.[18] The participants were first interviewed about their musculoskeletal pain. The area of pain was localized using a body chart diagram. The participants evaluated pain intensity using the VAS scale by placing a mark at a point on a 10 cm line to rate the pain intensity; the far left indicated no pain, and the far right indicated the most intense pain imaginable.[18,19] The definition of musculoskeletal pain in this study was bone, joint, or muscle pain caused by repetitive strain or overuse.[4] In addition, participants who suffer from neuropathic pain often describe the sensation as being like an electric shock or a burning sensation.[20] active, passive, and accessory movement tests were used to differentiate musculoskeletal pain from neurological pain. Furthermore, we distinguish neuropathic pain from musculoskeletal pain using this essential feature of neuropathic pain.[4,20] Individuals with SCI with a VAS scale ≥ 1 were allocated to the musculoskeletal pain group, and those with a VAS scale <1 were in the no-pain group.[21]

The Functional Independence Measure-Locomotor (FIM-L) criteria were used to evaluate the participants' levels of locomotor disability.[16] The FIM-L5 is an exception (household locomotion), in which participants walk only short distances (a minimum of 15 meters independently with or without a device). The activity takes more than a reasonable amount of time, or there is safety consideration. With FIM-L6, patients have modified independence. They can walk at least 50 meters but use a brace (orthosis) or prosthesis on the leg, special adaptive shoes, cane, crutches, or walker; they take more than a reasonable amount of time to complete the activity; or there are safety considerations. With FIM-L7, patients have complete independence. They can walk a minimum of 50 meters without an assistive device. The patients perform the activity safely.[16]

Statistical analysis

The study data was analyzed using STATA ReleSTATA10. The normal distribution was verified through a Kolmogorov-Smirnov test. Descriptive statistics were applied to evaluate demographic factors, SCI features, and the prevalence of musculoskeletal pain. The severity of SCI was categorized into 4 subgroups: 1) C1-C4 AIS A, B and C; 2) C5-C8 AIS A, B and C; 3) T1-S3 AIS A, B and C; 4) AIS D at any injury level according to international SCI core data set with the reference. Mann-Whitney U tests for continuous data and the Chi-square test for categorical data were used to compare group results. Logistic regression analysis (odds ratio [OR]) was used to analyze risk factors of musculoskeletal pain. The factors associated with musculoskeletal pain in ambulatory individuals with SCI included age (<65, ≥65 years), gender (male and female), BMI (normal and overweight), levels of locomotor disability (FIM-L5, 6, and 7), causes (traumatic and non-traumatic), levels of SCI diagnosis (tetraplegia and paraplegia) and stages of injury (sub-acute and chronic). The significant difference was set as a p-value of < 0.05.

Results

At the beginning, 174 individuals with SCI were interested in participating in this research. Nevertheless, 36 participants were excluded because they were unable to ambulate (N=15), had osteoarthritis of the knee (N=12), had brain involvement (n=5), and had pressure sores (N=4). Finally, a sample of 138 completed this research. The demographic and SCI characteristics data were non-normal distribution and presented in median values, as shown in Table 1. Most participants were males, and the median age was 54.5 years (40.0-65.0) at the chronic stage, during which the median time since injury was 42

months (13.00-91.25). Injury levels among the individuals ranged from C4 to the cauda equina with AIS C and D.

Seventy-six of the 138 participants complained of moderate musculoskeletal pain, with an average VAS score of 5 (the median value of the intensity of pain score was between 4 and 6). The most common areas of pain were the lower back (27%), hip (23%), and shoulder (15%), as shown in Figure 1. Logistic regression analysis found that factors associated with musculoskeletal pain were male gender (OR, 3.56; 95% CI, 1.62-7.84; *p*=0.002) and FIM-L 6 (OR, 2.57; 95% CI, 1.08-6.10; *p*=0.032), as presented in Table 2.

Table 1. Demographics and characteristics of participants.

Variable	Total (N=138)	Pain (N=76)	No pain (N=62)	*p* value
Age at injury (years) [a]	54.50 (40.00-65.00)	53.50 (40.25-66.75)	55.00 (37.50-64.25)	0.550
Time since injury (months)[a]	42.00 (13.00-91.25)	42.00 (18.25-83.75)	42.50 (8.75-42.50)	0.583
Body mass index (kg/m^2)[a]	21.95 (18.97-25.20)	21.95 (18.82-25.07)	21.90 (19.10-25.62)	0.966
Gender: male; N (%)[b]	90 (65)	57 (75)	33 (53)	0.008*
Etiology: traumatic; N (%)[b]	59 (43)	31 (41)	28 (45)	0.606
Levels and severity of SCI; N (%)[b]				
C1-4 AIS A, B and C	1(1)	0 (0)	1 (2)	0.068
C5-8 AIS A, B and C	6 (4)	6 (8)	0 (0)	
T1-S3 AIS A, B, and C	44 (32)	26 (34)	18 (29)	
AIS D at any NLI	87 (63)	44 (58)	43 (69)	
Walking devices used; N (%)[b]				
Independence	48 (34)	22 (46)	26 (54)	0.417
Cane	12 (37)	4 (61)	8 (33)	
Crutches	12 (9)	8 (67)	4 (33)	
Walker	50 (20)	29 (58)	21 (42)	
Level of locomotor disability; N (%)[b]				
FIM-L7	46 (33)	20 (43)	26 (57)	0.141
FIM-L6	76 (55)	47 (62)	29 (38)	
FIM-L5	16 (12)	9 (56)	7 (44)	

Note: NLI: neurological level of injury, FIM-L: functional Independent Measure-Locomotion score FIM-L5: participants walk only short distances (a minimum of 17 m) independently with or without a device, FIM-L6: participants walk a minimum of 50 m (150 ft) but use a brace (orthosis) or prosthesis on the leg, special adaptive shoes, cane, crutches, or walker, FIM-L7: participants walk a minimum of 50 m (150 ft) without assistive device, [a]data were presented in terms of the median (interquartile range: Q1-Q3). The findings between the groups were compared using the Mann-Whitney U test, [b]these variables were categorized data, and a chi-square test was used to compare differences between groups according to the following criteria, gender: male/ female, etiology: non-traumatic/ traumatic,[*]indicates a significant difference between groups (p<0.05).

Table 2. Factors associated with musculoskeletal pains among ambulatory individuals with spinal cord injury (SCI).

Variable	Total (N)	Pain, N (%)	No pain, N (%)	aOR (95% CI)	*p* value
Gender					
Female	48	19 (25)	29 (47)	1	
Male	90	57 (75)	33 (53)	3.56 (1.62-7.84)	0.002*
Age					
<65 years	87	48 (63)	39 (63)	1	
≥65 years	51	28 (37)	23 (37)	0.81 (0.36-1.79)	0.607
Cause					
Traumatic	59	31 (41)	28 (45)	1	
Non-traumatic	79	45 (59)	34 (55)	1.45 (0.67-3.13)	0.340
Body mass index					
Normal (18-23.0 kg/m^2)	79	46 (61)	33 (53)	1	
Overweight (≥23.0 kg/m^2)	59	30 (39)	29 (47)	0.96 (0.87-1.06)	0.130
Stage of injury					
Sub-acute stage (<12 months)	32	15 (20)	17 (27)	0.90 (0.29-1.44)	
Chronic stage (≥12 months)	106	61 (80)	45 (73)	0.56 (0.23-1.31)	0.181
Level of SCI diagnosis					
Tetraplegia	23	11 (14)	12 (19)	1	
Paraplegia	115	65 (86)	50 (81)	0.49 (0.18-1.31)	0.157
Levels of locomotor disability					
FIM-L7	46	20 (26)	26 (42)	1	
FIM-L6	76	47 (62)	29 (47)	2.57 (1.08-6.10)	0.032*
FIM-L5	16	9 (12)	7 (11)	2.30 (0.62-8.60)	0.214

Note: *SE: standard error, aOR: adjusted odds ratio, 95%: CI95% confidence interval, AIS: American Spinal Injury Association (ASIA) Impairment Scale, [a]aOR: significant difference from the reference group for which the value was set at 1.0 (p<0.05), *significant difference between groups (p<0.05).*

Discussion

Few is known about musculoskeletal pain in ambulatory individuals with SCI; therefore, this study aimed to explore factors contributing to musculoskeletal pain in people with SCI. The findings demonstrated that 55.07% of ambulatory individuals with SCI reported moderate pain, and the top three areas of suffering were lower back, hip, and shoulder suffering (Figure 1). In addition, ambulatory individuals with SCI who were male gender and had a high level of locomotor disability (FIML-6) were associated with an increased risk of musculoskeletal pain (Table 2).

Approximately 55% of individuals with SCI experience musculoskeletal pain; the pain data showed the association between chronic SCI with ambulation and various levels of locomotor disability, including FIM-L6 (62%), FIM-L7 (43%), and FIM-L5 (56%) (Table 1). The lower back, hip, and shoulder were most affected (Figure 1). Different impairments between the lower limbs and the use of a walking device to compensate for these impairments are important causes of asymmetrical walking in individuals with neurological disorders, which may encourage patients to learn to limit the asymmetrical use of their limbs, increasing their risk of musculoskeletal pain and joint damage in the lower limb of greater use.[22] Moreover, the extreme use of the upper limbs to compensate for loss of strength and/or mobility in lower limbs might induce an injury to the upper extremity structures.[22,23] Therefore, areas of pain were shown in the lower back, hip, and shoulder (Figure 1). However, previous studies reported that the area most affected by pain was the shoulder.[5,22] The reason might be that most of the participants were wheelchair users.[24] The present findings focused only on ambulatory individuals with SCI who could walk and who had a high risk of developing musculoskeletal pain. Therefore, medical rehabilitation could find an effective strategy to prevent negative effects for these individuals with SCI.

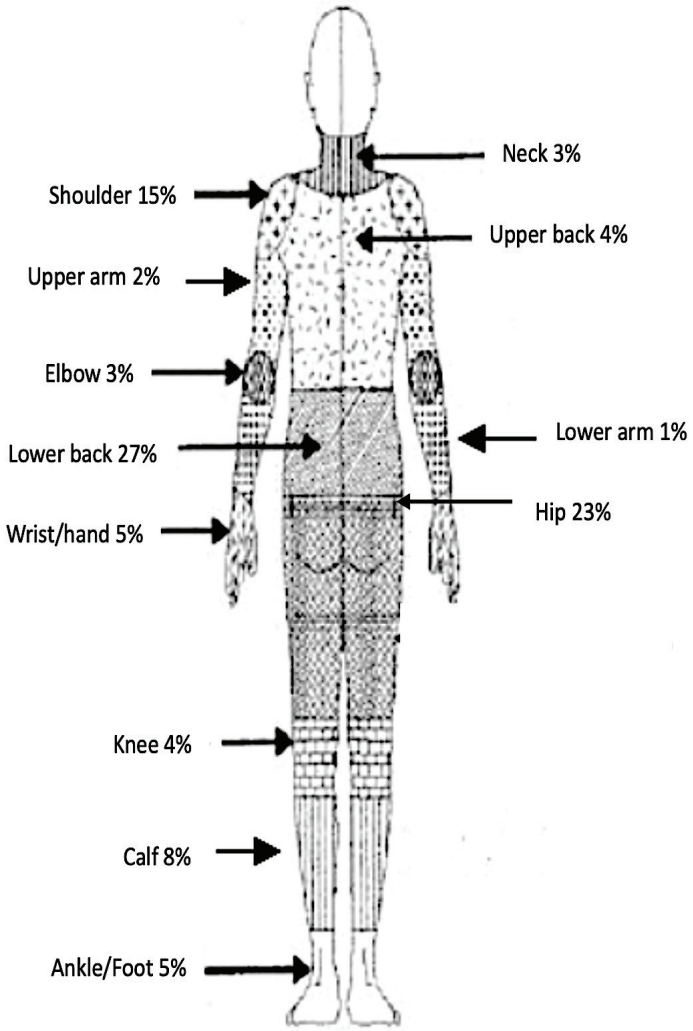


Figure 1. *Percent reported area of pain (The percent of pain in each area was derived from the total 191 pain areas and each area was included from both sides)*

This study proves the hypothesis that male individuals with SCI are at a greater risk of musculoskeletal pain than females with SCI. This finding aligns with the study of Hassan&Kamrujjaman, who reported an increased prevalence of pain in males with SCI than females with SCI.[25] However, other studies have indicated that females with SCI are more likely than males to experience musculoskeletal pain.[12,13,25] Barbetta *et al*. found that women are twice as likely to suffer from upper extremity pain due to physiological, and structural variances in their shoulders and because more women use their forearms to propel their wheelchairs than men.[12] In the present study, we hypothesize that male challenges and daring behaviors improve self-confidence to execute everyday tasks more than females, which promotes the risk of musculoskeletal injury. According to van Drongelen *et al.,* participants with higher functioning levels measured by FIM who perform too many activities of daily living (ADL) are more likely experience complaints from overuse. In contrast, participants with lower functioning levels who perform fewer tasks are less likely to experience overuse pain complaints.[24] Furthermore, Phonthee *et al*. reported that improved functional ability may lead to greater integration of walking into everyday activities and reduced reliance on a wheelchair. High ability levels might also be accompanied by increased confidence and decreased movement awareness.[14] Thus, challenge and courage in male ambulatory with SCI may explain a higher risk of pain than those in females.

Furthermore, the current findings demonstrate that participants with FIM-L6 (able to walk at least 50 meters with AAD) have a higher risk of musculoskeletal pain than those with FIM-L7 (able to walk at least 50 meters independently) and FIM-L5 (able to walk maximum 17 meters with or without AAD). Participants with FIM-L6 are a group of individuals who can walk a long distance or can walk to participate in their community, but they also need AAD. A previous study found that persons with arthritis who frequently use canes or walkers to decrease weight on their legs are especially susceptible to joint inflammation caused by repetitive forces.[22] Therefore, long-distance walking with AAD may promote the risk of musculoskeletal pain more than long-distance without AAD and short distances with or without AAD. This finding indicates that even though patients with SCI can walk independently, AAD use also induces the risk of pain.

Therefore, intervention or follow-up to wean off of AAD after SCI is crucial.

Finally, this study did not find an association between musculoskeletal pain and age, the SCI diagnosis level, and the injury stage (Table 2). The researcher supposes that most of the study participants were at a chronic stage and may have almost full functional recovery. In addition, most of them had a lower level of SCI diagnosis. Therefore, they could preserve musculoskeletal structure during walking and contributed to showing non-significant in age, level of SCI diagnosis, and stage of injury in this study. However, this study has some limitations regarding its findings' clinical implications. The design of this study was cross-sectional; therefore, it was unable to confirm the causality of pain. Thus, further exploration of long-term follow-up musculoskeletal pain is needed.

Conclusion

The finding found that male individuals with SCI and FIM-L6 had a high risk of developing musculoskeletal pain. Daring behaviors in men and AAD-related long-distance walking may increase the incidence of musculoskeletal pain in ambulatory patients with spinal cord injury.

Conflicts of interest

The authors declare that they have no conflicts of interest.

Ethical approval

The participants gave their informed consent before enrolling in the study, which was approved by the Institute Ethics Committee for Human Research (no. 591462).

Acknowledgements

We sincerely thank the Improvement of Physical Performance and Quality of Life (IPQ) research group for financial support.

References

[1] Groah SL, Charlifue S, Tate D, Jensen MP, Molton IR, Forchheimer M, et al. Spinal cord injury and aging: Challenges and recommendations for future research. Am J Phys Med Rehabil. 2012; 91: 80-93. doi: 10.1097/PHM.0b013e31821f70bc.

[2] Zullo S, Ingravallo F, Crespi V, Cascioli M, D'Alessandro R, Gasperini M, et al. The impact of the COVID-19 pandemic on people with neurological disorders: An urgent need to enhance the health care system's preparedness. Neurol Sci. 2021; 42(3): 799-804. doi: 10.1007/s10072-020-04984-4.

[3] Haisma JA, van der Woude LH, Stam HJ, Bergen MP, Sluis TA, Post MW, et al. Complications following spinal cord injury: Occurrence and risk factors in a longitudinal study during and after inpatient rehabilitation. J Rehabil Med. 2007; 39: 393-8. doi: 10.2340/16501977-0067.

[4] Siddall PJ, McClelland JM, Rutkowski SB, Cousins MJ. A longitudinal study of the prevalence and characteristics of pain in the first 5 years following spinal cord injury. Pain. 2003; 103:249-57. doi: 10.1016/S0304-3959(02)00452-9.

[5] Das A, Equebal A, Kumar S. Incidence of musculoskeletal pain and its impact on daily and functional activities in Indian spinal cord injury patients. Int J Physioth Res. 2013; 3: 99-106.

[6] Hassanijirdehi M, Khak M, Afshari-Mirak S, Holakouie-Naieni K, Saadat S, Taheri T, et al. Evaluation of pain and its effect on quality of life and functioning in men with spinal cord Injury. Korean J Pain. 2015; 28: 129-36. doi: 10.3344/kjp.2015.28.2.129.

[7] Dryden DM, Saunders LD, Rowe BH, May LA, Yiannakoulias N, Svenson LW, et al. Utilization of health services following spinal cord injury: A 6-year follow-up study. Spinal Cord. 2004; 42: 513-25. doi: 10.1038/sj.sc.3101629.

[8] Ragnarsson K. Management of pain in persons with spinal cord injury. J Spinal Cord Med. 1997; 20: 186-99. doi:10.1080/10790268.1997.11719468.

[9] Rintala DH, Loubser PG, Castro J, Hart KA, Fuhrer MJ. Chronic pain in a community-based sample of men with spinal cord injury: prevalence, severity, and relationship with impairment, disability, handicap, and subjective well-being. Arch Phys Med Rehabil. 1998; 79: 604-01. doi: 10.1016/s0003-9993(98)90032-6.

[10] Kennedy P, Frankel H, Gardner B, Nuseibeh I. Factors associated with acute and chronic pain following traumatic spinal cord injuries. Spinal Cord. 1997; 35: 814-17. doi: 10.1038/sj.sc.3100569.

[11] Tsuritani I, Honda R, Noborisaka Y, Ishida M, Ishizaki M, Yamada Y. Impact of obesity on musculoskeletal pain and difficulty of daily movements in Japanese middle-aged women. Maturitas. 2002; 42: 23-30. doi: 10.1016/s0378-5122(02)00025-7.

[12] Barbetta DC, Lopes AC, Chagas FN, Soares PT, Casaro FM, Poletto MF, et al. Predictors of musculoskeletal pain in the upper extremities. Spinal Cord. 2016; 54: 145-9. doi: 10.1038/sc.2015.126.

[13] Müller R, Brinkhof MW, Arnet U, Hinrichs T, Landmann G, Jordan X, et al. Prevalence and associated factors of pain in the Swiss spinal cord injury population. Spinal Cord. 2017; 55: 346-54. doi: 10.1038/sc.2016.157.

[14] Phonthee S, Saengsuwan J, Siritaratiwat W, Amatachaya S. Incidence and factors associated with falls in independent ambulatory individuals with spinal cord injury: A 6-month prospective study. Phys Ther. 2012; 93: 1061-72. doi: 10.2522/ptj.20120467.

[15] Saensook W, Phonthee S, Srisim K, Mato L, Wattanapan P, Amatachaya S. Ambulatory assistive devices and walking performance in patients with incomplete spinal cord injury. Spinal Cord. 2014; 52: 216-9. doi: 10.1038/sc.2013.120.

[16] Behrman AL, Harkema SJ. Locomotor training after human spinal cord injury: A series of case studies. Phys Ther. 2000; 80(7): 688-700. doi:10.1093/PTJ/80.7.688.

[17] Kirshblum SC, Waring W, Biering-Sorensen F, Burns SP, Johansen M, Schmidt-Read M, et al. Reference

for the 2011 revision of the International Standards for Neurological Classification of Spinal Cord Injury. J Spinal Cord Med. 2001; 34: 547-54. doi: 10.1179/107902611X13186000420242.

[18] Reed MD, van Nostran W. Assessing pain intensity with the visual analog scale: A plea for uniformity. J Clin Pharmacol. 2014; 54(3): 241-4. doi: 10.1002/jcph.250.

[19] Weigl K, Forstner T. Design of paper-based visual analogue scale Items. Educ Psychol Meas. 2021 ;81(3):595-611. doi: 10.1177/0013164420952118.

[20] Crawford B, Bouhassira D, Wong A, Dukes E. Conceptual adequacy of the neuropathic pain symptom inventory in six countries. Health Qual Life Outcomes. 2008; 6:62. doi: 10.1186/1477-7525-6-62.

[21] Hawker GA, Mian S, Kendzerska T, French M. Measures of adult pain: Visual Analog Scale for Pain (VAS Pain), Numeric Rating Scale for Pain (NRS Pain), McGill Pain Questionnaire (MPQ), Short-Form McGill Pain Questionnaire (SF-MPQ), Chronic Pain Grade Scale (CPGS), Short Form-36 Bodily Pain Scale (SF-36 BPS), and Measure of Intermittent and Constant Osteoarthritis Pain (ICOAP). Arthritis Care Res. 2011; 63: S2040-52. doi: 10.1002/acr.20543.

[22] Kumprou M, Amatachaya P, Sooknuan T, Thaweewannakij T, Mato L, Amatachaya S. Do ambulatory patients with spinal cord injury walk symmetrically? Spinal Cord. 2017; 55: 204-7. doi: 10.1038/sc.2016.149.

[23] Bateni H, Maki BE. Assistive devices for balance and mobility: benefits, demands, and adverse consequence. Arch Phys Med Rehabil. 2005; 86: 134-45. doi: 10.1016/j.apmr.2004.04.023.

[24] van Drongelen S, de Groot S, Veeger HE, Angenot EL, Dallmeijer AJ, Post MW, et al. Upper extremity musculoskeletal pain during and after rehabilitation in wheelchair-using persons with a spinal cord injury. Spinal Cord. 2006; 44: 152-9. doi: 10.1038/sj.sc.3101826.

[25] Hassan R, Kamrujjaman M. A cross-sectional study of spinal cord injury-induced musculoskeletal Pain. Curr Med Res Opin. 2019; 2(12): 367-71. doi: 10.15520/jcmro.v2i12.234.