ORIGINAL ARTICLE

Factors Associated With Pressure Ulcer Risk Among Spinal Cord Injury Adults in Kuala Lumpur, Malaysia: A Community-based Study

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ABSTRACT

Introduction: Pressure ulcers (PUs) are a leading health problem among spinal cord injury(SCI) patients. Therefore, this comprehensive study was aimed at determining the association between potential factors and the occurrence of PUs among SCI adults in community settings. **Methods:** A cross-sectional study was conducted among adults with SCI aged 18 years and above from five selected locations in Kuala Lumpur, Malaysia. The study was carried out through interviews based on validated questionnaires such as the Dietary History Questionnaire (DHQ), Spinal Nutrition Screening Tool (SNST), Physical Activity Scale for Individuals with Physical Disabilities (PASIPD), Barthel Index for Activities of Daily Living (ADL), and Instrumental Activities of Daily Living (IADL). Estimated weight and height were obtained using recumbent formula. The stages of their PUs were assessed based on National Pressure Ulcer Advisory Panel (NPUAP) grading system. **Results:** A total of 40 subjects participated in the study, 25% of whom were having PUs. Their nutritional inadequacies were identified, whereby 90%, 70% and 85.5% of them were receiving below their daily requirement of energy, carbohydrate and protein, respectively. The fat and sodium intakes of 55% of them were above the Malaysian Recommended Nutrient Intakes(RNI). It was successfully found that physical activity could decrease the risk of PUs(R^2=0.654, OR=0.310, $p<0.05$). **Conclusion:** Overall, 25% of the subjects had PUs that were associated with physical inactivity. The majority of the subjects did not meet their nutrient requirements. Therefore, there is a need for increased physical activity and improved nutrient intake in order to reduce the risk of pressure ulcers among SCI adults in communities.

Keywords: Factors, Community, Nutrition, Pressure ulcer, Spinal cord injury

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INTRODUCTION

Pressure ulcers (PUs), at an incidence of 25-66%, according to a systematic review by Regan et al. (1) in 2009, remain a leading health problem for patients with spinal cord injury (SCI). A study at the Kuala Lumpur Hospital reported that 57% of the patients who were admitted to the Department of Rehabilitation Medicine, most of whom were young males aged between 16 and 30 years, had experienced a traumatic SCI (2). Data from a prospective study found that the majority of the SCI patients had stage I pressure ulcers, with the most common locations for PUs being the sacral (43%), heel (19%) and ischial (15%) regions (3).

Immobility and decreased sensation among SCI patients appear to be strong risk factors for the development of PUs (1). A review by Saghaleini et al., (2018) found that the risk of pressure ulcers was related to malnutrition. An inadequate nutrient intake is closely related to the development of PUs and impaired wound healing (4). Although the recommended nutrient intake among these population is unknown, high protein oral nutritional supplements are effective in reducing the risk of PU by 25% among spinal cord injury patients (5). Roberts (2015) stated that the protein intake is essential to maintain a positive nitrogen balance, and vitamin and mineral supplements are recommended for patients with a poor dietary intake (6).

However, very few studies have comprehensively assessed the association between a wide range of factors with the risk of PUs. Further, most of the data available on the development of PUs only focused on patients in the intensive care unit and older adults. Therefore, this study was aimed at determining the association between the risk of PUs with a wide range of factors such as the

sociodemographic characteristics, functional status, physical activity, and nutrient intake among SCI adults in a community setting.

MATERIALS AND METHODS

Study Design

This cross-sectional study was conducted and involved 40 SCI individuals from five locations, i.e. Outpatient Orthopaedic Clinics, Hospital Canselor Tuanku Muhriz (HCTM), Malaysia Paralympic Sports Excellence Centre (MPSEC), Beautiful Gate Kepong, Independent Living Training Centre (ILTC) and primary care centre, HCTM. All of them were members of the Malaysian Spinal Injuries Association (MASIA), which is a non-profit organisation. Ethical approval was obtained from the Medical Research Ethics Committee of Universiti Kebangsaan Malaysia (UKM PPI/111/8/JEP-2019-166). The consent of the subjects or their caregivers was obtained prior to the data collection.

Sampling and Subjects

The subjects were selected through purposive sampling. The inclusion criteria included SCI adults aged 18 years and above, able to be assessed for anthropometry measurements at least by a recumbent technique, and the subjects or caregivers must be able to communicate either in Malay or English. The exclusion criteria included those who had PUs that were unrelated to SCI and hospitalized patients. Sample size was calculated based on Cochran 1977 formula (7) as below:

$$n = (Z\alpha/2 \times \sigma)^2 / \Delta^2$$
$$= (1.96 \times 3.3)^2 / (10.9 \times 0.1)^2$$
$$= 36 \text{ subjects}$$

Add 10% drop out = 40 subjects
Mean and standard deviation extracted from Silveria et al. (2019) (8) study.

Data Collection

In this study, the sociodemographic information, including personal data such as the subject's name, gender, age, race, education level, marital status, occupation, household income, health profile, date and purpose of treatment, were obtained through an interview or from the medical records. The anthropometric measurements that were assessed in this study included the estimated weight and height, body mass index (BMI), mid upper arm circumference (MUAC), calf circumference (CC), knee height, arm span (AS), and hip circumference (HC). Body weight was measured using a digital weighing scale (SECA, Seca 803, USA). Height was measured using stadiometer (SECA, Seca 213 Portable, USA).The formula by Shahar & Pooy (2003) (9) and Harith et al., (2002) (10) were used to estimate the height, as follows:
Male: [0.681 x AS (cm)] + 47.56
Female: [0.851 x AS (cm)] + 18.78

While for estimated weight, formula is obtained from Ross (2002) (11);
Male: KH (cm) x 1.10 + MUAC (cm) x 3.07-75.81
Female: KH (cm) x 1.10 + MUAC (cm) x 2.81 – 66.04

The body mass index (BMI) was calculated using the formula, weight (kg)/height (m^2), and was categorized based on the criteria of the World Health Organisation (12). For subjects with PU, the stages of pressure injury was assessed based on the stages defined by the National Pressure Ulcer Advisory Panel (NPUAP) (13). Pressure ulcer of the subjects can be categorized into four stages and this is equivalent to the depth of damage or the degree of severity of the pressure wound. Stage I PU can be defined as intact skin with non-blanchable redness of a localized area usually over a bony prominence, stage II PU is partial-thickness loss of skin with exposed dermis, stage III PU is Full-thickness loss of skin, in which adipose (fat) is visible in the ulcer and granulation tissue and stage IV PU is Full-thickness skin and tissue loss with exposed or directly palpable fascia, muscle, tendon, ligament, cartilage or bone in the ulcer (13).

Validated questionnaires such as the Barthel Index for Activities of Daily Living (ADL) (14) and Instrumental Activities of Daily Living (IADL) (15) were used to evaluate the functional status of the subjects. Daily activities included in this questionnaire included functional status for eating, bathing, dressing, using the toilet, moving (from bed to chair and back), mobility and climbing stairs. The interpretation of the functional status depends on the total score or Bartel Index of the subject whether it is independent, minimally dependent and so on (14). As for the IADL questionnaire, the ability to use the telephone, go out and buy necessities, do house chores, manage money, move to a distant place, prepare food and take medicine were asked in this tool (15). The Physical Activity Scale for Individuals with Physical Disabilities (PASIPD) questionnaire by Washburn et al. (2002) was used to determine the physical activity level of the subjects (16). This questionnaire focuses on recreational activities, and any work that involves physical activities such as home renovation, gardening, sports activities and so on. The number of days in a week and the time allocated for doing such activities are also recorded in this form. For the calculation of the score, the average hour per day for each activity was multiplied by the metabolic equivalent (MET) value depending on the intensity of the activity (16).

The 7-days dietary intake of the subjects was also assessed based on a validated dietary history questionnaire (17) and their estimated daily energy intake requirement was calculated using the Mifflin-St Jeor equation (18). The dietary intake was analyzed using the Nutritionist ProTM (Axxya Systems Stafford, USA) software. All the macronutrients and micronutrients, including vitamins and minerals were compared using the Recommended

Nutrient Intakes for Malaysia (19). The protein requirement for the subjects with PU was calculated according to the NPUAP guidelines, which was 1.25 g/kg protein/day for those with stage I and II ulcers, and 1.5 g/kg protein/day for those with stage III and IV ulcers (4). Finally, the risk of malnutrition in the subjects was analysed using the validated continuous scoring system of the Spinal Cord Nutrition Screening Tool (SNST) (20), which has a sensitivity of 87.1% and specificity of 85.5%. The information required in this form consists of height, weight, body mass index, age, spinal cord injury, other medical conditions, skin condition, diet, appetite and ability to eat. The risk of malnutrition can be categorized into three categories: Low risk (0-10 scores); moderate risk (11-15 scores) and high risk (>15 scores) (20).

Statistical Analysis

The data collected were analysed using IBM SPSS Statistics version 25.0. The normality of the data was determined using the Shapiro Wilk test for sample sizes of less than 100. Both parametric and non-parametric tests, including the independent t-test, Mann Whitney test, Pearson's chi-squared test and Fisher's exact test as well as the binary logistic regression test, were used to determine the statistical significance. These tests were used to compare the means, make cross tabulations and identify the correlations between the associated factors and the presence of PUs. The independent-t-test and Mann-Whitney test were used to study the mean difference of continuous variables between the presence or absence of PUs. On the other hand, the chi-squared test was used to determine the association between the categorical variables and the presence of PUs. Fisher`s exact test was employed when the expected count of less than 5 was more than 20%. On the other hand, the binary logistic regression analysis was used to identify the risk factors with the presence of PUs among SCI adults in an urban setting after the adjustments for body mass index, energy, protein, vitamin A and C intake.

RESULTS

Sociodemographic Profile

A total of 40 SCI subjects (21 Chinese, 10 Indians and 9 Malays) were included in the study. The majority of those who completed the interview were members of the Malaysian Spinal Injuries Association (MSIA) from five locations in Kuala Lumpur (45.0% from HCTM, 22.5% from Beautiful Gate Kepong, 12.5% from ILTC, 12.5% from MPSEC, and 7.5% from primary care centre). Overall, 25% of the subjects had different stages of PU, ranging from stage I to III, as shown in Figure 1. All of them had stage III PU in the area below the sacral region, which is also known as a sacral ulcer (100%).

Based on Table I, the mean age of the subjects was 47 years. The majority of them were males (80.0%), Chinese (52.5%), who were still working (62.5%), and had received an education for 10.3 ± 2.7 years.

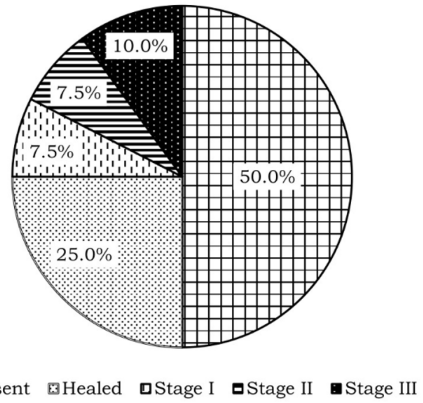

Figure 1: Percentage of subjects according to stage of pressure ulcer

Table I: Sociodemographic profile of subjects according to the presence of PU

Characteristics	Pressure Ulcer, *n(%)*		Total (n=40)	*p* value
	Yes (n=10)	No (n= 30)		
Age				
Mean ± standard deviation	46.3 ± 14.5	47.5 ± 11.1	47.2 ± 11.8	0.779[a]
Gender				NS
Male	8(80.0)	24(80.0)	32(80.0)	
Female	2(20.0)	6(20.0)	8(20.0)	
Race				0.097[d]
Malay	1(10.0)	8(26.7)	9(22.5)	
Chinese	4(40.0)	17(56.7)	21(52.5)	
Indian	5(50.0)	5(16.7)	10(25.0)	
Marital Status				0.716[c]
Single	6(60.0)	14(46.7)	20(50.0)	
Married	4(40.0)	16(53.3)	20(50.0)	
Education				
Mean ± standard deviation	11.6 ± 2.8	9.9 ± 2.6	10.3 ± 2.7	0.115[b]
Occupation Status				NS
Not working/Retired	4(40.0)	11(36.7)	15(37.5)	
Working	6(60.0)	19(63.3)	25(62.5)	
Monthly Household Income (USD)				
Mean ± standard deviation	345.6 ± 330.3	589.6 ± 515.7	528.6 ± 484.1	0.114[b]
Smoking habits				0.509[d]
Non-smoker	8(80.0)	18(60.0)	26(65.0)	
Ex-smoker	1(10.0)	7(23.3)	8(20.0)	
Smoker	1(10.0)	5(16.7)	6(15.0)	
Alcohol Intake				0.560[c]
Non drinker	10(100)	27(90.0)	37(92.5)	
Ex-drinker	0(0)	3(10.0)	3(7.5)	

NS = not significant
[a] Analysed using Independent-T Test
[b] Analysed using Mann-Whitney Test
[c] Analysed using Fisher's Exact test (2- sided)
[d] Analysed using Pearson Chi Square Test

As for unhealthy behaviour, the majority of them were non-smokers (65.0%) and non-drinkers (92.5%). However, there was no significant difference in the sociodemographic characteristics of the SCI adults with or without PUs ($p > 0.05$) for all the parameters.

Self-reported Health Profile

As shown in Table II, overall, the subjects had been having SCI for a mean duration of 18.4 years. The causes of SCI included motor vehicle accidents (45.0%), followed by falls from a height (22.5%), infections (10%), tumours (10%), operation failures (7.5%), and others (5%). Thoracic injuries topped the list (45%), followed by cervical (37.5%), lumbar (15%) and sacral (2.5%) injuries. Furthermore, 72.5% of the subjects were paraplegic, and 27.5% were tetra/quadriplegic.

Table II also shows that the top three diseases faced by the SCI subjects were hypertension (22.5%), hypercholesterolemia (20.0%), and type 2 diabetes mellitus (20.0%), and 20.0%, 15.0% and 17.5% of the subjects, respectively were on medication for the mentioned diseases. All the SCI subjects (100%) had problems with mobilization and transfer activities, for which wheelchairs and hoists were used to assist and optimise their activities. Apart from that, the top three impairments shown in Table II were urinary problems (72.5%), with 65.0% of them being on catheters or diapers; lower limb spasticity (52.5%), with 12.5% of them being on the anti-spasticity medication, 'Baclofen'; and constipation (50%), where half of them needed laxatives or enemas to assist in their bowel movements.

Table II: Self-reported health profile of subjects according to the presence of PU

Parameters	Pressure Ulcer, *n(%)*		Total (n=40)	*p* value
	Yes (n=10)	No (n= 30)		
Duration of SCI (years)				
Mean ± standard deviation	15.1 ± 9.5	19.5 ± 12.4	18.4 ± 11.8	0.310[a]
Level of SCI				0.700[c]
Cervical	3(30.0)	12(40.0)	15(37.5)	
Thoracic	6(60.0)	12(40.0)	18(45.0)	
Lumbar	1(10.0)	5(16.7)	6(15.0)	
Sacral	0(0)	1(3.3)	1(2.5)	
Paraplegic Category				NS
Paraplegia	7(70.0)	22(73.3)	29(72.5)	
Tetra/Quadriplegia	3(30.0)	8(26.7)	11(27.5)	
Diseases				
Hypertension	2(20.0)	7(23.3)	9(22.5)	NS
Hypercholesterol	3(30.0)	5(16.7)	8(20.0)	0.388[b]
Diabetes Mellitus	2(20.0)	6(20.0)	8(20.0)	NS
Stroke	0(0)	1(100)	1(2.5)	NS
Osteoarthritis/osteoporosis	1(10.0)	5(16.7)	6(15.0)	NS
Heart disease	1(10.0)	1(3.3)	2(5.0)	0.442[b]
Cataract	0(0)	1(3.3)	1(2.5)	NS
Renal problem	1(10.0)	3(10.0)	4(10.0)	NS
Asthma	2(20.0)	2(6.7)	4(10.0)	0.256[b]
Tuberculosis	0(0)	2(6.7)	2(5.0)	NS
Gout	0(0)	3(10.0)	3(7.5)	NS
Thyroid problem	0(0)	1(3.3)	1(2.5)	NS
Cancer	1(10.0)	1(3.3)	2(5.0)	0.442[b]
Cellulitis	0(0)	1(3.3)	1(2.5)	NS
Impairments				
Urine problem (on catheter)	9(90.0)	20(66.7)	29(72.5)	0.233[b]
Urinary tract infection	0(0)	3(10.0)	3(7.5)	0.560[b]
Difficulties in moving	10(100.0)	30(100.0)	40(100.0)	NS
Hip fracture	1(10.0)	2(6.7)	3(7.5)	NS
Leg spasm	6(60.0)	15(50.0)	21(52.5)	0.721[b]
Leg numbness	0(0)	4(13.3)	4(10.0)	0.556[b]
Difficulties in chewing	0(0)	3(10.0)	3(7.5)	0.560[b]
Difficulties in swallowing	0(0)	3(10.0)	3(7.5)	0.560[b]
Low appetite	3(30.0)	8(26.7)	11(27.5)	NS
Vomit	0(0)	2(6.7)	2(5.0)	NS
Constipation	7(70.0)	13(43.3)	20(50.0)	0.273[b]
Hemorrhoid	0(0)	5(16.7)	5(12.5)	0.306[b]
Gastric/ulcer	5(50.0)	9(30.0)	14(35.0)	0.278[b]
Insomnia	0(0)	2(6.7)	2(5.0)	NS

NS = not significant
[a] Analysed using Independent-T Test
[b] Analysed using Fisher's Exact test (2- sided)
[c] Analysed using Pearson Chi Square Test

The most common impairments related to food intake were gastric problems (gastric ulcers, duodenal ulcers, gastritis) (35.0%), followed by poor appetite (27.5%), difficulties in chewing (7.5%), swallowing (7.5%) and vomiting (5.0%). However, there was no significant difference in the health profile parameters of the SCI subjects with or without PUs.

Nutritional Status

As shown in Table III, the mean BMI of the subjects was 26.1 kg/m^2, indicating that most of the subjects were overweight, but there was no significant difference among those in the study group. The risk of malnutrition, as assessed using SNST, was significantly higher among the subjects with PUs (9.0 ± 1.9) compared to those who had no PU (7.5 ± 1.7) (Table III). Nevertheless, both scores were still in the category of low risk of malnutrition (≤ 10.0).

With respect to dietary intake, the majority of the subjects did not achieve their requirements for both macro- and micronutrients. Based on Table 3, 90% of the subjects did not meet their individual energy requirements, while 85% were falling short in their protein requirement, and 70% in their carbohydrate requirement. More than half of the subjects (55%) had a fat intake of 35.8 ± 6.0%, which exceeded the RNI of 25 - 30 % of total energy intake. Similar findings were found for their sodium intake, where more than half of the subjects (55%) exceeded the Malaysian RNI for sodium.

Functional Status and Physical Activities

As shown in Table III, the mean ADL score of the subjects with PUs (44.5 ± 25.2) was significantly lower compared to the subjects without PUs (68.9±21.6). Besides, the subjects with PUs also showed a significantly lower mean PASIPD score of 0.6 ± 0.6 MET hr/day compared to the subjects without PUs (3.2 ± 2.8). Overall, the mean ADL and PASIPD scores were 62.8 and 2.5 MET hr/day, respectively.

Risk factors of developing PU

By using binary logistic regression, a low level of physical activity was found to be significantly associated with the risk of PUs ($R2 = 0.654$, $OR = 0.310$, $p < 0.05$) after adjustments for body mass index, energy, protein, vitamin A and C intake, as shown in Table IV.

DISCUSSION

A comprehensive investigation was carried out on a wide range of factors associated with the presence of PUs among SCI adults in a community setting. A PU prevalence of 25% in this study was almost consistent with that of a previous study among hospitalised patients in the Spinal Unit, Department of Orthopaedics and Traumatology, HCTM (21). The prevalence of PU caused by SCI was also almost similar to a community-based study in the United States, which gave a result

Table III: Nutritional status, functional status and physical activity of subjects according to the presence of PU

Parameters	Pressure Ulcer, *n(%)*		Total (n=40)	*p* value
	Yes (n=10)	No (n= 30)		
Anthropometry				
Mid upper arm circumference (cm)	29.9 ± 3.6	29.6 ± 3.4	29.7 ± 3.4	0.831[a]
Calf circumference (cm)	30.3 ± 3.0	31.6 ± 4.9	31.3 ± 4.5	0.779[b]
Thigh circumference (cm)	50.3 ± 15.6	47.1 ± 6.3	47.9 ± 9.4	0.595[b]
Knee height (cm)	49.9 ± 2.3	49.0 ± 2.9	49.2 ± 2.8	0.416[a]
Arm span (cm)	169.0 ± 6.6	170.1 ± 7.7	169.8 ± 7.4	0.690[a]
Estimated weight (kg)	70.3 ± 10.8	68.6 ± 10.4	69.0 ± 10.4	0.658[a]
Estimated height (cm)	161.8 ± 4.5	163.5 ± 6.3	163.1 ± 5.9	0.429[a]
Body Mass Index/kgm^{-2}	27.0 ± 4.4	25.8 ± 4.4	26.1 ± 4.4	0.458[a]
Risk of Malnutrition ([1]SNST score)				
Mean ± standard deviation	9.0 ± 1.9	7.5 ± 1.7	7.9 ± 1.8	0.024[a]*
Dietary Intake				
Energy & Macronutrients				
Energy (kcal/day)	1409.9 ± 337.0	1231.7 ± 283.5	1276.3 ± 303.5	0.109[a]
Below requirement	8(80.0)	28(93.3)	36(90.0)	0.256[c]
Carbohydrate (g/day)	166.0 ± 43.5	143.9 ± 40.5	149.4 ± 41.8	0.150[a]
% based on total energy intake/day	47.2 ± 7.0	46.8 ± 7.3	46.9 ± 7.1	0.895[a]
Below requirement	7(70.0)	21(70.0)	28(70.0)	NS
Protein (g/day)	62.4 ± 15.7	51.0 ± 13.6	53.8 ± 14.8	0.033[a]*
% based on total energy intake/day	17.7 ± 1.9	16.6 ± 2.9	16.9 ± 2.7	0.256[a]
Below requirement	9(90.0)	25(83.3)	34(85.0)	NS
Fat, Total (g/day)	54.6 ± 17.7	49.7 ± 15.1	50.9 ± 15.7	0.392[a]
% based on total energy intake/day	34.7 ± 6.4	36.1 ± 6.0	35.8 ± 6.0	0.528[a]
Exceed RNI	8(80.0)	27(90.0)	35(87.5)	0.584[c]
Vitamins				
Thiamin	0.6 ± 0.2	0.5 ± 0.2	0.5 ± 0.2	0.417[b]
Below requirement	10(100.0)	29(96.7)	39(97.5)	NS
Riboflavin (mg/day)	1.1 ± 0.4	0.7 ± 0.3	0.8 ± 0.4	0.034[b]*
Below requirement	7(93.3)	28(93.3)	35(87.5)	0.089[c]
Niacin (mg/day)	8.2 ± 2.8	6.7 ± 2.8	7.1 ± 2.9	0.152[a]
Below requirement	10(100.0)	30(100.0)	40(100.0)	NS
Ascorbic acid (mg/day)	76.5 ± 36.1	70.4 ± 46.6	71.9 ± 43.8	0.365[b]
Below requirement	4(40.0)	20(66.7)	24(60.0)	0.159[c]
Vitamin A (RE/day)	684.3 ± 259.3	490.8 ± 212.8	539.2 ± 237.5	0.024[a]*
Below requirement	4(40.0)	22(73.3)	26(65.0)	0.123[c]
Minerals & Trace elements				
Calcium (mg/day)	348.7 ± 162.2	227.6 ± 84.9	257.9 ± 119.4	0.039[b]*
Below requirement	10(100.0)	30(100.0)	40(100.0)	NS
Iron (mg/day)	13.6 ± 5.4	12.6 ± 6.5	12.9 ± 6.2	0.606[b]
Below requirement	2(20.0)	13(43.3)	15(37.5)	0.269
Phosphorus (mg/day)	788.2 ± 251.8	570.1 ± 161.3	624.6 ± 207.6	0.003[a]*
Below requirement	4(40.0)	22(73.3)	26(65.0)	0.123[c]
Sodium (mg/day)	2355.9 ± 791.9	2119.5 ± 670.2	2178.6 ± 699.6	0.362[a]
Exceed RNI	5(50.0)	17(56.7)	22(55.0)	0.731[c]
Potassium (mg/day)	1291.5 ± 416.0	925.1 ± 262.4	1016.7 ± 342.0	0.012[b]*
Below requirement	10(100.0)	30(100.0)	40(100.0)	NS
Functional status				
ADL score	44.5 ± 25.2	68.9 ± 21.6	62.8 ± 24.7	0.011[b]*
IADL score	9.0 ± 4.8	11.2 ± 3.0	10.7 ± 3.6	0.220[b]
Physical activity				
PASIPD score	0.6 ± 0.6	3.2 ± 2.8	2.5 ± 2.7	0.001**[b]

NS = not significant ADL = Activity of Daily Living IADL = Intrumental Activity of Daily Living PASIPD = Physical Activity Scale for Individual with Physical Disabilities

[a] Analysed using Independent t-test [b] Analysed using Mann-Whitney U test [c] Analysed using Pearson Chi Square Test [d] Analysed using Fisher's Exact Test

* Significant at p < 0.05 ** Significant at p < 0.01

of 21% (22). As observed in other studies, the present study also determined that the location of SCI in the thoracic region and the development of PUs below the sacral region were common among the majority of the subjects (3).

This study also showed that more than 75% of the subjects probably did not meet their energy requirements because the SCI patients themselves had higher requirements due to the physiological and metabolic changes that had occurred in their bodies. Such changes, in turn, led to changes in their nutrient requirements, adverse food-drug complications, and disruptions to their food intake (4, 23, 24). Most of the subjects were overweight, and according to previous research obesity is associated with higher prevalent in developing PU (24). The energy requirement for SCI patients would be higher than the normal population

Table IV: Final associated factors to the presence of PU

Parameters	Estimate	OR (95%CI)	Standard Error	*p* value
Age	-0.059	0.943 (0.922-0.971)	0.054	0.272
Gender	-0.751	0.472 (0.332-0.573)	0.323	0.570
Risk of malnutrition	4.178	0.240 (0.179-0.293)	0.768	0.267
Physical activity (PASIPD)	-1.172	0.310 (0.233-0.401)	0.580	0.043*
Functional status (ADL)	0.513	0.230 (0.103-0.365)	0.427	0.230

Analysed using binary logistic regression the adjustments for body mass index, energy, protein, vitamin A and C intake.
*Significant at $p < 0.05$.

as they are in hypermetabolic conditions (23, 24). For example, SCI patients with underlying hypertension or infections tend to increase their energy usage, thus leading to endogenous protein catabolism (25). Protein is a very important macronutrient for the healing of wounds (5). Therefore, the protein intake of subjects with PUs has to be significantly higher. However, in the present study, the protein intake of the subjects was below the requirement recommended by the NPUAP (4), which varies according to the severity of the PU. In the meanwhile, most of the nutrients intake such as vitamin A, B, C and micronutrients were below the recommended intake requirement. These nutrients are essential for wound healing, therefore a complete and balanced diet should be practiced among SCI patients by the advice from the professional dietitian and nutritionist (4).

Medical problems such as chewing and swallowing problems, gastric reflux and vomiting, urinary problems, constipation and physical impairments were the leading causes of suboptimal food intake in this study. This finding was also consistent with that of a previous study among hospitalised patients in HCTM, where the most frequent complications faced by the patients were bladder and bowel problems (23). Based on a study by Chen et al. (2014), secondary changes in the vagal function might cause gastric dysfunction, where the sensitivity of vagal afferents to chemical and mechanical stimuli are decreased in SCI patients (24). In the present study, the majority of the subjects were in the overweight category, based on the BMI classification of WHO (2006) (12). This was consistent with the finding of Powell et al., (2017) with regard to SCI patients in rehabilitation centres (25), and it might have been due to the high fat intake, which exceeded the RNI guidelines in 2017, and the low level of physical activity among the SCI subjects, as reported by Groah et al., (2009) (26). In addition, the high sodium intake in excess of the RNI 2017 guidelines was probably associated with the substantial problem of hypertension suffered by the SCI subjects in the present study, as reported by Suzana et al., (2011) (27).

In addition, Alhaugh et al., (2017) reported that malnutrition is associated with PUs (28). However, the present study did not find any association between malnutrition, as diagnosed by means of the SNST score, and PUs. There is a need to assess malnutrition by using a more objective and comprehensive assessment such as a subjective global assessment (SGA). In the current study, it was found that the risk of PUs was reduced by an increase in physical activity. Alavi et al., (2016) also proved that the main reasons for the development of PUs are the compression pressure on a large surface area of tissue and the lack of physical activity, which act as associated factors with regard to the severity of PUs (29). The limited physical activity among the SCI subjects, most of whom were paraplegic or tetra/quadriplegic, also led to a lower functional status in relation to the activities of daily living (30). Implementing an appropriate physical regimen prescribed by a trained physical therapist for medically-stable SCI patients can promote maintenance of skin integrity, improve cardiovascular functions, and prevent fatigue and deconditioning. Turning or repositioning bed-ridden SCI patients every 2 hours in the acute and rehabilitation phases can also prevent PU development (31).

Although the sample size was justified to be sufficient, the limitation of this study is the small sample size to obtain more significant results. This was attributed to the difficulty of obtaining SCI patients in Kuala Lumpur. Besides, as this was a cross-sectional study, it may not have accurately reflected the factors that affect the PU staging trend. Cohort studies with a larger sample size are recommended to further determine the factors associated with the severity of PUs. This study also faced difficulties in obtaining anthropometric information, since most of the subjects were wheelchair-dependent or bedridden, and had no weight history records that could be referred to. Therefore, the weight loss percentage, which is another important parameter to determine the risk of malnutrition, could not be accurately determined in this study. Nevertheless, this study was able to successfully estimate the prevalence of PUs and their associated risk factors amongst SCI adults in an urban community setting. The results of this study will be useful in designing an epidemiological and intervention study among SCI patients in the future.

CONCLUSION

Overall, 25% of the subjects with PUs were also physically inactive. The majority of the subjects did not meet their energy, carbohydrate, and protein requirements, and exceeded the recommended levels of fat and sodium intakes. A low level of physical activity was found to be significantly associated with the risk

of PU. Therefore, there is a need to increase physical activity such as turning or repositioning bed-ridden SCI patients every 2 hours and arms or legs lifting as well as improve their nutrient intake in order to reduce the risk of PUs.

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