Original Article

A Cross-Sectional Study on Prevalence of Cardiovascular Risk Factors in Persons with Spinal Cord Injury

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ABSTRACT

Objectives: To describe the prevalence of cardiovascular risk factors (dyslipidemia, diabetes, central obesity and smoking) and the current management in persons with spinal cord injury (SCI).
Study design: Cross-sectional study.
Setting: Spinal cord injury rehabilitation clinic of a university hospital.
Subjects: A total of 205 persons with SCI participated in this cross-sectional study between June 2018 and May 2019.
Methods: A self-constructed data collection form was administered via face-to-face interviews. Medical information was extracted from medical records and central obesity was determined by measuring the waist circumference in a supine position, at a point immediately below the lowest rib.
Results: Majority of the participants (91.0%) had at least one cardiovascular risk factor. Dyslipidaemia was the most common cardiovascular risk factor (85.4%), followed by central obesity (59.0%), diabetes (20.5%), and smoking (12.2%). This study revealed that up to 44.0% of the study population did not receive any intervention for dyslipidaemia. Participants who used wheelchairs, motorized or manual, as their main mode of mobility, were three times more likely to have low HDL compared with participants who walked (OR 3.46, 95% CI 1.3-9.4 and OR 3.09, 95% CI 1.4-7.1 respectively).
Conclusion: Cardiovascular risk factors are prevalent among SCI population. Dyslipidaemia was the most common health hazard and approximately one-third of them did not receive any intervention. Users of manual wheelchairs, self-propelled or pushed by others, were three times more likely to have low HDL compared with those who walk.

Keywords: cardiovascular risk factor, spinal cord injury, cross-sectional study, obesity

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Introduction

Due to the advancement of medical care, persons with spinal cord injury (SCI) can experience a longer lifespan but are at a higher risk of contracting cardiovascular-related diseases, which include dyslipidaemia, hypertension, diabetes, smoking and obesity.[1] The leading cause of mortality in persons with chronic SCI is the cardiovascular disease (CVD).[2] Persons with SCI have a higher risk of developing cardiovascular risk factors and the onset is earlier compared with the able-bodied population.[3]

Muscle atrophy and obesity due to paralysis and inactivity in SCI contribute to the development of cardiovascular risk factors.[4] At this point of time, there are no established guidelines available for managing cardiovascular risk factors in individuals with SCI. Muscle atrophy and obesity due to paralysis and inactivity in SCI contributed to the development of cardiovascular risk factors.[4] Studies of the relationship between a lack of physical activity and development of CVD have shown mixed results; the optimal type, intensity and adequate duration of exercises to reduce CVD have yet to be determined.[5] Evidence of an independent risk factor linking to SCI for the development of cardiovascular diseases has been inconsistent. Some studies reported mixed or non-significant associations between SCI characteristics and cardiovascular risk factors.[6,7] Recent studies were done in populations with different dietary and activity norms, which may not be applicable to the local Malaysian population.[1,6,7]

In Malaysia, CVD is the leading cause of death, for both men and women. The local registry of CVD showed that most patients (96.8%) have at least one of the established CV risk factors - hypertension (65%), dyslipidemia (37%) and /or diabetes (46%).[8] Thus, this study aims to investigate and describe the following aspects: the prevalence of cardiovascular risk factors, namely diabetes, smoking, central obesity and dyslipidaemia; the difference in prevalence between various SCI characteristics; as well as current management of dyslipidaemia among persons with SCI. The results of this study could help plan or prioritize future health interventions, and audit the current management to improve the existing practices or develop guidelines if applicable. At this juncture, there are no established guidelines available for managing cardiovascular risk factors in individuals with SCI.

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Methods

Study design

This cross-sectional study was conducted at the University Malaya Medical Centre (UMMC), which is a tertiary educational research hospital. It is situated in Kuala Lumpur, the capital of Malaysia and provides a comprehensive range of in- and out-patient SCI rehabilitation services.

This study was approved by University Malaya Medical Centre Medical Research Ethics Committee (Approval number: 201826-6010).

Sample size

This study utilizes a universal sampling method by including all the patients who had attended the SCI out-patient rehabilitation clinic throughout the study period (June 2018 and May 2019). A sample size of 216 participants from the expected population size of 500 were required to achieve the 95% confidence level, with a 5% margin of error. A total of 205 persons with SCI participated in this cross-sectional study.

Participants

Inclusion criteria

Individuals with SCI of at least one-year duration, aged more than 18 years old, with traumatic or non-traumatic SCI of all levels, and classified as ASIA Impairment Scale (AIS) A, B, C and D were included in this study.

Exclusion criteria

Individuals with severe traumatic brain injury, metastatic spine disease, and congenital spine disease were excluded in this study.

Data collection

This study used a self-constructed three-part data collection form. The first part contained demographic data (age, gender, race, level of education, and family history of cardiovascular disease). The second part consisted of SCI characteristics (level and severity of injury, aetiology of injury, duration of injury, and main mode of mobility). The third part consisted of comorbidities prior to sustaining SCI, lipid and blood glucose profile parameters, management of dyslipidaemia (if any), smoking history, and measurement of waist circumference. The demographics, SCI characteristics, and morbidity data were collected from the medical records whilst data of family history and mobility were obtained via face-to-face interviews.

Participants were considered to have dyslipidaemia if they had abnormal values of blood lipids within the last one year and/or were taking lipid-lowering drugs. This study used the Malaysian Clinical Practice Guidelines for Dyslipidaemia[8] and Diabetes Mellitus Type 2[9] to determine the cut-off points for diagnosing dyslipidaemia and diabetes. The following lipid levels were used to diagnose dyslipidaemia: total cholesterol > 5.2 mmol/L; high density lipoprotein cholesterol (HDL-C) < 1 mmol/L (males), and < 1.2 (females); triglycerides (TG) > 1.7 mmol/L, and low density lipoprotein cholesterol (LDL-C) > 3.4 mmol/L.[8] Diabetes is diagnosed when venous plasma glucose is more than 7.0 mmol/L (fasting) and > 11.1 mmol/L (random).[9]

The waist circumference, in centimeters (cm), was measured in supine position immediately below the lowest rib[10] after normal expiration. The cut-off point of obesity was taken as ≥ 90 cm in males and ≥ 80 cm in females, according to the WHO guidelines.[11] Lipid profile parameters, glucose level and management records of dyslipidaemia were extracted from the electronic medical records. In the event of no recent blood investigations taken in the last 12 months, the investigator ordered new blood investigations.

Data analysis

Descriptive analyses of categorical variables were expressed in frequencies and percentages. The multiple logistic regression was used to test the relationship between age, level and severity of injury, duration of injury, aetiology of injury, and mode of mobility, with respect to cardiovascular risk factors. Data were analyzed using the SPSS version 24.

Results

A total of 205 persons with SCI participated in this study; the demographic characteristics are presented in Table 1. The mean (SD) age was 51.3 (15.6) years with majority of

Table 1. Participants' demographics and spinal cord injury characteristics

Demographic data	n (%)	Mean (SD)
Age (years)	20-82	51.3 (15.6)
Gender		
Male	147 (71.7)	
Female	58 (28.3)	
Race		
Malay	67 (32.7)	
Chinese	103 (50.2)	
Indian	34 (16.6)	
Others	1 (0.5)	
Education level		
Primary	39 (19.0)	
Secondary	110 (53.7)	
Higher	56 (27.3)	
Family history of cardiovascular disease		
Yes	62 (30.2)	
No	143 (69.8)	
Level and severity of injury		
Complete tetraplegia	19 (9.3)	
Incomplete tetraplegia	43 (21.0)	
Complete paraplegia	56 (27.3)	
Incomplete paraplegia	87 (42.4)	
Aetiology of injury		
Traumatic	127 (62.0)	
Non-traumatic	78 (38.0)	
Duration of injury (range in years)	1-47	11 (10)
Mode of mobility		
Motorized/ pushed by others	37 (18.0)	
Manual wheelchair	99 (48.3)	
Walking	69 (33.7)	

Table 2. Prevalence of cardiovascular risk factors (n = 205)

Risk factor	Yes n (%)	No n (%)
Dyslipidaemia	175 (85.4)	30 (14.6)
High total cholesterol	45 (22.0)	160 (78.0)
High triglyceride	54 (26.3)	151 (73.7)
Low HDL	96 (46.8)	109 (53.2)
High LDL	100 (48.8)	105 (51.2)
Central obesity	121 (59.0)	84 (41.0)
Diabetes	42 (20.5)	163 (79.5)
Smoking	25 (12.2)	180 (87.8)

HDL, high density lipoprotein; LDL, low density lipoprotein

Table 3. Management of dyslipidaemia in participants (n = 175)

Management	n (%)
Dietician referral	19 (10.8)
Pharmacology	49 (28.0)
Dietician and pharmacology	30 (17.2)
None	77 (44.0)

HDL, high density lipoprotein; LDL, low density lipoprotein

the participants being male (71.7%), and more than half of them received secondary school education (53.7%). Most of the participants (69.8%) had no family history of cardiovascular diseases. Majority of the participants had traumatic SCI (62%) and the most common impairment was incomplete paraplegia (42.4%). The mean (SD) duration post injury was 11 (10) years. The most common mode of mobility was the self-propelled manual wheelchair (48.3%).

Prevalence of cardiovascular risk factors and management of dyslipidaemia are described in Table 2 and Table 3. Majority of the participants (91%) had at least one cardiovascular risk factor; 29% had only one risk factor, 39% had two, 21% had three, and 2% had four cardiovascular risk factors. Overall, the most prevalent cardiovascular risk factor was dyslipidaemia (85.4%). Among those with dyslipidaemia, 48.8% had high LDL, and 46.8% had low HDL. Although dyslipidaemia was common, 44.0% of the study participants did not receive any intervention.

Participants who used motorized wheelchairs or manual wheelchairs pushed by others and self-propelled manual wheelchairs were three times more likely to have low HDL compared with those who walk, with OR 3.46, 95% CI 1.27-9.43, and OR 3.09, 95% CI 1.35-7.08 respectively. There was no difference in the prevalence of diabetes, smoking, waist circumference, high LDL between the participants with paraplegia and tetraplegia, complete and incomplete injury, traumatic and non-traumatic SCI and duration of injury (Table 4 and Table 5).

Discussion

This study showed a high prevalence of cardiovascular risk factors among individuals with spinal cord injury; dyslipidaemia (high LDL and low HDL) was the most common risk factor followed by central obesity, diabetes, and smoking. The prevalence found in this study was higher than that of the general population in Malaysia. According to the National Health and Morbidity Survey (NHMS) Malaysia 2015,[12] 63% of the adult population had at least one cardiovascular risk factor. Our finding is consistent with the study by Wahman et al.[1] in which 97% of the study population had at least one risk factor, and 87% had two or more cardiovascular risks. The identified risk factors were dyslipidaemia, hypertension, diabetes, obesity, and smoking.

The current study showed that SCI characteristics such as level of injury, severity of injury, aetiology of injury and

Table 4. Multiple logistic regression tested the relationship between level and severity of injury, duration of injury, aetiology of injury and mode of mobility with dyslipidaemia

	Dyslipidaemia			
	Total cholesterol	Triglyceride	HDL	LDL
Age	0.20	0.61	0.10	0.02
	0.97 (0.94-0.99)	0.99 (0.97-1.01)	0.98 (0.96-1.00)	0.97 (0.95-0.99)
Level and severity of injury				
Incomplete para (ref)	0.14	0.13	0.27	0.82
Complete tetra	1.98 (0.36-10.81)	3.02 (0.74-12.25)	1.45 (0.40-5.25)	1.45 (0.40-5.21)
Incomplete tetra	0.32 (0.09-1.06)	1.71 (0.68-4.30)	1.70 (0.74-3.88)	0.82 (0.37-1.81)
Complete para	1.63 (0.63-4.21)	2.82 (1.12-7.09)	2.08 (0.92-4.68)	1.15 (0.53-2.52)
Aetiology of injury			0.61	0.35
Non-traumatic (ref)	0.30	0.75		
Traumatic	1.52 (0.68-3.38)	1.12 (0.53-2.36)	1.18 (0.61-2.30)	1.35 (0.72-2.55)
Duration of injury	0.15	0.06	0.01	0.97
Mode of mobility	0.97 (0.93-1.01)	0.96 (0.92-1.00)	0.95 (0.92-0.99)	1.00 (0.97-1.03)
Walking (ref)	0.23	0.96	*0.01	0.20
Motorized/ pushed by others	0.24 (0.47-1.23)	0.93 (0.30-2.87)	3.46 (1.27-9.43)	0.42 (0.15-1.15)
Manual wheelchair	0.77 (0.30-1.99)	1.08 (0.42-2.80)	3.09 (1.35-7.08)	0.92 (0.43-2.00)

p-value, OR (95% confidence interval)

HDL, high density lipoprotein; LDL, low density lipoprotein; para, paraplegia; tetra, tetraplegia

Table 5. Multiple logistic regression tested the relationship between level and severity of injury, duration of injury, aetiology of injury and mode of mobility with diabetes, smoking and central obesity

	Diabetes	Smoking	Central obesity
Age	0.01	0.17	0.05
	1.04 (1.02-1.07)	0.97 (0.95-1.00)	1.02 (1.00-1.04)
Level and severity of injury	0.10	0.79	0.70
Incomplete para (ref)	0.19 (0.03-1.21)	0.78 (0.71-8.64)	1.26 (0.35-4.52)
Complete tetra	0.39 (0.14-1.07)	1.59 (0.40-6.38)	1.19 (0.52-2.74)
Incomplete tetra	0.43 (0.16-1.19)	1.52 (0.51-4.50)	0.70 (0.31-1.56)
Complete para			
Aetiology of injury			
Non-traumatic (ref)	0.60	0.23	0.02
Traumatic	0.81 (0.38-1.75)	1.97 (0.65-5.91)	0.44 (0.23-0.87)
Duration of injury	0.47	0.17	0.51
Mode of mobility	1.01 (0.97-1.05)	1.03 (0.98-1.07)	1.01 (0.97-1.04)
Walking (ref)	0.34	0.18	0.22
Motorized/ pushed by others	1.56 (0.50-4.89)	0.27 (0.02-2.86)	0.46 (0.17-1.23)
Manual wheelchair	0.68 (0.27-1.68)	1.92 (0.53-6.96)	1.01 (0.45-2.26)

p-value, OR (95% confidence interval)
Para, paraplegia; tetra, tetraplegia

duration post-SCI do not lead to a higher number of cardiovascular risk factors. As such, our findings do not support incorporating SCI status as an independent variable for development of cardiovascular risk factors. Saunders et al.6 and Bauman et al.[13] reported that diabetes, hypertension and dyslipidaemia were associated with injury level and ambulatory status. An evidence report written by Wilt et al.[14] stated that the link between spinal cord injury and the risk of carbohydrate abnormalities was weak, and people with SCI may not be at a greater risk compared with those with able bodies. Hence, the existing guidelines for assessing and managing cardiovascular risk factors in able-bodied individuals should be applicable to persons with SCI as well.

Another important finding of this study is the relationship between mode of mobility and low HDL. This study showed that participants who self-propel their manual wheelchairs have the similar risk of low HDL compared with those who use motorized wheelchairs or manual wheelchairs pushed by others. HDL is known to be an independent risk factor for developing cardiovascular diseases.[15] Manual wheelchair propulsion is often advocated as a form of physical activity to reduce cardiovascular risks, and the finding from this study would have an influence on how clinicians should advise their patients. A compendium examining energy expenditure in wheelchair-related physical activities among wheelchair users showed these comparative figures: propelling a wheelchair on a flat surface at 2 mph or 53.6 m/min has a metabolic equivalent of task (MET) amounting to 3.3 kcal/kgh, while an able-bodied person walking at the same speed has a MET of 2.8 kcal/kgh.[16] However, another study reported that the average speed of wheelchair propulsion among paraplegics was 29.2 m/min, which is considered a slow pace.[17] We did not measure the speed of wheelchair propulsion among manual wheelchair users in this study, but it can be postulated that the speed of propulsion was inadequate to achieve the target heart rate required for reducing cardiovascular risks. Individuals with SCI who normally walk have a higher energy expenditure rate compared with their able-bodied peers; the mean energy expenditure per meter (EE/m) for the SCI participants is 0.33 (± 0.29) calories compared with 0.08 (± 0.02) calories for the able-bodied participants.[18]

This study utilized waist circumference instead of body mass index (BMI) to measure central obesity, which has been associated with an increased risk of cardiovascular diseases.[19] Waist circumference was found to be a better marker for obesity than BMI as the latter can underestimate obesity of a person in the SCI population.[20] This is because individuals with chronic SCI have greater fat mass and less fat-free mass per unit BMI when compared with age-matched able-bodied control subjects.[21,22] Here is another possible reason why BMI tends to underestimate obesity of a person in SCI population: it is difficult to measure a wheelchair-dependent person's height accurately. Ideally, a standing height should be obtained, but this may not be possible for a person with SCI population. Some studies use the subject's recall of height, which is not recommended as it leads to bias and errors.[23] Measuring the length can also be done but it can be quite challenging for persons of the SCI population with limb contractures. The use of waist circumference measurement to estimate central obesity of a person in the SCI population also has its own challenges. There was no standardized method as how to measure the waist circumference of a person in the SCI population. Waist circumference of a person in the SCI population was measured in supine position, but different locations of the body were used in different studies: directly below the lowest rib, narrowest waist, immediately above the iliac crest, and midpoint between the lowest rib and the iliac crest.[7,8,23,24] Measurement taken directly below the lowest rib was the best, due to ease of measuring and it eliminates errors caused by abdominal distension and bowel impaction, which are common issues of persons with SC.[10] A study by Onat A et al.[19] showed that visceral adipose tissue was found to be higher in people of the SCI population compared with that of the normal able-bodied individuals with the same waist circumference, based on the computed tomography (CT) scan. Thus the cut-off point for waist circumference of persons in the SCI population may not be the same as that of individuals in the non-SCI population.

There are several limitations in our study. First, we did not identify patients who were previously diagnosed with dyslipidaemia, but achieved normal blood lipid levels with non-pharmacological interventions during the recruitment period. Second, there were no standardized methods to measure the waist circumference of a person with SCI or a specific location of the body around which a measurement can be taken. Third, there was no preceding definition of waist circumference for the Asians from the SCI population; as such, prevalence of obesity could be underreported. Finally, we did not take into consideration the level of physical activity, especially time and intensity of using a manual wheelchair of each participant. Thus, it is still possible that different ways of using a manual wheelchair could potentially modify cardiovascular risks in people with SCI.

Our study findings may have some major implications on how we should manage cardiovascular risks in people with SCI. This research does not support the idea of incorporating SCI status as an independent variable for developing cardiovascular risks. Therefore, the existing guidelines for assessing and managing cardiovascular risk factors in able-bodied individuals should be applicable to persons with SCI as well. This study emphasizes that patients with SCI are encouraged to explore opportunities for increasing their physical activities; those who have the potential to walk should be assisted to do some walking, and as the walking ability improves it may eventually become the main mode of mobility. Propelling wheelchair can be physically demanding; hence, there is room for future research to investigate these areas: the intensity and duration of wheelchair propelling, the types of manual wheelchairs, and effects of wheelchair-related activities on cardiovascular disease risks.

In conclusion, this study reveals that cardiovascular risk factors were prevalent among people of the SCI population. Dyslipidaemia was the most common risk factor, but more than one-third of them were not on any intervention. Users of manual wheelchairs, regardless of the operating manners--self-propelled or pushed by others, had low HDL compared with those whose main mode of mobility is walking.

Disclosure

The authors declare that there is no conflict of interest.

Acknowledgement

Nil

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