JACOBS PUBLISHERS

OPEN ACCESS

Jacobs Journal of Physical Rehabilitation Medicine

Research Article

Dyslipidemia is Common after Spinal Cord Injury - Independent of Clinical Measures

Peter Flank*[1] RPT, MSc, Anna Ramnemark[2], MD, PhD, Richard Levi[1] MD, PhD, Kerstin Wahman [3,4] RPT, PhD, Martin Fahlström[5] MD, PhD.

[1]*Department of Community Medicine and Rehabilitation, Rehabilitation Medicine, Umeå University, Sweden*

[2]*Department of Community Medicine and Rehabilitation, Geriatric Medicine, Umeå University, Sweden*

[3]*Department of Neurobiology, Care Sciences and Society, Division of Neurodegeneration, Section Neurorehabilitation, Karolinska Institutet, Sweden*

[4]*Rehab Station, Stockholm/Spinalis R&D Unit, Sweden*

[5]*Department of Clinical Sciences, Professional Development, Umeå University, Sweden*

**Corresponding author: Dr. Peter Flank, RPT, MSc, Department of Community Medicine and Rehabilitation, Rehabilitation Medicine, Umeå University, SE-90187 Umeå, Sweden, Tel: +46705837972; Fax: +46907856990; E-mail: peter.flank@umu.se*

Received: 04-30-2015

Accepted: 05-14-2015

Published: 05-22-2015

Abstract

Objective: To survey the incidence of clinical risk markers and its correlation with established clinical measurements for cardiovascular disease (CVD) in a heterogeneous spinal cord injured (SCI) patient population.

Design: Descriptive, cross-sectional study.

Subjects: 78 patients with SCI, at different injury and functional level.

Methods: Anthropometric data, blood pressure, a blood lipid panel, blood glucose and a questionnaire were analyzed.

Results*:* Eighty-one percent of all patients had dyslipidemia (DL) and a majority of the patients with abdominal measures below the recommended cut-off levels had DL. Self-reported physical activity above the cut-off level was reported by 32.1% of the patients. There were no differences in clinical measures, serum lipid values and blood glucose between physically active and not active patients. No differences were seen between men/women, tetraplegia/paraplegia and wheelchair dependent/not wheelchair dependent patients.

Conclusion: DL is common and seems to be not treated or undertreated in the studied SCI patient group with different neurological lesion and functional levels. General anthropometric clinical measures do not seem to be valid for evaluating risk for CVD in this patient group.

Keywords : Cardiovascular Disease; Tetraplegia; Paraplegia; Blood Lipids; Blood Glucose; Anthropometry; BMI ; Physical Activity

Introduction

The acute care and management of the spinal cord injured patient has improved significantly in the last decades. Persons with spinal cord injury (SCI) now live longer, but secondary complications remain major concerns. Causes of death among persons with SCI have changed somewhat over time [1]. Up until the mid-20th century, the leading cause of death was renal and pulmonary conditions. Today, the leading cause of death is cardiovascular disease (CVD) [2]. CVD is the cause of death in 46% of SCI subjects surviving at least 30 years post injury [3]. Other studies have indicated that patients with SCI have a 2.5-5 times higher risk for CVD [3, 4] and a 8.5 times higher risk for myocardial infarction [5]. than the general population. At annual checkups, urinary and pulmonary function as well as presence of pressure ulcers has traditionally been examined, whereas CVD risk indicators have been neglected. As our knowledge regarding the changing morbidity and mortality patterns after SCI has increased, an increased focus on CVD prevention and lifestyle promotion seems appropriate.

Thus, the development of evidence-based recommendations regarding physical activity and pharmacological treatment are called for in an effort to improve health and decrease CVD risk among persons with chronic SCI [6, 7]. There is currently a lack of evidence-based clinical guidelines for evaluating risk markers for CVD in the SCI patient group. Also, it is not fully known whether general recommendations concerning physical activity as prevention for CVD are applicable or not on SCI patients [8, 9]. In the general population, apart from blood lipid and blood glucose analysis, Body Mass Index (BMI) and waist circumference (WC), as being risk markers, are measured and included in population-based health care programs [10].

We have, in a previous study, discussed the value of BMI and different BMI cut-off levels as a predictor for CVD in a homogeneous SCI patient group. We concluded that BMI might have a limited value predicting the risk for CVD. The study on wheelchair dependent paraplegics showed that around 80% had DL regardless on BMI level (11). Another study has also shown that BMI underestimates body fat in persons with SCI (12). Also, a valid BMI value is difficult to obtain in SCI patients, as there is controversy regarding how to obtain a correct body height measure in a population where spinal deformities, joint contractures and vertebral body compressions are common [13].

WC and sagittal abdominal height (SAH) are other commonly used clinical measurements for assessing health risk associated with obesity. In the SCI patient group, both measures are using the cut-off limits for the general population [14], something which has been problematized by other authors [15]. In conclusion, there is a need for evaluating these clinical measures as risk markers for CVD in patients with SCI.

Aim

The aim of this study was to survey the incidence of clinical risk markers and its correlation with established clinical measurements for CVD in a heterogeneous SCI patient population.

Methods

The Neurorehabilitation Ward at the University Hospital of Umeå is a specialist clinic for SCI patients living in northern Sweden. During a 2½ year period, between August 2012 and December 2014, all consecutive SCI patients were invited to participate in the study at their regular check-up. Seventy-eight of the 81 patients that were assessed during the period gave their informed written consent and were included in the study group. Data consisted of a standard physical examination, including anthropometric measures, at the clinic, blood sampling and a questionnaire. Time since injury was 1-53 years, neurological level of lesion was ranging from C4 to L3. Patient descriptors are presented in Table I.

Table I. Patient descriptors of 78 patients with spinal cord injury, AIS-grade A, B, C or D for at least one year.

Variable	Whole group (n=78)	Men (n=61)	Women (n=17)	p-value
Age, years, mean (SD)	50.2 (14.4)	50.9 (12.1)	47.6 (13.6)	0.380
Injury duration, years, mean (SD)	14.5 (12.5)	13.1 (12.1)	19.4 (13.0)	0.045
Tetraplegia/paraplegia (%)	50.0/50.0	54.1/45.9	35.3/64.7	0.170
Wheelchair dependence (%)	70.5	70.5	70.6	0.994
AIS-grade (%)				0.578
A	64.0	65.6	58.8	
B	2.5	1.6	5.9	
C	2.5	1.6	5.9	
D	31.0	31.1	29.4	
Smokers	1	0	1	

SD: standard deviation

Body weight was measured in kilograms on a calibrated scale. Body height was obtained by measuring with the patient lying supine on a bed, using a meter stock. BMI was then calculated [16].

Supine abdominal height (SAH) was measured in cm with a meter stock and a spirit level, with the patient lying on a bed, with the hips and knees in 90 degrees of flexion. The measure was done at the end of a normal expiration at the level of the umbilicus. A supine abdominal height <22cm for men and <20cm for women were considered normal, according to the cut-off limits used in the general population in Sweden [14, 17].

WC was measured in cm at the level of the umbilicus, using a stretch-resistant measuring tape with the subject lying supine [13]. An increased WC was defined as values exceeding one or both of two cut-off points. "The lower cut-off point was ≤94cm for men and ≤80cm for women. The higher cut-off point was ≤102cm for men and ≤88cm for women. The higher cut-off point was ≤102cm for men and ≤88cm for women. Values in excess of the lower cut-off point is considered to be associated with an "increased risk", and values in the excess of the higher cut-off to be associated with a "substantially increased risk" of CVD [10].

Blood glucose concentrations and a lipid panel [total cholesterol (TC), low-density lipoprotein cholesterol (LDL), high-density lipoprotein cholesterol (HDL), low-density lipoprotein cholesterol/ high-density lipoprotein cholesterol quota (LDL/HDL quota) and triglycerides (TG)] were quantified in whole blood drawn from a superficial vein following an overnight (midnight) fast and then analyzed.

"Dyslipidemia (DL) was defined as at least one pathological lipid level according to guidelines of the National Cholesterol Education Project – Adult Treatment Panel III [7] and/or ongoing drug treatment for DL. Cut-off levels were: TC≥5.0mmol/L, LDL≥3.0mmol/L, HDL≤1.0mmol/L (men) and HDL≤1.3mmol/L (women), LDL/HDL-quota≥5.0, TG>1.7mmol/L. The cut-off limit for blood glucose was ≥6.1mmol/L.

Systolic (SBP) and diastolic (DBP) blood pressure was measured in mmHg after 10 minutes of rest, recorded on the left arm with a calibrated manometer. Hypertension (HTN) was defined as SBP ≥140mmHg and/or a DBP ≥90mmHg [18].

Self-reported physical activity was registered using a questionnaire, adapted and tested for this population [8, 19, 20]. The following characteristics were targeted: type(s) of physical activity; frequency, duration and intensity of activity. Our cut-off comprised a level of physical activity corresponding to a minimum of 30 min at least 5 days per week. Participants were dichotomized into two groups based on their self-report, either performing physical activity on a moderate and/or vigorous level ≥30 min per day at least five days per week, or not.

Data were analyzed by using IBM SPSS Statistics 22. Values are described as mean+SD. When analyzing the material, comparisons were made between men vs. women, patients with tetraplegia vs. paraplegia and wheelchair dependent (WD) patients vs. non-wheelchair dependent (NWD). Differences in numerical values were calculated using Mann-Whitney U-test, categorical differences were calculated using Chi-square test. A p-value <0.05 was considered significant.

The study was approved by the Central Ethical Review Board in Umeå, No 2012-252-31M.

Results

"A comparison between men and women is shown in Table 1.There were no differences in basic characteristics betweentetraplegics and paraplegics. WD were younger (48.0±13.9 years vs. 55.4±14.3 years, p=0.033) and had a longer time since in-jury (17.0±13.1 years vs. 8.5±8.2, p=0.004) than NWD. There were no other differences in basic characteristics between WD and NWD."

Table II. Serum lipids, blood glucose, hypertension, Body Mass Index (BMI) and anthropometric data in 78 patients with spinal cord injury.

Variable	Whole group (n=78)	Men (n=61)	Women (n=17)	p-value
TC, mean (SD)	5.0 (1.0)	5.0 (1.0)	5.3 (1.0)	0.175
LDL, mean (SD)	3.3 (1.0)	3.2 (1.0)	3.4 (0.9)	0.468
HDL, mean (SD)	1.2 (0.3)	1.1 (0.3)	1.3 (0.3)	0.018
LDL/HDL quota, mean (SD)	3.0 (1.2)	3.0 (1.3)	2.8 (1.0)	0.450
TG, mean (SD)	1.4 (0.7)	1.4 (0.8)	1.2 (0.5)	0.358
Blood glucose, mean (SD)	5.3 (1.1)	5.3 (1.2)	5.1 (0.6)	0.903
HTN, %	38.5	39.3	35.3	0.761
BMI, mean (SD)	25.3 (5.9)	25.1 (4.5)	26.0 (9.6)	0.744
SAH, cm, mean (SD)	22.7 (3.5)	23.1 (3.3)	21.2 (3.8)	0.086
SAH below 22/20cm, %	33.3	34.4	29.4	0.201
WC, cm, mean (SD)	96.2 (14.6)	97.8 (14.1)	90.4 (15.0)	0.059
WC below 94/80cm, %	35.9	39.3	23.5	0.103
WC below 102/88cm, %	62.8	65.6	52.9	0.091

SD: standard deviation, TC: total cholesterol, mmol/L, LDL: low-density lipoprotein cholesterol, mmol/L, HDL: high-density lipoprotein cholesterol, mmol/L, LDL/HDL quota: low-density lipoprotein cholesterol/ high-density lipoprotein cholesterol quota, TG: triglycerides, mmol/L, SAH: sagittal abdominal height, WC: waist circumference

There were no significant differences in blood lipids, blood glucose and anthropometric data when comparing patients with tetraplegia and paraplegia.

A comparison between WD and NWD is shown in Table III.

Table III. Serum lipids, blood glucose, hypertension, Body Mass Index (BMI) and anthropometric data in wheelchair dependent and non-wheelchair dependent patients with spinal cord injury.

Variable	Whole group (n=78)	Wheelchair dependent (n=55)	Non-wheelchair dependent (n=23)	p-value
TC, mean (SD)	5.0 (1.0)	5.1 (1.0)	5.0 (1.1)	0.801
LDL, mean (SD)	3.3 (1.0)	3.3 (1.0)	3.2 (1.0)	0.888
HDL, mean (SD)	1.2 (0.3)	1.1 (0.3)	1.2 (0.3)	0.162
LDL/HDL quota, mean (SD)	3.0 (1.2)	3.1 (1.2)	2.7 (1.2)	0.157
TG, mean (SD)	1.4 (0.7)	1.4 (0.7)	1.4 (0.9)	0.926
Blood glucose, mean (SD)	5.3 (1.1)	5.1 (0.8)	5.6 (1.6)	0.071
HTN, %	38.5	27.3	65.2	0.002
BMI	25.3 (5.9)	24.0 (4.6)	28.3 (7.6)	0.003
SAH, cm, mean (SD)	22.7 (3.5)	22.3 (3.9)	23.5 (2.2)	0.108
SAH below 22/20cm, %	33.3	41.8	13	0.014
WC, cm, mean (SD)	96.2 (14.6)	94.7 (15.2)	99.8 (12.4)	0.140
WC below 94/80cm, %	35.9	41.8	21.7	0.092
WC below 102/88cm, %	62.8	63.6	60.9	0.818

SD: standard deviation, TC: total cholesterol, mmol/L, LDL: low-density lipoprotein cholesterol, mmol/L, HDL: high-density lipoprotein cholesterol, mmol/L, LDL/HDL quota: low-density lipoprotein cholesterol/ high-density lipoprotein cholesterol quota, TG: triglycerides, mmol/L, SAH: sagittal abdominal height, WC: waist circumference

Eighty-one percent of the patients had DL. BMI was significant-ly higher in patients with DL (25.5±4.6 vs. 24.4±9.1, p=0.041) but 28 patients out of 60 (46.7%) with DL had a BMI below 25. DL was correlated to abdominal measures above cut-off lev-el, SAH 22/20cm (p=0.002), WC 94/80cm (p=0.001) and WC 102/88cm (p=0.033). Nevertheless, a majority of the patients with measures below the recommended cut-off values also had DL (Table IV).

Table IV. Frequency of dyslipidemia in SCI patients with anthropometric data below the recommended cut-off levels.

Variables	Whole group (n=78)	Men/Women (n=61/17)	Tetraplegia/Paraplegia (n=39/39)	WD/NWD (n=55/23)
Normal SAH, %	61.5	57.1/80.0	64.3/58.3	60.9/66.7
WC below 94/80cm, %	60.7	58.3/75.0	60.0/61.5	56.5/80.0
WC below 102/88cm, %	73.5	70.0/88.9	61.9/82.1	71.4/78.6

SAH: sagittal abdominal height, WC: waist circumference, WD: wheelchair dependent, NWD: non-wheelchair dependent

"Nine patients (11.5%) were on medication for high serum lipids. TC and LDL was lower in patients with medication (4.4±0.77 vs. 5.1±1.02, p=0.021 and 2.6±0.85 vs. 3.4±0.96, p=0.029 respectively), but there was no difference in frequen-cy of DL in patients with or without medication.

Patients on anti-diabetic medication (n=4) had a mean blood glucose value of 7.7±3.2, while the 74 patients without medi-cation had a mean blood glucose value of 5.1±0.7 (p=0.071).

Mean SBP was 126.7±22.2 and DBP was 77.4±10.4. There were no differences between men and women. Paraplegics had higher SBP than tetraplegics (133.7±16.7 vs. 119.7±24.8, p=0.003). NWD had both higher SBP (135.0±20.2 vs. 123.2±22.2, p=0.031) and DBP (80.9±10.1 vs. 76.0±19.3,p=0.039).

Fourteen patients (17.9%) were on hypertension medication, and they had higher SBP (145.9±20.8 vs. 122.5 ±20.2, p=0.000) and DBP (83.4±10.1 vs.76.1±10.0, p=0.009) than patients with no hypertension medication."

87.2% of the patients had one or more of the diagnoses screened in this study, i.e. DL, HTN, diabetes mellitus and overweight/obesity (BMI >25).

Self-reported physical activity above the cut-off level was reported by 32.1% of the patients. No differences were seen between men/women, tetraplegia/paraplegia and WD/NWD concerning physical activity. There were no differences in serum lipid values and blood glucose values, SBP, DBP or BMI between patients who reported to be physically active or not active. There was no correlation between physical activity and DL.

Discussion

This study indicates that a vast majority (81%) of the studied SCI patients with different injury and functional levels have DL. The mean values of BMI, SAH and WC are above the recommended cut-off levels for the general population in Sweden. Also, a majority of patients with values below the cut-off levels have DL. Similar results have been reported in a more homogenous population of WD-patients with paraplegia [11].

DL is often left untreated, or is left suboptimally treated in this study group. A similar conclusion was stated by Lieberman et al [21], who found that undertreatment of high serum lipids is a major health challenge and that there is need to improve treatment and control of DL in the SCI population. Cragg et al [22], state that clinicians should provide treatment of SCI patients DL in accordance with clinical practice recommendations for similarly high-CVD-event-risk populations. In patients with SCI, there is a need for early and regular monitoring for CVD risk markers. As Myers et al [23] states, SCI persons have an increased prevalence of almost all risk factors for CVD and therefore pose a major challenge for clinicians working with this patient group.

There are different recommended cut-off levels in the general population for both WC and SAH in different countries [14]. Seidell et al [24], state that WC shows a relation to increased all-cause mortality. However, data are lacking on appropriate cut-off measures of abdominal obesity for predicting risk of all-cause mortality in different ethnic and population groups, SCI included, other than European, North American and Australian white populations. In a recent study, Ravensbergen et al [15], have suggested a WC cut-off limit of 94cm in the SCI population, and that it is an examination that is easy to use and more sensitive than BMI. A limitation in that study is that the authors have suggested one cut-off limit for the entire SCI population, without having different cut-off limits for men and women. In our study a majority of the patients with normal WC values had DL, and WC might therefore not be an adequate predictor of CVD in this patient group. The same results were seen when measuring SAH.

In a previous study [11] we have shown that BMI also has a limited clinical value when assessing risk for CVD, since a majority of the patients had DL independent of cut-off levels. Conclusively, the recommended clinical measures and cut-off levels that are used for the general population to predict risks for CVD, might not be sufficient for this patient group. Because of muscle paralysis and contractures, techniques for measuring both WC and BMI in the SCI patient group differ compared to the general population, and cut-off levels seem not to be valid for evaluating health status. Also, to our knowledge there are no longitudinal studies on clinical measures and mortality in CVD in the SCI patient group, which makes it difficult to give recommendations to individual patients based on the clinical measures. Further studies are needed to evaluate what methods and measures that should be used to predict and prevent CVD in this patient group. Body weight and strength are of importance for ADL and independence, but might have a limited value when assessing risk for CVD.

Our study group consisted of a heterogeneous SCI patient group with tetraplegia and paraplegia, as well as WD and NWD patients. One might have expected that the level and severity of SCI would affect the blood lipid values and anthropometric data, as well the level of physical activity. It could also be expected that less muscle mass and function might be related to a lower level of physical activity and poorer risk marker values. However, when comparing the groups, there were negligible differences concerning the studied variables, including the self-reported physical activity level, which was lower than in the general Swedish population, where about 65% reported to be physically active 30 minutes or more, at least 5 days per week [25]. The 32.1% who reported to be physically active above cut-off level in this study, is in line with the results from our previous study on wheelchair dependent paraplegics [8]. The reasons for not being regularly physically active might be the same for the SCI patients, regardless of injury level and being wheelchair dependent or not. Lack of interest, economic factors, transportation problems, pain etc. is perhaps equally existing problems for patients in this group and causes a low level of regular physical activity [26, 27].

Different studies on SCI patients [13, 28], have discussed the relevance and value of anthropometric measures. General cut-off levels may not be adequate. Also, generally used risk scores to predict future CVD risk, such as Framingham Risk Score [29] has its limitations. Framingham Risk Score has, to our knowledge never been validated for use in persons with SCI. Among other measures, Framingham Risk Score is based on blood pressure and BMI, two values that are difficult to use and interpret on this patient group, due to autonomic dysfunctions, contractures etc. Therefore, we have chosen to use DL as a main risk marker for CVD, which also might have limitations.

There is a high risk for CVD in the SCI patient group [5, 24] and guidelines for the general population, such as the National Cholesterol Education Program (NCEP) might not be appropriate for the SCI population [30], something which is supported by the results from this study.

To get a better view over risk markers, treatment and prevention strategies for CVD in this patient group, there is a need for longitudinal studies, as well as studies on different clinical methods, such as Dual-energy X-ray Absorptiometry (DXA), for developing clinical guidelines.

Conclusion

DL is common and seems to be not treated or undertreated in the studied SCI patient group with different neurological lesion and functional levels. General anthropometric clinical measures do not seem to be valid for evaluating risk for CVD in this patient group.

Acknowledgements

We gratefully acknowledge Promobilia Foundation, who has supported this study by grant.

References

1. Frankel HL, Coll JR, Charlifue SW, Whiteneck GG, Gardner BP et al. Long-term survival in spinal cord injury: a fifty year investigation. Spinal Cord. 1998, 36(4):266-274.

2. Garshick E, Kelley A, Cohen SA, Garrison A, Tun CG et al. A prospective assessment of mortality in chronic spinal cord injury. Spinal Cord. 2005, 43(7):408-416.

3. Whiteneck GG, Charlifue SW, Frankel HL, Fraser MH, Gardner BP et al. Mortality, morbidity, and psychosocial outcomes of persons spinal cord injured more than 20 years ago. Paraplegia. 1992, 30(9):617-630.

4. Yekutiel M, Brooks ME, Ohry A, Yarom J, Carel R. The prevalence of hypertension, ischaemic heart disease and diabetes in traumatic spinal cord injured patients and amputees. Paraplegia. 1989, 27(1):58-62.

5. Wahman K, Nash MS, Lewis JE, Seiger A, Levi R. Increased cardiovascular disease risk in Swedish persons with paraplegia: The Stockholm spinal cord injury study. J Rehabil Med. 2010, 42(5):489-492.

6. World Health Organization (WHO). Global Recommendations on Physical Activity for Health. 2010.

7. National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report. Circulation. 2002, 106(25):3143-3421.

8. Flank P, Fahlstrom M, Bostrom C, Lewis JE, Levi R,. Self-reported physical activity and risk markers for cardiovascular disease after spinal cord injury. J Rehabil Med. 2014, 46(9):886-890.

9. Hicks AL, Martin Ginis KA, Pelletier CA, Ditor DS, Foulon B. The effects of exercise training on physical capacity, strength, body composition and functional performance among adults with spinal cord injury: a systematic review. Spinal Cord. 2011, 49(11):1103-1127.

10. World Health Organization (WHO). Waist Circumference and Waist-Hip Ratio. Geneva: WHO; 2008.

11. Flank P, Wahman K, Levi R, Fahlstrom M. Prevalence of risk factors for cardiovascular disease stratified by body mass index categories in patients with wheelchair-dependent

paraplegia after spinal cord injury. J Rehabil Med. 2012, 44(5):440-443.

12. Spungen AM, Adkins RH, Stewart CA, Wang J, Pierson RN et al. Factors influencing body composition in persons with spinal cord injury: a cross-sectional study. J Appl Physiol (1985). 2003, 95(6):2398-407.

13. Buchholz AC, Bugaresti JM. A review of body mass index and waist circumference as markers of obesity and coronary heart disease risk in persons with chronic spinal cord injury. Spinal Cord. 2005, 43(9):513-518.

14. Madden AM, Smith S. Body composition and morphological assessment of nutritional status in adults: a review of anthropometric variables. Journal of human nutrition and dietetics : the official journal of the British Dietetic Association. 2014.

15. Ravensbergen HR, Lear SA, Claydon VE. Waist circumference is the best index for obesity-related cardiovascular disease risk in individuals with spinal cord injury. J neurotrauma. 2014, 31(3):292-300.

16. World Health Organization (WHO). BMI classification. Geneva: WHO; 2011.

17. Riserus U, de Faire U, Berglund L, Hellenius ML. Sagittal abdominal diameter as a screening tool in clinical research: cutoffs for cardiometabolic risk. Journal of obesity. 2010, 2010(2010): 7.

18. Whitworth JA. World Health Organization ISoHWG. 2003 World Health Organization (WHO)/International Society of Hypertension (ISH) statement on management of hypertension. J Hypertens. 2003, 21(11):1983-1992.

19. Rimmer JH, Riley BB, Rubin SS. A new measure for assessing the physical activity behaviors of persons with disabilities and chronic health conditions: the Physical Activity and Disability Survey. Am J Health Promot. 2001, 16(1):34-42.

20. Washburn RA, Zhu W, McAuley E, Frogley M, Figoni SF. The physical activity scale for individuals with physical disabilities: development and evaluation. Arch Phys Med Rehabil. 2002, 83(2):193-200.

21. Lieberman JA, Hammond FM, Barringer TA, Goff DC, Jr., Norton HJ et al. Adherence with the National Cholesterol Education Program guidelines in men with chronic spinal cord injury. J spinal cord med. 2011, 34(1):28- 34.

22. Cragg JJ, Stone JA, Krassioukov AV. Management of cardiovascular disease risk factors in individuals with chronic spinal cord injury: an evidence-based review. Journal of neurotrauma. 2012, 29(11):1999-2012.

23. Myers J, Lee M, Kiratli J. Cardiovascular disease in spinal cord injury: an overview of prevalence, risk, evaluation, and management. Am J Phys Med Rehabil. 2007, 86(2):142-52.

24. Seidell JC. Waist circumference and waist/hip ratio in relation to all-cause mortality, cancer and sleep apnea. Eur J Clin Nutr. 2010, 64(1):35-41.

25. Public Health Agency of Sweden. [National Health Report 2009.]

26. Cowan RE, Nash MS, Anderson KD. Exercise participation barrier prevalence and association with exercise participation status in individuals with spinal cord injury. Spinal Cord. 2013, 51(1):27-32.

27. Scelza WM, Kalpakjian CZ, Zemper ED, Tate DG. Perceived barriers to exercise in people with spinal cord injury. Am J Phys Med Rehabil. 2005,84(8):576-583.

28. Eriks-Hoogland I, Hilfiker R, Baumberger M, Balk S, Stucki G, Perret C. Clinical assessment of obesity in persons with spinal cord injury: validity of waist circumference, body mass index, and anthropometric index. The journal of spinal cord medicine.j Spinal cord Med 2011, 34(4):416-422.

29. D'Agostino RB, Sr., Vasan RS, Pencina MJ, Wolf PA, Cobain M et al. General cardiovascular risk profile for use in primary care: the Framingham Heart Study. Circulation. 2008, 117(6):743-753.

30. Gilbert O, Croffoot JR, Taylor AJ, Nash M, Schomer K, Groah S. Serum lipid concentrations among persons with spinal cord injury - a systematic review and meta-analysis of the literature. Atherosclerosis. 2014, 232(2):305-312.