ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2014;95:1083-92

ORIGINAL ARTICLE

Trajectories in the Course of Body Mass Index After Spinal Cord Injury

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Abstract

Objective: To identify different trajectories of the course of body mass index (BMI) after spinal cord injury (SCI) and to study whether other cardiovascular risk factors (blood pressure, lipid profile) follow the same trajectories.

Design: Multicenter prospective cohort study with measurements at the start of active rehabilitation, after 3 months, at discharge, and 1 and 5 years after discharge.

Setting: Rehabilitation centers.

Participants: Persons with a recent SCI (N=204).

Interventions: Not applicable.

Main Outcome Measure: BMI trajectories.

Results: Three BMI trajectories were identified: (1) a favorable stable BMI during and after rehabilitation (±22−23kg/m^2) (54%); (2) a higher but stable BMI during inpatient rehabilitation (±24kg/m^2) and an increase after discharge (up to 29kg/m^2) (38%); and (3) an increase in BMI during inpatient rehabilitation (from ±23 up to 28kg/m^2) and leveling off after discharge (8%). Profile analyses showed that an unfavorable change in BMI was not accompanied by clear unfavorable changes in blood pressure or lipid levels.

Conclusions: BMI in people with SCI follows distinct trajectories. Monitoring body mass, food intake, and daily physical activity during and especially after inpatient SCI rehabilitation is important to prevent obesity and related cardiovascular risk factors.

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People with a spinal cord injury (SCI) have a lower resting metabolic rate because of muscle paralysis and, therefore, reduced muscle mass below the lesion.[1] As a result of their often sedentary lifestyle caused by paralysis and the inability to regularly perform sports activities,[2] their energy expenditure during activities is also reduced. In the context of an unchanged food intake, the overall lower energy expenditure may lead to a positive energy balance, causing an accumulation of body fat[3] and, finally, obesity. Being overweight is a serious problem in people with SCI; 5 years after discharge of inpatient rehabilitation, the percentages of overweight and obese persons are 21% and 54%, respectively.[1]

Obesity is associated with an unfavorable metabolic profile[4] and a higher risk of diabetes and cardiovascular disease.[5] Obesity in combination with muscle atrophy can lead to severe forms of pressure ulcers.[6] Furthermore, a higher body mass will lead to an increased load on the upper extremities during wheelchair propulsion or when making a transfer. This can lead to

Supported by the Dutch Health Research and Development Council, The Netherlands Organization for Health Research and Development Rehabilitation Program (grant nos. 1435.0003 and 1435.0025).

No commercial party having a direct financial interest in the results of the research supporting this article has conferred or will confer a benefit on the authors or on any organization with which the authors are associated.

0003-9993/14/$36 - see front matter © 2014 by the American Congress of Rehabilitation Medicine
http://dx.doi.org/10.1016/j.apmr.2014.01.024

musculoskeletal overuse problems,[7] a common problem in people with SCI.[8] The increasing mass and concomitant secondary problems can, in turn, lead to a further decrease in activities, deconditioning, difficulties in social participation, low self-esteem, and a lower quality of life.[9]

To our knowledge, only 2 studies, one of which is the same cohort as the present study, are available that focused on change in body mass index (BMI) during and after rehabilitation. These studies showed that BMI of people with a recent SCI, on average, increased during the first years after injury.[10,11] However, this does not necessarily have to occur in all persons with SCI. Insight in different BMI trajectories offers possibilities to discover which individual characteristics could be risk factors for developing obesity. Furthermore, because a higher BMI tends to associate with more hypertension[12] and an unfavorable lipid profile[4] in people with SCI, it is of interest to see whether these cardiovascular risk factors show similar trajectories to the BMI trajectories. Knowing more about different BMI trajectories and their impact on cardiovascular risk factors is important for prevention programs.

Therefore, the aims of this study were (1) to identify subgroups with distinct BMI trajectories between the start of active SCI rehabilitation up to 5 years after discharge; (2) to study differences in personal and lesion characteristics between trajectories; and (3) to determine whether other cardiovascular risk factors (blood pressure, lipid profile) follow the same trajectories.

We hypothesized that there will be different BMI trajectories during and after SCI rehabilitation and that because of the association between BMI and hypertension[12] and lipid profile,[4] cardiovascular risk factors change unfavorably together with an increase in BMI.

Methods

Participants

The current study was part of a Dutch prospective cohort study (called the Physical Strain, Work Capacity and Mechanisms of Restoration of Mobility in the Rehabilitation of Persons with SCI study).[13] Participants (N = 204) from 8 rehabilitation centers that specialize in SCI rehabilitation in The Netherlands were included. They were eligible to enter the project if they had an acute SCI, were between 18 and 65 years of age, were classified as grades A, B, C, or D on the American Spinal Injury Association Impairment Scale, were expected to remain permanently wheelchair dependent, did not have a progressive disease (eg, malignant tumor) or psychiatric problem, and had sufficient understanding of the Dutch language to understand the purpose of the study and the testing methods.

Ethics approval was received from the medical ethics committee of Foundation Rehabilitation Limburg/Institute for Rehabilitation questions Hoensbroeck for the first 4 measurements, and the medical ethics committee of the University Medical Center Utrecht approved the addition of the fifth measurement. After they were given information about the testing procedure, all participants completed an informed consent form.

List of abbreviations:

AIC	Akaike information criterion
ANOVA	analysis of variance
BMI	body mass index
HDL	high-density lipoprotein
LCGMM	latent class growth (mixture) model
LDL	low-density lipoprotein
SCI	spinal cord injury

Design

Data for the current study were collected at the start of active rehabilitation (when patients could sit for 3−4h), 3 months later, at discharge of inpatient rehabilitation, 1 year after discharge, and 5 years after discharge. Persons with a BMI value on at least 2 test occasions were included in the analysis, as was done in earlier publications.[14] Data were collected by trained research assistants with a paramedical background using standardized procedures.

Body mass index

Body mass of the participant was assessed by the research assistant on each test occasion. Mass was measured with the participant hanging in a patient lift including a weighing scale or with a large weighing scale on which the participant could be measured in his/her wheelchair. In the latter case, the mass of the wheelchair was measured separately and subtracted from the total mass. The height of the participant was asked at the start. BMI was calculated as body mass (kg)/height (m^2). The prevalence of being overweight and obese was calculated with the adjusted cutoff points for people with SCI (recommended: BMI$<$22kg/m^2; overweight: 22$\leq$BMI$<$25kg/m^2; obese: BMI$\geq$25kg/m^2).[15]

Blood pressure and lipid profile

A physician recorded resting systolic and diastolic arterial pressure using a manual sphygmomanometer while participants were seated in their wheelchair. The measurements were recorded once at the same time of the day during every visit.

Blood samples were taken in the morning when persons were in a fasting state. Total cholesterol (mmol/L) and triglycerides (mmol/L) concentrations were measured using standardized enzymatic procedures. High-density lipoprotein (HDL, mmol/L) were determined after selective precipitation of the very low-density lipoprotein (LDL) fractions (mmol/L); LDL was calculated using the Friedewald equation.[16]

Information on current medication use was obtained by the physiatrist. The database was checked for common prescriptions for blood pressure and lipid profile medication.

Personal and lesion characteristics

Participant information regarding age, sex, and lesion characteristics at T1 was collected. The cause of injury (traumatic, nontraumatic) was registered. Lesion characteristics (level, completeness) were determined by a physiatrist using the International Standards for Neurological Classification of SCI. Tetraplegia was defined as a lesion at or above the T1 segment, and paraplegia was defined as a lesion lower than T1. A lesion was defined as motor complete when subjects had American Spinal Injury Association Impairment Scale grades A or B.

Statistical analysis

Descriptive statistics of BMI, personal and lesion characteristics, and blood pressure and lipid profile were calculated.