STUDIES ON ENERGY EXPENDITURE IN WALKING AFTER STROKE

Akademisk avhandling

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This thesis is based on the following papers:

I. Danielsson A, Sunnerhagen K S.
Oxygen consumption during treadmill walking with and without body weight support in patients with hemiparesis after stroke and in healthy subjects.
Archives of Physical Medicine and Rehabilitation 2000;81:953-7.

II. Danielsson A, Sunnerhagen KS.
Energy expenditure in stroke subjects walking with a carbon composite ankle foot orthosis.
Journal of Rehabilitation Medicine 2004;36:165-8.

III. Danielsson A, Willén C, Sunnerhagen KS.
Measurement of energy cost by the Physiological Cost Index in walking after stroke.
Archives of Physical Medicine and Rehabilitation 2007;88:1298-303.

IV. Danielsson A, Willén C, Sunnerhagen KS.
Energy cost, walking habits and physical activity late after stroke.
Manuscript.

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Studies on energy expenditure in walking after stroke

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ABSTRACT

Aims: The aims were to assess energy expenditure during different conditions, evaluate measurement methods and assess physical activity after stroke.

Methods: In total 51 persons with stroke >6 months previously (mean age 56) and 24 reference persons participated. In study I, oxygen consumption (VO_2), heart rate (HR) and perceived exertion were measured at treadmill walking with 0% and 30% body weight support (BWS) in 9 stroke and 9 reference subjects. Study II evaluated VO_2, HR, gait speed and perceived exertion in 10 subjects with stroke walking with and without a carbon composite ankle foot orthosis. Measurement of VO_2 was compared to the Physiological Cost Index (PCI), a HR based estimate of energy cost, in study III, where 20 stroke and 16 reference subjects participated. In 11 of the stroke subjects, measures were also compared from walking with and without an orthosis. Study IV quantified the energy cost indoors and outdoors by the PCI and the 6 minute walking distance. Physical activity, walking habits and perceived difficulties were also assessed by questionnaires in 31 persons at a median of 8 years after stroke.

Results: Overall, the subjects with stroke walked with lower speeds and higher energy cost compared to reference subjects. With 30% BWS, VO2 was lower than with 0% BWS, in both the stroke and healthy subjects. Furthermore, HR and perceived exertion were lower with 30% BWS in the stroke group. The energy cost in walking with ankle foot orthosis was statistically, although not clinically relevant, lower and the speed was higher compared to unbraced walking. Energy cost measured by VO_2 and PCI mean values did not differ significantly between test and retest, but the differences in PCI were large in the stroke group. VO_2, age, sex and group assignment could explain 53% of the variation in the PCI. VO_2 but not PCI could detect a statistically significant difference in energy cost of walking with and without an orthosis. Persons with stroke a long time ago walked with increased energy cost and decreased distance as compared to reference values. Two-thirds experienced walking difficulties and 50% showed reduced walking habits. Walking difficulty and Body Mass Index were associated with energy cost and walking distance. The latter was also associated with physical activity level, but no relation with physical environment was found.

Conclusions: Body weight support might decrease energy demands of walking both in stroke subjects and healthy persons. Hence, gait training with BWS may be feasible in case of low physical capacity. An ankle foot orthosis might reduce the energy cost and increase walking speed after stroke. The PCI showed limited reliability and validity after stroke and was not sensitive enough to detect a difference in energy cost when an orthosis was applied. Thus, for research purposes, measurement of VO_2 is preferable. Late after stroke, walking ability was impaired, walking difficulties seemed to predict the energy cost, and perceived difficulties and physical activity level were associated with walking distance.

Key words: Gait, rehabilitation, assessment, physical therapy, oxygen consumption, body weight support, orthotic devices, physical activity

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