

Summary



The profound increase in the number of elderly people in the Netherlands in the future, will result in an increase in number of patients in need for rehabilitation care. With ageing several physiologic functions decline and the resulting physical impairments may negatively affect the course of functional status. At older age, people may develop multiple morbidities, which have been demonstrated to be negatively associated with quality of life, and performance of activities in daily life, and, lead to a higher use of healthcare services. Cognitive impairments may also increase with age, and have been shown to impact on disability, well-being and the use of healthcare services. Physical impairments, multiple morbidities and cognitive impairments are the most important causes of limitations in functioning in the elderly. For the development of rehabilitation programs for an ageing population, knowledge of these determinants on the course of functioning is essential.

The present thesis is part of the CARPA study 'Co-morbidity and Ageing in Rehabilitation Patients: the influence on Activities'. This study investigates the course of functional status and the impact of physical impairments, co-morbidity and cognitive impairments on this course in elderly patients with late-onset sequelae of poliomyelitis, osteoarthritis and Parkinson's disease. This thesis encompasses the studies with regard to late-onset sequelae of poliomyelitis.

Although poliomyelitis has become an almost forgotten disease in the Western world after the introduction of routine vaccination in the late 1950s, there are still many individuals with polio residuals. As these people are ageing, they are confronted with new neuromuscular symptoms 30 to 40 years after the original childhood disease. These symptoms include a gradual or, less frequent, abrupt onset of progressive new weakness, abnormal muscle fatigability, with or without generalized fatigue, muscle atrophy, or pain. The denominator for these late-onset symptoms is post-polio syndrome (PPS). Taking into account that PPS is a diagnosis by exclusion and that this thesis focused on the impact of age and co-morbidity on functioning of elderly patients with a history of poliomyelitis, the more neutral term late-onset sequelae of poliomyelitis (LOSP) was preferred.

The new late-onset neuromuscular symptoms cause increasing difficulties with physical functioning, such as walking, standing, climbing stairs and other mobility-related activities of daily life. To date, studies on the course of functioning of people with a history of poliomyelitis have almost always excluded subjects above the age of 65 and subjects with co-morbidity, or co-morbidities were not assessed or not reported. Therefore, these studies may have underestimated the functional problems and rate of decline in ageing former polio patients. As the impact of age and co-morbidity on the course of functioning in patients with LOSP remains unresolved, this thesis aims to describe the course of functional status of patients aged 45 – 85 years with late-onset sequelae of poliomyelitis over a period of 5 years and to explore the impact of age and co-morbidity.

Chapter 2 systematically reviewed studies focussing on the course of functional status and muscle strength over time and prognostic factors of change in patients with LOSP based on a literature search. A computerized literature search up to July 2004 was conducted and these results were published (**chapter 2.1**). An unpublished update of

the literature from July 2004 to July 2009 was added in **chapter 2.2**. The original review comprised 2 studies on the course of functional status and 4 studies on the course of muscle strength with sufficient methodological quality. In **chapter 2.2**, 2 additional articles with sufficient or high quality on the course of functional status (including the 5-year longitudinal CARPA study (**chapter 6**)), and the course of muscle strength, were summarized. Adding the results of these studies to the original systematic review gave better insight in the course of functioning and muscle strength in patients with LOSP. The heterogeneity in outcome measures between studies, prevented a quantitative analysis of the decline in perceived functional status over time. Nevertheless, all studies on perceived functioning reported a deterioration over time. Walking ability, assessed with timed walking tests, deteriorates slowly, 0.2 – 0.7% per year. Muscle strength declines approximately 3 times faster (1.5 – 1.9% per year). Factors that negatively affect the decline in functioning that have been reported in high-quality studies were the severity of polio residuals and co-morbidity, while age so far has not been shown to influence the decline in functioning. In general, studies require long term follow-up periods to observe a change in functioning with a minimum between 3 and 5 years depending on the outcome measures and study population. Furthermore it was concluded that uniformity in outcome measures between prognostic studies on all levels of functioning (impairments, activities and participation) is crucial to compare studies and to gain better insight in the course of functioning over time and factors that may affect this course in polio survivors.

In **chapter 3**, the baseline data of the entire CARPA study with regard to the Western Ontario and MacMasters Universities Osteoarthritis Index (WOMAC) have been used to investigate whether its physical functioning subscale can be used to assess physical functioning in patients with LOSP and in patients with Parkinson's Disease (PD). The WOMAC originally is an osteoarthritis-specific questionnaire to establish the level of physical functioning. The baseline data of the WOMAC physical functioning subscale (WOMAC-PF) of 288 patients with osteoarthritis, 200 patients with Parkinson's disease and 168 patients with LOSP have been analyzed. Unidimensionality was adequate and item fit was generally good. Differential item functioning was found to be present between the 3 diagnostic groups in 10 of 17 WOMAC-PF items. Therefore it was concluded that the WOMAC-PF is an unidimensional measure of physical functioning in patients with LOSP and PD, in addition to its established use in OA. When making cross-diagnostic comparisons of the level of physical functioning, directly comparing WOMAC-PF scores may not be adequate due to the presence of differential item functioning.

Chapter 4, 5 and 6 reported on the data derived from the 5-year follow-up study of 168 patients with late-onset sequelae of poliomyelitis, aged 45 – 85 years.

Heterogeneity in outcome measures used in studies focusing on patients with late-onset sequelae of poliomyelitis prevents summarizing the evidence in an effective way. The aim of **chapter 4** therefore was to prioritize one questionnaire and one walking test from a number of questionnaires and tests that are widely used in post-polio populations by comparing their reproducibility, measurement range and mutual associations, in order to advocate their use as core qualifiers of physical functioning in research and clinical practice.

Physical functioning subscales from Short Form-36 (SF36-PF), WOMAC and Nottingham Health Profile were compared as well as timed-up-and-go test, time needed to walk 10 meter at self-preferred and maximum speed and distance walked in 2 minutes at self-preferred speed. The results showed that the test-retest reliability of all questionnaires was sufficient to excellent. The smallest detectable changes were best for SF36-PF and WOMAC-PF and the 2-minute walking test. SF-36 physical functioning scale and 2-minute walking test showed the highest correlation. Based on these results, the SF36-PF and 2-minute walking test were recommended as core qualifiers for physical functioning, to assess the perceived physical performance and walking capacity in research and clinical practice.

In **chapter 5** functional independence and perceived physical functioning of patients with LOSP in 3 age groups (45 – 54 years, 55 – 64 years and 65 – 85 years) were compared and the impact of age and co-morbidity on these outcome measures was investigated. Elderly patients showed a lower level of functional independence, whereas no difference in perceived physical functioning was found. The co-morbidity score increased with age. Age was independently associated with functional independence, but not with perceived physical functioning. This may corroborate an age-related shift in the perception of physical limitations. The co-morbidity categories ‘cardiac’, ‘vascular’, ‘endocrine,metabolic’ and ‘muscle,bone,skin’ appeared to be associated with both functional independence and perceived physical functioning. It was concluded that co-morbidity negatively affects functional independence and perceived physical functioning. Prospective studies with unselected study populations, without exclusion of co-morbidity or elderly subjects, but including age-matched controls and measures to record co-morbidity were advised to investigate the influence of co-morbidity on the course of functioning in this population.

Chapter 6 presented the results of the 5-year observational cohort study with regard to the course of functioning and muscle strength and the impact of age and co-morbidity on the course of functional independence and perceived physical functioning. Disability, measured as functional independence, walking capacity and perceived physical functioning, declined little. The rate of decline in functioning was in line with other studies on polio survivors. Muscle strength, assessed as maximal quadriceps strength on a fixed dynamometer, decreased somewhat more. Unfortunately selective drop-out, resulting in a functionally better group with less co-morbidity, must be assumed at the fifth measurement due to temporary malfunction of the dynamometer. Judging from the decline in muscle strength at the 3-year follow-up, the 5-year measurements probably underestimate the real decline in muscle strength and the decline measured at 3-year follow-up may better reflect the true decline in ageing polio survivors. Co-morbidity increased over the years and a higher level of co-morbidity correlated with a lower score in functional independence and faster decrease in functional independence. For functional independence and perceived physical functioning prognostic models were constructed. Legs strength sum score and co-morbidity total score were prognostic factors for functional independence, whereas age was not. The prognostic model for perceived physical functioning included gender, age, legs strength sum score and co-morbidity total score, but no prognostic determinants were identified. To our surprise, age did not impact on functioning and future long-term follow-up studies should be

conducted with age-matched controls to compare the rate of decline in subjects with and without a history of poliomyelitis. Long-term follow-up with a sensitive outcome measure for musculoskeletal co-morbidities should determine whether the impact of co-morbidity will increase over the years.

Finally, **chapter 7** discussed the main findings and clinical implications, critically focused on the methodology and gave recommendations for future research.

Four imaginary patients who differ in age, gender, extent of paresis of the legs and rate of co-morbidity were discussed to give some idea of the difference in the progression of disability in terms of functional independence between patients and the importance to consider age, co-morbidity and paresis for the functional prognosis of individuals with LOSP.

The longitudinal data showed that walking measured with walking tests deteriorates slowly, whereas muscle strength declined faster. Furthermore 2 studies, including our own, reported that the severity of polio residuals was a prognostic factor of functioning. The difference in deterioration rate between walking capacity and muscle strength supports the concept of 'overuse' of muscles in daily life. To maintain functioning over the years, patients are forced to use their weakening muscles at increasing relative loads.

In rehabilitation therapy, 2 approaches, that can be complementary to each other, can be distinguished: (1) preservation or improvement of muscular capacity and (2) the reduction of physical demands of daily life activities. Especially patients with relative good functional prognosis and muscle strength should be considered to use preservation of muscular capacity as an appropriate mean of therapy, because these patients still have a muscle status that can be trained. Patients with a worse functional prognosis should be considered to benefit from multidisciplinary treatment programs focusing on the reduction of physical demands, necessitating life style changes, because these patients are likely less able to train their limited and overused muscles.

An important methodological limitation to this study is the fact that sampling bias and selective drop-out might have occurred in our cohort. Therefore, an underestimation of the increase in disability and decline in muscle strength cannot be excluded and should be considered in especially the older subjects.

In future research this cohort should be followed further to gain insight in the long-term course of functioning and the impact of prognostic factors. The challenge will be to assure complete data collection with regard to the different outcome measures, especially muscle strength. Age-matched controls must be included to separate LOSP-related decline in functioning from age-related decline. A comprehensive measure of co-morbidities of the musculoskeletal system should be added to the outcome measures. Based on new insights, questionnaires on fatigue, activity monitoring and the collection of blood samples to assess the level of cytokines are to be added to the measurements.

The goal for the future with respect to rehabilitation must be that the millions of polio survivors can retain their functioning at the highest achievable levels as they age.

