Brain Injury, February 2008; 22(2): 135–145

informa
healthcare

Exercise and health-related quality of life during the first year following acute stroke. A randomized controlled trial

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(Received 11 October 2007; accepted 6 January 2008)

Abstract

Purpose: To evaluate the impact of two different physiotherapy exercise regimes in patients after acute stroke on health-related quality of life (HRQoL) and to investigate how the degree of motor and balance function, gait capacity, activities of daily living and instrumental activities of daily living influenced HRQoL.

Methods: A longitudinal randomized controlled stratified trial of two interventions: the intensive exercise groups with scheduled intensive training during four periods of the first year after stroke and the regular exercise group with self-initiated training.

Results: There was a tendency of better HRQoL in the regular exercise group on NHP total score ($p = 0.05$). Patients with low scores in activities of daily living, balance and motor function and inability to perform 6-minute walk test on admission, scored lower on self-perceived health than patients with high scores and ability to perform the walking test. At 1 year post-stroke, total scores on NHP were moderately associated with motor function ($r = -0.63$), balance ($r = -0.56$), gait ($r = -0.57$), activities of daily living ($r = -0.57$) and instrumental activities of daily living ($r = -0.49$–0.58). The physical mobility sub-scale of NHP had the strongest association ranging from $r = -0.47$–0.82.

Conclusion: The regular exercise group with self-initiated training seemed to enhance HRQoL more than the intensive exercise group with scheduled intensive training. The degree of motor function, balance, walking capacity and independence in activities of daily living is of importance for perceived HRQoL.

Keywords: *Excercise, health related quality of life, level of function, physical therapy, stroke*

Introduction

Stroke is a major cause of long-term disability which may handicap patients in everyday life and thus lead to deterioration of their quality of life (QoL) in several areas [1]. As stroke mortality rates are declining [2], afflicted individuals are increasingly likely to live with their residual impairments and disabilities. Impairments and disabilities will influence QoL in patients with stroke in one way or another [2]. However, QoL is a broad concept and covers such areas as social, environmental, economic and health satisfaction. Health-related quality of life (HRQoL), on the other hand, is less wide and includes the self-perceived consequences of mental and physical health on the person's life [3]. HRQoL in stroke survivors is reported lower than in the average population [3–5]. It is therefore of importance to evaluate HRQoL in order to assess and improve the possibilities for patients with stroke to return to the community [6–14]. However, data on HRQoL in stroke trials are modest, especially reports of the longitudinal aspect [3–5]. On the other hand, the goals in stroke rehabilitation are often related to HRQoL. It has been generally

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ISSN 0269–9052 print/ISSN 1362–301X online © 2008 Informa UK Ltd.
DOI: 10.1080/02699050801895423

hypothesized that improved functions, such as motor function, transfer, gait capacity, activities of daily living (ADL) and speech, will lead to improved HRQoL [5, 15–18]. Physical activity and exercise have been reported to improve motor function, ADL and reduce depression in patients with stroke in several studies [19–22]. From this perspective, it seems likely that physical activity and exercise would be beneficial in maintaining and improving HRQoL, but little is known of what type of physical activities or exercise programmes might have an impact on HRQoL. Exercise has been predictive of less depression in stroke patients and remission of depressed mood has been associated with improved physical functioning [21, 22]. However, patients with stroke in general receive little or no physical activity, exercise or follow-up after the initial rehabilitation [3] and report lower HRQoL than their healthy counterparts in the population [11].

The present study was designed to address the question of whether and how HRQoL, as measured with the Nottingham Health Profile (NHP), was influenced by two different exercise programmes in patients suffering a first stroke during the first year after stroke. A further aim was to investigate how the degree of function influenced HRQoL over the same period. It was hypothesized that a programme of frequent, regular and scheduled exercise would be more beneficial in improving HRQoL than an exercise programme which was activated when required and not on a regular, scheduled basis. Furthermore, it was hypothesized that HRQoL was influenced by level of motor function, balance, gait capacity and ADL and that, with improved functions, HRQoL would also improve.

Design and methods

The study was a longitudinal randomized controlled stratified trial in patients with first-ever stroke during the years 2003–2005. Patients were randomized to one of two different groups by a person not involved with the patients or the treatment in the ward. Randomization was performed with a dice; patients with uneven numbers went to group 1, an intensive exercise group, and those with even numbers to group 2, a regular exercise group. The different interventions started when patients with stroke were discharged from the acute hospital. All patients received the same task-oriented functional training, during the acute stay in the hospital, as has been reported effective in an earlier study [19].

The randomization protocol was sealed for 1.5 years, from the start of the study until the last patient included was tested at 1 year follow-up, in order to keep the blinding intact all through the intervention period. The study was an intention-to-treat trial with the aim of being double-blind; that is, neither the investigator nor the patients knew to which group the patients were allocated.

On the basis of an earlier study [3] a power calculation was made on HRQoL as measured with Nottingham Health Profile (NHP) and it was estimated that 29 participants were required in each group to detect a difference in motor function with a significance level of 0.05 and a power of 80%. Based on the calculations of HRQoL, a statistical effect size of 24% was expected.

For the primary analysis, the patients were divided into the intensive exercise group and the regular exercise group. Furthermore, for a secondary analysis, the patients were divided into sub-groups of high and low function concerning activities of daily living, motor function, balance and gait capacity, regardless of exercise regime. This latter division was made on the scores on admission, in order to investigate the different levels of motor and activity functions on HRQoL and did not interfere with the primary analysis. The scores used for dichotomizing the sub-groups were chosen because the scores of the tests are believed to reflect the degree of severity of the stroke incident; severe or moderate. The outcome of the stroke at this early stage may have an input on the potential degree of recovery of the patient with stroke, his/her ability to participate in activities and HRQoL. A more in-depth description of this procedure can be found in the methods section.

Subjects

The patients were all admitted to a stroke unit in an acute primary hospital covering a geographical area with a population of 140 000 in the years 2003–2004. Patients with stroke were consecutively screened for inclusion as they were admitted to the hospital. All patients and their families were informed about the tests and the use of the test results and were asked to sign a written statement in which they formally consented to participate in the study. The informed consent was obtained by methods approved by the Regional Committee of Medical Research Ethics. The information was given in written and verbal form.

Interventions

The participants would be randomised to one of two groups at discharge; one of these would be given intensive physiotherapy regularly, starting from discharge from the hospital, with special emphasis on endurance, strength and balance during four

Table I. Exercise protocol for the groups.

	The intensive exercise group	The regular exercise group
Frequency	2–3 times a week	No recommendations—usual procedures
Intensity	Endurance: 70–80%, calculated from maximal pulse Strength: 50–60% calculated from 1RM Balance: maximal or 15–17 on Borg's rating scale of perceived exertion.	No recommendations—usual procedures
Time	40–60 minutes	No recommendations—usual procedures
Type	Endurance exercises: • walking • treadmill • step • stationary bicycling (arm, leg or combined) • Working with balls or balloons Strength exercises: 10 repetitions in 3 sets *Extension of back*: pulley, pull-down, 'walking stick', prone-extension *Stomach*: ordinary sit-ups with fixation of pelvis if necessary *Arms*: push-ups in chair, weight–lifting, water bottles, pulley *Hips–legs*: ordinary knee flexion/extension, walking-stairs, steps *Legs–feet*: toe and heel rise on the floor, step, Airex mat, with or without support Balance: • walking on even/uneven surface • walking in 8, keeping borders • walking on a line • dual task • obstacles • dancing • tai-chi If not possible with any of the above: • sitting: senior dance, balls, balloons Do light stretching of large muscles at the end!	No recommendations—usual procedures

periods of the first year after stroke, with a total treatment period of at least 80 hours. The exercises in this group were scheduled and planned at the time of discharge from the stroke unit. A more detailed description of the exercises is presented in an earlier report and in Table I. The regular exercise group would have physiotherapy exercises if required, as the regular custom was. The type of exercises done in this group was a decision between the physiotherapist and the patient. In some cases this meant no follow-up treatment [20]. Both groups received interdisciplinary treatment if needed. The patients did not know which group they were randomized to at discharge from the hospital. The intensive exercise group was contacted by a physiotherapist after discharge from the hospital and started their programme immediately and followed the outline of this programme for 1 year post stroke. The regular exercise group had no such contact and was checked for different assessments at 3, 6 and 12 months post-stroke, as agreed upon when admitted to the hospital.

Inclusion criteria were first-time-ever stroke with neurological signs, computer tomography confirmation of the stroke and voluntary participation. Exclusion criteria were more than one stroke incident, subarachnoid bleeding, tumour, brain stem or cerebellar stroke and other serious illness. Seventy-five patients fulfilled the inclusion criteria and were randomized to one of the two groups after the first test occasion 3–5 days after admission. The randomization was put into effect as the patients were discharged from the hospital and did not interfere with the treatment at the hospital.

Outcome measures

A test protocol for evaluation of motor function, balance, mobility, walking speed and length, personal ADL, instrumental activities of daily living (IADL) and HRQoL was set up, consisting of well-known clinical measurements that could be implemented anywhere without laboratory equipment. These included the Motor Assessment Scale (MAS), Berg Balance Scale (BBS), 6-minute walk test (6MWT) and the Barthel Index of Activities of Daily Living (BI), which are functional measurements that can be said to represent measurements on the activity level according to the World Health Organization's International Classification of

Functioning (ICF) [23]. The Nottingham Health Profile (NHP) and IADL represent the level of participation in ICF. These tests would give an overall, thorough impression of the patient's motor function from different levels and activities, throughout the first year after the stroke.

The patients were tested on admission, at discharge and 3, 6 and 12 months after the onset of stroke by an experienced investigator, blinded to group allocation. The tests were performed in the general hospital, in the patients' homes and in community service centres.

- *The Motor Assessment Scale* is a test of motor function developed by Carr and Shepherd [24]. Each item scores from 0 = no function to 6 = normal function. Hence, the total scores of the eight items range between 0–48. The test has been shown to have high inter- ($r = 0.89$–0.99) and intra-reliability ($r = 0.87$–0.98) [25] and high construct cross-sectional validity ($r = 0.88$ and $r = 0.96$) [21]. The MAS scores in this study were also dichotomized into lower scores (0–35) and higher scores (36–48). The lower MAS scores were estimated with a cut-off of 4 on all the sub-scores, scores below the cut-off indicating a lower level of motor function.
- *The Barthel Index of Activities of Daily Living* is a test of primary activities of daily living developed by Mahoney and Barthel [26] for the purpose of measuring functional independence in personal care and mobility. The items are weighted differently. The scores reflect the amount of time and assistance required by a client. A score of 0 (complete dependence), 5, 10 or 15 is assigned to each level, with a possible total score of 100 (totally independent). The test has high scores for inter- ($r = 0.70$–0.88) and intra-reliability ($r = 0.84$ and $r = 0.98$) and construct cross-sectional validity ($r = 0.73$–0.77) [27, 28]. The scores of BI were also dichotomized into lower (0–59) and higher scores (60–100) in this study. This division was based on the clinical guideline of a cut-off point of 60. Scores below 60 indicate a need for institutional care [27].
- Walking capacity was monitored by the 6-*Minute walk test*, using a standardized protocol [28, 29]. Distance walked (m) and gait velocity ($m\ s^{-1}$) were measured by the investigator. The 6MWT was performed in an 85 m long corridor in the hospital or different institutions. In patients' homes, this test was preferably performed outdoors on an 85 m long stretch on an even level. Indoors in patients' homes the longest stretch was chosen, but this was done only twice with two patients, 6 and 12 months post-stroke. The patients were encouraged to walk as fast and as long a distance as they could in 6 minutes. The 6MWT is also used to assess exercise tolerance [29, 30, 31], thus measuring functional exercise capacity. Gait velocity has been tested among elderly individuals for validity and reliability, with satisfactory results [25] and it has also been used in several stroke studies. The walking distances of the 6MWT were also dichotomized into not being able to perform the test (0 m) and a higher gait capacity, being able to perform the test (>1 m). This division was based on the assumption that individuals with no capacity for walking in the acute stage would have more problems and a lower health-related quality of life than those with some or a full capacity to walk.
- *The Berg Balance Scale* (BBS) is a balance test consisting of 14 items, scored from 0 = no balance to 4 = full balance. This scale has been found to be especially sensitive for detection of risks of falls in frail elderly persons. An overall score of less than 45 points, out of a maximum of 56, is associated with a 2.7-times increase in the risk of a future fall [32]. The BBS has been used in many studies and has been tested for reliability and validity with good results [25, 33]. The BBS scores were also dichotomized into higher and lower function with a cut-off total score of 32, which has been identified as a predictive score for falls [32].
- *The Nottingham Health Profile* is a two-part self-administered questionnaire of which part 2 is optional. The profile was designed to measure perceived health problems, but is best regarded as a measure of distress in the physical, emotional and social domains [35]. The NHP is a self-report, yes/no answer, two-part generic quality of life measure. Part one, used in this study, consists of a 38-item questionnaire with six sub-scales: emotional reactions (nine items), physical mobility (eight items), pain (eight items), sleep (five items), social isolation (five items) and energy level (three items). The items refer to problems with normal functioning that a person may experience as a result of ill health. Each affirmative answer is scored and weighted. The scores range from 0 (no perceived stress) to 100 for each sub-scale and the total score, where a high score indicates poor HQoL. This measure has been used for assessing HQoL in stroke patients [3, 10, 11, 20]. It has been found to have good reliability and validity [11, 35].
- Information on *IADL* was recorded according to *The Duke Older Americans Resources and Service Procedures (OARS) Multidimensional Functional Assessment of Older Adults by Fillenbaum*, where the part concerning self-care capacity captures the dimensions of PADL and IADL [36].

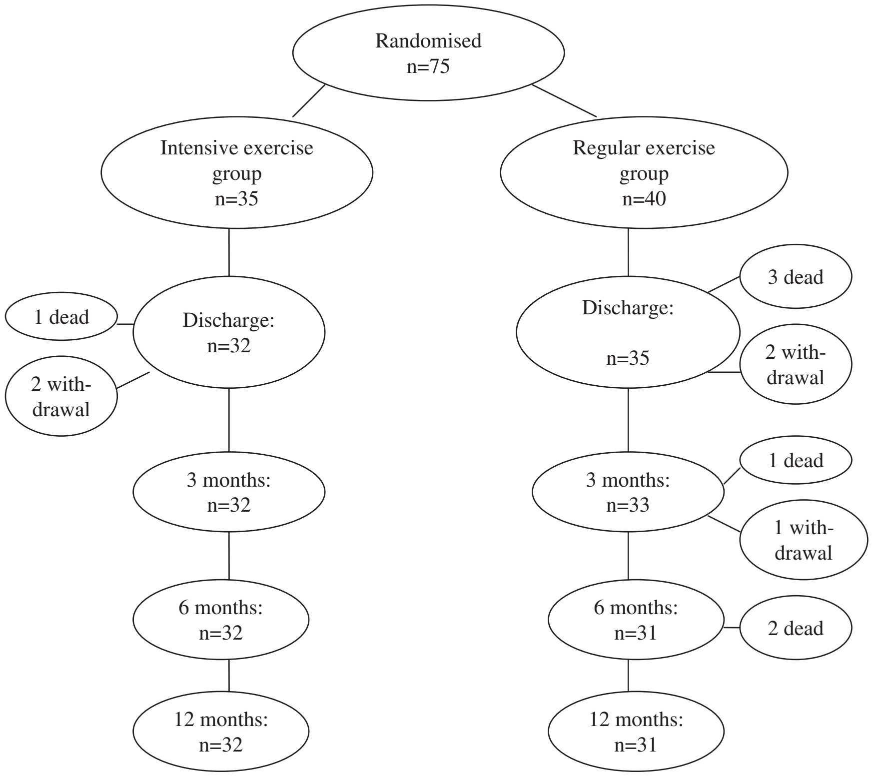

Figure 1. Flow chart over stroke patients admitted to the trial.

The information was collected by a structured interview with the stroke patients and their carers. They were asked 10 questions about use of the telephone, getting to places out of walking distances which require a car or a bus, purchasing of groceries/clothes, cooking capacity, housework in general, medication, care of economy and bank transfers and whether they received help and from whom. The answers were divided into three levels: independent = 2, some help = 1 and totally dependent = 0. The part concerning self-care capacity has been tested for validity ($r = 0.89$) and reliability ($r = 0.87$), with satisfactory results [36].

Statistical analysis

The results were analysed in an SPSS programme version 13. Descriptive statistics were used to summarize demographic, stroke and baseline characteristics. All analyses were performed on an intention-to-treat basis. Mean and standard deviation (SD) were calculated for NHP.

A general linear model for repeated measurements, with mixed between-within subjects analysis of variance (ANOVA) was performed, using change from baseline to 12 months as the dependent variable for each of the sub-scales of NHP with treatment group and high/low ADL, gait capacity, balance and motor function, respectively, as a fixed factor and gender as covariates at all times. The significance level was set at $p < 0.05$.

Spearman's rank correlation coefficients were calculated to assess the associations between NHP sub-scale scores and scores for different items of the IADL assessment by Fillenbaum, MAS total score, BBS total score, BI total score and gait, all on admission. A correlation of ≤ 0.4 was considered poor, between 0.41–0.69 as moderate and ≥ 0.7 as good.

Results

A total of 75 patients with stroke, admitted to the local hospital, adhered to the inclusion criteria during the period September 2003 to September 2004. The patients were included in the study consecutively: 35 in the intensive exercise group and 40 in the regular exercise group. Four patients died and four withdrew during the acute stage (flow chart, Figure 1). The reasons for the latter withdrawals were a new diagnosis, anxiety, cognitive status/dementia and advanced age (98 years), respectively, and one patient did not want to participate. The last 1 year follow-up tests were done in September 2005.

Table II. Descriptive data on admission for the intensive exercise group, the regular exercise group and groups with high and low scores for the Barthel Index of Activities of Daily Living (BI), Motor Assessment Scale (MAS), Berg Balance Scale (BBS) and 6-Minute Walk Test (6MWT).

	IG ($n = 35$)	RG ($n = 40$)	BI < 60 ($n = 35$)	BI > 60 ($n = 40$)	MAS < 35 ($n = 37$)	MAS > 35 ($n = 38$)	BBS < 32 ($n = 35$)	BBS > 32 ($n = 40$)	6MWT = 0 ($n = 25$)	6MWT > 0 ($n = 50$)
Female/Male (*n*):	14/21	18/22	18/17	14/26	17/20	15/23	17/18	15/25	14/11	18/32
Left/right lesion (*n*)	16/19	21/19	19/16	18/22	20/17	17/21	19/16	18/22	15/10	22/28
Age (years)										
mean	76	72	75.6	71.4	76.8	70.2	75.2	71.9	73.9	73.2
SD	12.7	13.6	9.5	13	12.9	12.9	13.7	12.8	14.8	12.5
Medication Y/N (*n*)	33Y/2N	37Y/3N	32Y/3N	38Y/2N	34Y/3N	36Y/2N	32Y/3	38Y/2N	22Y/3N	48Y/2N
Assistive devices (*n*)	5	4	7	2	8	1	8	1	5	4
Occupation: (*n*)										
Retired	28	27	27	28	30	25	26	29	18	37
Working	7	13	8	12	7	13	9	11	7	13
Civil status (*n*):										
Married	17	26	22	21	22	19	21	20	16	25
Single	18	14	13	19	15	19	14	20	9	25
Self-reported health (*n*):										
Good	17	25	17	25	17	25	16	26	11	31
Moderate	17	14	17	14	18	13	18	13	13	18
Major	1	1	1	1	2	0	1	1	1	1
Had children Y/N	27Y/8N	25Y/15N	22Y/13N	30Y/10N	24Y/13N	29Y/9N	22Y/13N	30Y/10N	16Y/9N	36Y/14N
Days in the hospital										
mean	22	16	27.6	10.9	27.5	10.6	28.1	10.9	29.6	13.6
SD	13	10	8.9	6.6	9.7	6.7	9.5	6.9	8.9	9.3
Blood pressure (mean mm Hg)	166/90	156/89	170/96	153/84	167/94	154/85	171/97	151/84	177/96	153/86

Demographic data are presented in Table II. There were no significant differences between the groups regarding age, hemisphere of lesion and marital status at baseline on admission to the stroke unit. Both intervention groups and the sub-groups improved in function over time (Table III). Adherence to exercise programmes was high in both groups. In the intensive exercise group, exercises were initiated and led by a physiotherapist as planned and described earlier. In the regular exercise group the tendency was self-initiated training. The patients exercised in a gym or at home with programmes they received from a physiotherapist, others did exercises on their own [20]. The exercises in the regular exercise groups were tailored after the patients' explicit needs or requests, since the patients themselves were active to seek out therapy after the test occasions. Interdisciplinary treatment did not differ between the two groups.

The primary analysis did not show any significant differences between the intensive exercise group and the regular exercise group in baseline scores for MAS, BI, IADL, BBS and 6MWT. However, in the secondary analysis, when the patients were divided into groups with low and high BI scores, low and high MAS scores, low and high BBS scores and ability to perform 6MWT or not, regardless of exercise regime, significant differences were found in all total scores (Table III).

There was a tendency towards improvement in scores of all sub-scales of NHP, between admission and 3 and 6 months after the stroke, regardless of how the group of patients were divided (intensive or regular exercise, BI over or under 60 points, MAS over or under 35 points, BBS over or under 32 points or ability to perform 6MWT or not). However, at the 12-month follow-up the scores tended to have stabilized or slightly declined (Tables IV and V).

In a general linear model for repeated measurements with comparison of the two exercise groups, significant differences were found in favour of the regular exercise group in the NHP sub-scale physical mobility and NHP total score, but not in any of the other sub-scales (Table IV).

When the whole patient group was divided into two levels of functioning, as indicated by BI $\leq$60>, MAS $\leq$ 35 >, BBS $\leq$ 32 > or ability to perform 6MWT or not on admission, patients with low function in all groups scored significantly lower on self-perceived health as measured with NHP, compared to patients functioning high (Table V). The total scores of NHP were on admission BI $\leq 60 = 40.2$ vs. BI $> 60 = 24.4$, MAS $\leq 35 = 39.3$ vs. MAS $> 35 = 24.5$, BBS $\leq 32 = 37.8$ vs. BBS $< 32 = 26.5$ and not being able to perform 6MWT $= 41.8$ vs. being able to perform 6MWT $= 26.9$. This trend was equal for scores on energy, pain, emotional reactions, sleep, social

Table. III Mean and SD of total score of the functional assessment: Motor Assessment Scale (MAS), Barthel Index of Activities of Daily Living (BI), Berg Balance Scale (BBS) and 6-Minute Walk Test (6MWT) on admission (1) and 3, 6 and 12 months after the stroke in the different groups: the intensive exercise group (IG), the regular exercise group (RG), BI < 60 >, MAS < 35 >, BBS < 32 > and 6MWT = 0 and 6MWT > 0 m.

		MAS 1.0	MAS 3.0	MAS 6.0	MAS 12.0	BI 1	BI 3	BI 6	BI 12	BBS 1.0	BBS 3.0	BBS 6.0	BBS 12.0	6MWT 1	6MWT 3	6MWT 6	6MWT 12
IG	*M*	26.7	36.4	37.9	36.7	56.6	82.9	84.5	80.8	25.9	38.5	40.4	38.3	187.9	304.9	316.1	335.8
	SD	18.2	13.9	12.8	14.3	38.9	26.4	23.9	26.5	23.1	16.9	16.9	19.5	211.1	206.2	227.6	260.3
RG	*M*	31.4	38.8	39.8	41.2	66.0	87.6	91.2	90.8	32.9	43.9	46.6	48.7	221.5	376.8	395.0	479.5
	SD	17.5	12.7	12.1	11.5	39.0	21.5	19.9	23.3	24.2	16.0	13.6	11.7	197.8	228.4	224.6	234.9
BI < 60	*M*	12.7	27.2	29.4	29.8	23.3	68.9	74.5	70.5	6.8	27.5	31.9	32.2	32.1	168.4	166.6	218.6
	SD	11.8	13.5	13.0	14.4	19.7	28.2	27.3	33.5	10.7	15.2	15.7	18.7	66.4	139.8	148.7	187.3
BI > 60	*M*	43.7	46.1	46.5	46.2	95.1	98.5	98.8	97.9	49.8	52.3	52.9	52.4	357.8	480.7	515.6	556.8
	SD	5.1	3.6	3.4	4.6	8.9	4.1	4.5	9.0	9.8	6.0	6.5	7.3	157.5	165.4	144.7	199.6
MAS < 35	*M*	13.5	27.5	29.8	29.2	27.7	70.0	75.2	69.5	9.2	27.7	31.5	31.5	38.3	166.5	167.8	204.2
	SD	11.9	12.9	12.7	13.9	26.2	27.6	26.7	32.9	12.8	14.6	14.9	18.3	69.5	132.3	151.4	175.9
MAS > 35	*M*	44.5	46.9	47.2	47.2	94.6	99.3	99.6	99.6	49.7	53.6	54.5	53.6	368.9	500.8	525.1	579.1
	SD	3.7	1.9	1.8	1.7	10.6	2.2	1.9	1.9	11.9	3.5	2.5	4.3	150.4	149.2	130.7	175.4
BBS < 32	*M*	12.8	27.3	29.4	29.3	25.1	68.8	73.6	68.8	5.5	26.8	31.3	31.1	28.3	167.6	163.2	208.2
	SD	12.1	13.7	13.1	14.5	23.1	28.1	26.9	33.2	7.1	14.8	15.7	18.5	54.8	140.2	144.4	172.3
BBS > 32	*M*	43.6	45.9	46.6	46.6	93.5	98.6	99.4	99.3	50.9	52.9	53.4	53.3	361.1	481.3	518.5	565.1
	SD	5.3	3.3	3.1	2.9	13.7	3.5	1.9	3.5	6.7	4.2	4.6	4.5	151.2	163.9	141.2	195.4
6MWT = 0	*M*	9.3	25.3	28.8	29.2	17.2	66.0	74.0	70.5	4.0	25.8	30.5	32.3	0	133.3	132.2	178.7
	SD	10.7	14.7	13.9	13.9	19.2	30.6	26.8	33.6	8.9	15.7	15.2	15.8		133.3	114.1	139.9
6 MWT > 0	*M*	39.2	43.2	43.4	43.1	83.8	93.9	94.1	92.3	42.5	48.1	49.4	48.3	308.7	433.9	458.5	504.9
	SD	11.1	7.9	8.5	10.3	24.7	13.7	16.4	20.6	17.6	11.8	11.8	15.0	173.4	183.6	190.0	232.1

Table IV. Nottingham Health Profile, mean (*M*) and standard deviation (SD) for total score and scores of different sub-scales in the groups receiving intensive or regular exercise, on admission and up to 12 months post-stroke; a low score indicates high quality of life. *p*-values for repeated measurements between the groups, level of significance $p < 0.05$.

		The intensive exercise group				The regular exercise group				
		Adm ($n = 35$)	3 Mo ($n = 32$)	6 Mo ($n = 32$)	12 Mo ($n = 32$)	Adm ($n = 40$)	3 Mo ($n = 33$)	6 Mo ($n = 31$)	12 Mo ($n = 31$)	*p*-value
Energy	*M*	31.3	17.3	22.6	34.9	33.1	17.2	14.0	19.2	0.13
	SD	37.8	25.8	31.0	37.5	35.9	23.8	24.6	29.5	
Pain	*M*	33.5	24.9	20.9	19.8	23.1	15.0	15.2	11.9	0.12
	SD	29.7	29.7	22.1	27.8	30.3	22.9	23.8	17.8	
Em. reac.	*M*	29.7	13.6	19.4	26.1	22.05	11.9	13.3	11.4	0.07
	SD	25.6	14.9	24.6	26.6	22.9	13.6	17.9	17.7	
Sleep	*M*	32.2	36.3	32.0	29.7	35.8	28.7	25.8	23.6	0.87
	SD	31.5	37.5	37.2	32.9	35.7	32.0	31.5	29.5	
Soc. isol.	*M*	25.1	12.8	19.0	24.3	18.4	12.8	20.5	13.4	0.11
	SD	28.6	17.4	26.5	31.5	26.9	17.4	26.7	19.7	
Phys. mob.	*M*	57.5	40.1	34.6	36.6	42.6	32.2	23.8	17.9	0.04
	SD	35.9	34.1	36.8	38.1	37.2	35.8	29.3	25.8	
Total	*M*	34.8	24.2	26.9	28.6	29.2	19.6	18.7	16.2	0.05
	SD	22.2	18.7	25.8	25.1	22.1	16.1	17.3	16.1	

isolation and physical mobility after 3, 6 and 12 months of follow-up in the sub-groups $BI \leq 60 >$, $MAS \leq 35 >$, $BBS \leq 32 >$ and ability to perform 6MWT or not (Table V).

The analysis of Spearman's rank correlation coefficient between scores of all sub-scales of NHP [35] and all items of IADL [36], MAS total score [24], BBS total score [33], BI total score [26] and distances of 6MWT [28, 29] at 1 year post-stroke was performed. The analysis showed that the sub-scale 'physical mobility' was highly correlated with the total scores of MAS, BBS, BI and 6MWT and

Table V. Nottingham Health Profile mean and SD for total score and scores of different sub-scales in the groups; Barthel Index of Activities of Daily Living (BI < 60 >), Motor assessment Scale (MAS < 35 >), Berg balance Scale (BBS < 32 >) and 6-minute walk test (6MWT < 0 m >) on admission up to 12 months post-stroke, *p*-values for repeated measurements, $p < 0.05$. Low score indicate high quality of life.

		Energy	Pain	Emotional reactions	Sleep	Social isolation	Physical mobility	Total
BI < 60	Adm ($n = 35$)	40.7/37.3*	37.2/30.4*	27.0/22.0	35.6/34.2	24.2/27.3*	76.5/27.8*	40.2/20.7*
(*M*/SD)	3 mo ($n = 29$)	24.1/29.6*	26.9/28.9*	15.6/16.3	37.6/37.2	22.3/21.1*	22.3/21.1*	31.2/16.2*
	6 mo ($n = 29$)	43.3/89.4*	27.5/27.0*	22.3/26.8	26.7/34.2	26.6/27.2*	53.5/33.6*	33.3/26.7*
	12 mo ($n = 28$)	39.6/39.8*	23.6/30.7*	25.2/27.5	26.8/32.3	29.5/33.5*	50.3/35.7*	32.5/26.3*
BI > 60	Adm ($n = 40$)	25.0/34.3*	20.4/27.8*	24.8/26.3	32.4/32.9	19.5/28.3*	25.9/26.6*	24.4/20.7*
(*M*/SD)	3 mo ($n = 36$)	10.7/17.6*	13.4/23.3*	10.3/11.4	27.1/32.2	6.8/11.7*	17.8/25.9*	14.3/13.7*
	6 mo ($n = 36$)	9.7/16.3*	10.4/15.7*	11.5/14.7	30.6/34.7	14.3/24.8*	9.6/15.9*	14.3/12.6*
	12 mo ($n = 35$)	17.2/26.1*	9.7/13.3*	13.9/19.1	26.6/30.8	10.4/15.5*	9.1/17.0*	14.5/13.2*
MAS < 35	Adm ($n = 37$)	40.2/38.8*	35.6/30.3*	26.3/22.3	35.6/33.4	24.6/26.7*	73.5/30.4*	39.3/20.7*
(*M*/SD)	3 mo ($n = 31$)	21.4/29.4*	26.1/28.6*	14.7/15.8	40.1/36.9	21.3/20.7*	60.0/27.9 *	30.6/16.4*
	6 mo ($n = 31$)	38.1/87.1*	25.3/26.8*	20.5/25.9	28.6/35.7	24.7/26.4*	51.6/33.3*	31.5/25.9*
	12 mo ($n = 29$)	37.3/38.7*	23.6/30.2*	24.4/26.2	27.3/31.7	28.5/33.3*	50.8/35.9*	32.0/26.2*
MAS > 35	Adm ($n = 38$)	24.7/32.5*	21.0/28.3*	25.5/26.2	32.2/33.6	18.7/28.9*	26.2/26.7*	24.5/21.1*
(*M*/SD)	3 mo ($n = 34$)	12.4/18.3*	13.3/23.6*	10.7/11.9	24.1/31.1	6.2/11.9*	15.9/25.6*	13.9/13.8*
	6 mo ($n = 34$)	12.6/19.9*	11.4/16.7*	12.4/15.9	29.1/33.4	15.3/25.9*	8.7/15.8*	14.9/14.3*
	12 mo ($n = 34$)	18.4/28.1*	9.3/13.1*	14.2/20.6	26.1/31.2	10.8/15.7*	7.4/12.2*	14.4/12.9*
BBS < 32	Adm ($n = 35$)	36.7/36.9*	34.5/30.2*	25.6/22.6	33.6/33.6	23.9/27.2*	72.3/30.9*	37.8/21.4*
(*M*/SD)	3 mo ($n = 29$)	22.8/28.0*	27.4/29.1*	15.6/16.3	38.2/38.7	20.3/20.8*	61.9/28.8*	31.0/16.9*
	6 mo ($n = 29$)	40.8/89.6*	27.9/26.9*	22.0/27.0	27.8/34.8	25.7/27.7*	53.3/34.1*	32.9/26.9*
	12 mo ($n = 28$)	38.2/40.5*	24.4/30.5*	25.7/28.1	27.3/32.1	30.9/34.1*	51.4/36.7*	32.9/27.0*
BBS > 32	Adm ($n = 40$)	28.5/35.8*	22.7/29.1*	26.1/25.9	34.1/33.5	19.6/28.5*	29.7/30.1*	26.5/21.6*
(*M*/SD)	3 mo ($n = 36$)	11.8/20.2*	12.9/22.9*	10.3/11.4	26.6/30.6	8.4/13.8*	16.8/24.2*	14.5/13.6*
	6 mo ($n = 36$)	11.9/19.6*	10.0/15.4*	11.7/14.6	29.7/34.3	15.0/24.7*	9.7/15..3*	14.7/12.7*
	12 mo ($n = 35$)	18.3/26.1*	9.1/13.1*	13.5/18.2	13.5/18.2	9.3/12.7*	8.2/12.4*	14.1/11.3*
6MWT = 0 m (*M*/SD)	Adm ($n = 25$)	47.2/41.5*	41.4/33.1*	28.4/24.7	33.6/34.4	26.1/30.8*	73.9/31.9*	41.8/24.2*
	3 mo ($n = 20$)	35.1/29.9*	26.2/29.9*	14.3/16.6	41.5/37.8	24.6/23.6*	58.4/32.1*	33.4/17.7*
	6 mo ($n = 20$)	49.1/103.8*	27.1/30.4*	19.6/25.9	27.5/36.2	29.1/28.3*	51.4/34.6*	33.9/27.7*
	12 mo ($n = 19$)	31.9/38.3*	24.4/32.0*	18.3/21.6	22.8/29.9	26.9/35.3*	50.5/36.8*	29.1/25.3*
6MWT > 0 m (*M*/SD)	Adm ($n = 50$)	25.0/31.5*	21.7/26.4*	24.6/24.2	33.9/33.1	19.5/26.2*	37.8/33.7*	26.9/19.4*
	3 mo ($n = 45$)	8.5/16.1*	16.4/24.8*	11.9/12.8	27.4/32.6	8.9/12.6*	27.4/31.5*	16.7/14.4*
	6 mo ($n = 45$)	13.9/25.9*	14.0/17.8*	14.8/19.4	29.5/33.8	15.6/24.7*	15.3/24.7*	17.9/17.3*
	12 mo ($n = 44$)	25.0/32.9*	12.2/18.0*	19.2/24.8	28.3/31.9	15.5/21.7*	15.9/21.6*	19.6/19.8*

* significance $p < 0.05$, for repeated measurements between the groups.

moderately correlated to items 1–8 of the IADL test (Table VI). The correlation coefficients between the scores of the sub-scales emotional reactions, sleep, energy and pain and all items of IADL, MAS total score, BBS total score, BI total score and 6MWT were low (Table VI). The sub-scale social isolation and the total score of NHP and the same total scores were moderately correlated.

Discussion

The most interesting and important finding in this study was that health-related quality of life, as measured by the Nottingham Health Profile, was closely related to motor function, balance, gait, activities of daily living and instrumental activities of daily living. This study has shown that this association follows the progression in the rehabilitation process after acute stroke, in that if the levels of function improve, so does HRQoL and vice versa (Tables III–V). This result is consistent with previous reports where physical disability, occurrence of a major stroke and poor locomotion were independently associated with a low health perception [34].

No difference in perceived HRQoL was found between the two exercise groups, which mean that the differences in exercise regimes had little or no influence on perceived HRQoL. On the other hand, both groups reported similar high activity level after discharge from the hospital; in the intensive exercise group the exercises was initiated by the physiotherapist and in the regular exercise group they were self-initiated [20]. The observed activity level in both groups was higher than in a previous study of post-stroke patients [3]. This lead to the conclusion that exercise that leads to improvements

Table VI. Spearman's rank correlation coefficients between Nottingham Health Profile (NHP) total score and scores for different sub-scales and Instrumental Activities of Daily Living all items, Motor Assessment Scale (MAS) total points, Berg Balance Scale (BBS) total points, Barthel Index of Activities of Daily Living (BI) total points and 6-minute walk test (6MWT distance), at 1 year post-stroke, $n=75$.

	Emotional reactions	Sleep	Energy	Pain	Physical mobility	Social isolation	Total score
1. Can you use the telephone?	−0.44 $p=0.001$	−0.21 $p=0.11$	−0.37 $p=0.003$	−0.32 $p=0.01$	−0.57 $p=0.001$	−0.35 $p=0.004$	−0.50 $p=0.001$
2. Can you make use of transports alone?	−0.44 $p=0.001$	−0.25 $p=0.05$	−0.40 $p=0.001$	−0.27 $p=0.02$	−0.64 $p=0.001$	−0.32 $p=0.01$	−0.49 $p=0.001$
3. Are you able to do your own shopping?	−0.55, $p=0.001$	−0.18 $p=0.16$	−0.43 $p=0.01$	−0.36 $p=0.004$	−0.58 $p=0.001$	−0.48 $p=0.001$	−0.57 $p=0.001$
4. Do you cook your own food?	−0.51 $p=0.001$	−0.21 $p=0.11$	−0.32 $p=0.01$	−0.32 $p=0.01$	−0.61 $p=0.001$	−0.52 $p=0.001$	−0.53 $p=0.001$
5. Do you do housekeeping chores?	−0.50 $p=0.001$	−0.22 $p=0.08$	−0.30 $p=0.01$	−0.35 $p=0.005$	−0.60 $p=0.001$	−0.49 $p=0.001$	0.52 $p=0.001$
6. Medication on your own?	−0.50 $p=0.001$	−0.14 $p=0.28$	−0.43 $p=0.001$	−0.33 $p=0.01$	−0.47 $p=0.001$	−0.43 $p=0.001$	−0.50 $p=0.001$
7. Do you do your household economics?	−0.53 $p=0.001$	−0.53 $p=0.001$	−0.42 $p=0.001$	−0.36 $p=0.004$	−0.56 $p=0.001$	−0.51 $p=0.001$	−0.57 $p=0.001$
8. Help transports, etc	−0.56 $p=0.001$	−0.56 $p=0.001$	−0.45 $p=0.001$	−0.39 $p=0.02$	−0.62 $p=0.001$	−0.49 $p=0.001$	−0.58 $p=0.001$
9. Who helps you?	−0.36 $p=0.004$	−0.36 $p=0.004$	0.26 $p=0.04$	0.28 $p=0.03$	0.32 $p=0.01$	0.23 $p=0.08$	0.3 $p=0.02$
MAS tot	−0.49 $p=0.001$	−0.23 $p=0.07$	−0.46 $p=0.001$	−0.42 $p=0.001$	−0.82 $p=0.001$	−0.57 $p=0.001$	−0.63 $p=0.001$
BBS tot	−0.50 $p=0.001$	−0.13 $p=0.31$	−0.47 $p=0.001$	−0.37 $p=0.003$	−0.71 $p=0.001$	−0.48 $p=0.001$	−0.56 $p=0.001$
BI tot	−0.46 $p=0.001$	−0.28 $p=0.03$	−0.24 $p=0.05$	−0.38 $p=0.002$	−0.76 $p=0.001$	−0.50 $p=0.001$	−0.57 $p=0.001$
6MWT ($n=50$)	−0.42 $p=0.001$	−0.24 $p=0.06$	−0.34 $p=0.006$	−0.33 $p=0.009$	−0.79 $p=0.001$	−0.48 $p=0.001$	−0.57 $p=0.04$

seems to influence HRQoL, since both groups improved in MAS, BBS, BI and 6MWT and both groups experienced an improvement in total scores of HRQoL. This study had calculated with a relatively small statistical power of 24% to detect any difference between the groups. The observed power, however, was 77% on NHP, which means the possibility to find a significant difference had increased in favour of one of the groups.

There was a general tendency to report better HRQoL on total score at 3 months and lower HRQoL at 6 and 12 months in the intensive exercise group, whereas the regular exercise group reported a steady improvement in HRQoL during the same time (Table IV). On sub-scales energy, emotional reactions, social isolation and physical mobility there was a variation between the groups in the same time perspective, the regular exercise group reported improved HRQoL in contrast to the intensive exercise group. The sub-scales pain and sleep on the other hand were reported steadily improving in both groups (Table IV).

It may be speculated whether the improved HRQoL in the regular exercise group might be a result of better self-assurance and coping, since the patients of this group took greater responsibility for their own training. This must be seen in contrast to the intensive exercise group with their compulsory training programme, where the responsibility for follow-up exercise was delegated to the physiotherapist. There is also the possibility that the compulsory training in the intensive exercise group might contribute to a sense of higher expectations and demands for 'getting better'. This, in turn, might lead to a more critical view of the impairments and disabilities after a stroke and perhaps also of their own coping ability.

The two groups trained equally hard [20]. This was unintentional and not expected. The design of the study relied upon the fact that regular physiotherapy and exercise had been found to be low in both intensity and frequency in an earlier study [3]. The authors under-estimated the degree to which the test occasions at 3, 6 and 12 months, which were equal in number in the two groups, would influence both motivation and stimulation. In fact, the results took a surprising turn in that the regular exercise group reported somewhat better

HRQoL, which might indicate that exercise that is high in intensity and frequency but with motivation on the part of the patient is better than a compulsory programme steered by external experts.

There were slightly more dropouts in the regular exercise group ($n = 9$) than in the intensive exercise group ($n = 3$). One may speculate on whether the patients who died or withdrew in that group had had a poorer performance and whether this had any influence on the reported HRQoL, whereas the poor performers had a greater impact on the reported HRQoL in the intensive exercise group.

The study also revealed that the level of functioning and the initial impact of the stroke on admission seemed to have a major influence on the development of HRQoL, with significant differences in total scores and in scores for the sub-scales energy, pain, social isolation and physical mobility in favour of higher functioning in MAS, BI, BBS and 6MWT (Table III).

One of the challenges in stroke rehabilitation seems to lie in maintaining the regained function in the moderate and more severe cases of stroke in a longitudinal perspective. In the initial stage, the recovery seemed to take place more quickly and to be more effective and the brain plasticity appeared to be at its peak at 3 months in the more severe cases. Motor function, ADL, gait and HRQoL improve significantly during the first months following an acute stroke [3, 20], but at 6 months there seems to be a shift to a decline in functions in those patients with a more severe stroke and in the long-run the regained capacity seems to be difficult to maintain despite a high level of exercise. On the other hand, a question that remains unanswered is how this group would have performed without any exercise or follow-up at all [37]. There is reason to believe that without exercises the result might have been devastating for those who scored lower than 60 on BI, lower than 36 on MAS and lower than 32 on BBS and in those unable to perform 6MWT on admission, as this is also indicated in other studies [37]. It has been suggested that if patients with stroke receive exercises frequently enough and with sufficiently high intensity, the functional levels can be maintained [20]. These results support this view.

Conclusion

HRQoL as measured by NHP is enhanced by exercise and physical improvement in the first year following acute stroke. The way the exercise was applied during the first year after the stroke onset did not seem to influence HRQoL as long as the exercises were regular, intensive, preferably self-initiated and supervized by medical staff or a physiotherapist. Furthermore, HRQoL, measured with the NHP total score, was associated with motor function, balance, gait capacity, activities of daily living and instrumental activities of daily living. The degree of motor function, balance, walking capacity and independence in activities of daily living is of importance for HRQoL.

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