TITLE PAGE: Adherence to a Long-Term Physical Activity and Exercise Program After Stroke Applied in a Randomized Controlled Trial

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Background. Persistent physical activity is important to maintain motor function across all stages after stroke.

Objective. The objective was to investigate adherence to an 18-month physical activity and exercise program.

Design. The design was a prospective, longitudinal study including participants with stroke randomly allocated to the intervention-arm of a randomized controlled trial.

Methods. The intervention consisted of individualized monthly coaching by a physical therapist who motivated participants to adhere to 30 minutes of daily physical activity and 45 minutes of weekly exercise over 18 months. The primary outcome was the combination of participants'

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self-reported training diaries and adherence as reported by the physical therapists. Mixed-effect models were used to analyze change in adherence over time. Intensity levels, measured by the Borg scale, were a secondary outcome.

Results. In total, 186 informed, consenting participants with mild-to-moderate stroke were included 3 months after stroke onset. Mean age was 71.7 years (SD = 11.9). Thirty-four (18.3%) participants withdrew and 9 (4.8%) died during follow-up. Adherence to physical activity and exercise each month ranged from 51.2% to 73.1% and from 63.5% to 79.7%, respectively. Over time, adherence to physical activity increased by 2.6% per month (OR=1.026, 95% CI 1.014–1.037). Further, most of the exercise was performed at moderate-to-high intensity levels, ranging from a score of 12 to 16 on the Borg scale with an increase of 0.018 points each month (95% CI 0.011-0.024).

Limitations. Limitations included missing information about adherence for participants with missing data and reasons for dropout.

Conclusions. Participants with mild and moderate impairments after stroke who received individualized regular coaching established and maintained moderate to good adherence to daily physical activity and weekly exercise over time.

Individuals surviving stroke are at risk of experiencing long-term impairments, limitations on activities and reduced participation.[1] Consequently, the rehabilitation process plays a key role in achieving functional recovery and community re-integration.[2] Long-term engagement in regular physical activity and exercise is highly recommended to sustain motor functions gained in rehabilitation and to reduce the risk of recurrent stroke.[3,4]

Implementing cardiorespiratory training within post-stroke rehabilitation programs improve measures of walking performance and reduce dependency.[5] Guidelines recommend that individuals surviving stroke, who are capable of engaging in physical activity, should perform continuous or accumulated exercise of moderate to high intensity, defined as vigorous activity sufficient to break a sweat or noticeably raise heart rate, ranging from 10 to 60 minutes, once to 5 times a week.[3,6,7] Nevertheless, several studies demonstrate that many individuals perform minimal, if any, physical activity or exercise on a regular basis after stroke.[8-11]

More knowledge of barriers to regular physical activity and exercise after stroke may improve rehabilitation programs.[12] However, there is neither much published research systematically registering long-term adherence to interventions, nor research on factors predicting adherence and dropout from activity after stroke.[13]

Results from the Life After STroke (LAST) study were recently published.[14] Despite neutral results concerning the study's primary and secondary outcomes, LAST showed that participants receiving regular individualized coaching on physical activity and exercise were significantly more active than participants receiving standard care.[14] To inform clinicians and increase knowledge about the feasibility of the intervention, it would be of great interest to investigate more thoroughly how well the participants adhered to the treatment protocol applied in the LAST-study and which factors were associated with good adherence.

The primary aim of the present sub-study was to assess the adherence of participants with stroke, randomized to the intervention-arm of the LAST-study, to the amount of time spent on physical activity and exercise required per protocol during 18 consecutive months. The secondary aims were to investigate 1) whether participants' age, sex, degree of dependency, cognitive function or goal attainment influenced participants' adherence; 2) participants' adherence to the intensity levels of physical activity and exercise required per protocol; and 3) to what extent participants achieved their individual goals related to physical activity and exercise.

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[H1]Methods

[H2]Study design, setting and participants

This was a prospective, longitudinal study including participants with stroke randomized to the intervention-arm of the LAST-study.[14] Inclusion criteria were diagnosis of first-ever or recurrent stroke (infarction or intracerebral hemorrhage), age ≥ 18 years, discharged from hospital or inpatient rehabilitation at inclusion, community dwelling with a modified Rankin Scale (mRS) score < 5, and cognitive function as evaluated by the Mini-Mental State Examination (MMSE) > 20 points (>16 points for individuals with aphasia). Exclusion criteria were serious medical comorbidity with short life expectancy, or a condition contraindicating motor training. In line with good clinical practice and the current Norwegian guidelines,[15] participants underwent a complete medical history and a physical examination by a medical practitioner during the screening procedures, aiming to identify neurological complications or medical comorbidities that could possibly require special considerations or constitute contraindications to high-intensity exercise. Explicitly, participants with uncompensated heart failure and/or unstable coronary function were excluded from the study. Eligible participants were recruited from 18 October 2011 to 26 June 2014 at the outpatient clinics at the stroke units of 2 Norwegian hospitals and consecutively randomized 10 to 16 weeks after the acute stroke. Follow-up assessments were completed by 15 January 2016. The study was approved by the Regional Committee of Medical and Health Research Ethics (REC no. 2011/1427).

[H2]Intervention

In addition to standard care after stroke,[15] participants randomized to the intervention group received a follow-up program delivered by the primary health care services in 3 Norwegian municipalities.[16] The program comprised regular individualized coaching, inspired by motivational interviewing techniques,[17] on physical activity and exercise by a physical therapist for 18 consecutive months after inclusion. Prior to the intervention, the physical therapists attended a one-day course in motivational interviewing technique and they were recommended to keep updated within this field. Participants were encouraged to perform 30 minutes of physical activity 7 days a week and 45-60 minutes of exercise once a week. In accordance with the World Health Organization, physical activity was defined as “any bodily movement produced by skeletal muscles that result in energy expenditure”.[18] Exercise was defined as a subcategory of physical activity that was planned, structured, repetitive and purposeful in the sense that the improvement or maintenance of one or more components of physical fitness was the objective.[18] Per protocol, exercise should include 2 to 3 bouts of vigorous activity. Hence, participants were encouraged to reach levels of high intensity during exercise corresponding to a score between 15 and 17 on the Borg scale 6-20.[19]

The physical therapists’ main purpose was to motivate and encourage the participants to follow an individually adapted training program. Schedules with at least 2 choices for physical activity (e.g. housework, walking, gardening) and 2 choices for exercise (e.g. hiking, swimming, bicycling) were set for each month based on the participants’ individual preferences and goals. If preferred, individuals were offered participation in existing outpatient, private and community-based treatment groups, individual physical therapy or home training. Participants were instructed in how-to report the amount and intensity of each session of physical activity and exercise in training diaries. During each monthly meeting the physical therapist conducted a conversation using elements from motivational interviewing, and in collaboration with the participant they reviewed and reassessed the content and progression of the planned training schedule. To enhance adherence, goal setting and regular evaluation of goals were emphasized during follow-up.

Regular meetings between the participant and the physical therapist were arranged once every month. The first 6 meetings were planned face-to-face, preferably at the participants’ home. During the next 6 months, every second meeting could take place as a phone meeting if preferred, and during the final 6 months, 4 of the 6 meetings could take place as phone meetings.[16]

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[H2]Baseline assessment

Prior to intervention, age, sex, living condition, type of stroke and medical history were recorded. Stroke severity was assessed by the National Institutes of Health Stroke Scale (NIHSS),[20] dependence by mRS[21] and cognitive function by the MMSE.[22]

[H2]Outcome measures

The primary outcome was adherence to the amount of time spent on daily physical activity and weekly exercise, assessed by the combination of 2 outcome measures. The first, and main, outcome measure was participants' self-reports in standardized training diaries, in which they were encouraged to report their actual performed amounts and intensities of physical activity and exercise immediately after the end of each training session. The second was an overall estimation of participants' adherence assessed by the physical therapists in separate adherence forms. At the regular appointments, the physical therapists reported whether the participants had performed the training program in line with the agreement or not. Reasons for non-adherence, in addition to the setting of the monthly meetings, were also recorded.

Secondary outcome measures in this study were the Borg Scale[19] and goal attainment scaling (GAS).[23] The Borg Scale was applied to measure participants' intensity levels during physical activity and exercise. This scale is based on perceived exertion during activity, ranging from 6 (no exertion at all) to 20 (maximal exertion), and appears to be a reasonable indicator of exercise intensity after stroke, at least at moderate intensities.[24] GAS was assessed to score the extent to which participants' individual goals were achieved during the intervention. The validity, reliability, and responsiveness of GAS as an outcome measure for rehabilitation has been supported.[25] GAS identifies and quantifies individual goals of treatment, enabling comparison between individuals. In the present study, goal attainment was evaluated 3, 6, 9, 12, 15 and 18 months after inclusion.

[H2]Statistical analyses

The baseline demographic and clinical characteristics are presented as numbers (percentages) of participants or mean (SD). Participants who died or were defined as "dropouts" were consecutively excluded. Hence, observations until withdrawal or death were included in the analyses.

Adherence was defined and presented, in 2 different ways. Firstly, participants who performed at least 210 minutes of physical activity (i.e. 30 minutes 7 days a week) and 45 minutes of exercise every week for at least 3 out of 4 weeks within each month, respectively, were defined as adherent to the treatment protocol. Secondly, the weekly amounts of physical activity and exercise, respectively, were accumulated as total sums undertaken during 4 weeks representing each month. Further, results were categorized into pre-specified subgroups and displayed for 18 consecutive months in area plots. These figures were used to illustrate categories of adherence to the amounts and intensities of physical activity and exercise, respectively, in addition to goal achievements over time. Adherence to the amount of physical activity was categorized as follows: 1) ≥ 30 min 7 days a week, as recommended per protocol; 2) 30 min 5-6 days a week, within recommendations for adults and elderly by the Norwegian Directorate of Health;[26] 3) < 30 min 5 days a week, below recommendations, and 4) 0 min. Correspondingly, adherence to exercise was categorized as: 1) ≥ 45 min weekly, as recommended per protocol; 2) 20-44 min weekly, within the Norwegian recommendations of exercise in individuals with stroke;[7] 3) 1-19 min weekly, below recommendations, and 4) 0 min. Further, intensity levels were categorized in accordance to prior research and the clinical application of the Borg scale,[7,27] namely levels of light (6-10 points), moderate (11-14 points) and high intensity (15-20 points).

The overall GAS score was calculated according to the algorithm presented by Turner-Stokes,[28] in which a score of 50 represents the expected level of performance. The proportion of participants who attended at least 2 out of 3 meetings face-to-face within every 3-month period has also been reported.

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We used mixed-effects logistic models with adherence measures (one at a time) as dependent variables, participant as a random effect, and time as the covariate to study change over time. Second, we added the following covariates separately to study their effect: 1) sex; 2) age (years); 3) mRS[21]; 4) MMSE[22]; and 5) GAS.[23] Further, change over time in levels of intensity during physical activity and exercise was assessed by linear mixed-effect models with participant as a random effect and time as the covariate.

Two-sided *P* values of ≤.05 were considered statistically significant. Statistical analyses were run in IBM SPSS Statistics, version 23.0, STATA, version 13.1, and Microsoft Excel 2010 for Windows.

[H2]Role of the Funding Source

This study was funded by the The Norwegian Fund for Postgraduate Training in Physiotherapy, in addition to The Liaison Committee for education, research and innovation in Central Norway and The Research Council of Norway. The funding sources had no influence on the study design, data collection, analysis, interpretation or manuscript preparation.

[H1]Results

A total of 186 participants were randomized to the intervention group of LAST and thus included in the present study. In total, 34 (18.3%) withdrew during follow-up. Among those who withdrew, 4 participants died after withdrawal, but before end of follow-up. In addition, 5 participants from the main sample died, making a total of 9 deaths (4.8%) during the study. 23 (12.4%) participants were excluded from the mixed-effect models because they did not contribute any valid data (Fig. 1).

The total sample, with a mean age of 71.7 years (SD = 11.9), involved participants affected by mild to moderate stroke (97.3% had a score < 8 points on the NIHSS), (Tab. 1). Participants who withdrew were older (mean 75.6 years versus 70.9 years, p = 0.03), and more men withdrew than women (24/104=23% versus 10/82=12%, p = 0.06). The remaining characteristics were similar between the groups.

[H2]Adherence to amount of physical activity and exercise

Results showed that the actual number of participants adherent to ≥ 210 minutes of weekly physical activity decreased from 87 to 79 during follow-up, while the proportion they represented of those with available data increased from 55.4% to 73.1% (Tab. 2). Correspondingly, participants who were adherent to ≥ 45 minutes of weekly exercise decreased from 103 to 71, equivalent to a decrease of 66.0% to 65.1% of those with available data (Tab. 2).

Further, figures 2-A and B ~~both~~ illustrate an increasing amount of deaths, withdrawals and missing data over time. On average, 6.8% and 2.2% reported zero minutes of exercise and physical activity, respectively. The reported amount of exercise required per protocol ranged from 42.5-64.0% each month, while 41.9-57.0% of participants reported physical activity required per protocol. Moreover, the reported amount of physical activity corresponding to ≥ 30 minutes 5 days a week, ranged from 48.9-66.7% of participants.

Data from 163 participants (87.6%) were included in the mixed-effect models. Results showed a monthly increase in adherence to physical activity, OR 1.026 (95% CI 1.014 – 1.037, p<.001), but not for exercise, OR 1.003 (95% CI 0.992 – 1.012, p=0.62). Further, adherence to the combination of physical activity and exercise increased significantly during follow-up, OR 1.018 (95% CI 1.008 – 1.028, p <.001), (Tab. 3). Adjusted for time, mRS was significantly associated with adherence to physical activity, as well as adherence to the combination of physical activity and exercise; OR 0.60 (95% CI 0.44 – 0.82, p <.001) and OR 0.78 (95% CI 0.60 – 0.99, p=0.05), respectively. Further, the male sex, OR 1.44 (95% CI 0.92 – 2.26, p=0.11) and increasing age, OR 0.977 (95% CI 0.957 – 0.998, p=0.03), were associated with adherence to exercise, although only the latter provided statistically significant associations. There was no statistically significant interaction effect between the 2 covariates.

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[H2]Intensity levels of physical activity and exercise

Among the participants who were defined as adherent to the amounts of physical activity and exercise, the mean (SD) ratings on Borg scale ranged from 12.2 (1.5) to 12.9 (1.8) for physical activity, and from 13.7 (1.7) to 14.5 (1.9) for exercise (Tab. 2).

Further, figures 2-C and D illustrate that an average of approximately half of the amount of physical activity and one third of the amount of exercise were performed with moderate intensity (i.e. 11-14 on the Borg scale). On average, almost one fourth of the exercise was performed with levels of high intensity (i.e. Borg scale ≥ 15) as recommended per protocol. Results from the linear mixed-models (Tab. 4) proved highly significant increases in reported Borg scale for both physical activity and exercise over time ($p < .001$).

[H2]Goal achievements

The mean GAS scores were below the expected level (ie, score of <50) at every evaluation point, ranging from 41.4 (SD = 9.6) to 44.2 (SD = 10.8) (Tab. 2). Overall, goal achievements over time were low (Figure 2-E), with goals achieved approximately among one fifth of participants at the lowest and one third of participants at the most.

[H2]Setting of monthly meetings

Table 2 shows that among those with valid data, 79.9% of the participants attended ≥ 2 out of 3 of the individual coaching face-to-face within the first 3-month period and 69.1% within the next 3-month period. Further, meetings face-to-face decreased to 25.6% within the last 3-month period.

[H1]Discussion

The main results showed that participants who received individual coaching over 18 months managed to establish and maintain moderate to good adherence to daily physical activity and weekly exercise over time post-stroke. Actually, there were slightly increasing amounts of physical activity among those who completed the long-term follow-up. However, discrepancies between participants were large. Individuals with a higher degree of dependency were less adherent to physical activity, and both increasing age and the female sex were associated with lower adherence to exercise. Further, intensity levels during both physical activity and exercise primarily corresponded to scores on the Borg scale equivalent to moderate intensities. Only one fourth of the reported amount of exercise was performed within levels of high intensity as required per protocol. Goals related to the individuals' training programs were poorly achieved over time.

This study sample was limited to voluntarily participating individuals, possibly leading to selection bias. This might reflect a higher extent of adherence to physical activity and exercise than what could be expected among the eligible participants who declined to participate. In addition, the sample consisted of participants mildly to moderately affected by stroke. Hence, for individuals more severely affected in both motor function and cognition, the results should be interpreted with caution. To ensure safety the intervention was conducted in line with good clinical practice and according to the current Norwegian national guidelines of treatment and rehabilitation after stroke.[15] However, it should be noted that other organizations recommend that people with stroke undergo graded exercise testing with ECG monitoring before beginning an exercise program.[29] Nevertheless, previous analysis showed 39% less hospital admissions due to vascular events in the intervention group compared to the control group (17 versus 28 events, $p=0.110$).[14] Further, there are no established consensus on how to measure and rate adherence of home-based rehabilitation interventions.[30] In this regard, the use of training diaries might be considered a weakness, as self-reported measurements are limited by recall bias, social desirability bias, and vulnerability to inaccuracies.[31,32] As people with stroke often suffers cognitive deficits, this might limit their ability to report activity levels accurately. Compared with objective measures, one should be cautious about under- or overestimating activity levels by the use of self-reports.[30,33] However, inflated self-reports of physical activity seems to be the largest challenge in people with stroke.[34] This might have resulted in overestimation of adherence in the current study. Nevertheless, reviewing training diaries on a

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daily basis probably helped to ensure adherence, in accordance to the protocol.[16] Additionally, as training diaries are one of the simplest and least equipment-expensive methods to register adherence in a long-term perspective, they were considered a valid measurement.[32,35] Further, the Borg scale appears to be a reliable and valid indicator of exercise intensity after stroke at moderate, but perhaps not at high-intensity levels.[24] Regarding GAS, the scale allows for important changes in function to be identified, which many current scales may not address.[23] However, GAS depends on the experience and ability of the clinicians to predict outcome.[28] Future work is needed to assess construct validity and generalizability of findings for GAS to become a routine outcome measurement in stroke rehabilitation. Lastly, it should be noted that the participant-therapist relationship might also have influenced the individuals' degree of adherence and could be of interest for future research.[36]

Results of the present study showed that proportions between 51.2% and 79.7% of participants reached the amounts of physical activity and exercise, respectively, as recommended per protocol each month (Tab. 2). Compared to previous studies, these findings suggest enhanced adherence rates. A large cross-sectional survey assessing levels of self-reported exercise among individuals in the chronic phase after stroke, found a proportion of 31% reporting regular exercise and 27% reporting infrequent or no exercise.[37] Furthermore, a Norwegian survey assessing self-reported activity levels in the general population, suggested that on average 32% of people aged 65 or older achieve 150 minutes of weekly physical activity.[38] Moreover, in studies measuring physical activity using accelerometers or other electronic devices among individuals with chronic stroke, ambulatory activity levels were found to be very low.[8-10] A significantly lower proportion of individuals seemed to meet the recommendations of 30 minutes of daily physical activity compared to the findings of the present study. The lack of established methods on assessing adherence to activity causes the use of various methodological approaches which limit the possibilities of comparing adherence rates between studies.[35,39] Nevertheless, considering the long-term perspective and the strict requirements for adherence in the present study, the adherence rates achieved are evaluated as moderate to good.

The stable and slightly increasing amounts of daily physical activity and weekly exercise observed across the 18-month follow-up is also in contrast to earlier research indicating that the majority of individuals post-stroke may plateau, reduce or cease their activity levels over time.[11,40] Several longitudinal studies, which demonstrated that intensity, frequency and duration of physical activity increased within the first three months post-stroke, but then plateaued, suggested that behavior patterns established within the first three months post-stroke might predict long-term physical activity habits.[9,41,42] In contrast, the findings of the present study suggest the possibility of increasing amounts of physical activity over time. This indicates that several elements of the follow-up program, such as self-monitoring one's behavior by the use of training diaries and participant-centered coaching techniques, might have promoted adherence to physical activity and exercise. The good adherence might also account for the possible benefit of the regular coaching reported in the LAST-study, assessed by the International Physical Activity Questionnaire (IPAQ)[43] during follow-up.[14]

There were large discrepancies in degrees of adherence between participants. Regarding physical activity, dependency levels were the only covariate contributing significantly to explain these differences. Hence, future work should investigate whether the intervention could opt for a more differentiated approach, in the sense that those with a higher degree of dependency might benefit from closer follow-up compared to their more independent counterparts. Noticeably, the individual face-to-face coaching was performed to a lesser extent than required per protocol. Hence, increasing the number of face-to-face meetings might also increase adherence for these participants. Nevertheless, there is a subtle balance between independent activity behavior and dependency of coaching. Further, increasing age was negatively associated with adherence to exercise; additionally, although not statistically significant, men were more likely than women to be adherent to exercise. Additional research is needed to determine the causes of these associations. Despite the lack of an interaction effect between age and sex, future interventions might need to specifically target exercise after stroke with regards to these aspects.

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Adherence to high-intensity levels during exercise proved to be a challenge in the present study. Despite a statistically significant increase equivalent to an average of 0.32 points on the Borg scale throughout 18 months, this is not necessarily of clinical importance. Common impairments, such as hemi-paretic gait, reduced balance, post-stroke fatigue and depression might be barriers to conducting high-intensity training for individuals after stroke.[6] Another explanation might be that some participants were afraid to push themselves beyond comfortable limits, fearing acute illness or discomfort.[44] Facing the challenge of achieving high intensities in clinical practice, and particularly as part of a home-training program,[45,46] teaching people with stroke how high intensity actually is experienced might be included in the intervention. Further, developing interventions to enhance adherence to high intensities in the long-term after stroke should be prioritized in future research.

The low degrees of goal achievement throughout the follow-up might be explained by several factors. Turner-Stokes emphasizes that goal achievement depends on both the participant's ability to achieve his or her goals and the clinician's ability to predict outcome, the latter requiring knowledge and experience.[28] The present results suggest that the physical therapists, in collaboration with the participants, had a tendency to incorporate over-ambitious goals. In addition, several participants chose somewhat vague goals that remained unchanged over time, struggling to define new and more specific goals. It is reasonable to assume that these long-term goals (e.g. "be able to catch the bus independently") made it difficult to see the direct link to the actual physical activity and exercise program (e.g. balance and walking training). Possibly, this might decreased adherence, and focusing more on intermediate goals should have been emphasized to a greater degree. Furthermore, Turner-Stokes underlines how the involvement of individuals with acquired brain injury presents particular challenges for GAS, as cognitive impairments, including executive dysfunction, and communicative problems may limit their ability to remember and articulate goals.[47] These were common challenges for some of the participants in the present study, affecting their ability and motivation to achieve goals.

Overall, the long-term follow-up program appears feasible for individuals after stroke with mild to moderate impairments. Regular coaching by a physical therapist might contribute to enhanced adherence to activity levels over time, and the findings give directions in understanding which factors that influence adherence to persistent physical activity and exercise over time after stroke. The intervention might also contribute to a continuation of well-established habits, perhaps beyond the duration of the long-term follow-up program. However, these suggestions are yet to be explored in future research.

In conclusion, this study has shown that individuals with mild to moderate stroke receiving individualized regular coaching by a physical therapist managed to establish and maintain moderate to good adherence to physical activity and exercise in the long-term. However, dependent participants were less adherent to physical activity than those who were independent, while the female sex and advanced age were associated with less adherence to exercise. Future research should investigate how to improve adherence for these subgroups of individuals.

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Ethics Approval
The study was approved by the Regional Committee of Medical and Health Research Ethics (REC no. 2011/1427).

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Disclosures
The authors completed the ICJME Form for Disclosure of Potential Conflicts of Interest and no conflicts were reported.

References

1. Langhorne P, Coupar F, Pollock A. Motor recovery after stroke: a systematic review. *Lancet Neurol.* 2009;8:741-754.
2. Brewer L, Horgan F, Hickey A, Williams D. Stroke rehabilitation: recent advances and future therapies. *QJM.* 2013;106:11-25.
3. Furie KL, Kasner SE, Adams RJ, et al. Guidelines for the prevention of stroke in patients with stroke or transient ischemic attack: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke.* 2011;42:227-276.
4. Hankey GJ. Secondary stroke prevention. *Lancet Neurol.* 2014;13:178-194.
5. Saunders DH, Sanderson M, Hayes S, et al. Physical fitness training for stroke patients. *Cochrane Database Syst Rev.* 2016;3:Cd003316.
6. Gordon NF, Gulanick M, Costa F, et al. Physical activity and exercise recommendations for stroke survivors: an American Heart Association scientific statement from the Council on Clinical Cardiology, Subcommittee on Exercise, Cardiac Rehabilitation, and Prevention; the Council on Cardiovascular Nursing; the Council on Nutrition, Physical Activity, and Metabolism; and the Stroke Council. *Circulation.* 2004;109:2031-2041.
7. Norwegian Directorate of Health. Aktivitetshåndboken. [Norwegian guidelines on physical activity in prevention and treatment]. In:2009: https://helsedirektoratet.no/Lists/Publikasjoner/Attachments/463/Aktivitetshandboken-IS-1592.pdf. Accessed August 17, 2018.
8. Rand D, Eng JJ, Tang PF, Jeng JS, Hung C. How active are people with stroke?: use of accelerometers to assess physical activity. *Stroke.* 2009;40:163-168.
9. Askim T, Bernhardt J, Churilov L, Fredriksen KR, Indredavik B. Changes in physical activity and related functional and disability levels in the first six months after stroke: a longitudinal follow-up study. *J Rehabil Med.* 2013;45:423-428.
10. Michael KM, Allen JK, Macko RF. Reduced ambulatory activity after stroke: the role of balance, gait, and cardiovascular fitness. *Arch Phys Med Rehabil.* 2005;86:1552-1556.
11. Fini NA, Holland AE, Keating J, Simek J, Bernhardt J. How physically active are people following stroke? Systematic review and quantitative synthesis. *Phys Ther.* 2017;97:707-717.
12. Tiedemann A, Sherrington C, Dean CM, et al. Predictors of adherence to a structured exercise program and physical activity participation in community dwellers after stroke. *Stroke Res Treat.* 2012;2012:136525.
13. Mead G, Bernhardt J. Physical fitness training after stroke, time to implement what we know: more research is needed. *Int J Stroke.* 2011;6:506-508.
14. Askim T, Langhammer B, Ihle-Hansen H, Gunnes M, Lydersen S, Indredavik B. Efficacy and safety of individualized coaching after stroke: the LAST Study (Life After Stroke): a pragmatic randomized controlled trial. *Stroke.* 2018;49:426-432.
15. Indredavik B, Salvesen R, Ness H, Thorsvik D. *Treatment and Rehabilitation After Stroke (Clinical Guidelines).* Oslo, Norway; Norwegian Directorate of Health. 2017.
16. Askim T, Langhammer B, Ihle-Hansen H, Magnussen J, Engstad T, Indredavik B. A long-term follow-up programme for maintenance of motor function after stroke: protocol of the life after stroke—The LAST Study. *Stroke Res Treat.* 2012;2012:392101.
17. Miller WR, Rollnick S. *Motivational Interviewing: Preparing People for Change.* 2nd ed. New York, NY: Guilford Press; 2002.
18. World Health Organization. Global Strategy on Diet, Physical Activity & Health 2017; http://www.who.int/dietphysicalactivity/pa/en/. Accessed August 17, 2018.
19. Borg GA. Psychophysical bases of perceived exertion. *Med Sci Sports Exerc.* 1982;14:377-381.

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20. Brott T, Adams HP Jr., Olinger CP, et al. Measurements of acute cerebral infarction: a clinical examination scale. *Stroke.* 1989;20:864-870.

21. Banks JL, Marotta CA. Outcomes validity and reliability of the modified Rankin scale: implications for stroke clinical trials: a literature review and synthesis. *Stroke.* 2007;38:1091-1096.

22. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state": a practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res.* 1975;12:189-198.

23. Rockwood K, Stolee P, Fox RA. Use of goal attainment scaling in measuring clinically important change in the frail elderly. *J Clin Epidemiol.* 1993;46:1113-1118.

24. Sage M, Middleton LE, Tang A, Sibley KM, Brooks D, McIlroy W. Validity of rating of perceived exertion ranges in individuals in the subacute stage of stroke recovery. *Top Stroke Rehabil.* 2013;20:519-527.

25. Hurn J, Kneebone I, Cropley M. Goal setting as an outcome measure: a systematic review. *Clin Rehabil.* 2006;20:756-772.

26. Norwegian Directorate of Health. Anbefalinger om kosthold, ernæring og fysisk aktivitet. [Norwegian recommendations on diet, nutrition and physical activity]. 2014; https://helsedirektoratet.no/Lists/Publikasjoner/Attachments/806/Anbefalinger-om-kosthold-ernering-og-fysisk-aktivitet-IS-2170.pdf. Accessed August 17, 2018.

27. Fletcher GF, Balady GJ, Amsterdam EA, et al. Exercise standards for testing and training: a statement for healthcare professionals from the American Heart Association. *Circulation.* 2001;104:1694-1740.

28. Turner-Stokes L. Goal attainment scaling (GAS) in rehabilitation: a practical guide. *Clin Rehabil.* 2009;23:362-370.

29. Billinger SA, Arena R, Bernhardt J, et al. Physical activity and exercise recommendations for stroke survivors: a statement for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke.* 2014;45:2532-2553.

30. Bollen JC, Dean SG, Siegert RJ, Howe TE, Goodwin VA. A systematic review of measures of self-reported adherence to unsupervised home-based rehabilitation exercise programmes, and their psychometric properties. *BMJ open.* 2014;4:e005044.

31. Pisters MF, Veenhof C, Schellevis FG, Twisk JW, Dekker J, De Bakker DH. Exercise adherence improving long-term patient outcome in patients with osteoarthritis of the hip and/or knee. *Arthritis Care Res (Hoboken).* 2010;62:1087-1094.

32. Sluijs EM, van Dulmen S, van Dijk L, de Ridder D, Heerdink R, Bensing J. *Patient Adherence to Medical Treatment: A Meta Review.* Utrecht, the Netherlands: NIVEL; 2006.

33. Prince SA, Adamo KB, Hamel ME, Hardt J, Connor Gorber S, Tremblay M. A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. *Int J Behav Nutr Phys Act.* 2008;5:56.

34. Resnick B, Michael K, Shaughnessy M, et al. Inflated perceptions of physical activity after stroke: pairing self-report with physiologic measures. *J Phys Act Health.* 2008;5:308-318.

35. Frost R, Levati S, McClurg D, Brady M, Williams B. What adherence measures should be used in trials of home-based rehabilitation interventions? A systematic review of the validity, reliability, and acceptability of measures. *Arch Phys Med Rehabil.* 2017;98:1241-1256.e45.

36. Wright BJ, Galtieri NJ, Fell M. Non-adherence to prescribed home rehabilitation exercises for musculoskeletal injuries: the role of the patient-practitioner relationship. *J Rehabil Med.* 2014;46:153-158.

37. Shaughnessy M, Resnick BM, Macko RF. Testing a model of post-stroke exercise behavior. *Rehabil Nurs.* 2006;31:15-21.

38. Hansen BJ, Sigmund AA, Steene-Johannessen J, Ekelund U, Nilsen AK, Andersen ID. *Physical Activity and Sedentary Time Among Adults and Elderly People in Norway: A National Survey 2014–2015.* Oslo, Norway: Norwegian Directorate of Health. 2015.

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39. Picorelli AM, Pereira LS, Pereira DS, Felicio D, Sherrington C. Adherence to exercise programs for older people is influenced by program characteristics and personal factors: a systematic review. *J Physiother.* 2014;60:151-156.

40. Morris JH, Williams B. Optimising long-term participation in physical activities after stroke: exploring new ways of working for physiotherapists. *Physiotherapy.* 2009;95:228-234.

41. Moore SA, Hallsworth K, Plotz T, Ford GA, Rochester L, Trenell MI. Physical activity, sedentary behaviour and metabolic control following stroke: a cross-sectional and longitudinal study. *PLoS One.* 2013;8:e55263.

42. Sanchez MC, Bussmann J, Janssen W, et al. Accelerometric assessment of different dimensions of natural walking during the first year after stroke: Recovery of amount, distribution, quality and speed of walking. *J Rehabil Med.* 2015;47:714-721.

43. Craig CL, Marshall AL, Sjostrom M, et al. International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc.* 2003;35:1381-1395.

44. Prout EC, Mansfield A, McIlroy WE, Brooks D. Patients' perspectives on aerobic exercise early after stroke. *Disabil Rehabil.* 2017;39:684-690.

45. Perri MG, Anton SD, Durning PE, et al. Adherence to exercise prescriptions: effects of prescribing moderate versus higher levels of intensity and frequency. *Health Psychol.* 2002;21:452-458.

46. Garber CE, Blissmer B, Deschenes MR, et al. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Med Sci Sports Exerc.* 2011;43:1334-1359.

47. Turner-Stokes L. Goal attainment scaling and its relationship with standardized outcome measures: a commentary. *J Rehabil Med.* 2011;43:70-72.

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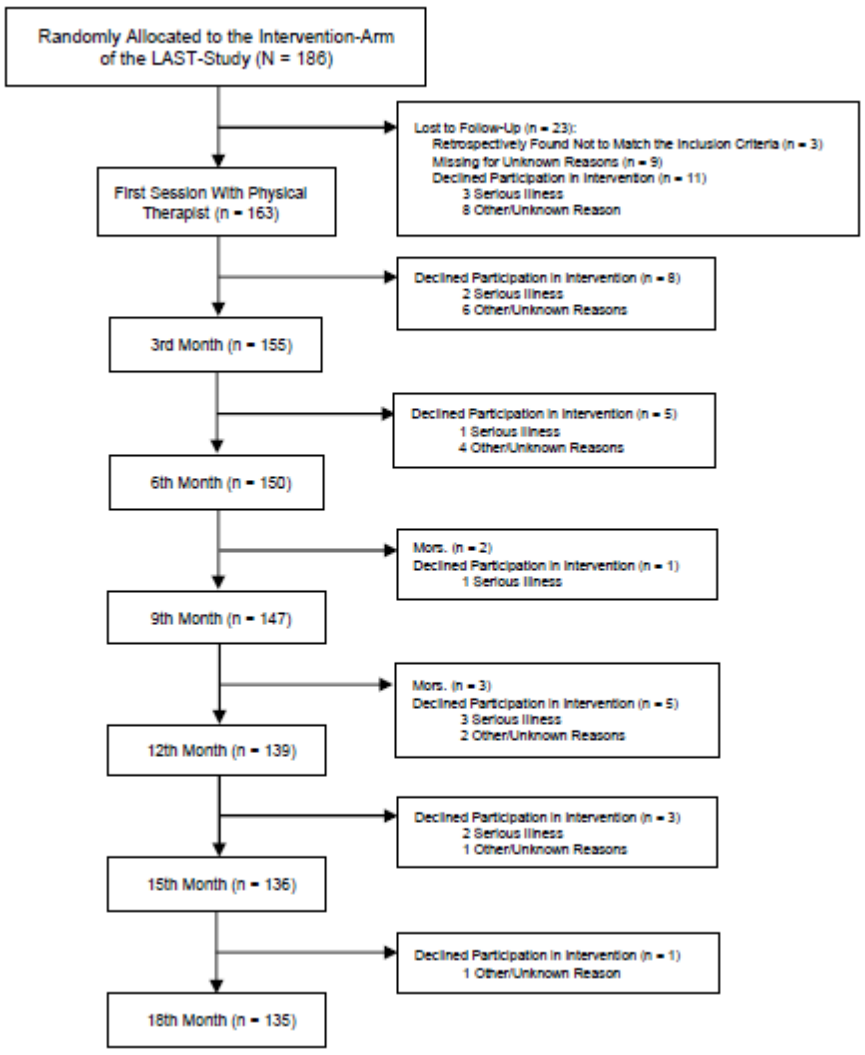

Figure 1. Flow chart. LAST = Life after stroke; Mors = death.

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Figure 2. Area plots illustrating adherence to the amounts (A, B) and intensities (C, D) of physical activity and exercise, in addition to goal achievements (E), during 18-month follow-up. Adherence to amounts of physical activity and exercise (A, B) were categorized as follows; blue fields indicate amounts required per protocol, red fields indicate amounts within the recommended levels of activity for adults and elderly people by the Norwegian Directorate of Health[26] (A) or amounts within the Norwegian recommended levels of exercise in participants with stroke[7] (B), green fields indicate amounts below recommendations, purple fields indicate no activity or exercise reported. Adherence to intensity levels during physical activity and exercise (C, D), were categorized into levels of light, moderate and high. Goal achievements (E) were dichotomized into achieved (≥50 points) and not achieved (<50 point) goals. Min = minute; Mors = death.

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Table 1.
Baseline Demographic and Clinical Characteristics of 186 Participants in the Intervention Group[a]

Characteristic	Value[b]
Age, mean (SD)	71.7 (11.9)
<80 y	142 (76.3)
≥80 y	44 (23.7)
Sex	
Women	82 (44.1)
Men	104 (55.9)
Living condition	
Living with someone	130 (69.9)
Living alone	56 (30.1)
MMSE score, mean (SD)	27.8 (2.3)
≥25	164 (88.2)
<25	22 (11.8)
Days from stroke, mean (SD)	111.3 (24.5)
Stroke type	
Infarction	172 (92.5)
Hemorrhage	14 (7.5)
NIHSS score, mean (SD)	1.5 (2.3)
Mild stroke (<8)	181 (97.3)
Moderate stroke (8–16)	5 (2.7)
Severe stroke (>16)	0
mRS score, mean (SD)	1.45 (1.08)
0	34 (18.3)
1	78 (41.9)
2	36 (19.3)
3	32 (17.3)
4	6 (3.2)
Comorbidity	
Stroke	29 (15.6)
TIA	20 (10.8)
Myocardial infarction	19 (10.2)
Heart failure	3 (1.6)
Atrial fibrillation	32 (17.2)
Hypertension	90 (48.4)
Diabetes	25 (13.4)
Lung diseases	19 (10.2)

[a]MMSE = Mini-Mental State Examination; mRS = modified Rankin Scale; NIHSS = National Institutes of Health Stroke Scale; TIA = transient ischemic attack.
[b]Data are reported as numbers (percentages) of participants unless otherwise indicated.

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Table 2.
Adherence to Physical Activity and Exercise During the 18-Month Follow-Up Program[a]

Parameter	Data for Month:																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Physical activity (PA)[b]																		
Total no. of participants	157	148	145	145	140	137	132	131	130	125	126	119	114	115	115	116	113	108
No. (%) of participants adherent to ≥210 min of PA/wk[c]	87 (55.4)	84 (56.8)	89 (61.4)	95 (65.5)	84 (60.0)	79 (57.7)	86 (65.2)	88 (67.2)	82 (63.1)	64 (51.2)	77 (61.1)	69 (58.0)	71 (62.3)	76 (66.1)	73 (63.5)	75 (64.7)	78 (69.0)	79 (73.1)
Borg Scale score (6–20) during PA, mean (SD)	12.2 (1.5)	12.5 (1.5)	12.4 (1.6)	12.5 (1.7)	12.5 (1.8)	12.6 (1.8)	12.6 (1.5)	12.5 (1.5)	12.6 (1.8)	12.4 (1.7)	12.4 (1.6)	12.4 (1.8)	12.4 (1.8)	12.7 (1.8)	12.6 (1.8)	12.9 (1.8)	12.9 (1.8)	12.9 (1.7)
Exercise[b]																		
Total no. of participants	156	148	145	143	140	138	133	131	131	129	128	120	116	118	118	117	113	109
No. (%) of participants adherent to ≥45 min of exercise/wk[d]	103 (66.0)	94 (63.5)	101 (69.7)	99 (69.2)	101 (72.1)	93 (67.4)	95 (71.4)	92 (70.2)	94 (71.8)	94 (72.9)	93 (72.7)	84 (70.0)	82 (70.7)	94 (79.7)	85 (72.0)	83 (70.9)	76 (67.3)	71 (65.1)
Borg Scale score (6–20) during exercise, mean (SD)	13.7 (1.7)	13.9 (1.8)	14.2 (2.1)	14.2 (1.9)	14.2 (1.8)	14.3 (1.8)	14.4 (1.8)	14.4 (1.8)	14.4 (1.8)	14.4 (1.7)	14.3 (1.8)	14.3 (1.7)	14.3 (2.1)	14.2 (2.1)	14.4 (2.0)	14.3 (2.1)	14.1 (2.1)	14.5 (1.9)
Physical activity and exercise[b]																		
Total no. of participants	155	147	144	143	139	136	131	130	129	125	126	118	114	115	115	116	112	107
No. (%) of participants adherent to both ≥210 min of PA/wk and ≥45 min of exercise/wk[e]	58 (37.4)	55 (37.4)	61 (42.4)	64 (44.8)	58 (41.7)	52 (38.2)	58 (44.3)	64 (49.2)	58 (45.0)	46 (36.8)	51 (40.5)	46 (39.0)	49 (43.0)	60 (52.2)	53 (46.1)	54 (46.6)	53 (47.3)	52 (48.6)
Individualized coaching, no. of participants			154			152			147			142			134			125
No. (%) of participants attending ≥2/3 meetings face to face			123 (79.9)			105 (69.1)			59 (40.1)			40 (28.2)			35 (26.1)			32 (25.6)
GAS[f]			138			126			122			109			112			92
GAS score, mean (SD)			44.2 (10.8)			43.3 (9.9)			41.4 (9.6)			42.6 (10.0)			42.9 (10.2)			42.9 (9.1)

[a]Data show numbers (percentages) of participants who adhered to the program and their reported levels of intensity (ie, scores on the Borg Scale) in 18 consecutive mo, each month consisting of 4 wk. GAS = goal attainment scaling.
[b]Participants with at least 3/4 wk with no missing data each mo.
[c]Participants who performed ≥30 min of PA 7 d/wk (ie, ≥210 min/wk) at least 3/4 wk/mo.
[d]Participants who performed ≥45 min of weekly exercise at least 3/4 wk/mo.
[e]Participants who performed ≥30 min of PA 7 d/wk (ie, ≥210 min/wk) and ≥45 min of weekly exercise at least 3/4 wk/mo.
[f]Number of participants with goals set and evaluated.

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Table 3.
Mixed-Effects Logistic Regression With Adherence as the Dependent Variable and Participant as a Random Effect[a]

Covariate	Adherence to Physical Activity			Adherence to Exercise			Adherence to Physical Activity and Exercise		
	OR	**95% CI**	***P***	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***
Month[b]	1.026	1.014–1.037	<.001	1.003	0.992–1.012	.624	1.018	1.008–1.028	<.001
Men vs women[c]	1.044 vs 1.0	0.532–2.049	.900	1.444 vs 1.0	0.923–2.260	.108	1.037 vs 1.0	0.603–1.785	.895
Age (y)[c]	0.990	0.960–1.021	.507	0.977	0.957–0.998	.030	0.984	0.959–1.008	.190
mRS score[c]	0.602	0.443–0.818	<.001	0.972	0.787–1.200	.791	0.777	0.604–0.999	.049
MMSE score[c]	0.992	0.862–1.143	.916	0.920	0.837–1.010	.081	0.926	0.827–1.037	.181
GAS score[c]	1.021	0.996–1.047	.098	1.010	0.990–1.032	.327	1.015	0.994 –1.036	.152

[a]GAS = goal attainment scaling; MMSE = Mini-Mental State Examination; mRS = modified Rankin Scale; OR = odds ratio.
[b]Unadjusted.
[c]Adjusted for time.

Table 4.
Mixed-Effects Linear Regression With the Borg Scale Score as the Dependent Variable, Participant as a Random Effect, and Month as the Covariate

Evaluation of Borg Scale Score	Nonstandardized Regression Coefficient	95% CI	*P*
During physical activity	0.020	0.015–0.025	<.001
During exercise	0.018	0.011–0.024	<.001

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