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A Home-Based Behaviour Change Intervention With Sedentary Behaviour and Physical Activity in People With Stroke and Diabetes—A Feasibility and Safety Study

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ABSTRACT

Background and Purpose: Stroke survivors with type 2 diabetes mellitus (DM) face heightened cardiovascular risks, which are exacerbated by sedentary behaviour (SB). Despite existing interventions, there remains a gap in the literature regarding effective strategies to reduce SB and increase physical activity (PA). The purpose of this study was to explore the feasibility and safety of the 12-week 'Everyday Life is Rehabilitation' (ELiR) intervention comprising recruitment, adherence, practicality, and implementation into everyday life.

Methods: Single-group longitudinal intervention study with 1-week baseline, motivational interviews at weeks 1 and 6, and 12-week follow-up. Stroke survivors with DM ($N = 14$) were recruited from Neurovascular Center at Zealand University Hospital, Roskilde. The ELiR intervention is a theory-based intervention that focuses on healthcare professionals (HCP) consultations with stroke survivors with DM to address SB and PA. Primary outcomes were recruitment, adherence, completion of physical tests (accelerometer measurements), cognitive tests, and safety. Secondary outcomes were sedentary time and steps collected using an accelerometer and glycated haemoglobin (HbA1c) measurements.

Results: 23 participants were recruited, of whom two were readmitted, one withdrew consent before the baseline test, and six were not discharged with a physiotherapy rehabilitation plan within 1–7 hospitalisation days. The remaining 14 were included and completed the study with a median modified Rankin scale (mRS) score of 1. The ELiR intervention revealed high adherence. Three participants experienced falls, and two were hospitalised. These incidents were not related to the intervention. Future adjustments include modified inclusion criteria, SMS-reminders, and point-of-care HbA1c measurements.

Discussion: The ELiR intervention was feasible and safe. Falls and serious adverse events are in line with previously reported risks. Self-reported questionnaires and clinical tests had low and moderate adherence, whereas accelerometers had high

Abbreviations: CCI, Charlson Comorbidity Index; CONSORT, Consolidated Standards of Reporting Trials; DM, Type 2 diabetes mellitus; ELiR, Everyday Life is Rehabilitation; GDPR, General Data Protection Regulation; GP, General Practitioner; GSES, General Self-efficacy Scale; HbA1c, Glycated haemoglobin; HCP, Healthcare professionals; IQR, Interquartile range; MFI-20, Multidimensional Fatigue Inventory; mmHg, Millimetre of mercury; MoCA, Montreal Cognitive Assessment; mRS, Modified Rankin Scale; NC, XX; NIHSS, National Institutes of Stroke Scale; PA, Physical activity; PAS2, Physical Activity Scale; PHQ-9, Patient Health Questionnaire; POC, Point-of-care; SB, Sedentary behaviour; SS-QOL, Stroke Specific Quality of Life Scale; SSS, Scandinavian Stroke Scale; TUG, 3-m timed up and go test.

adherence. However, the small sample size limits generalisability, and adjustments to the ELiR intervention are suggested to improve usability in physiotherapy practice before testing in RCT studies to confirm these findings.

1 | Introduction

Stroke and type 2 diabetes mellitus (DM) are two chronic conditions causing significant health challenges worldwide (Abbafati et al. 2020). While stroke is a leading cause of long-term disability, DM significantly increases the risk of stroke (Bambury et al. 2023; Kristensen et al. 2024; Mosenzon et al. 2023; L. Zhang et al. 2021) and worsens stroke consequences (De Silva et al. 2022; S. Yang et al. 2021). Sedentary behaviour (SB) is a risk factor for both recurrent stroke (Wang et al. 2022) and DM (Deng et al. 2022; Kennerly and Kirk 2018), whereas physical activity (PA) reduces these risks (Bassin and Srinath 2023; Hooker et al. 2022; Prior and Suskin 2018). Although guidelines recommend reducing SB and increasing PA (Kanaley et al. 2022; Mead et al. 2023; Sigal et al. 2018), SB is still frequent in these populations (Kennerly and Kirk 2018; Wang et al. 2022). SB is characterised by low energy expenditure such as sitting or lying while for example watching TV or reading (Tremblay et al. 2017). Stroke survivors and individuals with DM tend to spend more time in SB, exhibit lower levels of PA, and to a greater extent fail to meet PA guidelines compared with healthy counterparts (Duran et al. 2021; Fini et al. 2017; Kennerly and Kirk 2018). In addition, stroke survivors with DM are more sedentary than stroke survivors without DM (Alme et al. 2020).

PA plays a crucial role in preventing disability, enhancing physical function after stroke, and reducing mortality and morbidity in individuals with DM (Kanaley et al. 2022; Mead et al. 2023; Sigal et al. 2018). However, Saunders et al.'s meta-analysis showed no reduction in recurrent strokes or falls from PA interventions (Saunders, Mead, Fitzsimons, Kelly, van Wijck, Verschuren, Backx, and English 2021a); meanwhile, it seems possible to increase PA and reduce SB through combined exercise and behaviour change strategies (Goncalves et al. 2023; Oliveira et al. 2023). It is recommended to focus on integrating PA into everyday lives (Konerding and Szel 2021; Kringle, Gibbs, et al. 2020a), however, barriers to engaging in PA, such as fatigue and depression (Cartagena et al. 2021; Espernberger et al. 2021; Krawcyk et al. 2022), are prevalent in both populations (Alghamdi et al. 2021; Medeiros et al. 2022; Romadlon et al. 2021; Y. Zhang et al. 2017). Stroke survivors desire to reclaim their pre-stroke function and live a normal life, which highlights the need for tailored approaches (Billinger et al. 2014; Bodilsen et al. 2023; Saunders, Mead, Fitzsimons, Kelly, van Wijck, Verschuren, Backx, and English 2021b). However, limited energy resources make it difficult to adopt 'additional activities' into everyday life while striving to maintain a sense of normalcy (Bodilsen et al. 2023; Ezeugwu et al. 2017). Recognising these issues, the 'Everyday Life is Rehabilitation' (ELiR) intervention was developed to motivate and increase adherence to everyday PA and reduce SB through everyday activities (Bodilsen et al. 2023).

This study aimed to assess the feasibility and safety of the ELiR intervention comprising recruitment, adherence, and practicality of implementing the intervention into everyday life to inform adjustments before further evaluation.

2 | Methods

2.1 | Design

This feasibility study was conducted with the intervention described in the development process (Bodilsen et al. 2023) and evaluated recruitment speed, adherence, practicality, and implementation of the intervention within the home environment. The intervention is described briefly below. The intervention would be considered feasible if > 80% of the included participants completed the study and > 50% completed clinical outcome and accelerometer measurements. The intervention is considered safe if there is no increase in adverse events compared with previous literature.

2.2 | Recruitment and Setting

This study was conducted at the Neurovascular Center at Zealand University Hospital, Roskilde, Denmark (NC) between 01/09/2022 and 15/09/2023.

During admission to NC, patients were screened through medical records. Patients matching the inclusion criteria were recruited consecutively face-to-face. The inclusion criteria were: ischaemic stroke or intracerebral haemorrhage, DM diagnosed by an endocrinologist or general practitioner (GP) (American Diabetes Association 2010), a modified Rankin score (mRS) 1–3 at discharge (Banks and Marotta 2007), discharged with a rehabilitation plan within 1–7 hospitalisation days post-stroke, able to ambulate independently, speak and understand Danish, and able to give informed consent. Exclusion criteria were: aphasia, type 1 diabetes mellitus (American Diabetes Association 2010), mental illness, and other severe comorbidities for example terminal cancer. Also, participants were excluded if they changed their antidiabetic medicine within 6 weeks before or during the intervention. Participants were recruited before discharge from NC immediately after they were found in need of rehabilitation by a physiotherapist and baseline tested 1–7 days after discharge by SSNB (first author). Based on practical considerations, the aim was to recruit 15 -20 patients. The study utilised a single-group design, as the primary aim was to assess the feasibility and safety rather than evaluate its efficacy. A control group was deemed unnecessary at this stage, in line with standard feasibility study methodology (Teresi et al. 2022).

2.3 | Feasibility

Feasibility was assessed through recruitment speed, completion of clinical outcomes described below, ActivPAL accelerometer wear-time, and adverse events connected to wearing the accelerometer (e.g. rash or pain). Practicalities, such as the structure of the home visits and adherence to clinical outcomes, were further evaluated.

2.4 | Safety

Safety was assessed by monitoring falls, adverse events, discomfort associated with testing of clinical outcomes and accelerometer measurements. Fall incidents and adverse events were ascertained by asking the participants two structured and systematically questions at every home visit: 'Have you fallen or tripped during this study?' and 'Did you experience any discomfort or a need for medical attention during this study?' Additionally, the participant's medical records were screened for adverse events.

2.5 | Clinical Outcome

After inclusion and before baseline measurements, the following information was collected through medical records; age, sex, type of stroke, comorbidities, smoking and drinking status, Charlson Comorbidity Index (CCI) (score range 0–37, higher score representing more comorbidity) (Charlson et al. 1987), glycated haemoglobin (HbA1c) at admission (American Diabetes Association 2010), stroke severity (National Institutes of Stroke Scale (NIHSS); score range, 0–42, higher scores representing severe stroke (Lyden et al. 1994), Scandinavian Stroke Scale (SSS); score range, 52–0, lower score representing severe stroke (Aberg et al. 1985) and modified Rankin scale (mRS); score range, 0–6, higher scores representing more disability after stroke (Rankin 1957)).

Baseline measurements were collected at the first home visit (1–7 days after discharge) and the 12-week follow-up visit (Figure 1) by SSNB. Measures included function of extremities measured by the Fugl-Meyer assessment (higher scores indicating higher function) (Fugl-Meyer et al. 1975), gait measured by the 3-m timed-up-and-go test (TUG) (Richardson 1991), height measured with a measuring tape on the wall, weight measured with a bathroom scale, and waist circumference measured with a measuring tape between the inferior margin of the ribs and the upper iliac crest. Participants were interviewed about mRS, living arrangement, and education level, and blood pressure was measured after the participant had rested seated for 5–10 min using an Omron model: M7 Intelli IT (HEM7322 T-E). At the first home visit, participants performed the Montreal Cognitive Assessment (MoCA) (score range, 0–30, with scores < 26 indicating cognitive dysfunction defined by Nasreddine et al.) to measure cognitive function (Nasreddine et al. 2005). Within the first week after the baseline, participants completed self-reported questionnaires: PA levels were measured by the Physical Activity Scale (PAS2) (Andersen et al. 2010; E. S. L. L. Pedersen et al. 2018), quality of life was measured by the Stroke Specific Quality of Life Scale (SS-QOL) (Muus et al. 2007; Williams et al. 1999), self-efficacy was measured by The General Self-efficacy Scale (GSES) (Gemzøe Mikkelsen et al. 1999; Luszczynska et al. 2005), fatigue was measured by the Multidimensional Fatigue Inventory (MFI-20) (Smets et al. 1995; Watt et al. 2000) and depression was measured by the Patient Health Questionnaire (PHQ-9) (S. S. Pedersen et al. 2022; Spitzer et al. 1999). The participants were asked to fill in a sleep diary specifically developed for this study during the weeks of ActivPAL measurement, recording wake-up time, sleep duration, bedtime, number of times leaving the bed, and sleep quality on a scale from 1–5 where 1 was very bad and 5 was very good (Supporting Information S1: Supplementary file 1). The sleep diary was used to evaluate sleep patterns and relationships with PA levels during everyday life. The participants had their HbA1c measured in weeks 6 and 12 +/− one week at their GP.

2.6 | The ELiR Intervention

The ELiR is a 12-week multifaceted and theory-based intervention developed using a participatory approach involving patients, caregivers, and healthcare professionals (HCP) and is directed at the HCP's consultations with stroke survivors with DM. The ELiR intervention consists of two motivational interviews (30–45 min) conducted in the home environment face-to-face by physiotherapist SSNB in the first and sixth week after discharge delivered together with a double-page paper instrument (Supporting Information S1: Supplementary file 2). The sessions focus on assessing participants' knowledge of stroke, DM, SB, PA, and fatigue, identifying everyday challenges, and using action planning and goal setting to develop three individualised strategies for incorporating more movement into their daily lives. Participants also explore their motivations to tackle these challenges and increase their activity levels. For those experiencing fatigue, the instrument provides education and guidance on identifying energy-draining and energy-restoring activities along with recognising peak energy periods. Additionally, QR codes on the instrument link to webpages from the Danish Stroke Association and an educational video on fatigue. The development of the ELiR intervention is described in detail elsewhere (Bodilsen et al. 2023).

2.7 | Accelerometer Measurement

PA and SB were measured at weeks 1, 6, and 12 after discharge using the ActivPAL Micro 4, which is widely used in both

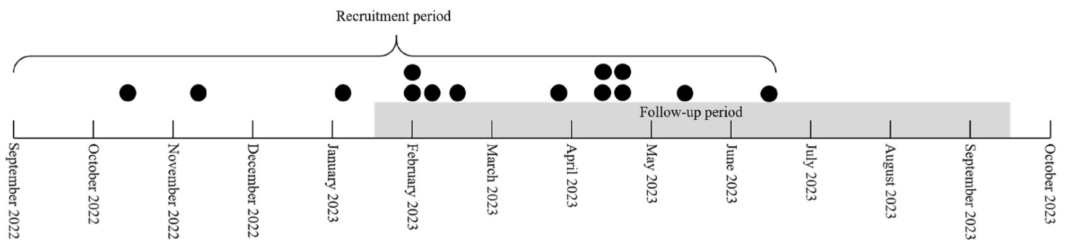

FIGURE 1 | Timeline of recruitment and follow-up throughout the study.

populations (Alothman et al. 2020; Fini et al. 2023; Mahendran et al. 2016). The ActivPAL is 23.5 mm wide, 43 mm long, and 5 mm thick, and weighs 9.5 g, featuring a built-in processor and accelerometer for sensing limb position and movement. It is encased in a finger exploration cap and affixed to the front of the non-paretic leg with transparent Tegaderm-tape and worn 24 h/d for 7 days, including bathing or water activities allowing participants to carry on their everyday life.

2.8 | Analysis

Descriptive statistics (means and standard deviations) were used to summarise participants' demographics and clinical outcomes. Percentages were used for summarising the completion of clinical outcomes, questionnaires, and HbA1c measurements. Accelerometer completion was based on the number of valid days. Data from participants with ≥ 4 valid days were included. A valid day was defined as wearing the accelerometer for at least 20 h per day. Mean sedentary time and step count were computed using the ActivPAL software PALbatch (v8.11.1.63) with the automated CREA analysis algorithm defining non-wear, upright position, lying, cycling, and seated transport. Data were stored and organised in a spreadsheet with each row representing an individual participant with a created participant ID. Analyses were performed using the RStudios software (version 2022.07.1 + 554).

Ethical Approval

Ethical approval was obtained from the Region Zealand Ethics Committee on 25/04/2022 (SJ950, EMN-2021–08261). This study complies with the Declaration of Helsinki and the General Data Protection Regulation (GDPR). All participants gave written informed consent and had no relation to the researchers or prior knowledge of this study. This study followed the Consolidated Standards of Reporting Trials (CONSORT) 2010 extension on reporting feasibility studies (Lancaster and Thabane 2019).

3 | Results

3.1 | Recruitment

Between September 2022 and June 2023, 698 patients' medical records were screened during admission, hereof 35 matched the inclusion criteria (Figure 2). Three patients declined to participate and nine could not be reached during admission due to other examinations. Twenty-three participants were recruited, hereof two were lost to inclusion, as they were readmitted between discharge and baseline testing and one withdrew consent before baseline testing. Another six participants were lost, as they were not discharged within 7 days of inclusion due to sudden further examinations or comprehensive rehabilitation needs. The study included $n = 14$ participants (Figure 1) all of whom had suffered an ischaemic stroke and among them, six

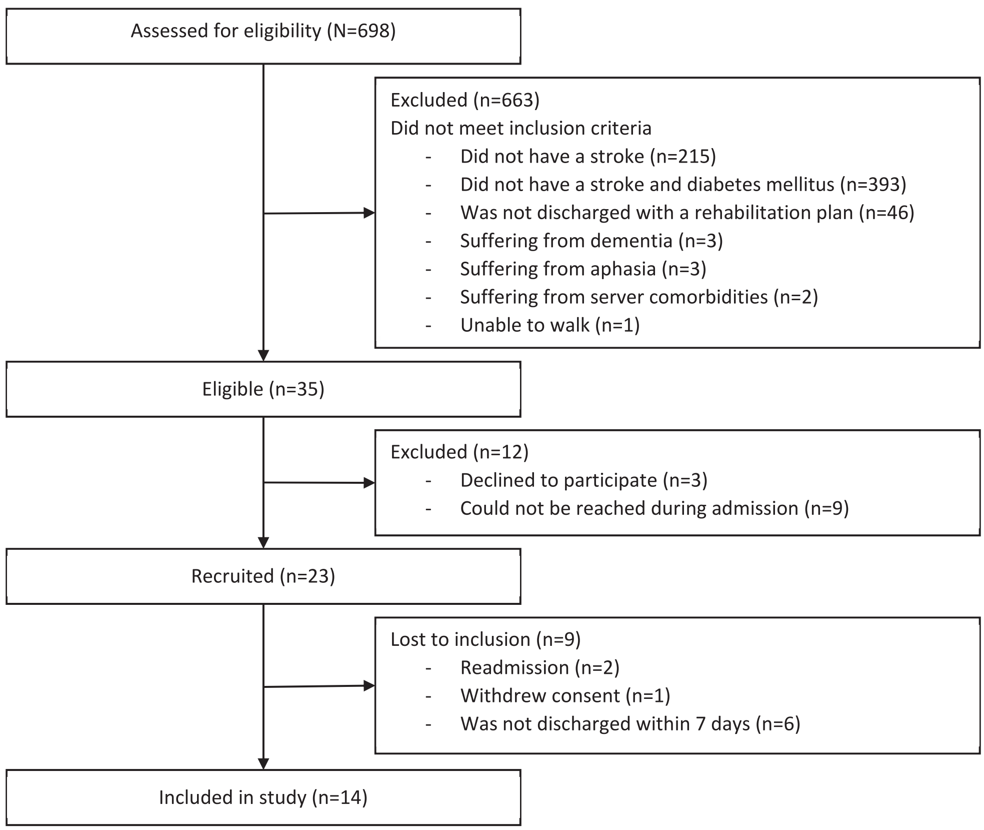

FIGURE 2 | Flow of participants through the study.

participants were female and nine were cohabitating with a partner (Table 1).

3.2 | Feasibility

All 14 participants completed all three home visits. Completion percentages of clinical outcomes and scores are presented in Table 2. Especially, completion of the SS-QOL and GSES was low with less than half completing these questionnaires. At weeks 1, 6, and 12, 14 participants (100%) wore the ActivPAL for more than 4 days; however, two of the devices did not start recording due to a technical issue in weeks 1 and 12 in two different participants. All other recordings were used in the analysis and the mean number of valid days was 6.3 days in week 1, 6.5 in week 6, and 6.1 in week 12. Half of the participants completed their sleep diary and had a mean sleep quality of 3.5 across all weeks. HbA1c completion and measurements are presented in Table 3. Activity and sleep data are presented in Table 4.

TABLE 1 | Participants characteristics.

Demographics and clinical characteristics (*N* = 14)	
Age	69.3 (12.3)
Women, *n* (%)	6 (42.9%)
Co-habitant, *n* (%)	9 (64.3%)
Education level > high school, *n* (%)	3 (21.4%)
Weight (kg)	84.2 (20.9)
BMI	27.7 (5.8)
Smoking, currently, *n* (%)	5 (35.7%)
Drinking > 10 units per week, *n* (%)	1 (7.1%)
Pre-morbid mRS, median (IQR)	0.0 (0–0)
Type of stroke, *n* (%)	
Ischaemic	14 (100%)
Haemorrhagic	0 (0%)
Days of admission	2.2 (2.3)
Comorbidities, *n* (%)	
Hypertension	13 (92.9%)
High cholesterol	10 (71.4%)
Atrial fibrillation	5 (35.7%)
Prior stroke	4 (28.6%)
Myocardial infarction	2 (14.3%)
Chronic obstructive pulmonary disease	2 (14.3%)
CCI	5.4 (2.6)
NIHSS	2.8 (1.3)
SSS	52.6 (4.8)
At baseline	
mRS, median (IQR)	1 (1–2)
MoCA	22.6 (4.0)

Note: Data are presented as mean (SD) unless otherwise indicated.
Abbreviations: BMI, body mass index; CCI, Charlson Comorbidity Index; IQR, Interquartile range; kg, kilo grams; MoCA, Montreal Cognitive Assessment; mRS, modified Rankin Scale; NIHSS, National Institutes of Stroke Scale; SSS, Scandinavian Stroke Scale.

3.3 | Safety

Eight adverse events (AE) were reported across three participants. One fell in the bathroom at night, one fell at night when getting into bed and one participant fell six times due to dizziness or not using a waking aid as recommended.

Apart from the abovementioned falls, two serious adverse events (SAE) were recorded. One participant was admitted to the hospital with an excessive nosebleed which started at night 2 days after the baseline test. The participant was discharged the following day without further treatment and was advised by a physician to limit PA for the following 5 days. One participant was admitted to the hospital after hurting her foot on the outside doorstep with a 1. phalange fracture and wore a food/ankle brace for 4 weeks. It is assumed that the AE and SAE are not directly related to the intervention. One participant experienced a skin reaction with itching and blushing from the Tegaderm-tape. No other participants reported any discomfort or AE related to testing or measurements.

4 | Discussion

This study aimed to determine the feasibility and safety of the ELiR intervention in stroke survivors with DM targeting SB and PA through motivational interviewing. Overall, the intervention was feasible and safe. The ELiR intervention appears to be simple and implementable; however, adjustments to the intervention are needed.

4.1 | Feasibility of the Intervention and Adjustments

Recruiting 23 participants from 698 screened patients and 14 participants subsequently completing the 12-week intervention took more than a year, demonstrating a slow inclusion rate that could impede future large-scale studies. Over half of the screened patients were excluded for not having DM. Due to the slow inclusion rate, primarily based on the inclusion criteria DM diagnosis, it is not feasible to complete large-scale studies within a fixed time frame. Hence, due to practical reasons, future participants do not necessarily have to be diagnosed with DM but only with stroke. However, the relevance of the ELiR intervention is still present as SB and low levels of PA are dominant in stroke survivors (Wang et al. 2022). Further, to increase the recruitment, the inclusion criteria discharged with a rehabilitation plan within 1–7 hospitalisation days will be changed to 1–14 days. This creates a more realistic setting, as stroke survivors discharged with a rehabilitation plan will have similar self-care abilities and physical function to live at home, regardless of their hospital stay duration. Fourteen participants completed all components of this study, including motivational interviews and TUG tests, with only one failing to complete the Fugl-Meyer test at 12 weeks, affirming the feasibility of interviews and clinical outcomes. Given the low completion rates of questionnaires and sleep diaries, text message reminders will be included in the future RCT studies to

TABLE 2 | Clinical outcome from baseline and 12-week test along with completion percentage.

	Baseline	12-week follow-up	Completion
Blood pressure			
Systolic, mmHg	135.4 (12.9)	137.0 (18.2)	100%
Diastolic, mmHg	81.5 (9.1)	81.4 (12.4)	100%
Fugl-Meyer, motor function			
Upper extremity	60.6 (7.6)	65.1 (1.4)	96.4%
Lower extremity	31.1 (2.9)	32.85 (2.2)	96.4%
TUG, sec.	14.1 (3.4)	12.3 (12.4)	100%
PAS2			
Sleep, h/d,	8.2 (2.3)	7.8 (2.2)	75.0%
Leisure sitting, h/d, median (IQR)	5.0 (4–6)	4.0 (3.8–4.25)	60.7%
LPA, h/w, median (IQR)	3.2 (1–7)	3.2 (2.0–4.9)	71.4%
MPA, h/w, median (IQR)	1.5 (0–2.8)	1.5 (0.0–1.8)	71.4%
VPA, h/w, median (IQR)	0.0 (0–0)	0.7 (0.0–0.8)	71.4%
SS-QOL	199.3 (45.3)	204.4 (34.1)	23.2%
GSES, median (IQR)	31.5 (23.3–38.3)	29.3 (9.2)	46.4%
MFI-20	57.7 (22.5)	53.3 (23.3)	53.6%
PHQ-9, median (IQR)	5.5 (1.8–8.5)	3.0 (1.0–6.75)	57.2%

Note: Data are presented as mean (SD) unless otherwise indicated.
Abbreviations: mmHg, millimetre of mercury; TUG, timed up and go test; PAS2, Physical Activity Scale 2; h/d, hours per day; h/w, hours per week; IQR, Interquartile range; LPA, light physical activity; MPA, moderate physical activity; VPA, vigorous physical activity; SS-QOL, Stroke Specific Quality of Life Scale; GSES, The General Self-efficacy Scale; MFI-20, Multidimensional Fatigue Inventory 20; PHQ-9, Patient Health Questionnaire 9.

TABLE 3 | Glycated haemoglobin (HbA1c) measurements with completion percentage.

	Baseline	6-week follow-up	12-week follow-up	Completion
HbA1c (IFCC mmol/mol)	52.8 (8.5)	55.2 (10.8)	53.3 (11.7)	76.2%
HbA1c (DCCT%)	7%	7.2%	7%	

Note: Data are presented as mean and (SD).
Abbreviations: DCCT, Diabetes Control and Complications Trial; HbA1c, glycated haemoglobin; IFCC, International Federation of Clinical Chemistry; mmol/mol, millimole per mol.

TABLE 4 | Sedentary time and steps per day at weeks 1, 6, and 12.

	Week 1 ($n = 13$)	Week 6 ($n = 14$)	Week 12 ($n = 13$)
Sedentary time in hours per day	12.7 (1.8)	11.8 (1.8)	12.1 (2.3)
Steps per day	3382 (2275.9)	3705 (1829.1)	4115 (2761)
Steps per day, range	150–8405	636–5977	63–10435
Sleep in hours per day	9.5 (0.9)	8.2 (1.5)	8.3 (1.1)
Sleep quality	3.7 (0.9)	3.0 (1.2)	3.7 (0.7)

Note: Data are presented as mean (SD) unless otherwise indicated.

improve completion rates. Additionally, a point-of-care (POC) device will be an alternative to measure HbA1c as only 76% of the scheduled measurements at GP were performed throughout this study. The POC device is a portable device enabling HCP to perform real-time testing at e.g. the participant's homes and obtain immediate results.

In summary, the feasibility of the ELiR intervention was demonstrated by meeting the predefined progression criteria for study completion and outcome measures. The intervention's duration and delivery mode were considered feasible, as each session lasted around 30 min and was conducted in participants' homes, aligning with the existing practices of municipal physiotherapists in a Danish setting where stroke survivors have home visits during rehabilitation. These findings support the potential for the intervention to progress to large-scale studies with some adjustments for the intervention to increase the completion of questionnaires.

4.2 | Safety of the Intervention

Three participants (21%) fell during the study and one sustained a fracture. Notably, two falls occurred at night, potentially unrelated to increased movement efforts, and one participant who experienced multiple falls did not use a walking aid. Falling occurs in 18%–34% of stroke survivors and individuals with DM (Simpson et al. 2011; Wagner et al. 2009; Weerdesteyn et al. 2008; Y. Yang et al. 2016). Reportedly, these populations have a 1.6 to 2.3 times higher risk of falling compared with their healthy counterparts (L. Jørgensen et al. 2002; Sarodnik et al. 2018; Simpson et al. 2011). In addition, fractures are common in these populations (Goto et al. 2019; Rasmussen et al. 2020; Sarodnik et al. 2018; Simpson et al. 2011). Stroke survivors often face challenges such as impaired balance, depression, and diminished daily activity capabilities, all of which increase the risk of falling (Xu et al. 2018). These factors are critical to handle and increased PA and exercise may be factors to reduce the rate of falls despite concurrent risk of falling (Denissen et al. 2019; O'Malley et al. 2021). Falls during the intervention are in line with falls previously reported in stroke survivors and thus unlikely due to the ELiR intervention itself. Hence the safety of the intervention is considered acceptable as to why the intervention may be used in future studies.

4.3 | Clinical Outcome of the Intervention

For both the intervention and accelerometer measurement, adherence was high. All participants completed the home visits and only one participant removed the accelerometer before planned. Similar results have been reported where participants adhere to behaviour change sessions very well and also reduce SB as seen in this study (Alothman et al. 2021; English et al. 2016; Kringle, Terhorst, et al. 2020b). The 14 participants in this study exhibited significant amounts of SB, being sedentary for about 12 h per day and averaging 3734 steps, compared to 8.3 h of SB and 5145 steps for adults with multi-morbidity (L. B. Jørgensen et al. 2022). Compliance with wearing the ActivPAL was high in this study and is generally high in both stroke survivors and DM individuals (Alothman et al. 2021; English et al. 2016; Kringle, Terhorst, et al. 2020b). Although this study was not designed to measure changes in SB and PA, a modest decrease in sedentary time and a slight increase in steps were observed during the intervention.

Monitoring DM is typically done using HbA1c measurements; however, it is suboptimal in this study, with only 76% of participants completing the measurements. Imai et al. reported that the median frequency of HbA1c measurements can be as low as 1.6 measurements per year, with about 50% adhering to recommended measuring intervals (Imai et al. 2021). HbA1c measurements are essential as they help control HbA1c levels, thereby reducing the risk of DM-related complications over time (Imai et al. 2021). In the first weeks following stroke HbA1c increased in this study, likely due to impairment and fatigue causing decreases in PA. Subsequently, HbA1c declined, suggesting a potential increase in PA, as there were no changes in medication and the fact that increased PA is associated with a decrease in HbA1c levels (Bassin and Srinath 2023; Boniol et al. 2017; de Moura et al. 2023; Konerding and Szel 2021). No participants had swallowing issues, and while diet changes were not monitored, both could affect HbA1c levels. Continuing to measure HbA1c can be beneficial as up to 1.7% of adults may have undiagnosed DM and 9.9% prediabetes (Lailler et al. 2020) both associated with increased risk of stroke (Bambury et al. 2023; Mosenzon et al. 2023; L. Zhang et al. 2021).

4.4 | Limitations and Future Perspectives

As stroke survivors, whether or not they have DM, have low levels of PA and increased SB (Kanaley et al. 2022; Kennerly and Kirk 2018; Mead et al. 2023; Sigal et al. 2018; Wang et al. 2022), the intervention remains relevant in this population and hence can be used in all stroke survivors. The inclusion window was increased to enhance the chances of recruiting stroke survivors while still hospitalised. Recruiting stroke survivors immediately post-stroke seems like challenging due to the crisis state at that moment. Despite these challenges, the study population is considered representative, which affirms the utility of these results. Modifying the intervention, such as including individuals without DM, should not be seen as diminishing its relevance, as it was developed for the immediate post-stroke application. This change aims to prevent modifications during future RCTs and mitigate bias risk.

This study encountered challenges in collecting complete data and especially questionnaires were not completed, which is likely in stroke populations (Groeneveld et al. 2019). The study involved a small sample with relatively mild stroke and no data was collected on reasons for the low response rate on questionnaires. Clinical outcome measures were not undertaken by independent assessors and changes in SB could not be attributed to the intervention alone as there was no control group.

This study demonstrated that the 'Everyday Life is Rehabilitation' (ELiR) intervention is feasible and safe with a comparable number of falls and serious adverse events as previously reported among stroke survivors and individuals with DM. Self-reported questionnaires and clinical tests had low and moderate adherence, while accelerometer measurements had high adherence. By including stroke survivors with and without DM, using SMS reminders and a point-of-care device, the intervention is a promising tool that can easily be implemented into clinical practice to support behaviour change and by that increase PA and reduce SB. The intervention must be evaluated in clinical trials to determine its effectiveness.

4.5 | Implications on Physiotherapy Practice

The ELiR intervention shows promise for integration into physiotherapy practice to reduce SB and increase PA in stroke survivors with or without DM. The high adherence to motivational interviews and accelerometer usage suggests that stroke survivors are receptive to structured behaviour change interventions. Physiotherapists should continue to incorporate strategies to promote safe physical activity while minimising fall risks. Overall, the ELiR intervention may easily be implemented in clinical practice, offering a tool to support behaviour change and improve rehabilitation outcomes for stroke survivors.

Suppliers list

Omron model: M7 Intelli IT (HEM 7322 E)

Omron Electronics A/S

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Author Contributions

All authors contributed to this study's development. S.S.NB. carried out the study. S.S.NB. wrote the first draft of this manuscript. T.H.T. and T. W. helped supervise the project. All authors discussed the results and contributed to the final manuscript.

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Ethics Statement

Ethical approval was obtained from the Region Zealand Ethics Committee on 25/04/2022 (SJ950, EMN-2021–08261). This study complies with the Declaration of Helsinki and the General Data Protection Regulation (GDPR). All participants gave written informed consent and had no relation to the researchers or prior knowledge of this study.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data are available upon request to the corresponding author.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.