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Sedentary behaviour in the first year after stroke: a longitudinal cohort study with objective measures

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ABSTRACT

Objective: To quantify longitudinal changes in sedentary behaviour (i.e. non-exercise seated or lying behaviour) following stroke, to ascertain whether reducing sedentary behaviour might be a new therapeutic target.

Design: Longitudinal cohort study of patients with acute stroke who were followed over one year.

Setting: Acute teaching hospital or outpatient clinic, and the community after discharge**.**

Participants: A convenience sample of patients with acute stroke (N=96; median age=72 y, inter-quartile range (IQR)=64-80; 67% male; median National Institute of Health Stroke Scale (NIHSS) score=2, IQR=1-3) who were assessed at one, six and twelve months following stroke.

Interventions: Not applicable.

Main outcome measures: Objective measures of amount and pattern of time spent in sedentary behaviour: total sedentary time, weighted median sedentary bout length and fragmentation index.

Results: Stroke survivors were highly sedentary, spending on average 81% per 24-h day in sedentary behaviour: median=19.9 h (IQR=18.4-22.1), 19.1 h (17.8-20.8) and 19.3 h (17.3-20.9) at one, six and twelve months, respectively. Longitudinal changes in sedentary behaviour were estimated using linear mixed effects models. Covariates were age, sex, stroke severity (NIHSS score), physical capacity (6-minute walk distance) and functional independence (Nottingham Extended Activities of Daily Living Questionnaire). Higher stroke severity and less functional independence were associated cross-sectionally with more sedentary behaviour (β=0.11, S.E.=0.05, P = 0.020 and β=-0.11, S.E.=0.01, $P < 0.001$, respectively). Importantly, the pattern of sedentary behaviour did not change over the first year following stroke and was independent of functional ability.

Conclusions: Stroke survivors were highly sedentary and remained so a year after stroke independently of their functional ability. Developing interventions to reduce sedentary behaviour might be a potential new therapeutic target in stroke rehabilitation.

Key words: accelerometry; sedentary lifestyle; stroke; functional ability, physical activity, activPAL

Physical activity is recommended in stroke rehabilitation and provides protective benefits in the primary and secondary prevention of stroke.[1-3] However, new evidence shows that sedentary behaviour in the general population has a deleterious effect on health, independently of the amount of physical activity.[4, 5] This raises the question that reducing sedentary behaviour, or changing patterns of sedentary behaviour, may present another therapeutic target for secondary prevention and rehabilitation of stroke survivors.

Sedentary behaviour is defined as a cluster of behaviours adopted in sitting or reclining postures with low energy expenditure (e.g. watching television or travelling by car).[6, 7] Sedentary behaviour has significant negative impacts on metabolism and cardiovascular health, especially when accumulated in long uninterrupted periods, which are not compensated by engagement in health-enhancing physical activity.[4, 8-11]

Behaviourally, sedentary time and low level of activity are distinct. For example, an individual can be classified as inactive (i.e. not meet the recommended guidelines for physical activity) but spend little time in seated postures, while conversely another individual can be physically active (e.g. running for 30 min per day) and yet spend prolonged periods sitting at work.

Little is known about sedentary behaviour in the stroke population, specifically the amount of time spent in sedentary behaviour and the manner in which sedentary time is accumulated.[12] A recent cross-sectional study reported no differences in sedentary time between stroke survivors (N=42) and healthy controls, however time since stroke was on average 2.8 y.[13] To date, the only longitudinal study (N=25) reported a decrease in sedentary behaviour at three months after stroke, with no further reduction at six months.[14] These studies were in small, non-representative samples and did not account for functional ability. Further, the follow-up time in the longitudinal study was relatively short.

Larger-scale, longer term studies using in-depth measures of sedentary behaviour, which account for functional ability, are therefore required to record the amount and patterns of sedentary behaviour over the longer term post stroke, and to explore whether this is correlated with functional ability or requires specific behavioural intervention.

The aim of the present study was to characterize the longitudinal changes in the amount and pattern of sedentary behaviour following stroke, using state-of-the-art objective measurement in free-living conditions on a larger, more representative sample and taking into account potential confounders; age, sex, stroke severity and functional ability. Although this was an exploratory study, it was hypothesized that sedentary time would decrease gradually over time in line with improvements in functional ability.

METHODS

Participants and study design

Participants with a recent acute haemorrhagic or ischaemic stroke were recruited between 1 July 2009 and 30 June 2011 as part of a longitudinal cohort study of fatigue after stroke (the Edinburgh Fatigue after Stroke, EFAS, study).[15, 16] Patients were admitted to the Western General Hospital or the Royal Infirmary of Edinburgh, or were seen in an outpatient clinic. Exclusion criteria were: subarachnoid haemorrhage (unless secondary to an intraparenchymal haemorrhage); dysphasia or cognitive impairments severe enough to preclude them giving informed consent; medically unstable and/or considered too unwell by the clinical team to participate. Written informed consent was obtained from all participants. The study was approved by the Lothian Research Ethics Committee. Participants underwent assessments at one, six and twelve months after stroke, which included a structured interview to identify participants with clinically significant fatigue and measurement of physical activity. Figure 1 shows the study protocol.

Measurements and procedures

Demographic and clinical characteristics were obtained from medical records, including stroke subtype according to the Oxfordshire Community Stroke Project classification

(OCSP)[17] and stroke severity according to the National Institute of Health Stroke Scale (NIHSS).[18, 19] The NIHSS is a 15 item systematic assessment tool that provides a quantitative measure of stroke-related neurologic deficit in the early stages after stroke. The maximum possible total score is 42 (representing the most severe neurological deficit). General cognitive functioning was measured using the Mini Mental State Examination (MMSE)[20] at the one-month assessment.

Sedentary behaviour

Sedentary behaviour was objectively measured using the activPAL™ activity monitor (PAL Technologies, Glasgow, UK). This monitor reliably detects sedentary postures via inclinometry of the thigh[21, 22] and has been validated in patients with stroke.[23] Participants wore the activPAL™ sensor on the leg unaffected by stroke for up to seven consecutive days. ActivPal is capable of recording for a maximum of seven consecutive days, and we used all available data.

Individual days of activPAL™ data were screened using PAL Analysis v5.9.1.1 software and valid days, defined as a 24-hour day of recording without any spurious data (e.g. due to an interruption in wearing time), were identified. A recent study showed that, for postural sensors such as the ActivPal, a single 24-hour recording period is sufficient for analysis of sedentary behaviour.[24]

Data were further processed using MATLAB (Version R2012b, The MathWorks, Inc.). Diurnal sedentary time curves were calculated by summing the sedentary time (min) for each hour of the day, separately for each follow-up assessment, and averaging data across all valid days.

Bouts of time spent sitting or lying were extracted from the activPAL™ data. No attempt was made to remove sleep time (both during day and night). Three metrics were extracted from the data to quantify the volume and pattern of sedentary behaviour[6]:

1. Total sedentary time. The total sedentary time (h per day) was computed by summation of all sedentary bouts (an uninterrupted period of sitting or lying down) divided by the number of days of recording for each individual.

2. Weighted median sedentary bout length. The length of the sedentary bout that corresponded to 50% of accumulated sedentary time (i.e. the 50% weighted percentile median bout length) was selected for each individual. A lower weighted median sedentary bout length suggests that sedentary time was accumulated predominantly in smaller bouts.

3. Fragmentation index. The fragmentation index was calculated as the ratio of the number of sedentary bouts divided by total sedentary time for each individual. This measure of behaviour dynamics summarizes the pattern of accumulation of sedentary time in one single metric.[25] A higher fragmentation index indicates that sedentary time is more fragmented because it is predominantly accumulated in frequent shorter bouts rather than a few prolonged periods.[6, 25]

Measures of functional ability

The Nottingham Extended Activities of Daily Living Questionnaire (NEADL)[26] was administered to measure self-reported activities of daily living. Scores range from 0 to 22, with higher scores reflecting higher levels of functional independence. The six-minute walking distance (6MWD) test[21] was performed to measure physical capacity.

Psychometric properties of the NEADL in stroke have been published previously; Wu et al.[27] reported the Minimal Detectable Change (4.9), Minimally Clinically Important Difference (6.1) and responsiveness (Standardised Response Mean=1.3). Reliability of the NEADL has been shown by Nouri et al.[28], although Green et al.[29] reported a large random error of 5.6/22. With respect to properties of the 6MWD test, Flansbjer et al.[30] reported the standard error of measurement (18.6 m), Minimal Detectable Change (36.6 m) and test-retest reliability (ICC=0.99), which was considered excellent. Kosak and Smith[31] reported responsiveness (Standardised Response Mean =1.52) and found intra-rater reliability (intraclass correlation (ICC)=0.74) and inter-rater reliability (ICC=0.78) to be adequate. Perera et al.[32] reported a Minimally Clinically Important Difference (50m) in a mixed population including people with stroke.

<u>Statistical analyses</u>

Kolmogorov-Smirnov tests were used to test the normality assumption. NIHSS and NEADL scores, weighted median sedentary bout length and fragmentation index were not normally distributed (*P*-values<0.05).

Outliers, defined as values greater than 5 S.D. from the respective sample mean, were dropped before analysis. Four outliers were excluded: one value for the fragmentation variable and three for the weighted median sedentary bout length variable. This was supported by a graphical check of the sample distributions.

To deal with missing data, the longitudinal patterns of sedentary behaviour were analysed using linear mixed effects models (R function lmer[33]). However, since mixed models assume that missingness is at random, we checked that there was no selection bias. Specifically, we used non-parametric tests (Mann-Whitney U and Chi-Square tests) to check that participants who completed one or two assessments did not differ from those who completed all three assessments on a range of baseline variables. We also compared the baseline characteristics between the original study sample and the valid accelerometry sample, to check for any selection bias due to compliance with accelerometry.

The main predictor in all models was linear time (one, six and twelve months follow-up). The model was fitted separately for each dependent variable: total sedentary time, weighted median sedentary bout length and fragmentation index.

Age, sex and stroke severity (NIHSS score) were considered as covariates in all models (Models 1-5). Further, functional independence (NEADL score) and physical capacity (6MWD) were added separately as covariates into consecutive models (Models 2 and 3, respectively). All models included the main effects of the covariates and their interaction with time.

Continuous variables were centered around their average value: age (70.8 years), stroke severity (NIHSS, 2.7), NEADL (18) and 6MWD (455 m). Sex was represented by a dummy variable. The dependent variables were all standardized into units of S.D. at baseline. All models had a random intercept and random slope of time.

Longitudinal patterns of functional ability were estimated using additional linear mixed effects models (Models 4 and 5), using the method described above.

PASW Statistics 18.0 software (SPSS, Inc., Somers, NY) was used for all statistical analysis other than the mixed models. Statistical significance was tested at $P<0.05$.

RESULTS

Sample characteristics

Age ranged from 38 to 90 years (median = 72). Seventy-nine patients (84%) had sustained a mild stroke (NIHSS score of 4 or less) (Table 1). Ninety-six patients provided valid activPAL™ data on at least one occasion. A total of 75, 64 and 58 recordings were obtained at the three consecutive assessments, respectively. The mean number of valid recording days was 5.65 (S.D. = 1.89) and most sessions contained one or two weekend days (11% and 84%, respectively).

To address concerns that data was missing non-randomly in this study (at six and twelve months), the sample of patients with one or two valid recordings (N=65) was compared with the sample of patients who completed all three assessments (N=31) on a range of baseline variables. The groups did not differ with respect to age, sex, NIHSS score, previous stroke or MMSE score, therefore there is no a-priori reason to suggest non-random dropout.

To address further concerns of selection bias, the sample of patients with at least one valid activPAL™ recording (N=96) was compared with the original sample (N=136) on age, sex and NIHSS score. No significant group differences were found, hence selection bias was deemed unlikely.

Sedentary behaviour

Overall, participants spent on average 81% of their day in sedentary behaviour (median = 19.5 h per 24-h day, inter-quartile range (IQR) = 18.1-21.2). Individual values ranged from 10.0 to 23.9 h (Figure 2A). Patients tended to accumulate sedentary time in prolonged bouts, with a weighted median sedentary bout duration of 1.7 h (i.e. 1h 42m) (IQR = 1.4-2.2) (Figure 2B). An hour of sedentary time tended to be accumulated in 2.3 bouts (fragmentation index; IQR = 1.8-2.9) (Figure 2C).

The diurnal sedentary time curves for each assessment were very similar (Figure 3). A reduction in sedentary time was observed mid-morning which then gradually increased during the afternoon and evening until sleep time. The curves include data from slightly different patient samples at each time point due to missing activPAL™ data, hence we cannot directly compare the different curves.

Longitudinal analyses of sedentary behaviour

Median sedentary time was 19.9 h (IQR = 18.4-22.1), 19.1 h (IQR = 17.8-20.8) and 19.3 h (IQR = 17.3-20.9) for consecutive assessments, respectively. Median and IQR values for all dependent measures and all assessments are shown in Table 2.

The results of Model 1 revealed no main effect of time on any of the sedentary behaviour metrics, indicating no significant change in sedentary behaviour per unit time (i.e. six months) (Table 3). A higher NIHSS severity score was associated cross-sectionally with greater sedentary time (β=0.11, S.E.=0.05, *P*=0.020). Weighted median sedentary bout lengths were higher for every year increase in age (β=0.02, S.E.=0.01, *P*<0.011).

Next, we added measures of functional ability, NEADL and 6MWD, as covariates into separate models (Models 2 and 3). Model 2 again revealed no main effects of time on sedentary behaviour. A higher NEADL score was associated cross-sectionally with less sedentary time (β=-0.11, S.E.=0.01, *P*<0.001), a shorter weighted median sedentary bout length (β=-0.08, S.E.=0.02, *P*<0.001) and higher fragmentation suggesting that patients interrupted sitting more often (β=0.10, S.E.=0.02, *P*<0.001). No main or interaction effects were found in Model 3 which included 6MWD as covariate (Table 3).

In summary, there were no longitudinal changes in the amount or pattern of sedentary behaviour for this patient cohort in the first year after stroke.

<u>Longitudinal analyses of functional ability</u>

There were no significant longitudinal changes in NEADL scores (Model 4) or in 6MWD (Model 5). Thus, functional ability did not improve significantly in the first year after stroke. NEADL scores were lower for every year increase in age (β=-0.01, S.E.=0.01, *P*<0.05). A higher NIHSS severity score was associated cross-sectionally with a lower NEADL (β=-0.14, S.E.=0.04, *P*<0.001), and also with a greater improvement in NEADL over time (β=0.05, S.E.=0.05, $P<0.01$). Further, a higher NIHSS severity score was associated cross-sectionally with a lower 6MWD ($\beta=-0.26$, S.E.=0.08, $P < 0.001$) (Table 4).

DISCUSSION

The principal finding of this study is that stroke survivors spent a large proportion of their day (19.5 h, 81%) in sedentary behaviour. Moore et al.[14] reported higher total sedentary time of 22.5 h overall compared to our study, however they may have overestimated true sedentary time by including all activities with less than three metabolic equivalents that might include quiet standing and slow paced walking.[34] Our value of total sedentary behaviour time is higher than previously reported sedentary time in healthy older adults of similar age who typically spend around 17 h (71%) sedentary.[1, 25] Further, patients with stroke tended to have prolonged, uninterrupted bouts of 1.7 h. Importantly, this pattern of sedentary behaviour did not change in the first year following stroke and was independent of functional ability. Thus, functional status was not reflected in sedentary behaviour.

The present results are surprising, because one would expect that survivors become less sedentary over time as suggested by Moore et al.[14], reflecting partial recovery of functional ability. In contrast, in our study longitudinal patterns of sedentary behaviour were not explained by functional ability. Indeed, most patients in our sample lived at home and reported high levels of functional independence, and yet they spent a large part of the day in prolonged sedentary pursuits.

Too much time spent in sedentary behaviour, especially when accrued in long, continuous bouts, is detrimental to cardiometabolic health.[4, 8-11] Therefore, our results strongly suggest that the increased cardiovascular risk after stroke might be exacerbated by the sedentary profile of stroke survivors. The finding of a sedentary lifestyle in people living with stroke -

despite adequate functional ability - underscores the importance of targeting behavioural change (including sedentary behaviour) in addition to functional ability in interventions. Thus, specific interventions aimed at reducing sedentary behaviour in stroke patients should be considered as a promising novel therapeutic target in order to prevent further cardiovascular complications.

Another finding of this study is that higher stroke severity was associated with greater sedentary behaviour. This is not surprising given that mobility impairments after stroke tend to be associated with more severe strokes. Interestingly, although many of the stroke survivors in our cohort had made a good functional recovery and were able to mobilise independently, they spent long periods of time sitting. We acknowledge that breaking up sedentary time in stroke survivors who are unable to mobilise independently may be challenging. An intervention targeted at reducing sedentary behaviour could offer a feasible approach to start behavioural change in this group.[35]

The diurnal pattern observed here is different from the (inverse) activity profiles commonly found in healthy people which typically show two peaks of activity mid-morning and afternoon.[36] In contrast, our study cohort tended to be the least sedentary mid-morning, followed by a continuous increase in sedentary time in the afternoon and evening. This could be related to energy depletion in the morning resulting in afternoon fatigue. Further, the sedentary behaviour profiles in the present stroke cohort resemble activity patterns found in patients with Parkinson's disease[36], suggesting that these might be a feature of certain neurological conditions.

Reducing the prolonged sedentary bouts in the afternoon and evening may be a suitable target for intervention. An alternative would be to promote activity pacing by segmenting physical activity into short bouts of activity, interrupting sedentary time throughout the day. Indeed, preliminary evidence suggests that frequently interrupting sedentary time may have beneficial effects on metabolic health and haemostasis[9, 37] highlighting that both the amount and patterns of sedentary behaviour are important for health.

This study has several strengths. It is the first to explore longitudinal patterns in objectively-measured sedentary behaviour over the first year after stroke. The present sample size is larger compared to similar-type studies including the study by Moore at al.[14], and participants were followed up during a longer period of time. Further, it is the first study to take into account functional ability. Sedentary behaviour was measured objectively with a valid body worn sensor which is regarded as gold standard compared to other sensors and by self-report.[38, 39] We used a number of validated measures to obtain a more complete picture of the pattern and dynamics of sedentary behaviour after stroke.[6] We have also shown the diurnal sedentary time curves in stroke patients.

Study Limitations

There are limitations. We obtained valid body worn sensor data from only 71% of the original sample. This is substantially higher than previously reported compliance rates[40], but may nonetheless have introduced differential bias. However, the final study sample (i.e. patients with at least one valid activPAL™ recording) did not differ from the original sample with respect to baseline characteristics. Some patients did not attend follow-up assessments for a variety of reasons. The majority of the patients in our cohort had minor neurological deficits. These factors limit the generalisability of findings. It should be noted however that patients with more severe stroke are likely to spend even more time in sedentary activities compared to the present cohort as suggested by our results. A number of other factors not addressed here may have predisposed patients to a sedentary lifestyle, including fatigue, depression and anxiety.[41-43] Further research into the determinants of sedentary behaviour after stroke is needed to inform targeted interventions.

A trend toward improvement in functional ability over time was noted, but this did not reach statistical significance. There are several possibly reasons for this: the stroke survivors whom we recruited had already reached a plateau of functional recovery; the study was not powered enough for NEADL and 6MWD; or these measures did not have sufficient responsiveness. Indeed, the changes in NEADL and 6MWD we observed were smaller than the minimal detectable changes reported for these measures.[27, 32]

Conclusions

This study shows that stroke survivors are highly sedentary and that the amount of time they spend sedentary does not change over the first year after stroke, independently of their functional ability. Thus, any change in functional ability is unlikely to transfer to a decrease in sedentary time. The present findings highlight that modifying sedentary behaviour might be a new therapeutic target to consider in rehabilitation programs.

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FIGURE LEGENDS

Figure 1. Study CONSORT diagram. Data were considered invalid when the data file contained less than a full day of activPAL recording, or when the recording contained obvious spurious data (e.g. due to an interruption in wearing time). Of the 96 participants with ≥1 valid activPAL recording, data were missing for 7 (7%), 18 (19%) and 29 (30%) participants at one month, six months and twelve months, respectively.

Figure 2. Boxplots of sedentary behaviour metrics at one month (N=75), six months (N=64) and twelve months (N=58) following stroke (N=96 with ≥1 valid activPAL recording): (A) total sedentary time, (B) weighted median sedentary bout length and (C) fragmentation index. Open circles and asterisks on the plots represent outliers and extreme outliers (i.e. a value more than three times the height of the box), respectively.

Figure 3. Diurnal sedentary time curves obtained through activity monitoring showing the average time (min) spent in sedentary behaviour for each hour of the day. The values at hour 1 represent the summed sedentary time from midnight to 1am. Error bars represent standard errors. Profiles are shown for one month (N = 75), six months (N = 64) and twelve months (N = 58) following stroke.

N	96
Male	64
Age (years)	72.2 (64-80)
NIHSS score	2 (1-3)
Mild stroke (NIHSS ≤4)	79
Moderate stroke (NIHSS>4)	15
Unknown	2
Previous stroke	20
Stroke Subtype (OCSP)	
TACS	5
PACS	33
LACS	28
POCS	30
History of diabetes	16
History of hypertension	48

Table 1. Demographic and clinical characteristics at baseline. Values are median (IQR) or number (N) unless otherwise stated.

NIHSS = National Institutes of Health Stroke Scale; OCSP = Oxford Community Stroke Project Classification; TACS = Total Anterior Circulation Infarct; PACS = Partial Anterior Circulation Infarct; LACS = Lacunar Infarct; POCS = Posterior Circulation Infarct.

	1 month			6 months			12 months		
	N	median	IQR	N	median	IQR	N	median	IQR
Sedentary behaviour									
Total sedentary time (h)	75	19.9	18.4-22.1	62	19.1	17.8-20.8	56	19.3	17.3-20.9
Weighted median sedentary bout length (h)	72	1.65	1.35-2.21	63	1.71	1.36-2.09	56	1.70	1.33-2.20
Fragmentation Index	74	2.21	1.70-2.88	63	2.41	1.87-2.96	57	2.48	1.91-2.94
Functional ability									
NEADL	94	16	10-20	81	19	15-21	71	20	15-21
6MWD (m)	49	432	348-488	41	455	322-498	30	477	438-515

Table 2. Number of cases, median, and inter-quartile range (IQR) for measures of sedentary behaviour and functional ability at one, six and twelve months following stroke.

6MWD = six-minute walking distance; NEADL = The Nottingham Extended Activities of Daily Living Questionnaire.

	Total sedentary time		**Median sedentary bout length**		**Fragmentation index**	
	Estimate (Std. Error)		Estimate (Std. Error)		Estimate (Std. Error)	
Model 1						
(Intercept)	0.52	(0.31)	-0.26	(0.32)	-0.43	(0.34)
time	-0.10	(0.18)	-0.16	(0.28)	0.08	(0.21)
age	0.00	(0.01)	0.02	(0.01) *	-0.02	(0.01)
sex	-0.41	(0.21)	0.15	(0.22)	0.36	(0.24)
severity	0.11	(0.05) *	0.07	(0.05)	-0.09	(0.05)
time x age	0.01	(0.01)	-0.01	(0.01)	-0.01	(0.01)
time x sex	0.01	(0.12)	0.18	(0.19)	-0.04	(0.14)
time x severity	-0.04	(0.03)	-0.09	(0.04) *	0.05	(0.03)
Model 2						
(Intercept)	0.43	(0.22)	-0.23	(0.29)	-0.37	(0.28)
time	0.08	(0.20)	-0.13	(0.29)	-0.02	(0.23)
age	-0.01	(0.01)	0.02	(0.01)	-0.01	(0.01)
sex	-0.37	(0.16) *	0.12	(0.20)	0.33	(0.20)
severity	0.02	(0.03)	0.03	(0.05)	-0.02	(0.04)
NEADL	-0.11	(0.01) †	-0.08	(0.02) †	0.10	(0.02) †
time x age	0.01	(0.01)	-0.01	(0.01)	-0.01	(0.01)
time x sex	-0.04	(0.14)	0.19	(0.19)	-0.03	(0.15)
time x severity	0.00	(0.03)	-0.08	(0.05)	-0.37	(0.28)
time xNEADL	0.02	(0.02)	0.02	(0.02)	-0.02	(0.23)

Model 3						
(Intercept)	-0.62	(0.37)	-0.55	(0.41)	0.43	(0.45)
time	0.01	(0.25)	-0.38	(0.49)	-0.08	(0.35)
age	-0.01	(0.01)	0.01	(0.01)	0.00	(0.01)
sex	0.16	(0.26)	0.14	(0.29)	-0.06	(0.32)
severity	0.09	(0.07)	0.01	(0.08)	-0.09	(0.08)
6MWD	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
time x age	0.00	(0.01)	-0.02	(0.02)	-0.01	(0.01)
time x sex	-0.08	(0.16)	0.37	(0.32)	0.10	(0.23)
time x severity	0.02	(0.05)	-0.06	(0.09)	-0.03	(0.07)
time x 6MWD	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)

Table 3. Linear mixed model results for the dependent variables total sedentary time, median sedentary bout length and fragmentation index. Covariates included in all models are: age, sex and stroke severity (as measured with the National Institute of Health Stroke Scale). Model 2 and 3 also account for the Nottingham Extended Activities of Daily Living (NEADL) and 6-minute walk distance (6MWD), respectively.

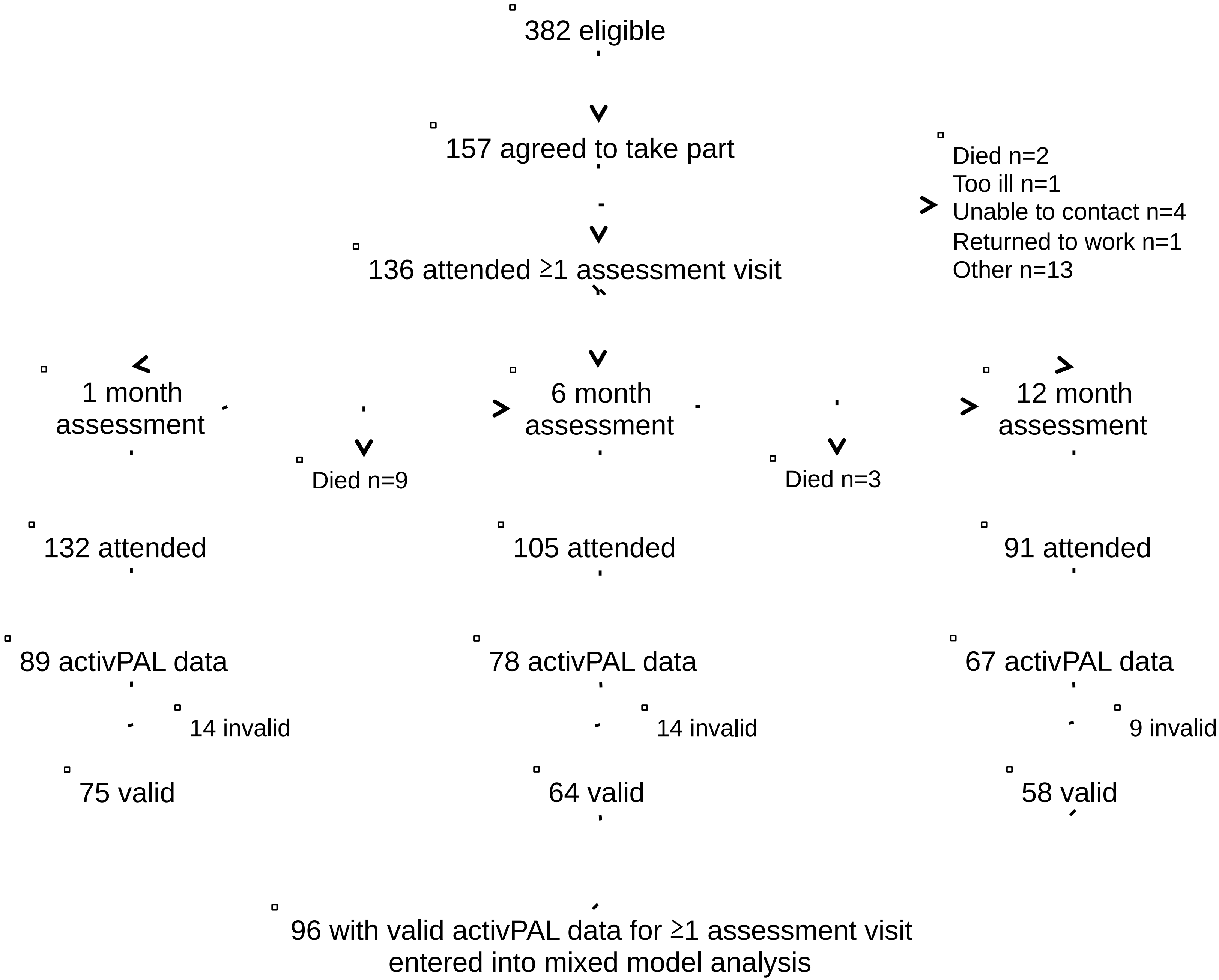
Note: the table shows the fixed effect estimates from the linear mixed models. * $p<0.05$, † $p<0.001$.

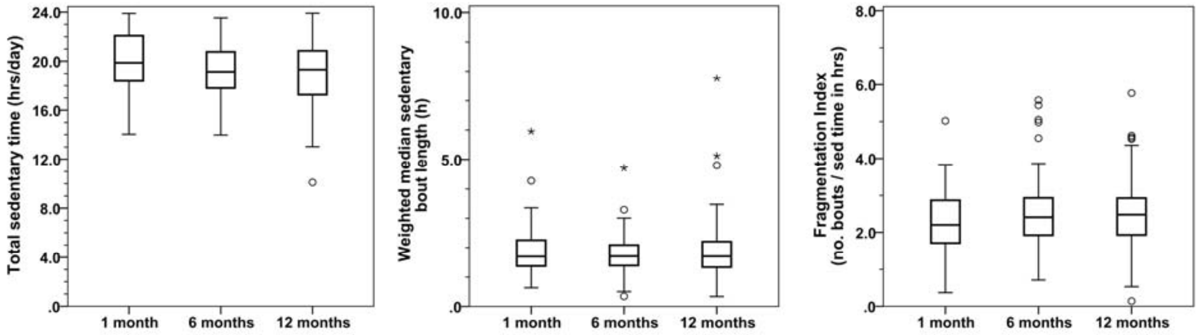
	NEADL (Model 4)		**6MWD (Model 5)**	
	Estimate (Std. Error)		Estimate (Std. Error)	
(Intercept)	0.29	(0.26)	0.41	(0.45)
time	0.08	(0.11)	0.14	(0.11)
age	-0.01	(0.01) *	-0.02	(0.01)
sex	-0.12	(0.18)	-0.36	(0.32)
severity	-0.14	(0.04)	-0.26	(0.08) †
time x age	0.00	(0.00)	-0.01	(0.00)
time x sex	0.09	(0.07)	0.02	(0.07)
time x severity	0.05	(0.02) *	0.02	(0.02)

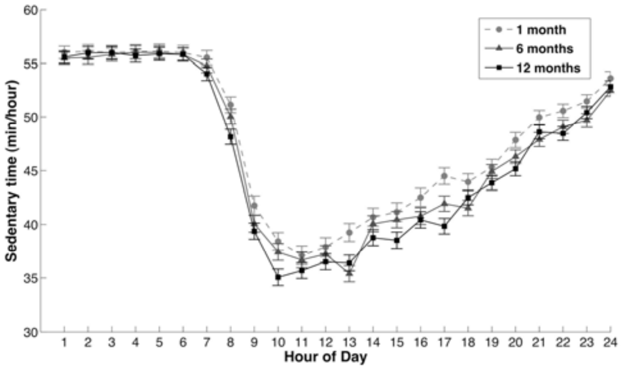
Table 4. Linear mixed model results for the dependent variables Nottingham Extended Activities of Daily Living (NEADL; model 4) and 6-minute walk distance (6MWD; model 5). Covariates included in all models are: age, sex and stroke severity (National Institute of Health Stroke Scale).

Note: the table shows the fixed effect estimates from the linear mixed models.

*p<0.05, †p<0.001.


382 eligible
157 agreed to take part
Died n=2
Too ill n=1
Unable to contact n=4
Returned to work n=1
Other n=13
136 attended ≥1 assessment visit
1 month assessment
6 month assessment
12 month assessment
Died n=9
Died n=3
132 attended
105 attended
91 attended
89 activPAL data
78 activPAL data
67 activPAL data
14 invalid
14 invalid
9 invalid
75 valid
64 valid
58 valid
96 with valid activPAL data for ≥1 assessment visit entered into mixed model analysis


Total sedentary time (hrs/day)
24.0
20.0
16.0
12.0
8.0
4.0
.0
1 month
6 months
12 months
Weighted median sedentary bout length (h)
10.0
5.0
.0
1 month
6 months
12 months
Fragmentation Index (no. bouts / sed time in hrs)
8.0
6.0
4.0
2.0
.0
1 month
6 months
12 months



60
55
50
45
40
35
30
Sedentary time (min/hour)
1 month
6 months
12 months
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour of Day