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Changes in sedentary behavior in the chronic phase following stroke

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ABSTRACT

Background: Sedentary behavior increases risk for cardiovascular diseases. Little is known about sedentary behavior through the chronic phase after stroke. We aimed to describe how long and short bouts of sedentary behavior changed over the first three years after stroke and if cognition at baseline was an independent risk factor for sedentary behavior.
Methods: This is a sub-study of the Norwegian cognitive impairment after stroke (Nor-COAST) study, a multi-center study recruiting patients with acute stroke. Sedentary behavior was monitored with a thigh-worn sensor (ActivPal3®), at three-, 18- and 36-months post stroke. Stroke severity was assessed by National Institutes of Health Stroke Scale (NIHSS) and cognition by Montreal cognitive assessment (MoCA). Mixed model analysis with mean number of sedentary minutes accumulated daily as the dependent variable was repeated for all four zones (<30min, 30-60min, 60-90min, >90min) and for total sedentary time.
Results: The number of included participants was 528 (mean age 71.4, NIHSS on day 1, 2.7). The total amount of sedentary time accumulated between 08.00-22.00 increased significantly from about 9.8 hours at three months to 10.1 hours at 36 months post stroke (p=0.002). Patient characteristics associated with prolonged duration of the sedentary bouts and sedentary time were age, high BMI, comorbidities, and impaired physical function. No significant associations between MoCA score and sedentary time were found.
Conclusion: The participants became increasingly sedentary and had fewer breaks in sedentary time from three to 36 months after stroke. Baseline cognition was not related to later sedentary behavior.

Introduction

Sedentary behavior, commonly defined as “any waking behavior characterized by an energy expenditure of ≤ 1.5 metabolic equivalents while in a sitting, reclined or lying position”, is an independent risk factor for cardiovascular diseases (CVD), including stroke, as well as for type 2 diabetes.[1] It is also linked to increased mortality, both for all-cause mortality and CVD mortality.[2-5] Sedentary behavior accumulated in longer, uninterrupted bouts is shown to be most harmful, especially for the least active individuals.[5] This may be due to other common risk factors for CVD in this population, such as increased waist circumference, blood glucose, triglycerides, change in insulin sensitivity and increased levels of the inflammatory biomarker C-reactive protein.[6,7]

It has been shown that older people with CVD spend the majority of their waking day sedentary.[8] This finding also applies to the stroke population with stroke survivors spending more than 78% of their waking time sedentary regardless of time since stroke.[9] Multiple factors, such as cognition, education, socioeconomic status, and sex have also been thought to influence movement behavior. Cognitive decline seems to impact sedentary behavior negatively through poorer executive functioning, while the male sex is associated with higher activity levels and less sedentary time.[10-12] Likewise, higher education and socio-economic status have been linked to higher levels of physical activity, especially during leisure time.[11,13,14]. However, higher education has also been linked to higher sedentary behavior levels. This is possibly due to an office-based workplace.[15] Likewise, the population of high-income countries tend to be more inactive than low-income

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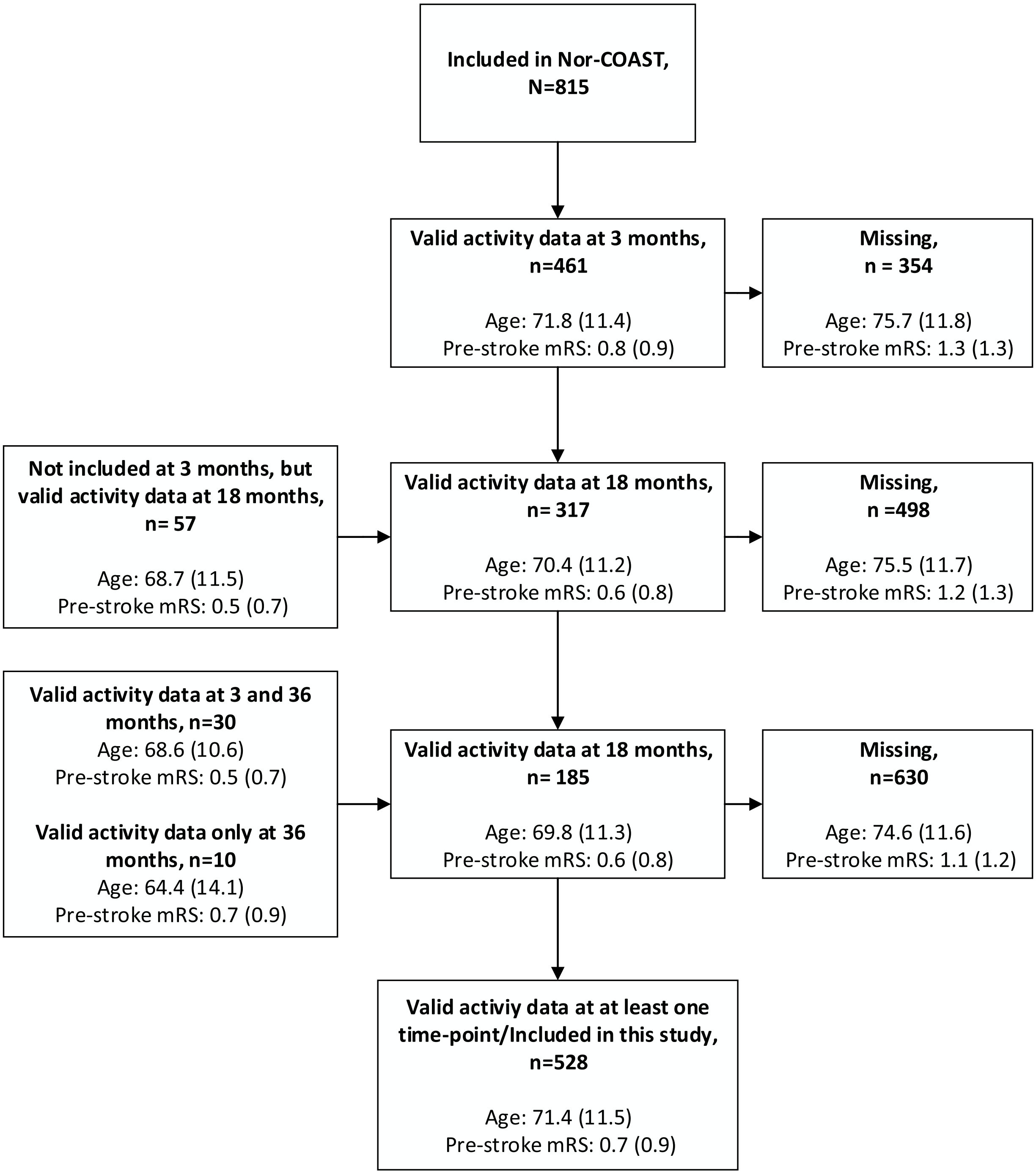

Fig. 1. Flow-chart for inclusion of participants
Abbreviations: Nor-COAST (*The Norwegian Cognitive impairment after stroke study*), pre-stroke mRS (*pre-stroke modified Rankin scale*).
Inclusion criterion: The final number of included participants consists of all participants who wore the accelerometer at at least one time point, meaning that they wore it at either 3, 18 or 36 months post stroke.

countries.[10,11]

Physical activity has been implemented as an important part of rehabilitation and secondary prevention following stroke, due to its positive effects on motor function and potential for improving cardiovascular health.[16] However, many stroke survivors suffer from barriers to physical activity such as fatigue, lowered endurance, and reduced motor function[16] as well as cognitive decline.[12] Therefore, a more feasible treatment option could be to motivate patients to reduce sedentary behavior by breaking up long periods of sitting time with short bouts of physical activity.[16] The positive effects of interrupting long bouts of sedentary behavior on blood pressure levels in stroke survivors have been documented in a previous study[17]. The study demonstrated that frequent, short activity breaks across the day provided a similar reduction in systolic blood pressure as performing moderate-to-vigorous intensity exercise regularly.[17] This shows the potential of using sedentary breaks as an important part of the treatment plan post stroke. However, first, we need to increase our knowledge about the natural course of sedentary behavior after stroke, how it develops over time and how it is associated with different risk factors.

A recent study showed that cognitive decline is associated with

Table 1
Baseline characteristics for participants with and without valid activity data

Baseline characteristics	Activity data			Missing activity data		
	N	Mean (SD) or n (%)		N	Mean (SD) or n (%)	
Demographics						
Age	528	71.4	(11.5)	287	77.5	(11.0)
Male sex	528	311	(58.9%)	287	138	(48.1%)
Housing conditions	528			287		
Living alone		166	(31.4%)		132	(46.0%)
Living with someone		362	(68.6%)		146	(50.9%)
Institution		0	(0.0%)		9	(3.1%)
Education (years)	528			287		
<=7		43	(8.1%)		61	(21.3%)
8-11		184	(34.9%)		122	(42.5%)
>=12		301	(57.0%)		104	(36.2%)
Assessments						
NIHSS on day 1 (0-42)	517	2.7	(3.9)	273	5.3	(6.4)
Mild stroke (0-4)		426	(82.4%)		176	(64.5%)
Moderate stroke[5-10]		82	(15.9%)		75	(27.5%)
Moderate to severe stroke[10-20]		4	(0.8%)		8	(2.9%)
Severe stroke (>20)		5	(0.1%)		14	(5.1%)
MoCA at baseline (0-30)	482	24.5	(4.8)	178	20.9	(5.7)
<=17		44	(9.1%)		50	(28.1%)
18-25		155	(32.2%)		72	(40.4%)
>=26		283	(58.7%)		56	(31.5%)
Pre-stroke mRS (0-5)	526	0.7	(0.9)	285	1.5	(1.4)
0 (no symptoms)		274	(52.0%)		104	(36.5%)
1 (no significant disability despite symptoms)		147	(28.0%)		47	(16.5%)
2 (slight disability)		73	(13.9%)		59	(20.7%)
3 (moderate disability)		30	(5.7%)		48	(16.8%)
4 (moderately severe disability)		2	(0.4%)		25	(8.8%)
5 (severe disability)		0	(0.0%)		2	(0.7%)
Charlson comorbidity index	528	3.8	(1.9)	287	4.8	(2.2)
SPPB (0-12)	489	8.1	(3.7)	254	4.7	(4.4)
<7 (low score)		143	(29.2%)		156	(61.4%)
>=7 (high score)		346	(70.8%)		98	(38.6%)
Stroke subtype	528			287		
Cerebral infarction		484	(91.7%)		253	(88.2%)
Cerebral hemorrhage		44	(8.3%)		34	(11.9%)
Mean BMI, kg/m^2	500	26.1	(4.2)	243	25.6	(4.3)

Abbreviations: SD*(Standard deviations)*, NIHSS (*National Institutes of Health Stroke Scale)*, pre-stroke mRS (*pre-stroke modified Rankin scale*), MoCA (*Montreal Cognitive Assessment)*, SPPB (*Short Physical Performance Battery)*, BMI (*Body Mass Index)*.

reduced adherence to physical activity recommendations after stroke, while previous studies investigating how cognition influences sedentary behavior in stroke patients are sparse.[18] Edwards et al. propose a conceptual-based neurocognitive affect-related model that links executive function, affect and future exercise.[19] This model emphasizes the importance of executive functioning when trying to maintain a consistent exercise routine, as executive function is central to fulfill a future goal.[20] Since planning, maintaining efforts despite distractions and inhibiting goal-inconsistent responses (here; long bout sedentary behavior) are important factors in rehabilitation/the chronic phase after stroke we could suppose that cognition and sedentary behavior are linked.[21]

A systematic review and meta-analysis examining the association between sedentary time and cognitive function in middle-aged and older adults showed no overall association between cognition and sedentary time.[22] However, the sub-group analysis showed a negative association with more sitting resulting in worse global cognitive function and processing speed for studies using a device to capture sedentary behavior.[22] Still, the same study concluded that more research on the field is needed to draw firm conclusions.[22]

The primary aim of this study was to describe how long and short bouts of sedentary behavior changed over the first three years after stroke. Our secondary aim was to investigate whether normal, slightly impaired, and impaired cognition at baseline was an independent risk factor for sedentary behavior.

Methods

Study design

This is a sub-study of the Norwegian Cognitive Impairment After Stroke study (Nor-COAST), a prospective cohort study recruiting patients with acute stroke in five Norwegian hospitals from May 2015 until March 2017[23]. The aim of the Nor-COAST study was to quantify and measure levels of cognitive impairments in a general Norwegian stroke population and to identify biological and clinical markers associated with prognosis for cognitive disorders following incident stroke.[23]

Participants

Participants eligible for inclusion in Nor-COAST were 1) admitted to a participating center within seven days after symptom onset, 2) diagnosed with acute stroke according to the WHO criteria or with MRI imaging (both first and recurrent stroke), 3) fluent in a Scandinavian language, 4) over 18 years of age, and 5) living in the catchment area of the recruiting hospitals. Those with an expected survival of less than three months were excluded. Eligible patients were included if they were able and willing to sign informed consent. Patients who were not able to give informed consent were also included if their next of kin gave oral consent to participation. The participants were recruited during the hospital stay.[23]

The only additional inclusion criterion for this sub-study was a valid activity registration at least one time point (either at three, 18 or 36 months).

Ethics

The Nor-COAST study was approved by the Regional Committee for Medical and Health Research Ethics (REC Nord 2015/171) and registered in ClinicalTrials.gov (NCT02650531). Further details are described in the protocol for the Nor-COAST study.[23]

Data collection

Participants were assessed during the initial hospital stay and at three-, 18- and 36-months post stroke (Fig. 1). At these four time points they completed a comprehensive test battery consisting of physical and cognitive tests, blood samples and neuroimaging. General information from the participants, such as demographic variables, past medical history, cardiovascular risk factors and function before the stroke, was obtained through hospital records and self-reports. The stroke severity was evaluated with the National Institutes of Health Stroke Scale (NIHSS)[24]. A mild stroke was defined by a NIHSS score $\leq$ 4. The Montreal Cognitive Assessment (MoCA) was used to assess cognitive function, with scores ranging from 0-30.[25,26] Higher MoCA scores indicate greater cognitive abilities. The pre-stroke Modified Rankin Scale (mRS) was used to measure the persons pre-stroke level of function.[27] Participants' physical performance was assessed with the Short Physical Performance Battery (SPPB) during the hospital stay, with scores ranging from 0-12 and higher scores denoting better function[28]. Data obtained at baseline was used in the statistical analyses.

We monitored the participant's activity and sedentary behavior patterns with the ActivPal device, (ActivPal3®, Model 20.2, PAL Technologies Ltd., Glasgow, United Kingdom). The activPAL uses an accelerometer to obtain information about position and activity. With a sampling frequency of 20 Hz, totals for the time spent lying/sitting, standing and stepping, every second of the day, is generated.

Table 2
Change in sedentary behavior over time measured in minutes. Linear mixed model with time as categorical covariate.

Distribution of daily sedentary time	3 months, n=461	18 months, n=317				36 months, n=185				Overall, n=528		
	Estimated daily sedentary time (minutes)	Estimated daily sedentary time (minutes)	Estimated change in minutes (3-18 months)	95% CI	p-value (3–18 months)	Estimated daily sedentary time (minutes)	Estimated change in minutes (18-36 months)	95% CI	p-value (18-36 months)	Estimated change in minutes (3-36 months)	95% CI	Total change: p-value (3-36 months)
Zone 1 (< 30 min)	232.9	224.5	-8.4	-15.5 to -1.4	0.020	218.4	-6.1	-15.1 to 2.8	0.180	-14.6	-23.2 to -5.9	0.001
Zone 2 (30-60 min)	148.7	148.8	0.0	-6.0 to 6.1	0.988	155.2	6.4	-1.3 to 14.2	0.101	6.5	-0.9 to 13.9	0.085
Zone 3 (60-90 min)	89.8	90.4	0.6	-5.1 to 6.3	0.835	98.4	8.1	0.9 to 15.3	0.029	8.7	1.7 to 15.6	0.015
Zone 4 (> 90 min)	118.1	130.4	12.3	-0.3 to 24.9	0.056	129.9	-0.5	-16.4 to 15.5	0.956	11.9	-3.6 to 27.3	0.134
Total	588.8	596.3	7.5	-1.8 to 16.8	0.112	606.8	10.5	-1.2 to 22.1	0.079	18.0	6.6 to 29.4	0.002

Abbreviations: CI (*Confidence interval*). Total shows the mean total time spent sedentary each day.
The statistically significant p-values (<0.05) are highlighted.

Furthermore, a semi-automatic algorithm was used to extract the bouts of sedentary behavior reported in this paper.[29] ActivPAL has shown to obtain reliable and valid data of position and activity in the stroke population.[30]

When all clinical tests were completed, the ActivPal sensor was attached to the unaffected thigh at each follow-up at the outpatient clinic and returned by mail. The participants were instructed to avoid swimming and bathing but could otherwise live as usual.

The participants wore the accelerometer for 24 hours for seven days following all four examinations in the study, however data from baseline was not included in our analyses. All recordings with a duration of at least four days were considered valid. Nighttime was set from 22.00 to 08.00.

In this study, we defined sedentary behavior as time spent immobile in a seated or lying position. The threshold for noise was 1.5 seconds and sedentary bouts were merged if the break lasted three seconds or less. Four zones of sedentary bout length were established to investigate the activity patterns of the participants: Zone 1: 10 seconds-30 minutes, Zone 2: 30-60 minutes, Zone 3: 60-90 minutes and Zone 4: > 90 minutes. The bout length and frequency data were derived using a MATLAB script (V.R2016b MathWorks, Natick, Massachusetts, USA). The lower boundary of 10 seconds in Zone 1 is in line with the default setting in the ActivPAL software[31]. In this paper we report time accumulated in the predefined bouts and total accumulated sedentary time as recommended by the Sedentary Behavior Research Network (SBRN)[1].

Statistics

Descriptive statistics are given as mean and standard deviation (SD) for continuous variables and as counts and percentages for categorical variables (Table 1).

We performed mixed model analysis with mean number of minutes accumulated in sedentary behavior as the dependent variable and participant as random effects. This was repeated for all four zones and for total sedentary time accumulated. For the primary aim, time as three category variable (3 months, 18 months, and 36 months), was the independent variable. For the secondary aim, time as three category variable and MoCA score as a continuous variable (centered at 28, 23 or 14 to represent normal, slightly impaired or impaired cognition), and their interaction were the independent variables of primary interest.[26,32,33] The interaction term shows whether the change of sedentary behavior over time depends on MoCA, and this was investigated by the likelihood ratio test. Age, sex, years of education, pre-stroke mRS and NIHSS scores along with Charlson comorbidity index and living arrangement (living alone or with someone) were included as potential confounders of secondary interest.

The mixed model analysis includes data from all 528 participants with valid recordings from at least one follow-up assessment. The results of mixed model analyses are unbiased if data are missing at random. In contrast, a complete case analysis restricted to the 120 participants that attended all three follow-ups, would be unbiased only under the more restrictive missing completely at random assumption and have less statistical power.

The normal distribution of the residuals was checked by visual inspection of QQ-plots. Statistical significance was defined as two-sided $p<0.05$.

The effect sizes are reported on the original scale, such as change in minutes in Table 2, and in accordance with our research aim we have investigated the change in sedentary behavior with time. Thus, explained variance and covariance structure are not reported as they have little relevance to the research aims.

All analyses were performed using Stata 17.0 and SPSS 27.

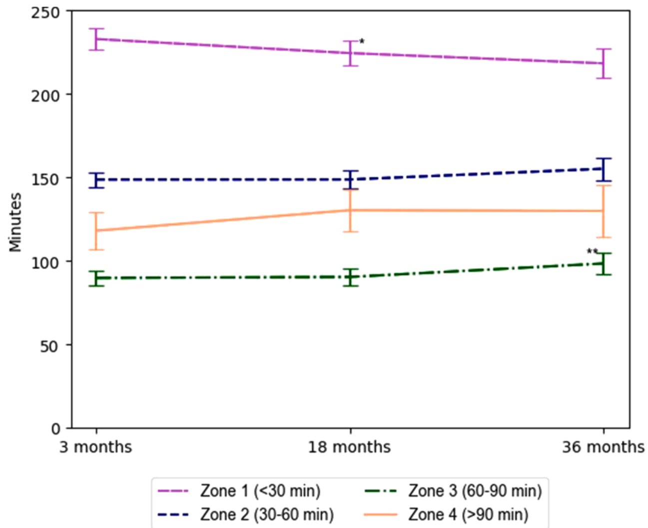

Fig. 2. Time spent sedentary from three to 36 months post-stroke, measured in minutes. Linear mixed model with time as categorical co-variate, unadjusted analysis (n=528)
*p-value of the change from 3 to 18 months p=0.02
**p-value of the change from 18 to 36 months p=0.029

Results

Participants characteristics

A total of 815 participants were included in the Nor-COAST study. Of these, 528 fulfilled the inclusion criteria for this sub-study (Fig. 1).

The mean age of the 528 people included was 71.4 years (SD: 11.5), ranging from 33 to 96 years. They were overall highly educated (12.6 years (SD: 0.2)) and 311 (58.9%) were male. Cognitively, the mean MoCA score at baseline was 24.5 points (SD: 4.8), indicating that the average participant scored at the cut-off between normal cognition and mild cognitive impairment[32,33]. The mean NIHSS score in the population on day one following hospital admission (2.7 points (SD: 3.9)) suggests that most participants underwent mild strokes. See Table 1 for details.

Additionally, there were some sex differences in our study. In general, the men were younger (70.4 years versus 72.8 years for women), higher educated (13.1 years versus 11.9 years for women), had better function pre-stroke (55% had no disability pre-stroke, versus 48% of the women) and more men lived with someone (78% versus 54% of the women).

Change in sedentary behavior

The course of sedentary behavior over time is illustrated in Fig. 2.

The results from the unadjusted mixed models analysis are found in table 2. The total amount of sedentary time accumulated between 8.00 and 22.00 changed significantly by 18 minutes from 588.8 minutes (i.e., 9.8 hours) at three months to 606.8 minutes (i.e., 10.1 hours) at 36 months post stroke (p=0.002).

After adjusting for all covariates, time spent in Zone 1 (bouts <30 minutes) decreased by 9.38 minutes (95% CI -16.90 to -1.86, p= 0.015) while time spent in Zone 4 (bouts > 90 minutes) increased by 17.56 minutes (95% CI 4.32 to 30.79, p=0.009), from 3 to 18 months.

The corresponding changes from 3 to 36-month follow-up, showed a decrease of 14.18 minutes (95% CI -23.37 to -4.98, p=0.003) in Zone 1

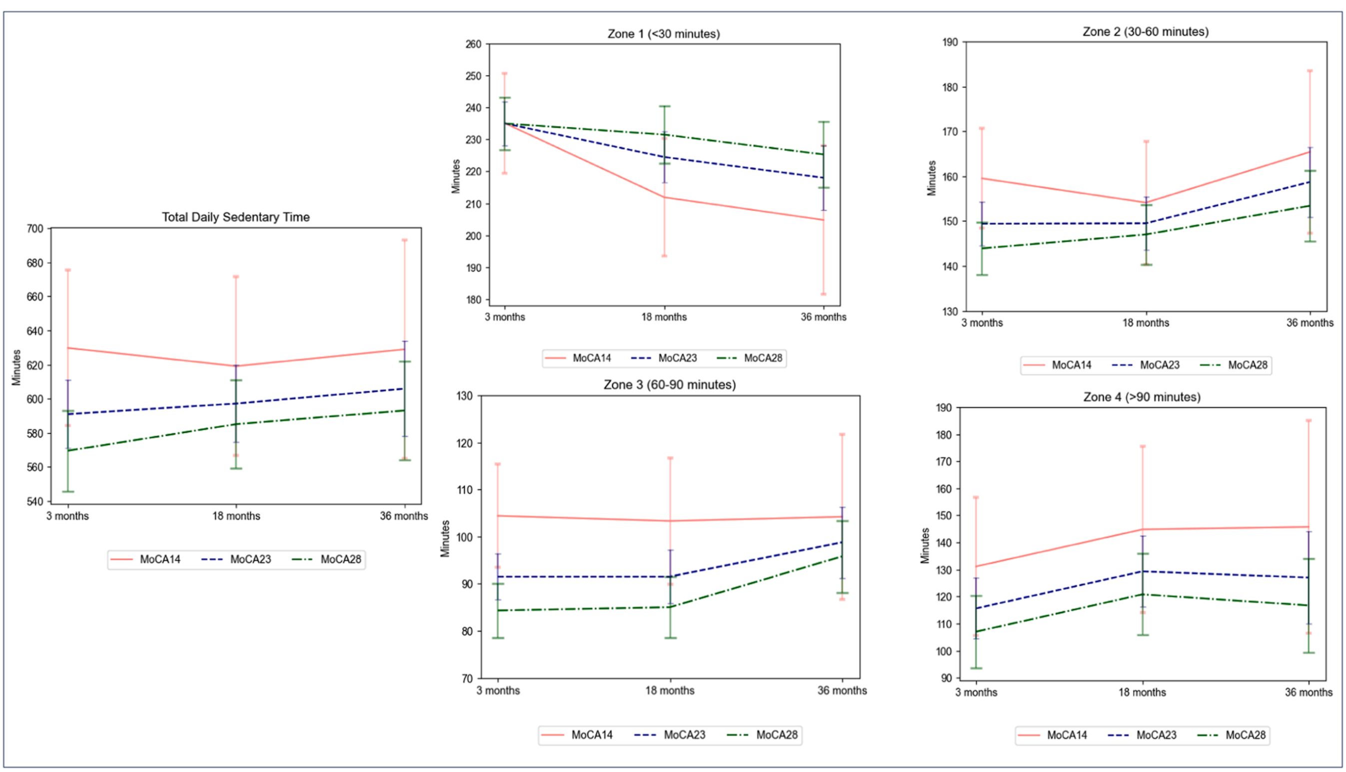

Fig. 3. Estimated means of sedentary behavior over time, based on unadjusted linear mixed models (n=528)
Abbreviations: MoCA (*Montreal Cognitive Assessment)*. MoCA14, MoCA23 and MoCA28: MoCA scores were centered at 14, 23 or 28 to represent impaired, slightly impaired, or normal cognition.

(bouts < 30 minutes), an increase of 10.12 minutes (95% CI 2.38 to 17.86, p=0.010) in Zone 2 (bouts of 30 to 60 minutes), and an increase of 10.05 minutes (95% CI 2.78 to 17.32, p=0.007) in Zone 3 (bouts of 60 to 90 minutes).

Cognitive function and risk of sedentary behavior

Despite decreasing time spent in Zone 1, especially for participants with impaired cognition (MoCA score centered at 14), the mixed model analysis showed no significant association between cognition at baseline and later sedentary behavior for any of the sedentary behavior zones. The results from the estimated marginal means, derived from the unadjusted and adjusted mixed model analysis, are found in Figs 3 and 4, respectively.

Discussion

In this study, we found a significant increase in the total time spent sedentary from three months to 3 years post stroke. Furthermore, we identified that the long-bout sedentary behavior increased from three to 18- and 36-months post-stroke. When looking at the connection between cognitive function and sedentary behavior we did not find any significant associations.

The stroke survivors in our study population spent about 10 out of 14 wake hours sedentary each day during the chronic phase. Such low activity levels are in line with previous research showing that stroke survivors are highly inactive compared to the general population.[8,9,34-36] These levels of inactivity are shown to increase the mortality risk, and the risk of dementia and mild cognitive impairment.[34-39]

The participants tended to spend progressively more time in longer uninterrupted bouts of sedentary behavior >60 minutes (Z3 and Z4) during the chronic phase. This was especially prominent for bouts of 60-90 minutes (Z3). The increased sedentary time might be due to a decline in motor function and mobility which most stroke survivors experience over time.[16] However, it might also be the other way around, that the loss of physical abilities is due to inactivity. Factors such as age, comorbidity burden and frailty may also influence the amount of sedentary behavior.[10,11] Interestingly, the increase in sedentary time during the chronic phase found in our study contrasts with previous longitudinal studies showing that physical activity levels plateaued after 3 months.[9] Possible explanations for the discrepancy between our and previous findings may be differences in how we measured activity patterns, the duration of observation and the number of participants included in each study. Another factor that might have influenced our findings is the difference in activity patterns following the seasons.[40]

While the total time spent sedentary only increased by 18 minutes (in the unadjusted analysis) the time spent sedentary in longer bouts (>30 minutes) actually increased with 33.9 minutes. This should be regarded as a clinically significant increase, as the most recent update of the WHO guidelines on physical activity and sedentary behavior have established that every minute counts and that it is beneficial in itself to break up sedentary time.[41,42] Furthermore, studies have found that mortality risks increase steadily up to nine hours of sedentary time per day, before becoming more pronounced from 9.5 hours a day.[38] Thus, a decrease of thirty minutes spent sedentary could arguably have a beneficial impact on our study population.

When investigating whether the MoCA score in the acute phase could predict sedentary behavior we did not get any significant results, which is in line with the overall results from the meta-analysis by Dillon and Morava[22]. In our study the participants with higher cognitive function tended to accumulate their sedentary time in shorter bouts, whereas those with poorer cognitive function seemed to have fewer sedentary breaks, thus accumulating more time in longer sedentary bouts (Figs 3 and 4). This pattern was more prominent in the unadjusted analyses

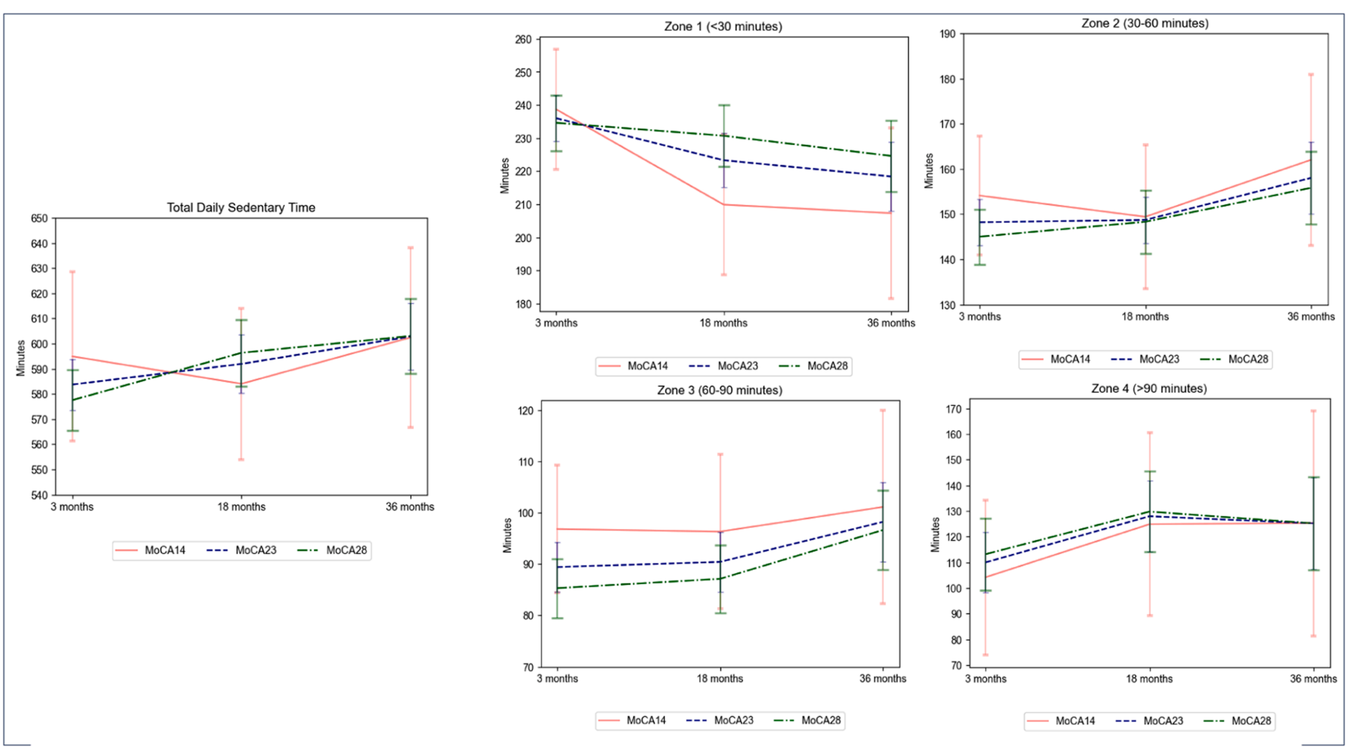

Fig. 4. Estimated marginal means of sedentary behavior over time, for different baseline MoCA scores. Based on linear mixed models adjusted for age, sex, BMI, education, living conditions, mRS pre-stroke, NIHSS, MoCA, and Charlson comorbidity index (n=528)

Abbreviations: MoCA (*Montreal Cognitive Assessment*), BMI (*Body Mass Index)pre-stroke mRS (pre-stroke modified Rankin scale), NIHSS (National Institutes of Health Stroke Scale).*

MoCA14, MoCA23 and MoCA28: MoCA scores were centered at 14, 23 or 28 to represent impaired, slightly impaired, or normal cognition.

than the adjusted ones.

The lack of statistically significant results does not necessarily mean that cognition and physical inactivity do not influence one another. MoCA is a global cognitive test, thus impairments in some cognitive domains could be overlooked. An example of such a specific cognitive domain could be executive function. Moreover, the MoCA score during the hospital stay might have been affected by other deficits than a chronic cognitive impairment one example being post stroke delirium[43,44]. Thirdly, the mean MoCA score in this sub-study was higher than in those excluded (mean score 24.5 against 20.9), this may also have contributed to the lack of significant results. Lastly, even if we see a pattern in the dataset indicating an effect of MoCA over time, the interaction term between time and MoCA score was not significant when investigated by the likelihood ratio test. However, to prove interaction terms statistically significant we usually require even larger sample sizes. In this study, we have demonstrated the significance of main effects as this is possible in moderate sample sizes.

This is the first study to assess sedentary behavior device-based in such a large stroke cohort at three time points from three to 36 months after stroke. In order to ensure objectivity, we relied on activity data from triaxial accelerometers as recommended by Hadjuk and Chaudhry[8]. The observations were only included if the ActivPAL was worn for at least four days. This, along with a 14 hour-day, increases the likelihood of capturing the actual habitual sedentary pattern of the participants.[45,46]

To get a better impression of how much of their wake time stroke patients spend sitting or lying we assumed a regular and average sleep pattern by setting time in bed from 22.00-08.00. This assumption may introduce some bias to the dataset for example by overestimating sleep time[47]. However, when comparing daytime data with the 24-hour data Alme et al. confirmed that more than 80% of the short sedentary bouts (<30min) occurred between 08.00 and 22.00[48]. This suggests that we succeeded in capturing daytime activity and excluding sleep time by using these limits.

Although our use of sedentary bout zones was based on the recommendations by the Sedentary Behavior Research Network and previous research, we acknowledge that there is no actual consensus on the bout lengths when assessing sedentary behavior[1,48]. It is therefore possible that the use of different bout zones could imply other results.

Even though the time spent sedentary is reliable, as it was device-based and not self-reported, we lack information on what the individuals were doing during the time spent sedentary. We know that time spent sedentary can be either mentally active or passive, which in turn might influence how harmful or not the sedentary behavior itself is.[49] New technologies, such as the sedentary behavior–triggered Ecological Momentary Assessment (EMA) could help with a better understanding of this in the future.[50]

The long period of follow-up, method of data collection and study population are strengths of the study because they allow us to investigate behavioral patterns over a long period in the chronic phase after a stroke. The different tests executed provide valuable information that increases our understanding of how we can help decrease harmful sedentary behavior. Nevertheless, they also restrict the study population to the younger and healthier stroke survivors. However, this is somewhat compensated for by the choice of statistical method, as it allowed us to include participants with missing data at one or two time points and thus decrease the risk of bias and confounding. Furthermore, the sample is regarded as representative of a significant proportion of the stroke population, who are suffering from mild or moderate strokes.[51]

Conclusion

Stroke survivors become increasingly sedentary with time. Especially sedentary time accumulated in bouts with a duration of >60 minutes increased in the first three years following the incident. This pattern was particularly common for the oldest participants, with higher BMI, most comorbidities, and lower levels of physical function. No significant association was found between global cognition and sedentary behavior in this study. Future research should investigate how certain cognitive domains, like executive function and attention, are associated with sedentary behavior in stroke patients.

CRediT authorship contribution statement

Tone Svalbjørg: Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis. **Torunn Askim:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Ingvild Saltvedt:** Writing – review & editing, Investigation, Funding acquisition, Data curation. **Katinka Alme:** Writing – review & editing, Data curation. **Stian Lydersen:** Writing – review & editing, Visualization, Methodology, Formal analysis. **Rannveig Eldholm:** Writing – review & editing, Supervision, Methodology, Investigation, Conceptualization.

Declaration of competing interest

There are no conflicts of interest to declare.

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