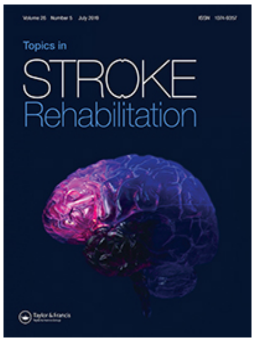

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Identifying factors associated with sedentary time after stroke. Secondary analysis of pooled data from nine primary studies.

Wendy Hendrickx [a,b,c], Carlos Riveros [d], Torunn Askim[e], Johannes B.J. Bussmann[f], Michele L. Callisaya[g], Sebastien F.M. Chastin[h,i], Catherine M. Dean [j], Victor E. Ezeugwu[k], Taryn M. Jones [j], Suzanne S. Kuys[l], Niruthikha Mahendran[m], Trish J. Manns[k], Gillian Mead[n], Sarah A. Moore[o], Lorna Paul[p], Martijn F. Pisters[a,c], David H. Saunders[q], Dawn B. Simpson[g], Zoë Tieges [r], Olaf Verschuren[s] and Coralie English[b]

[a]Department of Rehablilitation, Physiotherapy Science & Sport, Brain Center Rudolf Magnus, University Medical Center Utrecht, Utrecht University, Utrecht, The Netherlands; [b]School of Health Sciences and Priority Research Centre for Stroke and Brain Injury, Faculty of Health and Medicine, University of Newcastle, Newcastle, Australia; [c]Center for Physical Therapy Research and Innovation in Primary Care, Julius Health Care Centers, Utrecht, The Netherlands; [d]Bioinformatics, Hunter Medical Research Institute, Newcastle, Australia; [e]Department of Neuromedicine and Movement Science, Faculty of Medicine and Health Science, NTNU, Norwegian University of Science and Technology, Trondheim, Norway; [f]Department of Rehabilitation Medicine Erasmus, MC University Medical Center, Rotterdam, The Netherlands; [g]Menzies Institute for Medical Research, University of Tasmania, Hobart, Australia; [h]School of Health and Life Sciences, Glasgow Caledonian University, Glasgow, UK; [i]Department of Movement and Sports Sciences, Faculty of Medicine and Health Science, Ghent University, Ghent, Belgium; [j]Department of Health Professions, Faculty of Medicine and Health Sciences, Macquarie University, Sydney, Australia; [k]Faculty of Rehabilitation Medicine, University of Alberta, Edmonton, Canada; [l]National Head, School of Physiotherapy, Faculty of Health Sciences Australian Catholic University, Brisbane, Australia; [m]Discipline of Physiotherapy, Faculty of Health, University of Canberra, Canberra, Australia; [n]Centre for Clinical Brain Sciences, University of Edinburgh, Edinburgh, UK; [o]Stroke Research Group, Institute of Neuroscience and Newcastle University Institute for Ageing Newcastle University, UK; [p]School of Health and Life Sciences, Glasgow Caledonian University, Glasgow, UK; [q]Physical Activity for Health Research Centre, Institute for Sport, Physical Education and Health Sciences, University of Edinburgh, Edinburgh, UK; [r]Department of Geriatric Medicine, University of Edinburgh, Edinburgh, UK; [s]Brain Center Rudolf Magnus, Center of Excellence for Rehabilitation Medicine, De Hoogstraat Rehabilitation, University Medical Center Utrecht, Utrecht University, Utrecht, The Netherlands

ABSTRACT
Background: High levels of sedentary time increases the risk of cardiovascular disease, including recurrent stroke.
Objective: This study aimed to identify factors associated with high sedentary time in community-dwelling people with stroke.
Methods: For this data pooling study, authors of published and ongoing trials that collected sedentary time data, using the activPAL monitor, in community-dwelling people with stroke were invited to contribute their raw data. The data was reprocessed, algorithms were created to identify sleep-wake time and determine the percentage of waking hours spent sedentary. We explored demographic and stroke-related factors associated with total sedentary time and time in uninterrupted sedentary bouts using unique, both univariable and multivariable, regression analyses.
Results: The 274 included participants were from Australia, Canada, and the United Kingdom, and spent, on average, 69% (SD 12.4) of their waking hours sedentary. Of the demographic and stroke-related factors, slower walking speeds were significantly and independently associated with a higher percentage of waking hours spent sedentary (p = 0.001) and uninterrupted sedentary bouts of *>30* and *>60 min* (p = 0.001 and p = 0.004, respectively). Regression models explained 11–19% of the variance in total sedentary time and time in prolonged sedentary bouts.
Conclusion: We found that variability in sedentary time of people with stroke was largely unaccounted for by demographic and stroke-related variables. Behavioral and environmental factors are likely to play an important role in sedentary behavior after stroke. Further work is required to develop and test effective interventions to address sedentary behavior after stroke.

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Stroke; cardiovascular diseases; sedentary behavior; sedentary time; sitting time; sedentary bouts; factors; determinants

Introduction

Stroke is the second most common cause of death and the third leading cause of disability worldwide,[1,2] with the burden expected to increase during the next 20 years.[1] Almost 40% of the people with stroke have a recurrent stroke within 10 years,[3] making secondary prevention vital.[3,4] High amounts of sedentary time have been found to increase the risk of cardiovascular disease,[5–11] particularly when the sedentary time is accumulated in prolonged bouts.[12–15] Sedentary behavior, is defined as "any waking behavior characterized by an energy expenditure ≤1.5 Metabolic Equivalent of Task (METs) while in a sitting, reclining or lying posture".[16,17] Studies in healthy people, as well as people with diabetes and obesity, have shown that reducing the total amount of sedentary time and/or breaking up long periods of uninterrupted sedentary time, reduces metabolic risk factors

CONTACT Wendy Hendrickx W.Hendrickx@umcutrecht.nl Center for Physical Therapy Research and Innovation in Primary Care, Julius Health Care Centers, Emile Hullebroeckstraat 60, Utrecht 3543 BZ, The Netherlands; Coralie English coralie.english@newcastle.edu.au School of Health Sciences, University of Newcastle, University Drive, Callaghan NSW 2380, Australia

associated with cardiovascular disease.[6,9,10,12–15] Recent studies have shown that people living in the community after stroke spend more time each day sedentary, and more time in uninterrupted bouts of sedentary time compared to age-matched healthy peers.[18–20] Reducing sedentary time and breaking up long sedentary bouts with short bursts of activity may be a promising intervention to reduce the risk of recurrent stroke and other cardiovascular diseases in people with stroke.

To develop effective interventions, it is important to understand the factors associated with sedentary time in people with stroke. Previous studies have found associations between self-reported physical function after stroke and total sedentary time, but inconsistent results with regards to the relationship of age, stroke severity, and walking speed with sedentary time.[20,21] These results are from secondary analyses of single-site observational studies, not powered to address associations, and inconsistent in the methods used to determine waking hours; thus making direct comparisons between studies difficult.[20,21] Individual participant data pooling, with consistent processing of wake time data, allows novel exploratory analyses of larger datasets with greater power.

By pooling all available individual participant data internationally, this study aimed to comprehensively explore the factors associated with sedentary time in community-dwelling people with stroke. Specifically, our research questions were: (1) What factors are associated with total sedentary time during waking hours after stroke? (2) What factors are associated with time spent in prolonged sedentary bouts during waking hours?

Methods

Study design

This was an exploratory data pooling study, in which existing individual participant data were used for secondary analyses. By searches of databases, trial registries, and word of mouth, potentially eligible datasets were identified, and authors were invited to contribute their individual participant data and raw activity monitor data. The study was approved by the Human Research Ethics Committee of The University of Newcastle (H-2016–0427).

Study selection

Datasets from studies were included if they met the following criteria;

(1) Included adults with stroke who were living in the community,
(2) Measured sedentary behavior using the activPAL monitor (PAL Technologies Ltd, Glasgow, United Kingdom),
(3) The ethical approval and informed consent for the data collection permitted the use of the data for secondary analyses,
(4) The available data was not influenced by any form of intervention.

Authors of original studies provided de-identified datasets. Factors included in the datasets were mapped by one author (WH) in consultation with the co-authors. A list of factors of interest was created *a priori* (see Box 1), based on previous research in determinants of sedentary time and consideration of other relevant stroke-related factors.[20–28] For each dataset, we determined which factors were measured and what measurement instrument was used. Where different measurement instruments were used for the same factor, we sought valid methods to categorize or dichotomize data to facilitate data pooling (see supplementary Box 1 for the conversion methods). Where the original studies included repeated measures, we included data from one time-point only and used the time-point with the least missing data or at baseline in the case of intervention trials.

Activity monitor data

We chose to only include data on sedentary time that was measured using the activPAL monitor (PAL Technologies Ltd, Glasgow, United Kingdom) because it is highly reliable (Intraclass correlation coefficient 0.79–0.99) and valid (98–100% accuracy) for measuring sedentary time and posture transitions during daily life in people with stroke.[29–31] The ActivPAL uses an inclinometer worn on the anterior side of the thigh to determine if someone is either sedentary (sitting, lying or reclining), standing or walking making it a highly valid

Box. 1 Factors of interest determined a priori.

Demographics
- Age
- Sex
- Employment status
- Socio-economic status
- Education attainment
- Living status

Personal factors
- Body Mass Index
- Smoking
- Levels of moderate to vigorous physical activity
- Comorbidities

Environmental aspects
- Season of accelerometer data collection

Stroke related factors
- Type of stroke
- Time since stroke
- Stroke severity

Impairments
- Upper and lower extremity impairment
- Vision impairment

Walking ability
- Walking speed
- Walking capacity (distance)
- Use of walking aids

Physical ability
- Self-reported physical function
- Independence in activities of daily living

Cognition and mood
- Cognitive ability
- Fatigue
- Anxiety
- Depression

and accurate monitor to determine sedentary time.[29–31] A conversion to METs is also possible.[29–31] Event files from all participants were combined into one dataset. To identify waking hours, a custom algorithm was developed based on previously published codes.[32] The algorithm aggregated sleep time based on the largest bout of sitting/lying time within a 24-h period and then aggregated adjacent bouts of sitting/lying time where these bouts were interrupted by short bursts of activity, i.e. to account for getting up to the toilet overnight (see Appendix for more details). Our previous work has found that any three days of monitoring, regardless of weekend or weekday, is sufficient to accurately represent habitual physical activity over seven days.[33] We therefore included participants with at least three days of valid (>8 h day) waking wear time.[33] We excluded days in which more than 18 h of wake time were identified.

Data processing and analyses

From the activPAL data during waking hours, the percentage of total sedentary time and the percentage of waking hours spent in prolonged bouts of sedentary time was determined. Two variables were created for prolonged bouts: percentage of sedentary time in bouts *>30 min* and percentage of sedentary time in bouts *>60 min*.[9,10,12,18] Linear regressions (adjusting for age, gender, and study) were conducted to determine the association of individual factors with percentage of total sedentary time, percentage of sedentary time in bouts *>30 min*, and percentage of sedentary time in bouts *>60 min*. All factors and residuals (from regression analyses) were checked for normality and where needed the appropriate transformations were computed. Factors that were found significantly associated with univariable regressions ($p < 0.05$) were included in the multivariable regressions. We first determined the coverage of factors across studies and then conducted the multivariable regressions with the best coverage of factors across studies and the highest sample sizes. To avoid collinearity, if correlations between independent factors were higher than $r = 0.850$ one factor was removed from the analyses.[34,35] Both forward and backward stepwise linear regressions were run. Based on the 1:10 rule by Peduzzi et al.,[36] a sample of at least n = 250 was needed to be able to include all the factors we identified *a priori* (Box 1). All analyses were conducted with R statistical software, version 3.3.3 and IBM SPSS statistics version 22.

Results

Participant characteristics

Ten datasets were identified that met the inclusion criteria and we were able to obtain individual participant data from 9 (90%), including n = 350 individual participants (Table 1). In all, n = 274 (78%) individual participants contributed at least three days of valid activPAL data. There were no differences in demographics between the original (n = 350) and final (n = 274) sample (Table 2). On average, participants spent 69 (Standard Deviation 12)% of waking hours sedentary, 40 (SD 16)% of waking hours in sedentary bouts *>30 min* and 23 (SD 15)% of waking hours in sedentary bouts *>60 min*. Only age and gender were reported in all studies; other variables were reported in between 3 (33%) and 8 (89%) of included studies (Supplementary Table 1).

Factors associated with total sedentary time

The results of the univariable regression (adjusting for age, gender, and study) for percentage of total sedentary time are shown in Table 3. Body mass index ($p = 0.048$), stroke severity ($p = 0.035$), walking speed ($p < 0.001$), walking capacity ($p < 0.001$), walking aid use ($p < 0.001$), degree of independence in activities of daily living ($p = 0.014$), and anxiety ($p = 0.028$) were all significantly associated with percentage of total sedentary time. As walking speed and walking capacity were highly correlated ($r = 0.897$), and more data were available across the datasets for walking speed, only walking speed was included in the multivariable regression analyses. Only walking speed remained significant in the multivariable regression model ($p = 0.001$, see Table 4), which explained 14% of the variance in percentage of total sedentary time.

Factors associated with time spent in prolonged sedentary bouts

The results of the univariable regression (adjusting for age, gender, and study) for percentage of sedentary time in bouts *>30 min* and percentage of sedentary time in bouts *>60 min* are shown in Table 3. Body mass index ($p = 0.024$ and $p =$

Table 1. Characteristics of studies that provided data.

Author	Country	n	Design	Time since stroke	Walking ability
Dean*	Australia	4	Intervention	< 2 years	Able to walk 10 m independently, no aids
English 2016[21]	Australia	48	Observational	> 6 months	Able to walk independently indoors, no aids
Ezeugwu*	Canada	30	Intervention	2–4 months	Able to walk ≥ 5 m independently, no aids
Jones 2016[37]	Australia	21	Intervention	No criteria specified; recruitment from general population	Able to walk ≥ 50 m, no aids
Kuys*	Australia	29	Intervention	< 2 months	Able to walk 10 m independently
Mahendran 2016[38]	Australia	36	Observational	< 4 months	No criteria specified
Paul*	United Kingdom	56	Intervention	Discharged from active rehabilitation	Able to walk independently
Simpson*	Australia	30	Observational	No criteria specified; Participants were recruited from rehabilitation ward	No criteria specified
Tieges 2015[20]	United Kingdom	96	Observational	No criteria specified; Participants with a recent acute hemorrhagic or ischemic stroke were recruited	No criteria specified

*Data from ongoing trials

0.038), stroke severity ($p = 0.019$ and $p = 0.016$), walking speed (both $p < 0.001$), walking capacity (both $p < 0.001$), walking aid use ($p < 0.001$ and $p = 0.009$), and independence in activities of daily living ($p = 0.003$ and $p = 0.005$) were significantly associated with percentage of sedentary time in bouts *>30 min* and percentage of sedentary time in bouts *>60 min*. Fatigue was significantly associated only with percentage of sedentary time in bouts *>60 min* ($p = 0.044$).

Walking capacity was removed from the multivariable regression because of the high correlation with walking speed. In the multivariable regressions (Table 4), only walking speed was significantly associated with percentage of sedentary time in bouts *>30 min* ($p = 0.001$) and percentage of sedentary time in bouts *>60 min* ($p = 0.004$). For percentage of sedentary time in bouts *>30 min*, body mass index ($p = 0.049$) was also found to be significantly associated. The models explained 19% of the variance in percentage of sedentary time in bouts *>30 min* and 11% of the variance in percentage of sedentary time in bouts *>60 min*.

There was a wide range in time since the stroke in our dataset (1 to 237 months) and these data were highly skewed. To check whether this confounded results, we categorized the time since stroke into three epochs (1 to 3 months, 3 to 6 months and >6 months) and re-ran the regression models for the percentage of total sedentary time using this ordinal variable. This did not change the results.

Table 2. Participant demographics.

Characteristic	All available data	Pooled data
Sample size, n		
Total	350	274
Mean (SD) across studies	39 (25)	30 (15)
Sex, number male (%)	213 (61)	167 (61)
Age, (*yr*) mean (SD)	66 (14)	66 (13)
Time since stroke (*mth*) mean (SD)	17 (28)	18 (29)

Discussion

We pooled data from 274 individuals from three countries and found that people with stroke spent on average 69% of waking hours sedentary. Slower walking speed was the only factor independently associated with more total sedentary time, and more time spent in prolonged bouts of sedentary behavior. However, our models accounted for only a small proportion of the variance in sedentary behavior, suggesting that other factors not measured in the participants included in this study are also important.

Our findings in relation to walking speed are consistent with a previous study which found both slower walking speed, and other measures of poorer physical function (in this case the Stroke Impact Scale) were associated with greater sedentary time.[21] However, walking speed may also be a proxy measure for general health and co-morbidities.[39–41] In older people, walking speed is an important predictor of a number of adverse outcomes such as falls, activities of daily living difficulties, disability, institutionalization, comorbidities, and mortality.[39–43] Further research is needed to determine whether there is a direct causal pathway between slow walking speed and high sedentary time, or if it is a proxy measure of general health. It is possible that interventions aimed at improving the walking abilities of people with stroke

Table 3. Univariate regressions.

Factor	Number participants, n (number studies)	Missing data within studies, n (%)	Time spent sedentary		Time spent in sedentary bouts >30 min		Time spent in sedentary bouts >60 min	
			p value	Adjusted R^2	p value	Adjusted R^2	p value	Adjusted R^2
Demographics								
Educational level	52 (3)	0 (0%)	0.564	−0.052	0.709	<0.001	0.845	0.071
Living arrangements	144 (6)	0 (0%)	0.107	0.005	0.524	0.017	0.872	0.028
Personal factors								
BMI	205 (7)	27 (13%)	**0.048**	**0.023**	**0.024**	**0.037**	**0.038**	**0.031**
Smoker	171 (4)	6 (4%)	0.317	0.006	0.971	0.007	0.859	0.018
Comorbidities	147 (4)	0 (0%)	0.359	0.005	0.295	0.016	0.423	0.023
Stroke related factors								
Type of stroke	198 (6)	6 (3%)	−0.067	0.024	0.214	0.033	0.290	0.022
Time since stroke	268 (8)	3 (1%)	0.893	0.010	0.468	0.013	0.254	0.011
Stroke severity	118 (3)	2 (2%)	**0.035**	**0.030**	**0.019**	**0.046**	**0.016**	**0.045**
Walking ability								
Walking speed	195 (6)	6 (3%)	**<0.001**	**0.156**	**<0.001**	**0.167**	**<0.001**	**0.112**
Walking capacity (distance)	149 (5)	46 (31%)	**<0.001**	**0.158**	**<0.001**	**0.187**	**<0.001**	**0.158**
Walking aid	216 (7)	4 (2%)	**<0.001**	**0.064**	**<0.001**	**0.066**	**0.009**	**0.039**
Physical ability								
Degree of ADL independence	197 (6)	4 (2%)	**0.014**	**0.045**	**0.003**	**0.065**	**0.005**	**0.053**
Cognition and mood								
Cognitive function	145 (5)	37 (26%)	0.864	0.004	0.445	0.019	0.150	0.028
Fatigue	192 (6)	36 (19%)	0.084	0.027	0.101	0.026	**0.044**	**0.020**
Mood disorder	194 (6)	8 (4%)	0.235	0.019	0.179	0.016	0.315	0.006
Anxiety	153 (4)	3 (2%)	**0.028**	**0.031**	0.079	0.020	0.164	0.003
Depression	175 (5)	8 (5%)	0.055	0.027	0.118	0.016	0.095	0.008

All regressions corrected for age, gender, and study. Bolded values indicate statistical significance.
BMI = body mass index, ADL = activities of daily living

Table 4. Multivariable regression.

Dependent variable		Number participants, n (number studies)	Missing data within studies, n (%)	p value	Unstandardized β (95% CI)*	Standardized β*
Time spent sedentary	BMI	182 (7)	69 (27%)	0.071	0.206	
	Stroke severity	118 (7)	133 (53%)	0.231	0.139	
	Walking speed	**195** (7)	**56 (22%)**	**0.001**	**−0.115 (−0.182 to −0.048)**	**−0.390**
	Walking aid	197 (7)	54 (22%)	0.451	−0.094	
	Degree of ADL independence	197 (7)	54 (21%)	0.532	0.78	
	Anxiety	153 (7)	98 (39%)	0.512	−0.77	
Time spent in sedentary bouts >30 min	**BMI**	**182 (7)**	**69 (27%)**	**0.049**	**0.007 (0 to – 0.014)**	**0.222**
	Stroke severity	118 (7)	133 (53%)	0.182	0.151	
	Walking speed	**195 (7)**	**56 (22%)**	**<0.001**	**−0.153 (−0.235 to −0.070)**	**−0.410**
	Walking aid	197 (7)	54 (22%)	0.413	−0.100	
	Degree of ADL independence	197 (7)	54 (21%)	0.351	0.113	
Time spent in sedentary bouts >60 min	BMI	182 (7)	69 (27%)	0.110	0.186	
	Stroke severity	118 (7)	133 (53%)	0.132	0.177	
	Walking speed	**195 (7)**	**56 (22%)**	**0.004**	**−0.131 (−0.217 to −0.045)**	**−0.351**
	Walking aid	197 (7)	54 (22%)	0.670	−0.054	
	Degree of ADL independence	197 (7)	54 (21%)	0.333	0.122	
	Fatigue	192 (7)	59 (24%)	0.441	−0.091	

All regression were corrected for age, gender, and study. All regression analyses included data from: English, Ezeugwu, Kuys, Mahendran, Paul, Simpson, and Tieges. Bolded values indicate statistical significance.
*Since forward and backward methods were used for the regressions, not all data is available for the non-significant variables.

might help reduce the total sedentary time and the time spent sedentary in prolonged bouts. However, this premise requires testing in clinical trials.

We found few other factors were independently associated with high sedentary behavior. This is in contrast to previous studies. In older adults *without* stroke, age, gender, education level, living arrangements, body mass index, smoking status, and independence in activities of daily living, were all found to be associated with sedentary behavior.[22,25–27] In previous studies of people *with* stroke both age and stroke severity were associated with sedentary behavior.[20,21] In people with multiple sclerosis, both disease severity and physical ability are reported to be associated with high sedentary time.[44] Taken together, this suggests that the factors associated with high sedentary time may differ between population groups. This is important to consider when developing interventions to reduce sedentary behavior.

In our analyses, the regression models accounted for only a small proportion of the variance in sedentary behavior. It is likely that environmental and behavioral factors may also influence sedentary time in people with stroke, and this should be taken into consideration when designing interventions to reduce sedentary behavior in this population. Such interventions will need to be carefully developed and include strategies to address both the factors influencing sedentary behavior, and the barriers and motivations to increase light, moderate, and vigorous physical activity. Systematic reviews of clinical trials in other populations (healthy and older adults, those with diabetes or obesity) have highlighted the importance of developing interventions specifically targeted to reduce sedentary time, as such programs are more effective for reducing sedentary time compared with interventions that aim to increase physical activity alone.[45,46] An international consensus framework for sedentary behavior research across all population groups,[23] as well as qualitative research involving people with stroke,[47] highlights the importance of the environment, psychology (including motivation), education, and behavior as determinants of sedentary time. Development of effective interventions to address high levels of sedentary time in people with stroke will need to take all these factors into consideration.

Strengths and limitations

We pooled all available individual participant activity monitor data, and completed a novel exploratory analysis on a large dataset, with sufficient statistical power. We choose this novel data pooling methodology (instead of for instance meta-analyses) to be able to conduct independent secondary analyses using raw data. This also allowed the inclusion of data from ongoing and unpublished studies. We did not complete systematic literature searches, meaning that it is possible that some potentially relevant datasets were missed. The extensive international collaboration that was the foundation of this study allows confidence that we captured the vast majority of trials that have included activPAL data. The large dataset provides confidence in the results. We re-processed all raw activity monitor files using a custom-built algorithm to consistently and systematically identify sleep-wake time without manual error.[32] We decided to use only data in which the activPAL was used to measure sedentary time. This decision was based on the fact that different activity monitors use different methods to determine the sedentary time and movement, and therefore combining raw data from different monitors would introduce bias.[48,49] Two studies have shown the incompatibility of data from different monitors.[48,49] Only including activPAL data provides confidence in the validity of data between datasets. We acknowledge that this reduced the number of datasets we were able to include. Since the activPAL is highly reliable in the determination of sedentary behavior it is a commonly used monitor and therefore enabled the inclusion of most of the data that is available.

While we pooled all the available individual participant data, not all factors of interest we identified *a priori* were available. Furthermore, even where the same construct (for example, depression, anxiety, physical ability) was measured, the variability in the outcome measures used necessitated categorizing or dichotomizing data. To facilitate comparability of research findings and future data pooling studies, greater consistency in outcome measurement tools used is required.[50,51] The international Stroke Recovery and Rehabilitation Round Table group recently conducted a consensus project and have published recommendations for a core dataset for all stroke recovery and rehabilitation trials.[50]

Though the cut-offs of 30 and 60 min, used as an outcome variable for prolonged sedentary time, in their origin are arbitrary they have been used in previous studies on the risk of sedentary behavior.[12–15] These studies have shown that the risk of cardiovascular disease increases even more when the sedentary time is accumulated in these prolonged bouts.[12–15] Therefore these cut-offs provide a standard metric for prolonged sedentary time.

This study included only people with stroke living in the community, and for the most part only those able to walk independently, therefore results have limited generalizability beyond this group.

Conclusion

We found that variability in sedentary time of people with stroke was largely unaccounted for by demographic and stroke-related variables. Behavioral and environmental factors are likely to play an important role in sedentary behavior after stroke. Further work is required to develop and test effective interventions to address sedentary behavior after stroke.

Disclosure of interest

Authors have no conflicts of interest to declare.

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ORCID

Wendy Hendrickx http://orcid.org/0000-0002-0926-8869
Carlos Riveros http://orcid.org/0000-0002-2551-7618
Catherine M. Dean http://orcid.org/0000-0001-7502-1138
Taryn M. Jones http://orcid.org/0000-0003-3809-2126
Zoë Tieges http://orcid.org/0000-0002-3820-3917

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Appendix Sleep/Non-wear time identification algorithm

Objective

Identify the single daily longest period of sleep/non-wear activity in order to delineate what is considered as wake period.

Methods

The simple prescription given by Elisabeth Winkler et al. (Winkler et al. (2016)) was used as a starting point.

Recorded data consists of activPAL timestamped events, typified as *sitting/lying*, *standing* and *walking*. Events represent the longest continuous uninterrupted activity of each class. There is one event per step.

It was observed during initial implementation of Winkler's prescription that sleep period patterns for this cohort exhibit a more interrupted pattern, requiring a more flexible approach to correctly identify periods. The algorithm was modified as shown below.

Pseudocode:

Definitions

- **SL**: sleep period. A sleep period consists of a "chain" of "nearby" events, primarily of class *lying*, that accounts for the longest aggregated resting period in a 24hr interval. The meaning of "chain" and "nearby" is made precise through the pseudocode. A sleep period is defined by its start and end times, which must be start and end times of *lying*-class events, and all events encompassed in between. duration(SL) is the total accumulated time in *lying* events in **SL**.
- **e1, e2** represent generic *lying* events. A *lying* event carries an "aggregation opportunity window" of length of 12 min + 10% of event duration, capped at 45 min. Longer events have longer opportunity windows to be aggregated into the sleep event chain. The opportunity window of a *lying* event is denoted below as opp.window(e).
- **Ev** is the list of all events in a 24hr interval for an individual, from noon to noon next day.
- **LEv** is the list of *lying* events longer than 30 min in **Ev**, to be considered for aggregation in the sleep period ("long lying events")
- **Tlev** is the total time accumulated in long lying events in the day. Used in considering an alternative *chain* of *lying* events for the sleep period.

Algorithm

Note: how to read pseudocode. A simplified pseudocode of the algorithm is shown below. while and for each imply a loop, if imply testing a conditiont; the level of indentation indicates the actions included in the repeating part of the loop or the true outcome of the test. For clarity, abnormal termination conditions are excluded from the algorithm below.

```
Input: Ev
Output: SL

LEv = get lying events longer than 30 minutes from Ev
Tlev = sum of event duration for events in LEv
e1 = find longest event in LEv

A:
initialise sleep chain SL with e1
mark e1 as used
while there are unused events in LEv and SL modified since last pass
    for each unused event e2 in LEv, in descending duration order
        if opp.window(e2) overlaps SL
            add e2 to SL
              mark e2 as used
            endif
        endfor
    endwhile

if duration(SL) < 0.4 Tlev and there are unused events in LEv
    e1 = find longest unused event from LEv
    mark all events in LEv as unused
    mark e1 as used
    restart from A:
endif
```

Running environment

```
## R version 3.3.3 (2017-03-06)
## Platform: x86_64-redhat-linux-gnu (64-bit)
## Running under: Fedora 25 (Workstation Edition)
##
## locale:
##  [1] LC_CTYPE = en_AU.UTF-8       LC_NUMERIC = C
##  [3] LC_TIME = en_AU.UTF-8        LC_COLLATE = en_AU.UTF-8
##  [5] LC_MONETARY = en_AU.UTF-8    LC_MESSAGES = en_AU.UTF-8
##  [7] LC_PAPER = en_AU.UTF-8       LC_NAME = C
##  [9] LC_ADDRESS = C               LC_TELEPHONE = C
## [11] LC_MEASUREMENT = en_AU.UTF-8 LC_IDENTIFICATION = C
##
## attached base packages:
## [1] stats    graphics grDevices utils datasets methods base
##
## other attached packages:
## [1] lubridate_1.6.0 chron_2.3-50
##
## loaded via a namespace (and not attached):
##  [1] backports_1.0.5 magrittr_1.5 rprojroot_1.2 tools_3.3.3
##  [5] htmltools_0.3.5 yaml_2.1.14  Rcpp_0.12.10
  stringi_1.1.5
##  [9] rmarkdown_1.5    knitr_1.15.1 stringr_1.2.0
  digest_0.6.12
## [13] evaluate_0.10
```

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