Factors Associated with Level of Physical Activity After Minor Stroke

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Objectives: To explore factors from the acute phase, and after three and 12 months, associated with level of self-reported physical activity 12 months after a minor ischemic stroke with National Institutes of Health Stroke Scale (NIHSS) score ≤ 3 in persons 70 years or younger. *Materials and method:* In this longitudinal cohort study patients were recruited consecutively from two stroke units. Activity level were measured with three sets of questions addressing the average number of frequency (times exercising each week), the average intensity, and duration (the average time), and a sum score was constructed. The association between physical activity 12 months after stroke and sociodemographic factors, NIHSS, body mass index, balance, and neuropsychiatric symptoms were explored using multiple linear regression. *Results:* This study included 101 patients, with mean age (SD) 55.5 (11.4) years, NIHSS median (Q_1, Q_3) 0.0 (0.0, 1.0), and 20 % were female. Multiple linear regression analyses showed sick leave status at stroke onset, balance at three and 12 months, and anxiety, depression, apathy, and fatigue at 12 months to be factors associated with physical activity at 12 months after stroke. *Conclusion:* We found that pre-stroke sick leave, post-stroke balance, and neuropsychiatric symptoms were associated with the level of physical activity one year after minor stroke. This might be of importance when giving information about physical activity and deciding about post-stroke follow-up.

Key Words: Minor stroke—Physical activity—Balance—Depression—Anxiety—Fatigue—Apathy

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Received October 27, 2020; revision received January 5, 2021; accepted January 17, 2021.

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1052-3057/$ - see front matter

https://doi.org/10.1016/j.jstrokecerebrovasdis.2021.105628

Introduction

Health authorities recommend physical activity for general health and to prevent cardiovascular events.[1,2] Despite this, physical inactivity is the fourth leading risk factor for global mortality.[3] Physical activity has been defined as any bodily movement produced by skeletal muscles that results in energy expenditure, consisting of a broad spectre of daily life activities, including exercise, and resulting in physical fitness.[4] There is a dose-response effect of the amount of physical activity on health, where higher volumes, both time and intensity, of activity are associated with additional health benefits.[1] Physical activity is important after stroke, coming back to pre-stroke capacity[5], as well as for secondary prevention by improving stroke risk factors.[6] In general, people post-stroke have a low level of physical activity, also in the long-term.[7]

Due to new and improved treatments such as prophylactic interventions, reperfusion therapy, and stroke units, there is a positive development in outcome after stroke.[8,9] Today approximately two-thirds of the stroke patients experience only mild impairments in the acute phase[10] However, there is an increase in the proportion of affected younger people.[11,12] Researchers report that even minor stroke can result in impairments such as fatigue and psychological and cognitive impairments[13] that can impact the patients' ability to be active, participate in family and social life, and return to work and a complex everyday life.[14,15] A newly published paper reported that 43 % of younger persons with minor stroke had either fatigue or psychological symptoms 12 months after the stroke.[16]

A recent review focusing on community-dwelling adults with stroke showed that in addition to physical factors like stroke severity and older age, neuropsychiatric symptoms and social factors can impact the level of physical activity after stroke.[17] Given the potential benefit for health and secondary prevention of new cardiovascular events, knowledge about physical activity and associated factors is highly relevant for younger people with minor stroke with no overt or only mild neurological impairments. This group, with a lower likelihood of physical impairments, has a higher potential to engage in physical activity. In addition, in people with longer life expectancy, improvements of physical activity will have long time effects. However, there are few or no studies focusing on this specific population. We therefore aimed to explore which factors from the acute phase, three and 12 months are associated with self-reported physical activity at 12 months after a first-ever minor ischemic stroke with a National Institute of Health Stroke Scale (NIHSS)[18] score ≤ 3 in people 70 years or younger.

Method

Design and procedure

This 12-months observational longitudinal cohort study was part of the "Hidden impairments after cerebral stroke" study at Oslo University Hospital (OUH). We consecutively included patients hospitalized in the acute stroke units of OUH, Ullevål Clinic and Vestre Viken Hospital Trust, Bærum Hospital, between November 2014 and December 2016. The sample size was determined by the available number of cases at these two units during the study period. The inclusion criteria were being 18-70 years; having a first-ever minor ischemic stroke, being able to cooperate and to understand Norwegian. Minor stroke was defined by a score from 0 to 3 on the NIHSS.[18] The NIHSS rates impairments in 11 different functional domains commonly affected in patients with stroke, such as level of consciousness and orientation, facial palsy, motor function in arm and leg, language, and inattention. It ranges from 0 to 42 points, where a higher score indicates a more severe impairment. The diagnosis was based on the history of symptoms, the neurological examination, and all patients underwent magnetic resonance imaging (MRI) to verify an acute stroke. If there were no findings of acute infarction on the MRI, but neurological deficits compatible with cerebral stroke lasting more than 24 h, they were considered to have an ischemic stroke. The exclusion criteria were having a known psychiatric disorder, pre-stroke cognitive decline, defined as a score > 3.2 on the Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE)[19] or suffering a new stroke during the 12-month follow-up. The IQCODE is a questionnaire scored by a relative or next of kin, and an average score $\leq$ 3.2 points indicates a stable cognitive functioning prior to the stroke.[20] A physician was responsible for the inclusion. All patients gave their written, informed consent before inclusion, and all procedures followed the Declaration of Helsinki. The study was approved by the Regional Committee for Medical and Health Research Ethics in the Southeast of Norway (reference 2014/1268).

Trained staff in the ward performed data collection by interviews, patient records, and physical examinations of the patients. Sociodemographic data, i.e., sex, age, and education were obtained from the medical records in the acute phase. The living-alone status, sick leave status (including both full- and part-time sick leave), and Body Mass Index (BMI) were collected by interview and physical examination in the acute phase (sick leave status prestroke), at three and 12 months. The NIHSS examined in the acute phase was used to evaluate the severity of stroke impairments. Length of stay was also recorded.

The assessments were conducted as part of the clinical routine in the acute phase and at three months, while the 12-month follow-up was added for study purposes. All three assessments were carried out at the hospital facilities. At 12 months, the participants filled in the questionnaires on physical activity together with the physiotherapist, and on symptoms, i.e. anxiety, depression, fatigue, and apathy, together with the study physician.

Outcome measures

The main outcome was self-reported physical activity 12 months after stroke. We used the same questionnaire as used in the Nord-Trøndelag Health Study (HUNT), with three questions addressing physical activity during an average week regarding frequency (number of times being physically active each week), intensity, and duration of exercise[21] (see Table 2). The frequency was reported as 0, $<$ 1, 1, 2-3, or $\geq$ 4 times per week; duration was reported in minutes $<$ 15, 15-30, 31-60, or $>$ 60 min per session; and intensity as light (without sweating or losing breath), moderate (sweating and losing breath), or high (pushing oneself to near exhaustion). A summary score of frequency, duration, and intensity was constructed using the following equation: $1/5$ x frequency + $1/3$ x intensity + $1/4$ x duration, which has been used in previous studies.[22,23] The questionnaire has good validity and reliability when tested in males aged 20 − 39 years(21), and has also been used in a population of people with stroke.[24]

To measure balance, we used the comprehensive Balance Evaluation Systems Test (BESTest).[25] The BESTest is scored on an ordinal scale, with a maximum of 108 points. It has shown good validity and reliability when used in people with stroke.[26]

The Trail Making Test part B (TMT-B) was used to assess cognitive status at the three assessment time points post-stroke.[27] TMT-B measures executive functioning, split attention, visual search, and motor function, and has been associated with physical activity.[28]

Anxiety and depression were evaluated using the Hospital Anxiety and Depression Scale (HADS).[29] It contains 14 items, where seven items relate to anxiety (HADS-A) and seven items to depression (HADS-D). Each item is scored from zero to three, giving a maximum score of 21 points for each sub-section. Higher scores indicate a higher level of anxiety and depression. It has shown good validity when used in people with stroke.[30]

To measure apathy, we used the Apathy Evaluation Scale − Self Report (AES-S).[31] AES-S consists of 18 items covering the cognitive, emotional, and behavioural aspects of apathy, and is scored on a four-point ordinal scale resulting in a sum score between 18 and 72, where higher score indicates more apathy. The AES-S has shown good validity and reliability.[31]

Fatigue was evaluated using the Fatigue Severity Scale (FSS).[32] FSS is a nine-item questionnaire evaluating the impact of fatigue on physical, cognitive, and social domains of function. It is scored on a seven-point ordinal scale (strongly disagree to strongly agree), giving a sum score of nine to 63, where a higher score indicates more fatigue. The FSS has good reliability and validity among stroke patients.[33]

Statistical analysis

Data are presented as means and standard deviations (SD) for normally distributed variables, as median and first and third quartile for variables with skewed distribution, and as proportions and percentages for categorical variables.

To explore which variables in the acute phase and at three and 12 months were associated with self-reported physical activity at 12-month follow-up, we performed multiple linear regression analyses. We chose independent variables for the models based on a previous study[17] and clinical experience. Independent variables were sociodemographic data, i.e. age, sex, BMI, education, living-alone status, being on sick leave, NIHSS, BESTest, TMT-B, HADS, AES-S, and FSS. Bivariate correlation analyses were made to determine if there were issues with collinearity ($rs \geq 0.7$) between the independent variables. We also used bivariate linear regression to analyse the relationship between each of the independent variables and level of physical activity at 12-months post-stroke. Second, we included all the independent variables in the multiple linear regression models. The neuropsychiatric outcomes HADS-A, HADS-D, AES-S, and FSS were highly correlated, bordering to collinearity ($r_s \geq 0.7$). Therefore, we chose to perform three separate models with HADS, AES-S, and FSS per se. We used HADS as one scale but also performed sensitivity analyses by running the models over again with HADS-A and HADS-D separately.

Statistical analyses were performed using the Statistical Package for Social Science (SPSS) version 26 (IBM Corporation, Armonk, NY) program. P-values < 0.05 were considered as indicators of statistical significance, and all tests were two-sided.

Results

In total, 101 patients completed the 12-month follow-up. Inclusion and study flow are shown in Fig. 1. Patients' sociodemographic and clinical characteristics data are presented in Table 1. Of the participants, 21 (20.8 %) were female, and mean age was 55.5 (11.4) years, ranging from 30 to 70 years. The balance assessments took place at median (Q_1, Q_3) day 4[2,5] after arrival to the hospital, and median (Q_1, Q_3) length of stay was 6[5,8] days. At inclusion, 68 (67.3 %) of the participants had a NIHSS score of zero, which indicates no visible neurological impairments. Median scores on the BESTest were between 90-95 points at each of the test points. None of the patients used a walking device pre- or post-stroke.

Almost 80 % of the sample were physically active twice per week or more (Table 2). The multiple linear regression analyses with self-reported level of physical activity at 12 months after stroke as the dependent variable were performed in three separate models for each time point − the acute phase, three and 12 months (Tables 3 A and B). Being on sick leave at stroke onset, balance at three and 12 months, anxiety, depression, and apathy at 12 months were significant associated factors with level of physical activity at 12 months. The adjusted explained variance (R^2) of the model from the acute phase was 0.11; from three months 0.06; and at 12 months, the R^2 for the model with FSS was 0.16, for HADS 0.18 and for AES-S 0.22. The sensitivity analyses with HADS-A and HADS-D individually provided the same results as for the HADS as a total.

Discussion

We explored factors associated with level of physical activity 12 months after a first-ever minor stroke in patients 70 years or younger. At the three investigated time points − acute phase, three, and 12 months − we found that being on sick leave at stroke onset, balance at three and 12 months, and anxiety, depression, apathy, and fatigue at 12 months were independently associated with level of physical activity at 12 months. To our knowledge, this is the first study to explore factors associated with level of physical activity with this large number of participants with first-ever minor stroke.

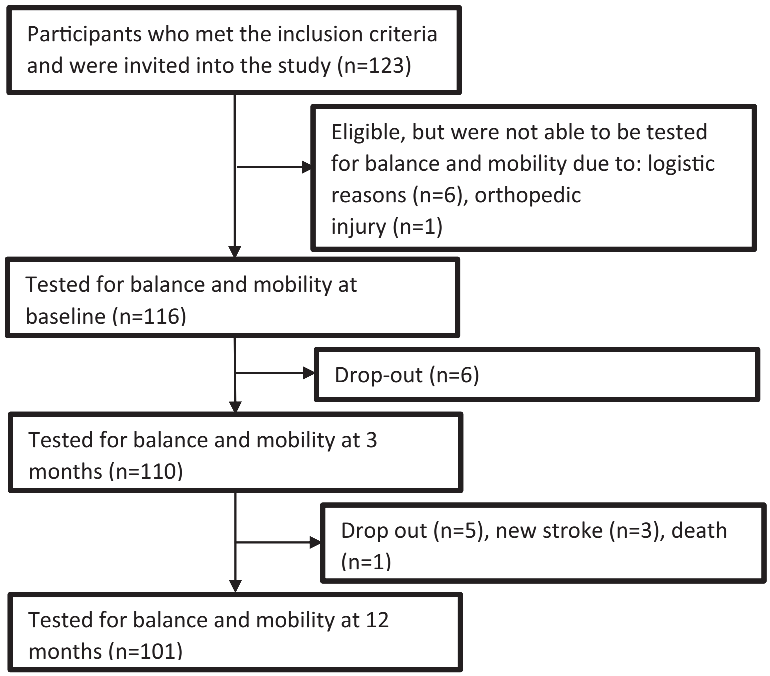

Fig. 1. *Flowchart for inclusion of the study participants.*

Table 1. *Sociodemographic data of all the participants.*

Variable (n = 101)	Acute phase	3 months	12 months
Sex (female), n (%)	21 (20.8)		
Age (years), mean (SD)	55.5 (11.4)		
Years of education, mean (SD)	15.3 (3.5)		
Body Mass Index, (kg/m^2), mean (SD)	27.3 (4.4)	27.5 (4.3)	27.7 (4.4)
NIHSS at inclusion	0.0 (0.0, 1.0)		
TOAST classification, n (%)			
Large vessel disease	18 (17.8)		
Cardio embolic disease	28 (27.7)		
Small vessel disease	30 (29.7)		
Stroke of other determined etiology	2 (2.0)		
Stroke of undetermined etiology	23 (22.8)		
Co-morbidity, n (%)			
Hypertension	45 (44.6)	43 (42.6)	43 (42.6)
Hyperlipidemia	74 (73.3)	68 (67.3)	63 (62.4)
Prior myocardial infarction or angina pectoris	8 (7.9)	6 (5.9)	5 (5.0)
Atrial fibrillation	13 (12.9)	11 (10.9)	13 (11.9)
Diabetes	13 (12.9)	17 (16.8)	20 (19.8)
BESTest (points)	90.7 (80.6, 96.3)	92.6 (86.1, 95.4)	94.4 (88.9, 98.1)
TMT-B (s)	84.5 (63.5, 123. 8)	78.0 (55.0, 102.0)	77.0 (56.0, 104.3)
Physical activity (points, sum score), mean (SD)			2.17 (.37)
FSS, (points)			2.8 (1.8, 4.4)
HADS (points)			5.0 (2.0, 11.0)
HADS A (points)			4.0 (1.0, 6.0)
HADS D (points)			2.0 (1.0, 4.5)
AES-S (points)			27.0 (23.3, 33.8)
Sick leave (yes), n (%)	9 (8.9) *	59 (58.4)	32 (31.7)
Living alone (yes), n (%)	25 (24.8)	23 (22.8)	21 (20.8)

TOAST = Trial of ORG 10172 in Acute Stroke Treatment. Data are reported as median with 1. and 3. quartile (Q_1, Q_3) unless otherwise indicated. *= sick leave status at stroke onset.

Table 2. *Self-reported physical activity at 12 months.*

Physical Activity	Total n=101
Frequency (times/week)	n (%)
Never	0 (0)
Less than once a week	6 (5.9)
Once a week	12 (11.9)
2-3 times a week	46 (45.5)
Almost every day	37 (36.6)
Duration (average time per session)	
< 15 min	0 (0)
16-29 min	18 (17.8)
30 − 60 min	57 (56.4)
> 60 min	26 (25.7)
Intensity (an average)	
- I take it easy without breaking into a sweat or losing my breath	34 (33.7)
- I push myself so hard that I lose my breath and break into a sweat	61 (60.4)
- I push myself to near-exhaustion	6 (5.9)

In line with the review of Thilarajah et al.,[17] we found that balance both at three and 12 months was associated with physical activity. In a previous publication, we showed although balance improved from acute phase to 12 months, one-in-four had impaired balance one year after minor stroke.[34] These balance impairments were mainly related to dynamic balance performance. Impairments in dynamic balance were also found in the study by Batchelor et a, where they compared people after minor stroke with age and sex matched controls.[35] Dynamic balance is the modality most needed during physical activity, and is not captured when using the NIHSS to evaluate stroke severity.[36] It is likely a mutual interaction between balance and level of physical activity, where having poor balance can lead to a decreased level of physical activity, and vice versa. Sick leave status at stroke onset explained some of the variance of physical activity 12 months after stroke, however we do not have information about cause of sick leave which could have shed more light on this associations. In addition to impairments in sensorimotor areas, neuropsychiatric symptoms are frequent and important impairments in persons with stroke.[16,37] Studies have suggested that higher levels of physical activity may have a positive impact on cognition[38], fatigue[39], depressive symptoms[40], and quality of life.[41]

The neuropsychiatric symptoms of fatigue, apathy, anxiety, and depression were highly correlated, and we chose to perform separate models with each of these symptoms to explore their associations with physical activity more thoroughly. A higher level of each of these symptoms was associated with being less physically active; however, the explained variance varied between 17.5 % for the model with anxiety/depression and 22.0 % for the model with apathy.

Fatigue is one of the most common complaints after minor stroke[42], and is also described as being independent of stroke severity and etiology.[43] Fatigue is rated among the top 10 most wanted research priorities in life after stroke by people post-stroke, their caregivers, and health professionals.[44] When experiencing a mild stroke at young age, fatigue has been shown to influence the prognoses regarding recovery and a higher activity level.[45,46] Even if the pathophysiology of fatigue is complex, current guidelines encourage regular physical activity for decreasing post-stroke fatigue.[47] Our study showed an association between fatigue and physical activity, where a higher level of physical activity was associated with a lower degree of fatigue. A better understanding of the relationships between neuropsychiatric impairments, such as fatigue, to physical activity might lead to better treatment strategies.[48,49] Our findings will contribute with data of young persons after mild stroke.

Approximately one-third of stroke patients experience depression and anxiety post-stroke[50], and these symptoms are often related.[51] Systematic reviews show physical activity both as prevention of developing, and as a treatment of depressive symptoms in people in general[52], as well as in stroke survivors.[53] Researchers have also shown the importance of maintaining and not decreasing the level of physical activity to reduce the risk of depression.[52] In the meta-analysis of Eng et al. (2014), the positive effect of exercise was not retained after terminating the exercise.[53] In our study, the presence of depression and anxiety were quite low compared with studies in general stroke populations[50,54], but are in line with Morsund et al. (2019), in which the population was quite similar to ours regarding the severity of stroke and age.[55]

Apathy following stroke is believed to be more frequent than previously known, with a prevalence of one in three patients post-stroke, and may have an impact on the rehabilitation.[56] The syndrome of apathy is defined as a primary absence or lack of feelings, emotions, interest, or concern.[57] Diagnostic criteria include lack of motivation, dependency on others to structure activity, or lack of concerns about one's personal problems.[58] In our study, a higher level of apathy was associated with being less physically active. The combination of lack of initiative and motivation and difficulties with structuring one's activities may explain the highest explained variance of the models. Consequently, patients with apathy may be in particular need of structured follow-up programs.

Limitations

Considering the fact that none of the models had very high explained variance, there may also be other factors influencing physical activity. In the study by Rand et al., people with minor stroke, despite having high capacity, did not use this potential to engage in physical activity.

Table 3. *Multiple linear regression analysis with self-reported physical activity level at 12 months post-stroke as the dependent variable.*

A) Factors present in the acute phase and at three months.

	Acute phase				3 months			
	Bivariate model		Multivariate model		Bivariate model		Multivariate model	
N=101	B (95% CI)	p	B (95% CI)	p	B (95% CI)	p	B (95% CI)	p
Age (years)	.000 (−.006, .006)	.997	.002 (−.005, .009)	.57	.000 (−.006, .006)	.997	.002 (−.006, .010)	.58
Sex	.01 (−.17, .18)	.95	.000 (−.19, .19)	.99	.01 (−.17, .18)	.95	−.003 (−.20, .20)	.98
Education (years)	.02 (−.01, .04)	.13	.002 (−.02, .02)	.87	.02 (−.01, .04)	.13	.01 (−.01, .03)	.36
NIHSS (points)	−.03 (−.11, .05)	.43*	−.02 (−.11, .07)	.67*				
BMI (kg/m^2)	−.02 (−.03, −.00)	.04*	−.02 (−.03, .02)	.08*	.20 (−.34, .00)	.05†	−.01 (−.03, .01)	.19†
BESTest (points)	.002 (−.002, .006)	.25*	.001 (−.003, .005)	.72*	.008 (.002, .014)	.01†	.01 (.002, .020)	.01†
TMT-B (s)	.000 (−.002, .001)	.55*	.000 (−.002, .001)	.69*	.000 (−.002, .002)	.74†	.001 (−.001, .003)	.29†
Sick leave	−.47 (−.71, −.24)	.001*	−.46 (−.73, −.19)	.001*	.002 (−.15, .15)	.97†	.003 (−.15, .16)	.97†
Living alone	−.03 (−.20, .14)	.75*	.03 (−.13, .20)	.70*	−.11 (−.29, .07)	.23†	−.05 (−.23, .13)	.56†

B) Factors present at 12 months.

	Bivariate model		Multivariate model with FSS		Multivariate model with AES-S		Multivariate model with HADS	
N=101	B (95% CI)	p	B (95% CI)	p	B (95% CI)	p	B (95% CI)	p
Age (years)	.000 (−.006, .006)	.997*	.002 (−.005, .009)	.56	.001 (−.006, .008)	.70	.001 (−.006, .008)	.75
Sex	.01 (−.17, .18)	.95*	.05 (−.14, .25)	.59	.02 (−.17, .20)	.86	.08 (−.12, .27)	.44
Education (years)	.02 (−.01, .04)	.13*	.003 (−.020, .025)	.82	.01 (−.01, .03)	.49	.001 (−.021, .023)	.95
BMI (kg/m^2)	−.02 (−.04, −.00)	.02‡	−.02 (−.04, .001)	.06‡	−.01 (−.03, .01)	.18‡	−.01 (−.03, .01)	.18‡
BESTest (points)	.01 (.01, .02)	.001‡	.01 (.001, .023)	.03‡	−.01 (.002, .020)	.016‡	.012 (.002, .021)	.016‡
TMT-B (s)	−.001 (−.003, .002)	.60‡	.001 (−.002, .003)	.63‡	.001 (−.002, .003)	.51‡	.001 (−.001, .004)	.36‡
Sick leave	−.08 (−.24, .07)	.30‡	.06 (−.11, .22)	.49‡	.04 (−.12, .19)	.64‡	.03 (−.13, .19)	.71‡
Living alone	−.02 (−.20, .16)	.79‡	.003 (−.17, .18)	.98‡	.03 (−.14, .20)	.72‡	.05 (−.13, .23)	.60‡
FSS (points)	−.08 (−.12, −.04)	.001‡	−.07 (−.12, −.02)	.004‡				
AES-S (points)	−.02 (−.03, −.01)	.001‡			−.02 (−.03, −.01)	.001‡		
HADS (points)	−.023 (−.03, −.01)	.001‡					−.02 (−.03, −.007)	.002‡

Note: Sex was coded 0 for male and 1 for female, Sick leave was coded 0 for working and 1 for being on sick leave, Living alone was coded 0 for living with somebody and 1 for living alone.
*Variables measured at inclusion, sick leave is pre-stroke.
†Variables measured at 3 months.
‡Variables measured at 12 months.

They described this observation to be similar to the phenomenon "learned non-use".[59]

Limitations of this study are the lack of information about pre-stroke physical activity and post-stroke exercise interventions. In addition, we measured the neuropsychiatric symptoms only after 12 months. Therefore, we cannot conclude that the observed impairments are necessarily caused by the stroke. Even if males are over-represented in younger age groups[60], the one-to-five distribution between female and males exceeds the anticipated sex bias, limiting the generalizability of our findings to other female patients with stroke. The use of self-reported levels of physical activity may result in recall bias and in social desirability, which may result in reporting too high levels of physical activity.[61] This could be the case also in our study, as the participants reported rather high levels of physical activity. None of our participants reported that they never exercised, while the corresponding number from a population-based study in Norway (mean age 53 ±15 years) was 24 % for men and 19 % for women.[62]

The major strengths of the study are the large sample size of a previously scarcely described group of patients, consecutive inclusion, the longitudinal follow-up, and the study has an almost complete dataset with very few dropouts.

Conclusion

In this study, we found that pre-stroke sick leave and post-stroke balance, anxiety, depression, apathy, and fatigue are associated with self-reported level of physical activity 12 months after a minor stroke. These findings provide important knowledge to healthcare professionals when giving information about physical activity and deciding about post-stroke follow-up. The inversely relationship between neuropsychiatric factors and level of physical activity should be further investigated through studies assessing these factors repeatedly at different stages pre- and post-stroke.

Funding

The study was funded by the Norwegian Fund for Post-graduate Training in Physiotherapy under Grant ID 76340.

Declaration of Competing Interest

The authors have no competing interests to declare.

Acknowledgments

We wish to thank all the participants for taking part in this study as well as our colleagues at the two stroke units—especially Kristina Flornes Aalo, Berit Tronsmo, and Kathrine Karlsen—for their support and assistance in data collection.

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