



## Research Article

### Poststroke Fatigue and its Effect on Functional Status and Quality of Life in Patient with Ischemic Stroke

Vildan YAYLA<sup>1</sup>, Hacı Ali ERDOĞAN<sup>1</sup>, Filiz AYDIN<sup>2</sup>, Meltem VURAL<sup>2</sup>, Murat ÇABALAR<sup>1</sup>, Sedef ERSOY<sup>2</sup>, Bahar ÇAKMAK BOZAN<sup>2</sup>

<sup>1</sup>Bakırköy Dr. Sadi Konuk Training ve Research Hospital Department of Neurology, Istanbul, Turkey <sup>2</sup>Bakırköy Dr. Sadi Konuk Training ve Research Hospital Department of Physical Medicine and Rehabilitation, Istanbul, Turkey

#### Summary

**Introduction:** Ischemic stroke constitutes 80% of all strokes and it is the first leading cause of disability. Although post stroke fatigue is frequent and adversely affects the quality of life, only few studies on this issue are present.

**Purpose:** In this study we aimed to assess the effect of post-stroke fatigue over functional and emotional status by scales.

**Methods:** A total of 39 ischemic stroke patients who were diagnosed in the last 15 months and admitted to our outpatient stroke clinic between January to April 2015 were included to the study. Fatigue severity was recorded by Fatigue Severity Scale (FSS) and functional status by Brunnstrom scale, respectively. Activities of daily living was evaluated by Barthel index and Modified Rankin Scale (mRS) and quality of life was assessed by Nottingham Health Profile. Hospital Anxiety and Depression Scale (HADS) was used to evaluate the anxiety and depression of the patients.

**Results:** The mean age of 23M/16F patients was  $67.74 \pm 12.11$  years. Left hemiparesis was present in 18 and right hemiparesis in 19 of the patients. A statistically significant negative correlation between fatigue severity and Brunnstrom and Barthel index values was detected. Fatigue severity was significantly higher in patients with high mRS score. A positively significant correlation was detected between fatigue severity and four sub-parameters of Nottingham Health Profile. According to HADS, fatigue severity was significantly higher in patients with high depression and anxiety scores.

**Conclusion:** Significant correlation determined between post-stroke fatigue severity and activities of daily living, quality of life, functional and emotional status. In this group of chronic patients, we believe that the consideration of all of these parameters constitutes a positive impact over the management of the patients.

**Key words:** Ischemic stroke, post-stroke fatigue, activities of daily living, functional status

### İskemik İnme Hastalarında Post-Strok Yorgunluğun Günlük Yaşam Aktivitesi ve Fonksiyonel Durum Üzerine Etkisi

#### Özet

**Amaç:** İskemik inme tüm inmelerin yaklaşık %80'ini oluşturmakta ve dünyada özür lülüğe yol açan hastalıklar arasında ilk sırayı almaktadır. Strok sonu yorgunluk oldukça sık görülmesine ve yaşam kalitesini olumsuz etkilemesine rağmen bu konuda yapılan çalışmalar az sayıdadır. Bu çalışma ile iskemik inme hastalarında bilimsel ölçekler kullanarak post-strok yorgunluğun yaşam kalitesi, fonksiyonel ve emosyonel durum üzerine etkisini değerlendirmek hedeflenmiştir.

**Method:** Hastanemiz inme polikliğine Ocak-Nisan 2015 tarihleri arasında başvuran son 15 ayda iskemik inme tanısı alan toplam 39 hasta dahil edildi. Yorgunluk şiddeti, Yorgunluk Şiddeti Skalası (FSS: fatigue severity scale), fonksiyonel durum Brunnstrom ölçeği ile kaydedildi. Günlük yaşam aktivitesi Barthel indeksi ve Modifiye Rankin Skalası (mRS) ile, yaşam kalitesi ise Nottingham Sağlık Profili ile değerlendirildi. Hastalarda anksiyete ve depresyon varlığı Hastane Anksiyete ve Depresyon Skalasıyla (HADS) araştırıldı.

**Bulgular:** Yaş ortalaması 67,74±12,11 yıl olan, 23'ü erkek 16'sı kadın toplam 39 hasta çalışmaya dahil edildi. Hastaların 18'inde sol ve 19'unda sağ hemiparezi mevcuttu. Brunnstrom ve Barthel indeksi değerleriyle yorgunluk şiddeti arasında istatistiksel olarak anlamlı, negatif ilişki bulundu. mRS yüksek olanlarda anlamlı şekilde yorgunluk şiddeti yüksek saptandı. Yorgunluk şiddeti ile Nottingham Sağlık Profiline dört alt parametresi arasında anlamlı düzeyde pozitif ilişki saptandı. HADS'a göre depresyon ve anksiyete skorları yüksek olanlarda yorgunluk şiddeti de anlamlı yüksekti.

**Sonuç-Yorum:** Hastalarımızda günlük yaşam aktivitesi, yaşam kalitesi, fonksiyonel ve emosyonel durumlarıyla strok sonrası yorgunluk şiddeti arasında anlamlı ilişki saptandı. Bu kronik hasta grubunda, tüm bu parametrelerin göz önünde bulundurulması hasta yönetimini olumlu yönde etkileyeceğini düşündürdü.

**Anahtar Kelimeler:** İskemik inme, post-strok yorgunluk, günlük yaşam aktivitesi, fonksiyonel durum

## INTRODUCTION

Stroke is the second leading cause of death and the first leading cause of disability amongst diseases in the world. Approximately 80% of stroke is ischemic nature<sup>(5)</sup>. Most of the hemorrhagic and ischemic stroke patients complain of post-stroke loss of motivation, unwillingness, fatigue and tiredness. Post-stroke fatigue (PSF) was defined in the 1980s by Leegaard as a symptom which is different from normal tiredness of extreme exercise but less energy that affects daily activities, quality of life and recovery<sup>(9,11)</sup>

The few studies on PSF demonstrated a relationship with depression, demographic characteristics, quality of life and daily living activities<sup>(2,6,9,18,25)</sup>. In this study, we aimed to assess the relationship between the severity of fatigue and demographic profile, quality of life, daily activities, emotional and functional status by validated questionnaires and to compare these findings between patients with and without fatigue.

## MATERIAL AND METHODS

Thirty-nine stroke patients were enrolled the study. They were diagnosed clinically

and radiologically with ischemic stroke within the last 15 months prior to their visit to stroke outpatient between 1 Jan – 30 April 2015. The severity of fatigue was assessed by the fatigue severity scale (FSS). The functional status was determined by the Brunnstrom score, the daily living score by Barthel index and Modified Rankin Scale (mRS) and the quality of life by Nottingham Health Profile. The presence of anxiety and depression were evaluated by the Hospital Anxiety and Depression Scale (HADS). Patients with severe dysarthria, aphasia, cognitive impairment or systemic illness such as anemia and thyroid dysfunction which might interfere with cooperation and directly cause fatigue were excluded from the study.

## Statistical Analysis

The statistical analysis was performed with the NCSS (Number Cruncher Statistical System) 2007 (Kaysville, Utah, USA) software. Data were analyzed by descriptive statistical methods (mean, standard deviation, median, frequency, rate, minimum, maximum), and the Mann-Whitney U test for the comparison of two groups which have non-normal

distributive data., The relationship between variables was assessed by Spearman's correlation analysis. For association of qualitative data, the Yates Continuity Correction test, Fisher's exact test and Fisher -Free Bremen Halton tests were used.  $P < 0.01$  and  $P < 0.05$  were accepted as significant.

## RESULTS

The age range of total 39 patients (23 M: 16 F) was 18-90 years (mean:67.74 $\pm$ 12.11 years). The demographic characteristics of the patients and their

medical histories are summarized in Table 1.

Demographic findings including the age, gender, marital status and education had no statistical significant relationship with fatigue. While smoking, diabetes mellitus, ischemic heart disease, congestive heart disease, COPD, peripheral vascular disease and hyperlipidemia had not significant effect on fatigue, but hypertension was significantly higher in the fatigue patients. (Table 2)

**Table 1:** The patients demographic profile and medical history

		Min-Max	Mean $\pm$ SD
Age (year)		36-89	67.74 $\pm$ 12.11
		n	%
Gender	Male	23	59.0
	Female	16	41.0
Marital status	Married	38	97.4
	Single	1	2.6
Education	Literate	15	38.5
	Primary school	20	51.3
	High school and more	4	10.3
Smoking		13	33.3
Diabetes Mellitus		15	38.5
Hypertension		27	69.2
Ischemic Heart Disease		14	35.9
Congestive Heart Disease		10	25.6
COPD		3	7.7
Peripheral Vascular Disease		4	10.3
Hyperlipidemia		12	30.8

COPD: Chronic Obstructive Pulmonary Disease

**Table 2:** The relationship of fatigue and the demographic profile - medical history

		Fatigue (-) (n=20)	Fatigue (+) (n=19)	p
		Mean±SD	Mean±SD	
Age(year)		67.05±10.17	68.05±12.89	<sup>a</sup> 0.789
		n (%)	n (%)	
Gender	Female	14 (70.0)	9 (47.4)	<sup>b</sup> 0.267
	Male	6 (30.0)	10 (52.6)	
Marital status	Married	20 (100)	18(94.7)	<sup>c</sup> 0.487
	Single	0	1 (5.3)	
Education	Literate	8 (40,0)	7 (36.8)	<sup>d</sup> 1.000
	Primary school	10 (50.0)	10 (52.6)	
	High school and more	1 (10)	2 (10.6)	
Smoking		7 (35.0)	6 (31.6)	<sup>b</sup> 0.821
Diabetes Mellitus		8 (40.0)	7 (36.8)	<sup>b</sup> 1.000
Hypertension		18 (90.0)	9 (47.4)	<sup>b</sup> 0.011*
Ischemic Heart Disease		9 (45.0)	5 (26.3)	<sup>b</sup> 0.378
Congestive Heart Disease		6 (30.0)	4 (21.1)	<sup>c</sup> 0.716
COPD		2 (10.0)	1 (5.3)	<sup>c</sup> 1.000
Peripheral Vascular Disease		1 (5.0)	3 (15.8)	<sup>c</sup> 0.342
Hyperlipidemia		6 (30.0)	6 (31.6)	<sup>b</sup> 1.000

<sup>a</sup>Student t test <sup>b</sup>Yates Continuity Correction <sup>c</sup>Fisher'sExact test <sup>d</sup>Fisher-freeman Halton test \*p<0.05

COPD: Chronic Obstructive Pulmonary Disease

There was not any significant difference between the groups with and without fatigue in terms of side of ischemic stroke lesion, loss of consciousness, incontinence, history of TIA, stroke or seizures and vertebro basilar insufficiency (Table 3).

There was a significant positive correlation between fatigue severity and fatigue sub-parameter of Visual Analog Scale (VAS) ( $r = 0.382$ ,  $p = 0.017$ ). But not correlation

was found between fatigue severity and VAS pain or sleep sub-parameters.

Brunnstrom upper-lower extremity and hand scores revealed a negative relationship between fatigue intensity (Table 4).

There was a positive correlation between fatigue intensity and Modified Rankin scale (mRS), but a negative correlation with the Barthel Index (Table 4).

**Table 3:** The relationship of fatigue with ischemic stroke and the medical history

		Fatigue (-) (n=20)	Fatigue (+) (n=19)	p
		n (%)	n (%)	
Lesionside	Right	14 (70.0)	9 (47.4)	<sup>b</sup> 0.267
	Left	6 (30.0)	10 (52.6)	
Consciousness		6 (30.0)	10 (52.6)	<sup>b</sup> 0.267
Incontinence		5 (25.0)	5 (26.3)	<sup>c</sup> 1.000
History of TIA		3 (15.0)	7 (36.8)	<sup>c</sup> 0.155
History of Ischemic Stroke		4 (20.0)	5 (26.3)	<sup>b</sup> 0.378
History of Epilepsy		6 (30.0)	4 (21.1)	<sup>c</sup> 0.716
Vertebrobasilar Insufficiency		2 (10.0)	1 (5.3)	<sup>c</sup> 1.000

<sup>b</sup>Yates Continuity Correction <sup>c</sup>Fisher's Exact test. TIA: Transient ischemic attack

**Table 4:** The relationship with scales and fatigue severity

N=39	Fatigue severity	
	R	p
VAS Fatigue	0.382	0.017*
VAS Pain	-0.153	0.353
VAS Sleep	0.049	0.766
Brunnstrom Upper Extremity	-0.455	0.004**
Brunnstrom Hand	-0.506	0.001**
Brunnstrom Lower Extremity	-0.466	0.003**
Modified Ashworth Scale	0.273	0.092
Modified Rankin Scale	0.565	0.001**
Barthel Index	-0.486	0.002**
Nottingham Total	0.517	0.001**
Nottingham Energy	0.437	0.005**
Nottingham Pain	0.146	0.377
Nottingham Emotional Reactions	0.350	0.029*
Nottingham Sleep	0.363	0.023*
Nottingham Social Isolation	0.652	0.001**
Nottingham Physical Mobility	0.418	0.008**
HAD Anxiety	0.325	0.044*
HAD Depression	0.427	0.007**

R: Spearman's correlation coefficient \*p<0,05 \*\*p<0,01

The total scores on Nottingham Health Profile (NHP) and its sub-parameters; energy, emotional reactions, sleep, social isolation and physical mobility have significant positive relationship with fatigue intensity (Table 4).

Finally there was also a strong positive correlation between HAD Anxiety and Depression and fatigue severity.

VAS fatigue level, mRS, total Nottingham Health Profile (NHP) scores, and NSP sub-parameters of emotional reactions, energy, sleep, social isolation and physical activity levels were significantly higher in fatigue group than the non-fatigue group.

There was a significantly lower Brunnstrom and the Barthel Index scores within the fatigue group in comparison to the cases without fatigue. HADS anxiety and depression levels of the groups with fatigue were significantly higher.

**Table 5:** The relationship of scores and the presence of fatigue

	Fatigue (+)		p
	Fatigue (-) (n=20) Mean±SD (Median)	(n=19) Mean±SD (Median)	
VAS Fatigue	4.70±3.26 (4,5)	7.39±1.79 (8)	0.013*
VAS Pain	3.00±3.22 (2)	2.00±2.56 (0)	0.243
VAS Sleep	3.50±3.35 (3)	3.37±3.29 (3)	0.909
Brunnstrom Upper Extremity	5.65±0.88 (6)	4.53±1.71 (5)	0.008**
Brunnstrom Hand	5.65±0.88 (6)	4.37±1.86 (5)	0.004**
Brunnstrom Lower Extremity	5.70±0.66 (6)	4.63±1.49 (5)	0.003**
Modified Ashworth Scale	1.10±0.31 (1)	1.26±0.45 (1)	0.190
Modified Rankin Scale	0.70±1.26 (0)	2.58±1.58 (2)	0.001**
Barthel Index	93.00±15.84 (100)	76.84±28.53 (85)	0.015*
Nottingham Total	9.15±7.62 (7)	19.00±8.29 (18)	0.001**
Nottingham Energy	1.25±1.07 (1)	2.21±0.86 (2)	0.006**
Nottingham Pain	1.20±1.64 (0,5)	1.84±2.19 (1)	0.365
Nottingham Emotional Reactions	2.75±2.65 (1,5)	5.00±3.43 (5)	0.036*
Nottingham Sleep	0.75±1.07 (0)	2.32±1.73 (2)	0.0002**
Nottingham Social Isolation	0.55±0.76 (0)	2.79±1.81 (2)	0.001**
Nottingham Physical Mobility	2.60±2.26 (2,5)	4.95±2.39 (5)	0.005**
HAD Anxiety	6.80±2.73 (6)	9.26±3.28 (9)	0.004**
HAD Depression	9.25±2.15 (9)	11.11±2.88 (11)	0.025*

Mann Whitney U Test \*\*p<0,01\*p<0,05

## DISCUSSION

Post stroke fatigue (PSF) is a wide-spread and persistent symptom affecting approximately 40-74% of patients<sup>(2,4,6,7,9,12,21,25)</sup>. In a recent study with 90 stroke patients, almost half of the patients reported fatigue symptoms within a year of stroke diagnosis<sup>(11,26)</sup>. PSF prolongs the hospital stay and delays the rehabilitation and recovery of functional independence<sup>(6,10)</sup>.

Similar to other studies on post stroke fatigue, we did not find any correlation with a demographic profile such as age, sex, education and marital status in relation to fatigue severity<sup>(2,6,9,11)</sup>.

In a review by Ponchel et al. there was no gender-related evidence in 33 studies out of 46, whilst in 12 of them there was significant correlation with female gender and only 1 study revealed a positive relationship between males and PSF. The relationship of PSF with marital status is contradictory, but it is postulated to be more in patients living alone<sup>(6,15,16)</sup>. In a study, it is highlighted that comorbid diseases existing with stroke aggravated the severity of fatigue<sup>(20)</sup>. In our study group, we did not find any correlation with PSF and comorbidities except hypertension. This relationship of hypertension with fatigue was also observed in Harbison's study<sup>(8)</sup>. Our study and most recent studies did not show any significant correlation of the fatigue with side and extent of the lesion<sup>(2,9,25)</sup>. However, higher National Institute of Health Stroke Scores (NIHSS) in association with fatigue was reported<sup>(28)</sup>. And also, a significant correlation of right-sided lesions with tiredness was demonstrated<sup>(19)</sup>.

In our study, there was not any relationship with VAS for pain and sleep sub-parameters and fatigue severity however we observed a positive correlation with VAS fatigue sub-parameter. In a study, a

positive correlation between a general increased VAS with the intensity of fatigue was reported<sup>(17)</sup>. Assessment of the daily living activities with mRS demonstrated a positive relationship with severity of fatigue and a negative relationship with Barthel index. Higher mRS values and low Barthel index scores are associated with worsening of fatigue. Similarly, assessment of the functional status with the Brunnstorm scores revealed a negative relationship with the intensity of the fatigue. Lower Brunnstorm scores were associated with increased fatigue. These findings are in line with the observations of similar preceding studies, especially when the neurological deficit and the functional status were severely affected, the PSF appeared proportionally affected<sup>(1,2,3,6)</sup>. We observed a positive correlation between the quality of life and the severity of the fatigue. Measurement of quality of life with the Nottingham Health Profile showed, with exception of the pain score, significant correlations with all other parameters and the level of fatigue. Majority of studies with patients who develop PSF and subsequent poor quality of life scores, is leading to the conclusion that the severity of the fatigue is a good predictor for the quality of life<sup>(6,14,22,24,27)</sup>.

Fatigue and depression are independent symptoms but at the same time they influence each other independently. When they are present in the same patient irrespective of the severity of the stroke, the mortality increases. Patients with post-stroke fatigue seem to have a higher incidence (29-34%) of depression<sup>(13,15,17,26,29)</sup>. We also have noticed a higher incidence of depression and anxiety in relation to the severity of the fatigue. In our study, we grouped our patients as with fatigue and without fatigue. Both groups underwent the same assessments. The post-stroke fatigue group scored significantly lower on quality of life, daily living activities, emotional and

functional status than the group without the fatigue.

The results are unfortunately limited due to the small size of patient population, short follow-up and the lack of a control group but on the other hand the distinctive part in our study is based on intensive assessment on different levels and comparing the fatigued vs. the non-fatigued patients.

## CONCLUSION

Our patients daily living activities, quality of life, functional and emotional status are shown to be closely related to the severity of fatigue developed after stroke. At the same time patients who showed worse tiredness also showed lower scores on all the tests. PSF is an insidious symptom, which prolongs the hospital stay and delays recovery and rehabilitation and has a negative impact on the quality of life. Recognition and understanding of PSF has an impact on the development of new strategic approaches in order to improve the path to early recovery and rehabilitation and ultimately on gaining independent function and improvement of their quality of life.

## Correspondence to:

Vildan Yayla

E-mail: [yaylavildan@gmail.com](mailto:yaylavildan@gmail.com)

**Received by:** 27 December 2015

**Revised by:** 25 March 2016

**Accepted:** 04 June 2016

## The Online Journal of Neurological Sciences (Turkish) 1984-2016

This e-journal is run by Ege University Faculty of Medicine, Dept. of Neurological Surgery, Bornova, Izmir-35100TR

as part of the Ege Neurological Surgery World Wide Web service.

Comments and feedback:

E-mail: [editor@jns.dergisi.org](mailto:editor@jns.dergisi.org)

URL: <http://www.jns.dergisi.org>

Journal of Neurological Sciences (Turkish)

Abbr: J. Neurol. Sci.[Turk]

ISSNe 1302-1664

## REFERENCES

1. Badaru UM, Ogwumike OO, Adeniyi AF, Olowe OO. Variation in functional independence among stroke survivors having fatigue and depression. *Neurol Res Int* 2013; 2013:842980.
2. Choi-Kwon S, Han SW, Kwon SU, Kim JS. Poststroke fatigue: characteristics and related factors. *Cerebrovasc Dis* 2005; 19:84–90.
3. Christensen D, Johnsen SP, Watt T, Harder I, Kirkevold M, Andersen G. Dimensions of post-stroke fatigue: a two-year follow-up study. *Cerebrovasc Dis* 2008; 26:134–41.
4. Colle F, Bonan I, Gellez Leman MC, Bradai N, Yelnik A: Fatigue after stroke. *Ann Readapt Med Phys* 2006;49:272–276.
5. G. Eilertsen, H. Ormstad, and M. Kirkevold: Experiences of poststroke fatigue: qualitative meta-synthesis . *Journal of Advanced Nursing* 2013; 69:514–525
6. Glader EL, Stegmayr B, Asplund K: Poststroke fatigue: A 2-year follow-up study of stroke patients in Sweden. *Stroke* 2002;33:1327–1333.
7. G. Mead, J. Lynch, C. Greig, A. Young, S. Lewis, and M. Sharpe: Evaluation of fatigue scales in stroke patients. *Stroke* 2007; 38: 2090–2095.
8. Harbison JA, Walsh S, Kenny RA. Hypertension and daytime hypotension found on ambulatory blood pressure is associated with fatigue following stroke and TIA. *QJM* 2009; 102:109–15
9. Ingles JL, Eskes GA, Phillips SJ. Fatigue after stroke. *Arch Phys Med Rehabil* 1999; 80:173–8.
10. J. Y. Park, M. H. Chun, S. H. Kang, J. A. Lee, B. R. Kim, and M. J. Shin: Functional outcome in poststroke patients with or without fatigue. *American Journal of Physical Medicine & Rehabilitation/Association of Academic Physiologists* 2009; 88: 554–558.
11. Leegaard OF. Diffuse cerebral symptoms in convalescents from cerebral infarction and myocardial infarction. *Acta Neurol Scand* 1983; 67: 348–55.
12. Naess H, Lunde L, Brogger J, et al. Fatigue among stroke patients on long-term follow-up. *The Bergen Stroke Study. J Neurol Sci* 2011;312:138-141.
13. Naess H, Nyland H. Poststroke fatigue and depression are related to mortality in young

- adults: a cohort study. *BMJ Open*. 2013 Mar 1;3(3).
14. Naess H, Waje-Andreassen U, Thomassen L, Nyland H, Myhr KM. Health-related quality of life among young adults with ischemic stroke on long-term follow-up. *Stroke* 2006; 37:1232–6.
  15. Ponchel A, Bombois S, Bordet R, Hénon H. Factors Associated with Poststroke Fatigue: A Systematic Review. *Stroke Res Treat*. 2015;2015:347920
  16. Schepers VP, Visser-Meily AM, Ketelaar M, Lindeman E. Poststroke fatigue: course and its relation to personal and stroke-related factors. *Arch Phys Med Rehabil* 2006; 87:184–8
  17. S. Choi-Kwon and J. S. Kim. Poststroke fatigue: an emerging, critical issue in stroke medicine. *International Journal of Stroke* 2011; 6:328–336.
  18. Sisson RA. Cognitive status as a predictor of right hemisphere stroke outcomes. *J NeurosciNurs* 1995; 27:152–6.
  19. Sisson RA. Life after a stroke: coping with change. *RehabilNurs* 1998; 23:198–203
  20. Smith OR, van den Broek KC, Renkens M, Denollet J. Comparison of fatigue levels in patients with stroke and patients with end-stage heart failure: application of the fatigue assessment scale. *J Am Geriatr Soc* 2008; 56:1915–9.
  21. Staub F, Bogouslavsky J. Fatigue after stroke: a major but neglected issue. *Cerebrovasc Dis* 2001; 12:75–81.
  22. Tang WK, Lu JY, Chen YK, Mok VC, Ungvari GS, Wong KS. Is fatigue associated with short-term health-related quality of life in stroke? *Arch Phys Med Rehabil* 2010; 91:1511–5.
  23. Tseng BY, Billinger SA, Gajewski BJ, Kluding PM. Exertion fatigue and chronic fatigue are two distinct constructs in people post-stroke. *Stroke* 2010; 41:1–5.
  24. Van de Port IG, Kwakkel G, Schepers VP, Heinemans CT, Lindeman E. Is fatigue an independent factor associated with activities of daily living, instrumental activities of daily living and health-related quality of life in chronic stroke? *Cerebrovasc Dis* 2007; 23:40–5.
  25. Van der Werf SP, van den Broek HL, Anten HW, Bleijenberg G. Experience of severe fatigue long after stroke and its relation to depressive symptoms and disease characteristics. *EurNeurol* 2001; 45:28–33.
  26. Van Eijnsden HM, Van de Port IG, Visser-Meily JM, Kwakkel G. Poststroke fatigue: who is at risk for an increase in fatigue? *Stroke Res Treat*. 2012;2012:863978.
  27. Van Zandvoort MJ, Kappelle LJ, Algra A, De Haan EH. Decreased capacity for mental effort after single supratentorial lacunar infarct may affect performance in everyday life. *J NeurolNeurosurg Psychiatry* 1998; 65:697–702.
  28. Winward C, Sackley C, Metha Z, Rothwell PM. A population-based study of the prevalence of fatigue after transient ischemic attack and minor stroke. *Stroke* 2009; 40:757–61.
  29. Wu S, Barugh A, Macleod M, Mead G. Psychological associations of poststroke fatigue: a systematic review and meta-analysis. *Stroke* 2014; 45:1778–83.