Original article

Journals BAHIANA
SCHOOL OF MEDICINE AND PUBLIC HEALTH

Gait performance and quality of life in stroke survivors: a cross-sectional study

Desempenho da marcha e qualidade de vida nos sobreviventes de avc: um estudo transversal

Camila Marinho[1], Maiana Monteiro[2], Luciana Santos[3], Jamary Oliveira-Filho[4], Elen Beatriz Pinto[5]

[1]BAHIANA - School of Medicine and Public Health. Salvador, Bahia, Brazil. ORCID: 0000-0002-6864-0616. cami.mar@hotmail.com
[2]Federal University of Bahia Hospital. Salvador, Bahia, Brazil. ORCID: 0000-0002-3736-5455. maidellacella@yahoo.com.br
[3]BAHIANA - School of Medicine and Public Health, Salvador, Bahia, Brazil. ORCID: 0000-0002-2820-6639. lucorrea_21@hotmail.com
[4]Federal University of Bahia. Salvador, Bahia, Brazil. ORCID: 0000-0003-1915-0423. jamary@mail.harvard.edu
[5]Corresponding Author. BAHIANA - School of Medicine and Public Health. Salvador, Bahia, Brazil. ORCID: 0000-OOO3-3753-923X. elen.neuro@gmail.com

RESUMO | INTRODUÇÃO: O acidente vascular cerebral é uma das principais causas de deficiências neurológicas no mundo, podendo levar a um amplo espectro de deficiências físicas, inclusive no desempenho da marcha. Essas anormalidades de marcha têm um impacto substancial nas atividades funcionais, no estilo de vida, bem como nas percepções do indivíduo sobre a funcionalidade da vida diária e bem-estar após o acidente vascular cerebral. **OBJETIVO:** Avaliar o desempenho da marcha, identificando quais os componentes da marcha associados à deterioração da qualidade de vida em sobreviventes de AVC. **MÉTODOS:** Indivíduos com marcha independente após um acidente vascular cerebral, com ou sem o uso de ajudas para caminhar, como muletas ou bastões, foram incluídos no estudo. Os dados sócio-demográficos e clínicos foram gravados, em seguida, foram avaliados alguns testes, com o teste de caminhada de 6 minutos (TC6M), teste de caminhada de 10 metros (TC10M), Timed Up & Go (TUG) , Índice de Barthel modificado (IBM), National Institutes of Health Stroke Scale (NIHSS) e European Quality of Life - 5 dimensões (EQ-5D). Um modelo de regressão logística multivariada Stepwise avaliou preditores de qualidade de vida comprometida. **RESULTADOS:** Foram incluídos 124 indivíduos com idade média de 66 anos e mediana de NIHSS de 3 pontos. A média de EQ-5D foi de 0,44 (DP 0,38) e 91 indivíduos (73%) tiveram qualidade de vida comprometida. Houve uma correlação positiva entre o TC6 e o EQ-5D (r = 0,48, p <0,001). O aumento da idade, capacidade funcional, TC6, TC 10MW, gravidade do AVC e sexo feminino foram associados com comprometimento da QV (p <0,05). Na análise multivariada, TC6M (aumento de OR 0,94 por 10m, p = 0,046), capacidade funcional (OR 0,66, p = 0,022) e idade (OR 0,54 por aumento de 10 anos, p = 0,002) estiveram associados com qualidade de vida comprometida. **CONCLUSÃO:** A distância percorrida no TC6M foi o aspecto de marcha mais forte associado independentemente com a qualidade de vida em indivíduos com moradia comunitária com marcha independente após um acidente vascular cerebral.

PALAVRAS-CHAVE: Qualidade de vida. Marcha. AVC . capacidade funcional.

ABSTRACT | INTRODUCTION: Stroke is one of the major causes of neurological deficiencies in the world, and can lead to a wide spectrum of physical deficiencies, including gait performance. These gait abnormalities have a substantial impact on functional activities, lifestyle, and the individual's perceptions about the functionality of daily life and well-being after stroke. **OBJECTIVE:** To evaluate gait performance, identifying determining which gait components were associated with impaired quality of life in stroke survivors. **METHODS:** Individuals with independent gait after a stroke, with or without the use of walking aids such as crutches or canes were included in the study. The socio-demographic and clinical data were recorded, then some tests were evaluated, with o 6-minute walk test (6MWT), 10-meters walk test (10MWT), Timed Up & Go (TUG), modified Barthel Index (mBI),National Institutes of Health Stroke Scale (NIHSS) and European Quality of life – 5 dimensions (EQ-5D). A stepwise multivariable logistic regression model assessed predictors of impaired QoL. **RESULTS:** A total of 124 individual with a mean age of 66 years and median NIHSS of 3 points were included. The mean EQ-5D was 0.44 (SD 0.38) and 91 individuals (73%) had impaired QoL. There was a positive correlation between 6MWT and EQ-5D (r = 0.48, p <0.001). Increasing age, functional capacity, 6MWT, 10MWT, stroke severity and female sex were associated with impaired QoL (p<0.05). In the multivariable analysis, 6MWT (OR 0.94 per 10m increase, p=0.046), functional capacity (OR 0.66, p=0.022) and age (OR 0.54 per 10 year increase, p=0.002) were associated with impaired QoL. **CONCLUSION:** Distance walked in 6MWT was the strongest gait aspect independently associated with quality of life in community-dwelling individuals with independent gait after a stroke.

KEYWORDS: Quality of life. Gait. Stroke. Functional capacity.

Introduction

Stroke is one of the major causes of adult neurological impairments in the world[1], with persistent physical disability in 50 to 65% of stroke survivors[2], thus having a significant impact on patients' emotional and socio-economical life, their families, and health care services[1]. Disabilities are the reflection of restrictions or lack of ability to perform one activity in a way or in a normal range of motion.

Clinical manifestations of stroke are diverse and depend on type of stroke, lesion site and extent of brain injury, resulting in heterogeneous impairment levels and rehabilitation outcomes[1]. Damage to motor pathways of the central nervous system can lead to a broad spectrum of physical impairments including in gait performance. For these patients, gait recovery is a major priority[3,4]. Post stroke patients usually exhibit functional ambulation marked by changes in gait pattern such as decrease gait speed and total running distance, with increasing energy expenditure. These gait abnormalities have a substantial impact on functional activities, life style, as well as on the individual's perceptions of daily life functionality and well being after the stroke[3].

A variety of instruments have been used to assess the likelihood of a patient with stroke being able to ambulate. These tools encompass several aspects of gait performance such as speed, endurance and balance[5,6]. The six-minute walk test (6MWT) is a submaximal tool used to measure functional walking capacity and endurance in daily activities[3,6,7]. Walking speed can be evaluated by the 10MWT as the patient self-select gait speed to cover a 10-meter distance. The 10MWT is considered a functional capacity measure of the individual in the community[7]. The Timed Up &Go test (TUG) is an easy to administer tool largely used to assess mobility and fall risk in a wide range of population[8].

Health-related quality of life (HRQoL) reflects patient's perception of the illness impact on their social and emotional life and well-being[1,9]. Restoration of walking, often reported as the major goal in the rehabilitation program, plays an important role on a patient's quality of life. Thus, the purpose of this study was to assess the association of functional capacity and gait performance with quality of life on stroke survivors.

Methods

Participants

We conducted a cross-sectional study of a consecutive patients with stroke recruited from two outpatients stroke clinics in Salvador, BA, Brazil from March 2010 to September 2011. All patients received a clinical-radiological diagnosis of ischemic or hemorrhagic stroke, regardless of the number of events. The inclusion criterion was independent gait with or without the use of walking aids such as crutches or canes. Patients with impaired comprehension to tests instructions, blood pressure higher than 170x110mmHg on study admission and comorbidities affecting gait performance such as orthopedic diseases were excluded. Data collection was performed on recruitment day by a single investigator and informed consent was obtained from all participants. The study was approved by the SESAB Human Research Ethics Committee (Department of Health of the State of Bahia - protocol number 030/2010).

Sociodemographics and clinical data

For all patients, we collected demographic and clinical data such as age, sex, side of injury, time since stroke onset, number of strokes and diagnostic of depression. Medical records were verified for additional clinical information.

Stroke severity and Functional capacity

We used the National Institutes of Health Stroke Scale (NIHSS) to quantify stroke severity with higher values related to more severe deficits. Functional capacity was evaluated with the modified Barthel Index (mBI). To avoid collinearity of scale items evaluating gait, mBIwas segmented in two parts: mBI-W and mBI-NW. The mBI-W comprehended the ambulation assessment where the patient was asked to walk up and down stairs and to walk on a regular floor and the mBI-NW evaluated activities of daily living (feeding, bathing, grooming, dressing, bowels, bladder, toilet use and transfers)[10].

Gait performance assessment

Three tests were used to assess gait performance, TUG, 10MWT and 6MWT and there were at least five minutes rest between them. Subjects were individually instructed and all participants used a walking aid when needed.

TUG

Each patient was asked to lift from a standardized chair, walk 3 meters, turn around, walk back to the original chair and sit down with total time measured in seconds using a digital chronometer[8].

10MWT

Gait speed was assessed via 10-meter walking test (10MWT) in a 14-meter-wide corridor, with a dynamic start to allow 2-m acceleration, a timed 10-m distance and 2-m deceleration, where subjects were asked to walk at their normal comfortable pace[7].

6MWT

Subjects were instructed to walk as far as possible during 6 minutes in a 14-meter-wide corridor with distance marks on the floor - they were allowed to rest and then continue walking and no verbal encouragement was given during the test[3,6].

Quality of Life

The Euro-QoL – 5 dimensions (EQ-5D) scale was used for QoL assessment, measures 5 domains (mobility, pain/discomfort, self-care, anxiety/depression and usual activities) and patients indicate one of three levels of impairment for each domain (no, some/moderate and extreme). A composite QoL score was calculated based on previously published criteria, where scores varied between 0 to 1, with death receiving 0 and 1 being the best state of health. As a reference mark, patients with a score below 0.78 were considered to have impaired QoL[11].

Data analysis

For statistical analyses, we used the Statistical Package for the Social Sciences (SPSS) version 16.0. For continuous variables, we performed normality diagnostics based on histogram visual inspection, skewness, kurtosis, normal probability plots and Kolmogorov Smirnov tests. Comparisons between non-impaired and impaired QoL groups were performed using t test or Mann Whitney test for continuous variables and Fisher's exact test for categorical variables. Correlations between continuous scale measurements were analyzed using Spearman test. Model building for factors associated with impaired QoL started with the most significant variable on univariable analyses, adding each successive variable with the smallest marginal p-value. In order to avoid collinear variables but still account for confounding, variables were kept in the model either if its marginal p-value was less than 0.05 or if they changed the beta-coefficient of the existing variables in the model by more than 20%. For gait tests as factors associated with impaired QoL, ROC curves were constructed based on the trapezoidal rule, using Youden's index to identify the ideal cut-off value with optimal sensitivity and specificity.

Results

We evaluated 124 patients with a mean age of 66 years (SD 14), ranging from 24 to 94 years, 71 (56%) female. The majority of subjects (77%) had a clinical history of only one episode of stroke. (Table 1) Functionally, individuals ranged from moderate dependence to complete independence, with median mBI of 48 (range 30 to 50).

Table 1. Sociodemographic and clinical characteristics of the individuals with stroke.

Variables	Impaired QoL (EQ-5D < 0.78), (n=91)	Non-impaired QoL (EQ-5D ≥ 0.78), (n=33)	P value
Age (years), mean (SD)	65 (15)	70 (10)	.084
Female sex, n (%)	57 (63)	14 (42)	.064
months since stroke onset, median (IQR)	21 (24)	24 (30)	.314
Right-hemisphere lesion, n (%)	48 (53)	22 (67)	.247
Walking aid, n (%)	23 (25)	2 (6)	.021
Depression, n (%)	17 (19)	4 (12)	.389

SD: standard deviation; IQR: interquartile range; EQ-5D: European Quality of Life-5 Dimensions; QoL: quality of life

Ninety-one subjects (73%) had EQ-5D<0.78, with EQ-5D mean score of 0.44 (SD 0.38). The most frequently involved domains were usual activities (33% and 34% of patients reporting moderate or extreme changes, respectively), followed by mobility (61% and 2%), anxiety/depression (36% and 24%), pain (40% and 16%) and self-care (37% and 6%). Stroke severity and functional performance according to QoL categories is shown in Table 2. Patients with impaired QoL were younger, more commonly female, used walking aids, with more severe stroke (NIHSS), presented a worse functional capacity (mBI) and poorer performance in gait tests (TUG, 10MWT, 6MWT).

Table 2. Stroke severity and functional performance of the individuals with stroke.

Variables	Impaired QoL (EQ5D < 0.78), (n=91)	Non-impaired QoL (EQ5D ≥ 0.78), (n=33)	P value
NIHSS, median (IQR)	3 (3)	2 (3)	<.001
mBI, median (IQR)	47 (8)	50 (2)	<.001
mBI NW, median (IQR)	38 (7)	40 (1)	<.001
TUG(s), median (IQR)	18.2 (18.5)	13.3 (8.3)	<.001
10MWT(s) median (IQR)	12 (12)	8 (4)	<.001
6MWT(m), median (IQR)	228 (184)	322 (125)	<.001

NIHSS: National Institutes of Health Stroke Scale; mBI: Modified Barthel Index; mBI-NW: Modified Barthel Index without walking and stairs items; TUG: Timed Up& Go; 6MWT: six minute walking test; 10MWT: ten meter walking test; SD: standard deviation; IQR: interquartile range.

To correct for potential confounders after univariate analysis, variables with possible association (P < .1) were included in a multivariable logistic regression model (Table 3).The following variables remained independent factors associated with impaired QoL :mBI without walking and stair items (mBI-NW) (OR 0.66 for every increase in 1 point, p =0.022), age (0.54 for every increase in 10 years, p =0.002) and 6MWT(0.94 for every increase in 10 meters, p =0.046), after additional adjustment for stroke severity (NIHSS).

Table 3. Multivariate analysis for independent factors associated with of impaired quality of life (EQ-5D < 0.78). Model c-statistic = 79.7%.

	Odds Ratio	CI (95%)	P value
6MWT	0.94 for every increase of 10 meters	0.88 to 0.99	.046
Age	0.54 for each increase of 10 years	0.36 to 0.80	.002
mBI NW	0.66 for each increase of 1 point	0.46 to 0.94	.022

Note: adjusted by age, 6MWT and mBI. 6MWT: six minute walking test; mBI-NW: Modified Barthel Index without walking and stair items.

We also tested for a possible interaction between age and 6MWT; and between NIHSS and 6MWT; both were non-significant (p>0.1). Table 4 describes the correlation between the QoL domains and each independent factors associated with impaired QoL. Both 6MWT and mBI were correlated with worse QoL scores in domains of usual activities, mobility and self care; and age had a slightly protective effect on QoL, but we could not identify which domain was responsible for the effect.

Table 4. Correlation between independent factors associated with impaired QoL and each EQ-5D domain.

EQ-5D domains	6MWT	Age	mBI-NW
Mobility	-0.45**	-0.04	-0.42**
Self-care	-0.39**	0.02	-0.71**
Usual activities	-0.54**	0.16	-0.70**
Pain	-0.14	-0.17	-0.12
Anxiety/depression	0.15	-0.16	-0.17

6MWT: six minute walking test; mBI-NW: Modified Barthel Index without walking and stairs items. *p<0.05; **p<0.01

The ROC curve for 6MWT as independent factors associated with impaired QoL is shown in the Figure. As a single factors, 6MWT showed good discrimination, with area under the curve of 0.72 (95% CI 0.63 to 0.82). Optimal cut-off as evaluated by the Youden index was greater than or equal to 241 meters, which provided a sensitivity of 82% and specificity of 59%.

Figure 1: ROC curve for the 6-minute walking test as a independent factors associated with impaired quality of life. Area under the curve was 0.72 (95% CI 0.63 to 0.82), with optimal cut-off (Youden index) of 241 meters (sensitivity 82%, sensitivity 59%).
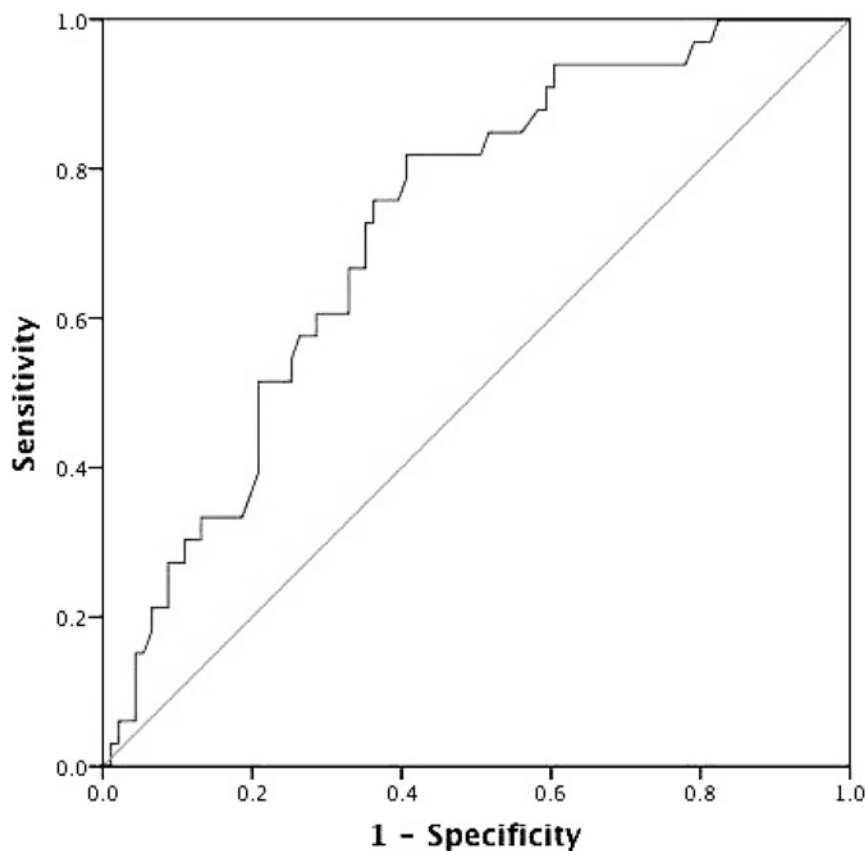
Discussion

The present study demonstrated that gait impairment, reduced functional capacity and younger age have a deleterious impact on community-dwelling individuals' quality of life after a stroke.

Gait performance as evaluated by 6MWT was the factor most strongly associated with quality of life in patients after stroke. 6MWT allows to evaluate the individual's ability in maintaining a moderate level of physical activity during a fixed time period, which indirectly reflects the potential to perform activities of daily living (ADL)[12,13]. We found a significant correlation among the 6MWT and the five QoL domains. Muren et al[3] described

similar findings using the Stroke Impact Scale where strongly correlated with Qol.

The 6MWT was originally developed for patients with decreased cardiorespiratory reserve[2,4,7,12]. Only modest association has been seen between 6MWT distance and aerobic capacity in these patients, thus providing evidence that distance in this test does not properly reflect cardiorespiratory aptitude in this population[14]. Cardiovascular performance may be limited in stroke survivors and this might be due stroke-specific impairments such as muscular weakness, balance deficit and spasticity, which can limit walking ability and performance in a submaximal test[3,14].

Other tests used in this study were the 10MWT and the TUG that measure resistance and functional mobility, respectively. Both of them did not correlate with QoL. Several studies have reported high correlations between 10MWT and 6MWT[2,4], although Lord and Rochester[15] stated that an increase in walking speed does not translate into a significant functional performance. However, Schmid et al[16] demonstrated that when the 10MWT outcome is stratify in groups, moving to a larger group of ambulation is associated with functional capacity and the QoL is considerably better.

When assessed in a clinical setting, the 6MWT has been demonstrated to be a significant predictor of walking in a natural environment, being superior to 10MWT, supporting the importance of submaximal endurance captured along six minutes[12].Our findings are in accordance with previous studies where the inability to maintain speed may interfere with walking performance in the community[7,17]. Furthermore, our results propose the 6MWT as factors associated with the quality of life on stroke survivors with good discrimination at a cut-off score of 241 meters. Moreover, gait impairment has an impact on the individual's perception of his/her daily life functionality and well-being after a stroke, as well as on his/her social participation[3,4].

Functional capacity evaluated by the mBI-NW was associated with impaired quality of life. Individuals who suffered a stroke may have an impaired quality of life, even without significant limitations in functional capacity[18]. In accordance with these outcomes, we showed that individuals mildly dependent on mBI also exhibited important impairments on quality of life. As demonstrated on post stroke individuals with mild or moderate functional capacity, the mBI ceiling effect could have influenced this result. Furthermore, the mBI only evaluates functional capacity regarding ADL, not capturing important decreases in physical or psychological functions in post stroke individuals, which emphasizes the importance of QoL evaluation as an outcome in stroke studies[19].

Stroke severity is expected to be associated with gait performance in walking tests. Stroke severity seems to modulate the magnitude of the relation between stroke-specific impairments, which are crucial factors for gait and distance in 6MWT[3]. Our results do not support these findings, as there was no association between stroke severity and 6MWT and QoL. This lack of effect of stroke severity might be due to a limitation of our study sample to patients who suffered relatively mild strokes (median NIHSS of 3).

The protective effect of age on QoL after stroke was unexpected in our study. While some studies suggest that QoL decreases with age due to reduced endurance or co-morbidities[2,20,21], others have found no significant relationship between aging and QoL in stroke survivors[22]. In our study, the majority of the population was composed of elderly (75%), with average age of 66 years and this might had a protective factor in our sample since based on theories supporting that elderly people have greater competence for emotional regulation, thus facing negative situations with greater well-being[23].

While some studies have described female gender as a determinant for poorer QoL[24,25], our results do not point to an association between QoL and gender or depression. Other studies support our findings and show no differences in magnitude by gender in stroke[20,22]. The retrospective collection approach to depression variable, may have underestimated its prevalence and consequently its association with quality of life.

Conclusion

In community-dwelling stroke survivors with independent gait, the 6MWT was the factor most strongly associated with impaired QoL, independently of stroke severity. The mechanism though which the gait performance is impaired after a stroke is heterogeneous, prospective studies should focus in the gait-specific impairments and in the functional performance outcomes in this population.

References

1. Quintas R, Cerniauskaite M, Ajovalasit D, Sattin D, Boncoraglio G, Parati EA et al. Describing functioning, disability, and health with the International Classification of Functioning, Disability, and Health Brief Core Set for Stroke. Am J Phys Med Rehabil. 2012;91(13 Suppl 1):S14-21. doi: 10.1097/PHM.0b013e31823d4ba9

2. Mudge S, Stott NS. Timed walking tests correlate with daily step activity in persons with stroke. Arch Phys Med Rehabil. 2009;90(2):296-301. doi: 10.1016/j.apmr.2008.07.025

3. Muren MA, Hutler M, Hooper J. Functional capacity and health-related quality of life in individuals post stroke. Top stroke rehabil. 2008;15(1):51-8. doi: 10.1310/tsr1501-51

4. Flansbjer UB, Holmback AM, Downham D, Patten C, Lexell J. Reliability of gait performance tests in men and women with hemiparesis after stroke. J Rehabil Med. 2005;37(2):75-82. doi: 10.1080/16501970410017215

5. Maeda A, Yuasa T, Nakamura K, Higuchi S, Motohashi Y. Physical performance tests after stroke: reliability and validity. Am J Phys Med Rehabil. 2000;79(6):519-25.

6. Daly JJ, Roenigk K, Cheng R, Ruff RL. Abnormal leg muscle latencies and relationship to dyscoordination and walking disability after stroke. Rehabilitation research and practice. 2011;2011:1-8. doi: 10.1155/2011/313980

7. Dean CM, Richards CL, Malouin F. Walking speed over 10 metres overestimates locomotor capacity after stroke. Clin Rehabil. 2001;15(4):415-21. doi: 10.1191/026921501678310216

8. Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. Phys Ther. 2000;80(9):896-903.

9. Alguren B, Fridlund B, Cieza A, Sunnerhagen KS, Christensson L. Factors associated with health-related quality of life after stroke: a 1-year prospective cohort study. Neurorehabilitation neural repair. 2012;26(3):266-74. doi: 10.1177/1545968311414204

10. Cincura C, Pontes-Neto OM, Neville IS, Mendes HF, Menezes DF, Mariano DC et al. Validation of the National Institutes of Health Stroke Scale, modified Rankin Scale and Barthel Index in Brazil: the role of cultural adaptation and structured interviewing. Cerebrovascular Dis. 2009;27(2):119-22. doi: 10.1159/000177918

11. Pinto EB, Maso I, Vilela RN, Santos LC, Oliveira-Filho J. Validation of the EuroQol quality of life questionnaire on stroke victims. Arq neuropsiquiatr. 2011;69(2B):320-3.

12. Donovan K, Lord SE, McNaughton HK, Weatherall M. Mobility beyond the clinic: the effect of environment on gait and its measurement in community-ambulant stroke survivors. Clin rehabil. 2008;22(6):556-63. doi: 10.1177/0269215507085378

13. Haacke C, Althaus A, Spottke A, Siebert U, Back T, Dodel R. Long-term outcome after stroke: evaluating health-related quality of life using utility measurements. Stroke. 2006;37(1):193-8. doi: 10.1161/01.STR.0000196990.69412.fb

14. Pang MY, Eng JJ, Dawson AS. Relationship between ambulatory capacity and cardiorespiratory fitness in chronic stroke: influence of stroke-specific impairments. Chest. 2005;127(2):495-501. doi: 10.1378/chest.127.2.495

15. Lord SE, Rochester L. Measurement of community ambulation after stroke: current status and future developments. Stroke. 2005;36(7):1457-61. doi: 10.1161/01.STR.0000170698.20376.2e

16. Schmid A, Duncan PW, Studenski S, Lai SM, Richards L, Perera S et al. Improvements in speed-based gait classifications are meaningful. Stroke. 2007;38(7):2096-100. doi: 10.1161/STROKEAHA.106.475921

17. Sibley KM, Tang A, Patterson KK, Brooks D, McIlroy WE. Changes in spatiotemporal gait variables over time during a test of functional capacity after stroke. Journal of neuroeng rehabil. 2009;6:27. doi: 10.1186/1743-0003-6-27

18. Kong KH, Woon VC, Yang SY. Prevalence of chronic pain and its impact on health-related quality of life in stroke survivors. Arch phys med rehabil. 2004;85(1):35-40.

19. van Exel NJ, Scholte op Reimer WJ, Koopmanschap MA. Assessment of post-stroke quality of life in cost-effectiveness studies: the usefulness of the Barthel Index and the EuroQoL-5D. Qual Life Res. 2004;13(2):427-33. doi: 10.1023/B:QURE.0000018496.02968.50

20. Haley WE, Roth DL, Kissela B, Perkins M, Howard G. Quality of life after stroke: a prospective longitudinal study. Qual Life Res. 2011;20(6):799-806. doi: 10.1007/s11136-010-9810-6

21. Singhpoo K, Charerntanyarak L, Ngamroop R, Hadee N, Chantachume W, Lekbunyasin O et al. Factors related to quality of life of stroke survivors. J Stroke Cerebrovascular Dis. 2012;21(8):776-81. doi: 10.1016/j.jstrokecerebrovasdis.2011.04.005

22. Xie J, Wu EQ, Zheng ZJ, Croft JB, Greenlund KJ, Mensah GA et al. Impact of stroke on health-related quality of life in the noninstitutionalized population in the United States. Stroke. 2006;37(10):2567-72. doi: 10.1161/01.STR.0000240506.34616.10

23. Scheibe S, Carstensen LL. Emotional aging: recent findings and future trends. J Gerontol B Psychol Sci Soc Sci. 2010;65B(2):135-144. doi: 10.1093/geronb/gbp132

24. Cerniauskaite M, Quintas R, Koutsogeorgou E, Meucci P, Sattin D, Leonardi M et al. Quality-of-life and disability in patients with stroke. Am J Phys Med Rehabil. 2012;91(13 Suppl 1):S39-47. doi: 10.1097/PHM.0b013e31823d4df7

25. Leach MJ, Gall SL, Dewey HM, Macdonell RA, Thrift AG. Factors associated with quality of life in 7-year survivors of stroke. J Neurol Neurosurg Psychiatry. 2011c;82(12):1365-71. doi: 10.1136/jnnp.2010.234765