Walking and Stair Climbing Abilities in Individuals After Chronic Stroke with and without Mental Health Problem

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Objective: *To compare muscle strength, balance, walking and stair climbing abilities among individuals after chronic stroke with or without mental health problems; to describe their physiological response after stress stimulation.*
Material and Method: *Subjects who had their first stroke more than one year ago were classified for mental health problems according to the Depression Anxiety Stress Scale-21. Lower extremity muscle strength of the quadriceps and plantar flexors, was measured by dynamometer. Balance and walking performance was measured by the Berg Balance Scale (BBS), 10-m walk test and timing of stair climbing. Community participation and spiritual well-being were measured. The physiological response of stress stimulation was assessed by the long stress test protocol of the biofeedback device.*
Results: *Forty-five subjects with chronic stroke aged 40-80 years were grouped by with (n = 25) and without mental health problems (n = 20). Significant differences were found in quadriceps muscle strength, BBS, walking and stair climbing speed, community participation and spiritual well-being between two groups. In the stress stimulus phase, the electromyography and heart rate variability demonstrated significant difference between those with and without stress.*
Conclusion: *Individuals with chronic stroke with mental health problems demonstrated decreased quadriceps muscle strength, balance and locomotor performances.*

Keywords: *Stress, Anxiety, Depression, Walking speed, Stair climbing*

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Walking and stair climbing is an optimal goal of rehabilitation in individuals with stroke. Lower extremity muscle strength and balance are related to walking and stair climbing performances[1,2]. The walking velocity may be confounded with cognitive anxiety, fear, fatigue and psychological factors[1]. Alteration of physical, psychological, emotional and social status after stroke induces mental health problems and leads to poor functional performances[3]. Mental health is defined as a state of well-being in which an individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and is able to make a contribution to his or her community[4]. The common disorders are stress, anxiety and depression.

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Stress is the response of mental, emotional and physical reaction to situations or events that happen to and influence more than their performance[5]. The sympathetic nervous system is aroused by stress and the responses could be detected[5]. The physiological responses to stress include an increased heart rate, tense muscles, heavy sweating, emotional highs and shortness of breath[17]. Stress is a common mental disorder in chronic illness disability and induces depression and anxiety. Post-stroke depression (PSD) was found in 30-50% of cases within the first year after stroke and is related to poor physical recovery and quality of life[6,7]. Depression is defined as a multifaceted experience of lowered energy and motivation, flattened affect, loss of sleep and appetite and other symptoms[5]. Astrom[11] reported the increase of PSD incidence at one to three years after stroke and is related to performance of activities in daily living. Anxiety occurs in response to stress and creates a diffuse sense of unease, anticipating something bad or harmful, but not knowing just what form it will take. It was found in 14 to 21% of cases after stroke and affected functional

mobility, cognition, communication and quality of life[8]. According to health definition, "Health is a dynamic state of complete physical, mental, spiritual and social well-being and not merely the absence of disease or infirmity"[4]. Seric[9] reported that spiritual well-being is an important component of the psychological well-being and part of the health-related quality of life of patients with severe chronic diseases. Individuals after stroke not only had physical impairments but also had mental health and spiritual problems affecting functional ability, locomotion and quality of life in individual. Therefore, the first objective of this study was to compare muscle strength, balance, walking, and stair climbing abilities in individuals with after chronic stroke with and without mental health problems (stress, anxiety and depression). The second objective was to describe the physiological response measured by the biofeedback device after stressful stimulation in individuals with and without stress.

Material and Method

The cross-sectional study was conducted. Subjects who had been diagnosed with a first stroke at least one year were invited to participate. The inclusion criteria were 40-80 years of age and not having cognitive impairment (assessed by Thai mini mental state examination ≥23). They had to be able to stand at least two minutes without using assistance and walk independently with or without ambulation devices for 40 meters[10]. Subjects who had other neurological conditions, cardio respiratory instability, musculo-skeletal problems and pain (Numeric rating scale >5) were excluded. The subjects signed the informed consent form for participating in the present study.

The mental health status was measured by the depression anxiety stress scale-21 (DASS-21)[11] and subjects were classified in two groups; with and without mental health problems. Each of the seven items of the DASS-21 was constructed for determining stress, anxiety and depression. The scale ranged from 0-3 and high scores referred to stress, anxiety and depression. The subjects who had the total scores of stress (>7), anxiety (>3) and depression (>4) were classified to have a mental health problem.

Lower extremity strength (LES) of the quadriceps and ankle plantar flexors muscles was assessed using a hand held dynamometer (HHD)[12]. The functional performances included balance, measured by the Berg Balance Scale (BBS)[13,14] and walking speed, measured by comfortable and fast gait speed of the ten-meter walk test (10mWT)[15].

Stair climbing was measured by timing stair-ascending and descending[10]. Community participation and spiritual well-being were measured by the participation domain of the stroke impact scale (SISpar)[16,17] and Functional Assessment of Chronic Illness Therapy Spiritual Well-Being (FACIT Sp-12)[18], respectively.

Stress stimulation was measured by the long stress protocol of the Bio-feedback system Nexus-10[19]. It measured the change of skin conductance response (SCR, microsiemens), skin temperature (Temp, Celsius), heart rate (HR, beats per minute), heart rate variability (HRV, beats per minute variability), respiratory rate (RR, rate per minute), and electromyography (EMG, hertz) at baseline and stress stimulation periods. The Nexus-10 can measure fast electrophysiological high speed signals (EEG/EMG/ECG/EOG etc) up to 2,048 samples/sec. Artifacts through movement of cables or other external sources of noise are reduced to a minimum[19]. The investigator was trained and practiced to carry out the Nexus-10 Mark II with seven normal subjects before collecting data. This study was approved by Mahidol University Institutional Review Board (COA. No. 2013/041.0705).

Descriptive statistics and independent t-test were used to compare the demographics, LES, functional abilities, community participation and spiritual well-being between two groups of mental health status. Non-parametric statistics were selected for data analysis when the normal distribution was not approved and with interval or ordinal data.

Results

Fifty-five subjects were enrolled from the physical therapy clinic, Faculty of Physical Therapy and Golden Jubilee Medical Center, Mahidol University and hospitals in Nakhonpathom Province. Of these, 45 subjects participated and were classified into two groups according to their DASS-21 scores: 25 subjects with mental health problems and 20 subjects without. While walking, 24 subjects (53.3%) used ambulation devices and four subjects wore ankle foot orthosis. The results show no significant differences of demographic variables between the two groups as shown in Table 1. Table 2 shows the significant difference of scores for quadriceps muscle strength, BBS, walking and stair climbing speed, community and spiritual well-being between the two groups (*p*-value <0.005). The physiological responses to stress measured by the Nexus-10 Mark II are shown in Table 3.

Table 1. Demographic data of stroke patients (n = 45)

Characteristics	Mental health problems (DASS-21)		*p*-value
	Without (n = 20)	With (n = 25)	
Age[a] (years), mean (SD)	59.10 (9.48)	61.28 (10.65)	0.478
Male, n (%)	13 (65)	21 (84)	0.141
Left hemiparesis, n (%)	10 (50)	14 (56)	0.688
Time after stroke (years), mean (SD)	5.75 (6.23)	4.80 (4.42)	0.729
Modified ashworth scale, n (%)			0.123
1	18 (90)	16 (64)	
1+	1 (5)	3 (12)	
2	1 (5)	6 (24)	

[a] The Independent t-test was used for age analysis and the nonparametrics for the other variables analysis

Table 2. The comparison of all outcomes measured between individuals post chronic stroke with and without mental health problem

	Mental health problem (DASS-21), mean (SD)		*p*-value
	Without (n = 20)	With (n = 25)	
HHD: quadriceps (newtons)	88.81 (16.04)	72.97 (21.67)	0.009**
HHD: plantar flexor (newtons)	47.48 (27.64)	41.47 (19.15)	0.394
Berg balance scale	50.05 (4.82)	44.56 (8.86)	0.012*
Walking speed measured by 10MWT (meter/second)			
Comfortable speed	0.56 (0.25)	0.36 (0.24)	0.013*
Fast speed	0.70 (0.37)	0.44 (0.29)	0.013*
Stair climbing (step/second)			
Ascending	0.66 (0.25)	0.47 (0.23)	0.011*
Descending[a]	0.65 (0.32)	0.44 (0.25)	0.016*
Community participation of stroke impact scale	58.00 (15.68)	45.20 (15.00)	0.008**
Spiritual well-being measured by FACIT	36.90 (5.41)	32.64 (7.64)	0.041*

* $p<0.05$ significant difference from without mental health problem
** $p<0.01$ significant difference from without mental health problem
[a] Analyzed by the Mann Whitney test

Discussion

Many previous studies have reported that mental health problems including stress, anxiety and depression were common mental disorder in individuals with chronic stroke. Poor functional performances and severe disability were related with individuals with stoke who had mental health problems[6]. Angeleri[20] found that stress was correlated with depression after stroke, functional dependence and social activity limitation in individuals three years after stroke. Goodwin[21] reported that individuals with depression after stroke were more likely to limit their ability to walk and stair climbing than those without. Similar to our results, the authors found the relationship between mental health, function performances and community participation after stroke. The authors also represented the association of all aspects of health including physical, mental and spiritual statuses in individuals with more than one year after stroke. Slow speed of locomotion in individuals with stroke who had mental health problems might be a cause of inattention to the rehabilitation program and/or neglect of their health condition[3].

Regarding Nexus-10 Mark II, all parameters were changed in the stress stimulation phase when compared with baseline data. The skin conductance, respiratory rate, EMG signals at trapezius muscle and

Table 3. Physiological responses to stress for the individuals after chronic stroke with stress and without mental health problem; mean ± SD

Parameters	Long stress protocol measured by Nexus-10 Mark II					
	Stress phase			% change scores = [(stress-baseline)/baseline]*100		
	None	Stress	*p*-value	None	Stress	*p*-value
SCR	1.10±0.83	1.37±1.29	0.658	10.54±31.43	13.82±48.16	0.703
Temp	30.33±4.26	31.12±3.46	0.544	0.79±2.74	-1.04±2.36	0.038*
HR	68.97±9.85	74.27±12.20	0.153	1.63±2.94	1.14±2.53	0.784
EMG	21.23±7.53	32.92±13.75	0.005*	7.25±31.91	0.05±21.66	0.692
RR	22.23±2.85	21.58±2.40	0.462	18.65±18.88	15.77±16.59	0.628
HRV	14.17±7.92	9.62±7.63	0.033*	-0.41±25.97	-7.41±26.11	0.421

* $p<0.05$ significant difference from without mental health problem.
SCR = skin conductance response (microsiemens); Temp = skin temperature (celsius), HR = heart rate (beats per minute); HRV = heart rate variability (beats per minute variability); RR = respiratory rate (rate per minute); EMG = electromyography (hertz)

HR increased in both groups. The high percentage of change of skin conductance (SCR) in stress groups paralleled the findings of Moscovitch[22]. Ohsuga[23] reported on physiological measures and their changes by stress stimulation in normal people. They explained that the decrease in skin temperature and heart rate variability (HRV) reflected an emotional constraint caused by sympathetic activation.

The present study had some limitations. Our cross-sectional, study design might not indicate the cause and effect. However, this study represented the association of all aspects of health including physical, mental and spiritual statuses in individuals more than one year after stroke. To the best of our knowledge, this is the first study employing the biofeedback device to examine the physiological response to stress stimulation. The responses were identified in individuals with and without stress. A follow-up study of the effects of mental health problems on functional recovery after stroke is suggested.

Conclusion

Decrease of LE muscle strength, functional performances, community participation and spiritual well-being were illustrated in individuals after chronic stroke with and without mental health problems. Therefore, understanding the association of physical, mental health and spiritual well-being status should be considered to identify barriers for health promotion.

What is already known on this topic?

Most of the previous studies revealed low functional performance in the individuals post stroke with depression.

What this study adds?

There were low scores of physical and functional performance, community participation, and spiritual well-being in individuals post chronic stroke with mental health conditions. The physiological responses of SCR and HRV were changed after stress stimulation test by biofeedback equipment in individuals with stroke.

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Potential conflicts of interest

None.

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ความสามารถในการเดินและขึ้นลงบันไดในผู้ที่มีโรคหลอดเลือดสมองระยะเรื้อรังที่มีและไม่มีปัญหาสุขภาพจิต

จารุวรรณ ประสมศรี, ชุติมา ชลายนเดชะ, สุนีย์ บวรสุนทรชัย, ศุภลักษณ์ เข็มทอง

วัตถุประสงค์: *เพื่อเปรียบเทียบความแข็งแรงของกล้ามเนื้อ ความสามารถในการทรงตัว ความสามารถในการเดิน และการขึ้นลงบันไดระหว่างผู้ป่วยโรคหลอดเลือดสมองระยะเรื้อรังที่มีและไม่มีปัญหาสุขภาพจิต และอธิบายผลของการตอบสนองทางสรีรวิทยาหลังจากได้รับการกระตุ้นความเครียด*

วัสดุและวิธีการ: *ผู้ที่เป็นโรคหลอดเลือดสมองครั้งแรกนานกว่า 1 ปี จะได้รับการจัดเข้ากลุ่มที่มีและไม่มีปัญหา สุขภาพจิตโดยแบบประเมิน Depression Anxiety Stress Scale-21 ความแข็งแรงกล้ามเนื้อขา (กล้ามเนื้อเหยียดเข่าและงอเข่าลง) ประเมินโดยไดนาโมมิเตอร์ ความสามารถในการทรงตัวและความสามารถในการเดินประเมินโดยแบบประเมิน Berg Balance Scale และ 10 meters walk test และขึ้นลงบันไดโดยการจับเวลาร่วมกับการประเมินการมีส่วนร่วมของในชุมชนและสุขภาวะที่สมบูรณ์ทางจิตวิญญาณ การตอบสนองทางสรีรวิทยาของการกระตุ้น ความเครียดประเมินจากโปรแกรมการกระตุ้นความเครียดแบบยาวของอุปกรณ์ไอโอฟีดแบค*

ผลการศึกษา: *ผู้เข้าร่วมศึกษาจำนวน 45 ราย มีอายุระหว่าง 40-80 ปี โดยอยู่ในกลุ่มที่มีปัญหาสุขภาพจิต 25 ราย และไม่มีปัญหาสุขภาพจิต 20 ราย พบความแตกต่างอย่างมีนัยสำคัญของความแข็งแรงกล้ามเนื้อเหยียดเข่า การทรงตัว ความเร็วการเดิน และการขึ้นลงบันได การมีส่วนร่วมของในชุมชนและสุขภาวะที่สมบูรณ์ทางจิตวิญญาณระหว่างสองกลุ่ม ในระยะกระตุ้นความเครียดพบค่าสัญญาณไฟฟ้ากล้ามเนื้อและความแปรปรวนการเต้นของหัวใจแสดงถึงความแตกต่างอย่างมีนัยสำคัญระหว่างผู้ที่มีและไม่มีความเครียด*

สรุป: *ผู้ป่วยโรคหลอดเลือดสมองระยะเรื้อรังที่มีปัญหาสุขภาพจิตจะมีสมรรถภาพทางกายรวมถึงความสามารถในการเคลื่อนที่ลดลงด้วย*