BALANCE ABILITIES AMONG STROKE PATIENTS USING BERG BALANCE SCALE

Hadeel, Al-Hadidi, Yasmin, Al Judo, Yasmin, Abu Rumman Rania, Al-Abadi and Aida, Al-Awamleh

The University of Jordan, School of Sports Sciences

Original scientific paper

Abstract
Stroke is a leading cause of disability and decline in the quality of life in adults and older people. It can cause different impairments in the physiological system involved in postural control, movement and cognitive ability. Balance is defined as the ability to maintain a position within the limits of stability or base of support. The aim of this study was to investigate dynamic and static balance among the stroke patients. Thirty one patients with stroke (stroke onset >3 months) (male =18 female=13 mean: 48± (aged between 17-70 years old participated in this study. The Berg balance test was used to measure static and dynamic balance ability among stroked patients. It is a qualitative measure that assesses balance via performing functional activities, such as reaching, bending, transferring, and standing that incorporates most components of postural control. The results showed that the mean BBS score was 25.71, where patients need assistance in most of the movements required to perform daily-life activities. Furthermore, males scored greater mean values than females on three movements (Sitting unsupported), (Standing with eyes closed) and the movement of (Standing with feet together). The results revealed that there was a significant difference in the Berg balance scale for the stroke patients according to age. Finally, The BBS is recommended for assessing the severity of balance impairment

Key words*: balance, Berg balance scale, stroke, gender*.

Introduction

The balance assessment for stroke patients is important. Balance involves the coordination and stability that affects most day-to-day activities, such as moving around and reaching for objects. Balance is the ability to keep the body upright and to keep control of body position during movement. It is essential for optimal functioning of the locomotor system (Nayak et al., 2010). There are two types of balance: static balance where the person has to keep his balance while being still, and dynamic balance, where he/ she has to keep his balance during movement. Balance is very complex and involves many different parts of the body, such as ears, eyes aswell as sensors in muscles and joints. These work together automatically and subconsciously; therefore, the person is usually unaware of them unless something goes wrong. (Joeand Starks,2013)

Stroke is a central nervous system disease caused by failure of blood supply due to ischemia, hemorrhage, heart disease, and diabetes (Prange, et al 2006). In addition, stroke leads to changes in several factors, such as normal postural tone, maintenance of balance, and biomechanical characteristics of muscles associated with muscle weakness. Impairments of body function lead to difficulty in performing independent gait due to decreased balance function, velocity, and endurance (Belgen, et al. 2006).

The World Health Organization (WHO) defined stroke as "a rapidly-developed clinical sign of focal disturbance of cerebral function of presumed vascular origin and of more than 24 hrs duration". This definition does not include `transient ischemic attacks` (Stokes, 1998). Stroke is a brain attack, or CVA is a sudden death of brain caused by a lack of supply in oxygen to the brain. (Owolabi et al ., 2015) suggested that the sudden death of some brain cells due to the lack of oxygen when the blood flow to the brain is lost by blockage or rupture of an artery to the brain, is also a leading cause of dementia and depression. The main types of stroke are Ischemic and Haemorrhagic stroke. Ischemic stroke or cerebral infarct (80% of strokes) results from a blockage or a reduction of blood flow in artery that supplies the brain. They are caused either by a clot (thrombus) which blocks the blood vessel or by the buildup of plaque often due to cholesterol within the arteries which narrows vessel, resulting in a loss of blood flow. Haemorrhagic strokes are due to the rupture of an artery within the brain triggering an intra-cerebral haemorrhage (15% of strokes) or to the rupture of aneurysm or AVM entailing subarachnoid haemorrhage (5% of strokes ((Braunwald et al., 2003). The berg balance scale is a performance-based measure consisting of (14) items with a maximum score of (56); it was originally developed to assess balance in older adults and determine the patient's ability (or inability) to safely balance during a series of predetermined tasks. (Berg. Et al . 1989) admission scores can predict the length of hospital stay and discharge destination (Mao HF et al. 2002: Wee JY, Wong H, Palepu A 2003). This present study was designed to investigate three main objectives. First, it evaluates balance among stroke patients and assesses the ability to perform static and dynamic balance and identify the risk of

falling; second, it explores whether there is a statistically significant difference in the balance performance between male and female stroke patients; and third, it explores whether there is a statistically significant difference in the balance performance regarding age .

Methods

Participants

A total of (31) stroke patients (18 male, 13 female) aged between (17-70) years were interviewed and participated in this study. The males have an average mean age of (48.06 ±17.58) years, while the females have an average mean age of (47.92±16.17) years and the overall mean for the sample individuals' age was (48.00 ± 16.72) years. Table (1) shows the sample characteristics.

The inclusion criteria were stroke onset for more than three months and an agreement to participate in this study.

The research's protocol was reviewed and approved by the ethics committee of the Faculty of Sports Sciences.

Table 1. Sample Characteristics.

Variable	Category	N	M (age)	SD (age)
Gender	Male	18	48.06	17.58
	Female	13	47.92	16.17
	Total	31		
Age	< 40years	8		
	>=40 years	23		
	Total	31		

Procedure

The Berg Balance Scale

The BBS was used to assesses the dynamic and static balance of individuals and their risk of falls, considering the environmental influence on function. It assesses balance performance of (14) subtests of various activities related to balance, where it takes (20-25) minutes to complete the tasks, including the individual's ability to sit, stand, reach, turn 360°, look over his/ her shoulders, stand on one foot, and place one foot on a stair or stool while standing unsupported. It has a maximum score of (56) points and a minimum of (0) points; each task has five possible scores ranging from (0) to (4) points with higher scores indicating better balance (Quinn L, Khalil H, Dawes H, et al 2013).

The BBS has shown to be valid across multiple-patient populations, where balance is of primary concern (Berg, Wood-Dauphinee, Williams, & Maki, 1992).

The test is simple and easy to administer and is safe for the elderly to perform (Bergland et al. 2010).

Content validity of the BBS was established in a 3-phase development process. Criterion-related validity has been supported by moderate to high correlations and it has shown to be valid across multiple-patient populations (Berg et al. 1992; Usuda et al. 1998; Whitney, et al. 2003).

The scale has shown good intra-rater and inter-rater reliability when used with an elderly population in Norway (Cronbach's α values were 0.87 and 0.9), which are considered as valid estimates (Halsaa et al. 2007; Telenius et al. 2015; Conradsson et al. 2007).

The functional outcomes of the stroke patients were evaluated by this test and the motor status of their limbs was evaluated (healthy and unhealthy limbs). The following table shows the items in the scale and their accompanying instructions:

Berg balance scale item	Instruction
1. Sitting to standing	The subject must not use hands or other support.
2. Standing unsupported	No support is allowed for two minutes.
3. Sitting with back unsupported,, but feet supported on floor or on a stool	The subject must maintain position with arms folded for 2 minutes.
4. Standing to sitting	The subject must be in standing position at the beginning.
5. Transfers	Chairs are to be arranged for pivot transfer and the subject is asked to transfer from one to another, alternatively.
6. Standing unsupported with eyes closed	The subject must maintain a still position for 10 seconds.
7. Standing unsupported with the feet together	The action must be performed without support.
8. Reaching forward with outstretched arm while standing	Arm must be lifted at 90 degrees and the subject is instructed to stretch fingers and reach forward as much as possible.
9. Picking up object from the floor from a standing position	The object to be picked must be placed in front of the subject's feet.
10. Turning to look behind over left and right shoulders while standing	Assessment of the twist turn action.
11. Turning 360 degrees	Assessment of a complete full circle turn in one direction, followed by another complete turn in the opposite direction.

12. Placing alternate foot on step/stool while standing unsupported	The action must be performed until each foot has touched the step/stool 4 times.
13. Standing unsupported with one foot in the front	If this is not possible, the foot can be placed forward ahead of the toes of the other foot.
14. Standing on one leg	The subject must maintain his/ her position for as long as possible.

The table below shows the score ranges and their interpretation:

Berg score (points)	Interpretation
45 – 56	Patient is mostly independent in his movement and there is a low risk of falling.
41 – 44	Patient is mostly independent in his movement, but there is a significant risk of falling.
21 – 40	Patient may require assistance in performing some of the tasks in the balance test and in general activities of daily living. There is a possibility of 100% for the risk of falling.
0 – 20	The patient is wheelchair bound at the moment or may be in the future and there is a possibility of 100% for the risk of falling (Berg et al 1992).

Results

The mean of BBS score was (25.71). This value is approximately (45.91 %) of the maximum scale degree (56), showing that the patients really need help in most of the movements and represent mild impairments in cognition level. Patients may require assistance in performing some of the tasks in the balance test and in general activities of daily living. There is a possibility of 100% for the risk of falling. Table (2) shows the means and standard deviations for the stroke patients .

Table 2. Means and standard deviations for the items of Borg balance scale for the stroke patients

BBS Items (movements)	M	Sd	Order
Sitting to standing	2.06	1.21	4
Standing unsupported	2.39	1.33	2
Sitting unsupported	3.42	0.89	1
Standing to setting	2.16	1.21	3
Transfers	2.06	1.18	4
Standing with eyes closed	1.97	1.11	6
Standing with feet together	1.58	1.15	10
Reaching forward with un stretched arm	1.48	0.89	11
Picking up an object from floor	1.26	1.06	12
Turning to look behind	1.71	1.35	8
Turning 360 degrees	1.77	1.31	7
Placing alternate foot on stool	1.19	1.08	13
Standing with one foot on stool	1.65	1.05	9
Standing on one foot	1.00	0.97	14
Total degree	25.71	12.55	

The most recognized balance movement by the sample was "Sitting unsupported" and was ranked with the highest movement mean (3.42), suggesting that the majority of the sample can perform this movement, while movement No.14 which is "Standing on one foot" seemed to be the most difficult movement to be performed and was ranked in the last order with a mean of (1.00). The results showed that there were gender differences regarding static and dynamic balance for the stroke patients.

Table 3. Gender differences in dynamic and static balance among stroke patients.

Variables	Gender	N	mean	SD	t	sig
Sitting to standing	Males	18	1.94	1.30	0.64	0.525
	Females	13	2.23	1.09		
Standing unsupported	males	18	2.44	1.50	0.27	0.783

	females	13	2.31	1.11		
Sitting unsupported	males	18	3.78	0.65	2.97	0.006*
	females	13	2.92	0.95		
Standing to setting	males	18	2.11	1.32	0.26	0.792
	females	13	2.23	1.09		
Transfers	males	18	2.28	1.23	1.19	0.243
	females	13	1.77	1.09		
Standing with eyes closed	males	18	2.39	0.92	2.74	0.010*
	females	13	1.38	1.12		
Standing with feet together	males	18	1.94	1.06	2.20	0.035*
	females	13	1.08	1.12		
Reaching forward with un stretched arm	males	18	1.50	0.92	0.11	0.908
	females	13	1.46	0.88		
Picking up an object from floor	males	18	1.28	1.07	0.11	0.906
	females	13	1.23	1.09		
Turning to look behind	males	18	1.78	1.52	0.32	0.746
	females	13	1.62	1.12		
Turning 360 degrees	males	18	1.83	1.38	0.29	0.773
	females	13	1.69	1.25		
Placing alternate foot on stool	males	18	1.50	1.15	1.94	0.061
	females	13	0.77	0.83		
Standing with one foot on stool	males	18	1.94	0.94	1.95	0.061
	females	13	1.23	1.09		
Standing on one foot	males	18	1.22	1.00	1.54	0.134
	females	13	0.69	0.85		
Total scale degree	males	18	27.94	12.66	1.17	0.250
	females	13	27.94	12.21		

The T- test was used to evaluate the differences between males and females over the berg balance scale for patients with stroke. The results indicated that there were no significant differences in approximately all the movements included in the scale as the significance values were (>0.05). Only three movements show sig levels (<0.05). These three movements were (Sitting unsupported, sig=0.006), (Standing with eyes closed, sig=0.010) and (Standing with feet together, sig = 0.035). The differences observed in these three movements were in favor of the males as they recorded greater mean values compared to the females as illustrated in the table (3).

Table 4. Age differences in dynamic and static balance among stroke patients

Variables	Age	N	mean	SD	t	sig
Sitting to standing	< 40 years	8	2.38	1.51	0.83	0.408
	40 + years	23	1.96	1.11		
Standing unsupported	< 40 years	8	2.63	1.19	0.57	0.567
	40 + years	23	2.30	1.40		
Sitting unsupported	< 40 years	8	3.63	0.74	0.75	0.455
	40 + years	23	3.35	0.93		
Standing to setting	< 40 years	8	2.38	0.92	0.57	0.572
	40 + years	23	2.09	1.31		
Transfers	< 40 years	8	2.50	1.20	1.22	0.232
	40 + years	23	1.91	1.16		

Standing with eyes closed	< 40 years	8	2.50	0.53	1.61	0.117
	40 + years	23	1.78	1.20		
Standing with feet together	< 40 years	8	2.00	1.07	1.20	0.237
	40 + years	23	1.43	1.16		
Reaching forward with un stretched arm	< 40 years	8	2.13	0.99	2.58	0.015*
	40 + years	23	1.26	0.75		
Picking up an object from floor	< 40 years	8	2.00	0.93	2.47	0.019*
	40 + years	23	1.00	1.00		
Turning to look behind	< 40 years	8	2.63	1.30	2.40	0.023*
	40 + years	23	1.39	1.23		
Turning 360 degrees	< 40 years	8	2.50	1.69	1.89	0.068
	40 + years	23	1.52	1.08		
Placing alternate foot on stool	< 40 years	8	1.50	0.76	0.93	0.359
	40 + years	23	1.09	1.16		
Standing with one foot on stool	< 40 years	8	2.25	0.89	1.98	0.057
	40 + years	23	1.43	1.04		
Standing on one foot	< 40 years	8	1.50	0.53	1.75	0.089
	40 + years	23	0.83	1.03		
Total scale degree	< 40 years	8	32.50	11.50	1.84	0.075
	40 + years	23	23.35	12.26		

Table (4) shows the significance of mean differences between age categories using the berg balance scale for the stroke patients using t-test. The results showed that there were no significant difference in approximately all the movements included in the scale as the sig values were (> 0.05). Only four movements show sig levels (< 0.05); these were (Reaching forward with un stretched arm, P= 0.015), (Picking up an object from floor, P=0.019), (Turning to look behind , sig =0.023) and (Turning 360 degrees, P = 0.023).
The differences observed in these four movements were in favor of (< 40) years old who scored greater mean values compared to those older than (40) years.

Discussion

The study was conducted to evaluate dynamic and static balance among stroke patients

The study focused on estimating patients' static and dynamic performance on Berg balance scale. The mean of BBS score was (25.71), representing mild impairments in cognition level. Figure (1) shows the results.

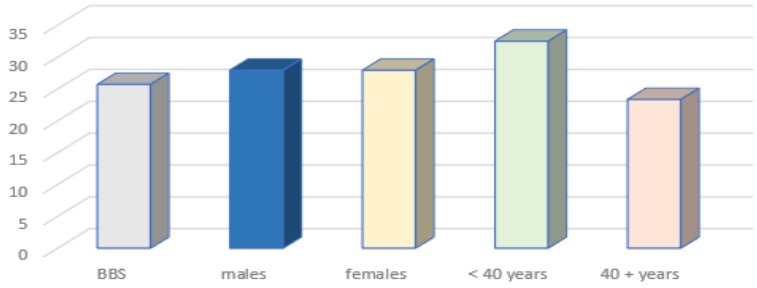

Figure 1. Balance abilities among stroke patients

Patients may require assistance in performing some of the tasks in the balance test and in general activities of daily living. Dynamic balance was better than static balance in all the items. Sitting unsupported gained the highest mean in test items. This is an indication that it is easy to apply it to all the members of the sample. Standing on one foot had the lowest mean in the test items, which indicates that a large number of the study sample individuals has difficulty in applying it. Reaching forward with non-stretched arm and retrieving object from floor had a slightly higher mean because patients need a high body balance and the same mechanism of application. Disabilities after stroke varied, and were mostly related to motor impairments.

The most frequent motor impairments are reduced power in the arm and/or leg in one side of the body, impaired motor control, uncoordinated movements, and reduced balance control (Saso et al., 2016). Researchers found that there were a positive correlation between balance impairments and decreased ankle proprioception among patients with stroke. These abnormal interactions between the three sensory systems could be the source of abnormal postural reactions (Keenan et al.1984; Tyson et al ., 2006; Bonan et al ., 2004;Nashner et al., 1982; Nashner et al., 1983). (Enrique et al., 2005) indicted that the static standing position use somatosensory information which comes from the lower limbs (feet pressure receptors, ankle joint receptors, muscle proprioceptors.

According to BBS, we found the most recognized balance movements among the sample was (sitting unsupported) with dynamic balance, which was ranked as the highest movement mean (3.42); suggesting that the majority of patients can perform this movement, while (standing on foot) movement with static balance was the most difficult and had a mean of (1.00).

This study revealed that there are gender differences on sitting unsupported, standing with closed eyes, and standing with feet together. The results showed that the differences were in favor of males because males have more muscles than females and the physical structure of the male is bigger and stronger. A study conducted by (Oppewal et al., 2013) found that females had poorer balance capabilities than males with regard to the variable of age.

The previous studies found that aging is associated with balance disturbances as a result of functional decline of the three sensory afferent systems (Gauchard et al ., 2001; Tyson et al ., 2006). The results showed that balance capacities decreased with increasing age (Oppewaletal., 2013) and that older adults use the hip and step strategies more frequently than the ankle strategy (Shumway-et al., 2001). The results of current study found that there are differences between age categories over the Berg balance scale for stroke patients on four movements (Reaching forward with un-stretched arm), (Picking up an object from floor), (Turning to look behind) and the movement of (Turning 360 degrees). The differences observed in these four movements were in in favor of (<40) years as they scored greater mean values compared to those older than 40 years. This means that the older the patient, the harder it is to perform a test.

Conclusion

The assessment of balance is an integral part of the examination of patients with stroke. Stroke can affect different functions independently. As balance problems are common after stroke and treatment of balance continues to be standard of care in stroke rehabilitation, the present study applied BBS to identify the stroke patient's balance (static and dynamic). The researchers recommended the necessity of paying more attention to the balance among stroke patients because it is important to give the individual strength and confidence concerning falling risk and patients should also be trained in exercises for balance, with more attention to older people. Balance is one of the important aspects during movement anywhere either indoor or outdoor to achieve the individual's need during day and to be independent in performing the activities of daily living with stroke, where the individual adapts his life style, habit, and daily routine .The activities of daily living are a series of basic activities performed by individuals on a daily basis necessary for independent living at home or in the community. There are many variations on the definition of the activities of daily living, but most organizations agree that there are (5) basic categories.

1. Personal hygiene, bathing, grooming and oral care.
2. Dressing - the ability to make appropriate clothing decisions and physically dress oneself.
3. Eating - the ability to feed oneself though not necessarily to prepare food.
4. Maintaining continence - both the mental and physical ability to use a restroom.
5. Transferring - moving oneself from seated to standing and get in and out of bed.

Whether or not an individual is capable of performing these activities on their own or if they rely on a family caregiver to perform, the ADLs serves as a comparative measure of their independence. Furthermore, it is important to train the healthy and unhealthy limbs so as not to lose sense with time. The researcher recommended conducting further studies with more samples to find more results and use other balance assessment tools among patients after stroke.

References

Belgen, B., Beninato, M., Sullivan, P.E., & Narielwalla, K. (2006). The association of balance capacity and falls self-efficacy with history of falling in community-dwelling people with chronic stroke. Arch Phys Med Rehabil. 87, 554-61.

Berg, K.O., Maki, B.E., Williams, J.I, Holliday, P.J., & Wood-Dauphinee, S.L. (1992). Clinical and laboratory measures of postural balance in an elderly population. Arch Phys Med Rehabil. 73(11):1073-80.

Bergland, A., Narum, I., Grønsted,t H., et al.(2010). Evaluating the feasibility and intercorrelation of measurements on the functioning of residents living in Scandinavian nursing homes. Phys Occup Ther Geriatr, 28:154–69.

Berg, K, Wood-Dauphine, S.L., Williams, J.L., Gayton, D. (1992). Measuring balance in the elderly: validation of an instrument. Canadian Journal of Public Health, 2: 7-11.
Bonan, I.V., Colle, F.M., Guichard, J.P., Viacut, E., Eisenfisz, M., et al. (2004). Reliance on visual information after stroke. Part I: Balance on dynamic posturography. Arch Phys Med Rehabil. 85(2):268-73.
Berg, K., Wood-Dauphinee, S.L., Williams, J.I., et al. (1989). Measuring balance in the elderly: Preliminary development of an instrument. Physiother Can. 41(6):304–11.
Berg, K., Wood-Dauphinee, S., Williams, J., & Maki, B. (1992). Measuring balance in the elderly: Validation of an instrument. Canadian Journal of Public Health, 83(2), S7-11
Conradsson, M., Lundin-Olsson, L., Lindelöf, N. et al. (2007). Berg balance scale: intrarater test–retest reliability among older people dependent in activities of daily living and living in residential care facilities. Phys Ther, 87:1155–63.
Enrique, V., Rubén, L., Martínez, L., & Pedro, A. (2005). Walking recovery after an acute stroke: Assessment with a new functional classification and the Barthel Index. Archives of Physical Medicine and Rehabilitation 86, 1239.
Gauchard, G.C., Jeandel, C., Perrin, P.P. (2001). Physical and sporting activities improve vestibular afferent usage and balance in elderly human subjects. Gerontology, 47(5):263-70.
Halsaa, K.E., Brovold, T., Graver, V. et al. (2007). Assessments of interrater reliability and internal consistency of the Norwegian version of the Berg Balance Scale. Arch Phys Med Rehabil, 88:94–8.43.
Keenan, M.A., Perry, J., Jordan, C. (1984). Factors affecting balance and ambulation following stroke. Clin Orthop Relat Res. (182):165-71.
Mao, H.F., Hsueh, I.P., Tang, P.F., et al. (2002). Analysis and comparison of the psychometric properties of three balance measures for stroke patients. Stroke. 33(4):1022–7.
Nashner, L.M., Black, F.O., Wall C 3rd. Adaptation to altered support and visual conditions during stance: Patients with vestibular deficits. J Neurosci. 2(5):536-44.
Nashner, L.M., Shumway-Cook, A., Marin, O. (1983). Stance posture control in select groups of children with cerebral palsy: Deficits in sensory organization and muscular coordination. Exp Brain Res. 49(3):393-409.
Oppewal, A., Hilgenkamp, T.I., van Wijck, R., & Evenhuis, HM. (2013). Feasibility and outcomes of the Berg Balance Scale in older adults with intellectual disabilities. Res Dev Disabil. 34(9):2743-2752.
Prange, G.B., Jannink, M.J., Groothuis-Oudshoorn, C.G., Hermens, H.J., & IJzerman, M.J. (2006). Systematic review of the effect of robot-aided therapy on recovery of the hemiparetic arm after stroke. J Rehabil Res Dev. 43, 171-84.
Quinn, L., Khalil, H., Dawes, H., et al. (2013). Reliability and minimal detectable change of physical performance measures in individuals with pre-manifest and manifest Huntington disease. Phys Ther 93:942–956.
Telenius, E.W., Engedal, K., & Bergland, A. (2015). Inter-rater reliability of the Berg Balance Scale, 30s chair stands test and 6 m walking test, and construct validity of the Berg Balance Scale in nursing home residents with mild-to-moderate dementia. BMJ Open Rehabilitation Medicine, 5.
Tyson, S.F., Hanley, M., Chillala, J., Selley, A., Tallis, R.C. (2006). Balance disability after stroke. Phys Ther. 2006;86(1):30-38. Erratum in: Phys Ther. 86(3):463.
Saso, A., Moe-Nilssen, R., Gunnes, M., Askim, T. (2016). Responsiveness of the Berg Balance Scale in patients early after stroke. Physiotherapy Theory and Practice. 32(4):251-261.
Shumway-Cook, A., & Woollacott, M.H. (2001). Motor control: Theory and practical applications. 2nd ed. Philadelphia (PA): Lippincott, Williams & Wilkins.
Tyson, S.F., Hanley, M., Chillala, J., Selley, A., & Tallis, R.C. (2006). Balance disability after stroke. Phys Therapy. 86(1):30-38. Erratum in: Phys Ther. 86(3):463.
Usuda, S., Araya, K., Umehara, K., Endo, M., Shimizu, T., & Endo, F. (1998) Construct validity of functional balance scale in stroke inpatients. Journal of Physical Therapy Science, 10, 53-56.
Whitney, S., D. Wrisley, et al. (2003). Concurrent validity of the Berg Balance Scale and the Dynamic Gait Index in people with vestibular dysfunction. Physiother Res Int 8(4): 178-86.
Wee, J.Y., Wong, H., & Palepu, A. Validation of the Berg Balance Scale as a predictor of length of stay and discharge destination in stroke rehabilitation. Arch Phys Med-Rehabil., 84(5):731–5.

Received: March 3, 2019
Accepted: August 15, 2020
Correspondence to: Davide Di Palma
University of Naples "Parthenope"
E-mail: davide.dipalma@uniparthenope.it