# Lower Limb Motor Coordination of Stroke Survivors, Based Upon Their Levels of Motor Recovery and Ages

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## Abstract

**Objective:** To describe the motor coordination (MC) of the paretic lower limb of stroke survivors based upon their levels of motor recovery and ages and to compare their LEMOCOT scores with those predicted for healthy subjects of similar ages and genders.

**Methods:** MC was assessed by the Lower Extremity Motor Coordination Test (LEMOCOT). The participants were divided, according to their ages and levels of motor recovery, based upon the Fugl-Meyer (FM) lower limb section scores (mild impairments: FM ≥ 23 and severe impairments: FM <23). To compare the LEMOCOT scores of the paretic lower limb with those predicted for healthy subjects, the predicted equations for the non-dominant lower limb of healthy subjects of similar ages and genders were employed. Results/Discussion: Age did not influence the LEMOCOT scores, but the subjects with severe motor impairments always showed lower scores, when compared to those with mild impairments, regardless of their ages. The subjects with mild motor impairments reached 75%, while those with severe motor impairments reached only 20% of the predicted scores for healthy subjects.

**Conclusions:** The findings suggested that the subjects with mild motor impairments had better MC, than those with severe impairments, regardless of their ages. Furthermore, the subjects with mild motor impairments reached 75%, whereas those with severe impairments reached only 20% of the predicted scores for healthy subjects

**Keywords:** Stroke, Lower extremity, Motor coordination

## Introduction

Loss of strength and dexterity following upper motor neuron damage, e.g., a stroke, mostly contribute to disabilities [1]. Motor coordination (MC) or dexterity refers to the ability to perform a motor task in an accurate, rapid, and controlled manner in order to achieve a given environmental demand [2,3]. Adequate MC of the lower limbs is important for the performance of activities of daily living, since they are involved in many everyday motor activities such as walking, running, ascending/descending stairs, standing from a chair, being the effective performance of these tasks critical for an independent life [4,5]. Furthermore, adequate lower limb MC significantly contributes to functionality of stroke individuals, being its loss the major contributor to disability in this population [6].

Usually, MC is tested under conditions, where some temporal and spatial accuracies are required [2]. The Lower Extremity Motor Coordination Test (LEMOCOT), developed to quantitatively assess lower limb MC [5], is a simple test with adequate psychometric properties for the assessment of MC in stroke subjects [7]. Furthermore, has the ability to detect changes in MC after stroke [8] and lower back pain [9], and it is a strong predictor of social participation after stroke rehabilitation [10]. The LEMOCOT reference values were established for healthy individuals, based on their ages and genders, and these factors together explained 44 to 48% of the variance in the LEMOCOT scores, when younger age and male sex were associated with better coordination [11]. However, for stroke subjects,

other factors may be more important. Menezes et al. [12] found that levels of motor impairments, as assessed by the Fugl-Meyer (FM) lower limb section scores and age together explained 49% of the variance in the LEMOCOT scores [12]. Thus, is necessary to investigate the MC performance of stroke survivors considering these predictor variables (motor recovery and age), such as was made to healthy subjects [11], considering the predictors age and gender.

Thus, considering significant impairments in MC after stroke and the previous reported predictors of the LEMOCOT scores for this population, the aim of the present study was to describe the motor coordination (MC) of the paretic lower limb of stroke survivors, based upon their levels of motor impairments and ages and to compare their LEMOCOT scores with those predicted healthy subjects of similar ages and genders.

## Methods

### Participants

Community-dwelling people with stroke living in the city of Belo Horizonte, Brazil, were recruited if they were ≥ 20 years of age and at least six months after the onset of the stroke; had weakness and/or increased tonus of the paretic knee extensor and/or ankle plantar flexor muscles, as determined by 15% strength differences between the paretic and non-paretic limbs [13] and/or scores different from zero on the Modified Ashworth Scale (MAS) [14]; and had no cognitive impairments, as determined by the following education-adjusted cut-off scores on the Mini-mental state examination: 18/19 for the

individuals with illiteracy and 24/25 for those with basic education [15].

## Procedures

Before data collection, eligible participants were informed about the objectives of the study and were requested do sign a written consent agreeing to participate of the study, based upon previous approval from the University ethical review board.

All data were collected by well-trained physical therapists. Initially, demographic and clinical data were obtained by interviews, including the subjects' ages and levels of motor impairments, which were determined by the Fugl-Meyer (FM) lower limb-section scores. The FM was selected because is the best predictor of the LEMOCOT scores in stroke survivors. The age was selected because also is a predictor of the LEMOCOT scores in stroke and healthy subjects, besides being an easy measure to obtain.

The FM is a valid and reliable scale used to assess motor recovery and is one of the most widely used instruments for clinical assessments [16]. A three-point ordinal scale is applied for each item, where "zero" is given to a task that cannot be carried-out, "one" when the task is partially performed, and "two" for tasks that can be completely performed [17].

To perform the LEMOCOT with their paretic lower limbs, the subjects seated on an adjustable chair with their feet resting flat on a thin rigid foam, heels on the proximal target, and knees at 90° of flexion [5]. Then, after a familiarization trial, they were instructed to alternately touch the proximal and distal targets placed 30 cm apart with their big toe, for 20 seconds. The number of touched targets was counted and registered for analyses [5].

## Statistical analyses

Descriptive statistics and tests for normality were calculated. The subjects were divided, according to their levels of motor impairments and ages. The participants were divided into two sub-groups, according to their levels of motor impairments (mild: FM $\geq$ 23 and severe: FM<23). To compare the LEMOCOT scores of the paretic limb of stroke subjects with those predicted for healthy subjects, the age- and gender-matched predictive equations for the non-dominant lower limb of healthy subjects reported by Pinheiro et al. [11], were employed. All analyses were performed with the SPSS (version 17.0) with a significance level of 5%.

## Results

A total of 102 subjects (59 with mild and 43 with severe motor impairments) , 61 men, with a mean age of 60.2 ± 10.4 years, ranging from 40 to 79 years and a mean time since the onset of the stroke of 71.2 ± 68.1 months, ranging from three to 380 months, were assessed. Their descriptive data are summarized in Table 1.

The mean LEMOCOT scores for the paretic lower limb, based upon the subjects' levels of motor impairments and ages are given in Table 2. Age did not influence the LEMOCOT scores, but the subjects with severe motor impairments always showed lower scores, when compared to those with mild impairments, regardless of their ages. The mean predicted LEMOCOT score for healthy subjects of similar ages and genders would be 30.7 ± 3.8. However, the subjects with mild motor impairments reached 75%, whereas those with severe motor impairments reached 20% of the predicted scores for healthy subjects.

| Variable | | n=102 |
|---|---|---|
| Gender, men, n (%) | | 61 (59.8) |
| Age (years), mean ± SD (range) | | 60.2 ± 10.4 (40-79) |
| Time since stroke (months), mean ± SD (range) | | 71.2 ± 68.1 (3-380) |
| LEMOCOT scores of the paretic lower limb, taps/sec, mean ± SD (range) | mild | 15.7 ± 11.7 (0-46) |
| | severe | 59 (57.8) |
| Lower limb motor recovery, Fugl-Meyer scale classification, n (%) | | 43 (42.2) |

**Table 1:** Participants' characteristics (* SD=Standard deviation)

| Age group (years) | n | Motor recovery | LEMOCOT scores |
|---|---|---|---|
| 40 – 49 | 12 | mild | 22.5 (8.3-33.3) |
| | 8 | severe | 3.9 (0-21.0) |
| 50 – 59 | 15 | mild | 25.5 (10.0-43.0) |
| | 13 | severe | 9.1 (0-18.7) |
| 60 – 69 | 18 | mild | 20.4 (6.0-34.0) |
| | 12 | severe | 4.3 (0-13.3) |
| 70 – 79 | 14 | mild | 23.5 (11.7-46.0) |
| | 10 | severe | 5.4 (0-18.0) |
| **Total** | 59 | mild | 23.0 (6.0-46.0) |
| | 43 | severe | 5.7 (0-21.0) |

**Table 2:** Mean scores and range (min-max) of the lower extremity motor coordination test of the paretic lower limb of stroke survivors, based upon their ages and levels of motor recovery

## Discussion

This study aimed to describe the motor coordination (MC) of the paretic lower limb of stroke survivors, based upon their levels of motor impairments and ages and to compare their LEMOCOT scores with those predicted for healthy subjects of similar ages and genders.

The mean LEMOCOT scores of the subjects with severe motor impairments were considerably lower than those with mild impairments. Furthermore, the subjects with mild impairments reached 75% of the predicted values for healthy subjects, whereas those with severe impairments reached only 20% of the expected values. Although Menezes et al. [7] reported that the mean scores of the paretic lower limb were approximately half of those predicted for the non-dominant limb of healthy individuals, when the sample was stratified according the levels of motor recovery, i.e. severity of motor impairments, these percentage values changed. In the present study, the stroke subjects with mild impairments achieved more than 50% of the predicted scores for the healthy subjects, while the stroke subjects with severe impairments achieved less than 50%. These findings corroborated those of Menezes et al. [12], who found that levels of motor recovery was the main predictor and explained 46% of the variance in the LEMOCOT scores. Thus, variables assessed by the FM lower limb motor section scores, such as motor synergy and range of motion, are important to execute the LEMOCOT. Furthermore, other studies also found that the motor recovery was significantly associated with other impairments after stroke [18,19].

Although age also was shown to be a predictor of the LEMOCOT scores [12], in the present study, younger subjects did not reach higher LEMOCOT scores. These results can be explained maybe because age explained only 3% of the variance in the LEMOCOT scores [12]. Other studies also reported that the age does not affect the performance of stroke survivors [20, 21].

## Study limitations

Although the sample was broad and drawn from various settings, it was not randomly selected and may not, therefore, be fully representative of the stroke population. Furthermore, the subjects' ages in the present study, ranged from 40 to 79 years. Although the incidence of stroke in subjects under 40 years is increasing over the last years [22], there were only six individuals under 40 years of age, number not sufficient to be included in the analyses. Finally, the external validity of the present results obtained here should be further confirmed and investigated in other populations. For instance, the subjects of the present study were in the subacutet chronic phase of stroke and had enough time to recover. However, subjects at acute stages of recovery could demonstrate different results.

## Conclusion

The findings suggested that the subjects with mild motor impairments had better MC of the paretic lower limb, than those with severe impairments, regardless of their ages. Furthermore, the subjects with mild motor impairments reached 75%, whereas those with severe impairments reached only 20% of the predicted scores for healthy subjects.

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