



## Original Research

# Sensory and Motor Thresholds of Transcutaneous Electrical Stimulation Are Influenced by Gender and Age

Rinaldo Roberto de Jesus Guirro, PhD, Elaine Caldeira de Oliveira Guirro, PhD,  
Natanael Teixeira Alves de Sousa, PT

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## Abstract

**Background:** Transcutaneous electrical stimulation (ES) is a therapeutic procedure used in rehabilitation. However, the effectiveness of it depends on sensory responses to pain and motor control in neuromuscular recruitment, considering the differences related to gender and age of the subjects treated, as well as the intensity and frequency of ES.

**Objective:** To determine the threshold of sensory perception (TSP) and the threshold of motor response (TMR) in young and elderly individuals of both genders.

**Design:** Randomized controlled clinical trial.

**Setting:** General community.

**Participants:** Eighty volunteers with no history of systemic diseases were selected to participate in the study: 40 men and 40 women were subdivided by convenience sampling and age group into young male and female (age  $21.6 \pm 2.4$  years) groups as well as into elderly female and male groups (age  $72.6 \pm 6.1$  years).

**Interventions:** The participants received electrical stimulation (ES) at 5 and 50 Hz, with pulse durations of 20, 100, 400, 1000, and 3000  $\mu$ s applied on the flexor muscle bellies of the wrist and fingers.

**Main Outcome Measures:** TSP was identified as the first sensation of increased current intensity and TMR as the minimum muscle contraction detected. The results were submitted to analysis of variance, followed by the Tukey's test, with a significance level of 5%.

**Results:** TSP was lower than TMR for all pulse durations, regardless of gender and age. In women, TSP was lower than that in young and elderly men at both frequencies. However, TSP was higher in elderly subjects than in younger subjects at 50 Hz for both genders. Age also affected the TMR, presenting higher thresholds in elderly subjects of both genders at 50 Hz; however the same occurred only in male subjects at 5 Hz.

**Conclusion:** Age and gender interfere directly with ES. These variables should be considered during rehabilitation because they indicate that electrical stimulation in elderly women should be carefully performed, as they have lower thresholds than elderly men when polarized currents are used, and there is a risk of skin lesion because of their high thresholds.

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## Introduction

Electrical stimulation, when applied with percutaneous electrodes, is a noninvasive therapeutic procedure useful in clinical practice. It has been often used in rehabilitation in several areas of health care, such as analgesia, tissue repair, circulation, and neuromuscular stimulation, especially at the sensory [1] and motor [2] levels. The term threshold is applied to denote the energy required to promote presynaptic excitation of the neuronal membrane, which produces sensory (sensory threshold) or motor response (motor threshold) [3].

The combination of physical parameters (ie, pulse duration, intensity, frequency) characterizes the different types of electrical currents, thus producing several therapeutic effects. Overall, higher frequencies in association with sensory threshold intensity [4] are used in the cases of cicatrization or acute pain, whereas low frequencies in association with motor threshold intensity can be applied in the cases of chronic pain. In addition, adequate intensities are required to produce analgesia [5], thus characterizing a dose-dependent response.

The current frequency, expressed in hertz (Hz), is an important parameter, as it exerts a direct influence

on the electrical resistance of the tissues [6,7]. The frequency-dependent response refers to the level of skeletal muscle contraction, as it may be either non-tetanic (low frequency) or tetanic (frequencies >30 Hz) [2]. Besides the parameters of electric current, there is evidence that other factors, such as age and gender, may influence the responses of sensory and motor thresholds [3,8,9]. As the stimulation of sensory and motor nerves can influence the rehabilitation process, one can obtain a better understanding of the influence of age and gender on the response thresholds, which may enable therapeutic interventions to be applied more effectively on a safer and more effective basis.

The physiological aging has a major impact on the sensory-motor processing due to reduced cerebral blood flow and structural and functional changes in peripheral and cortical neurons [8,10], thus reducing the number of cutaneous mechanoreceptors [11] and decreasing the conduction velocity of the peripheral [12] nerves. To overcome these deficits, different compensation methods play a crucial role in maintaining the functional performance, often correlated with increased brain activation areas [8,10,13].

There are few studies in the literature focusing on the sensory and motor responses to ES when gender and age of the participants are considered. Because of the various pathological conditions treated by electrical stimulation, knowledge of the subject becomes relevant, as sensory and motor behaviors are influenced by sexual hormones that can interfere with the therapeutic response.

Therefore, this study aimed to investigate the threshold of sensory perception (TSP) and the threshold of motor response (TMR) in healthy individuals of both genders and different ages, considering stimulation parameters such as frequency and pulse duration.

## Methods

The study was approved by the local ethics committee according to protocol number 64/05. All participants signed an informed consent form in accordance with the Declaration of Helsinki.

Eighty volunteers with no history of systemic diseases were selected to participate in the study: 40 men and 40 women. The subjects were subdivided by age and gender groups as follows: young males (n = 20), young females (n = 20), elderly males (n = 20), and elderly females (n = 20) according to the Health Sciences Descriptors [14], that is, young male and female adults (aged  $21.6 \pm 2.4$  years) and elderly female and male adults (aged  $72.6 \pm 6.1$  years). All of the subjects had normal mean body mass index ( $20\text{-}25 \text{ kg/m}^2$ ). The descriptors are a vocabulary that contains the standard terminology in health sciences developed by the Latin American and Caribbean Center for information on health sciences, considering the aging aspects for developing countries.

In addition to these, 6 volunteers were excluded for not having time to complete the 2 ES tests. The threshold of sensory perception (TSP) and the threshold of motor response (TMR) were evaluated, as shown in Figure 1.

The frequency to be used in each session of ES was randomly chosen for each individual (software research Randomizer Form v 4.0). A pulse generator was used for data collection (Dualpex 961; Quark, Piracicaba/SP, Brazil) at constant current intensity, and the following parameters were used for current stimulation: square biphasic wave; pulse durations of 20, 50, 100, 200, 300, 500, 1000, and 3000  $\mu\text{s}$ ; and frequency of 5 or 50 Hz.

New silicon-carbon electrodes measuring  $5 \times 2 \text{ cm}$  each were attached to the skin with water-soluble gel (2 mL) and placed over the flexor muscle bellies of the

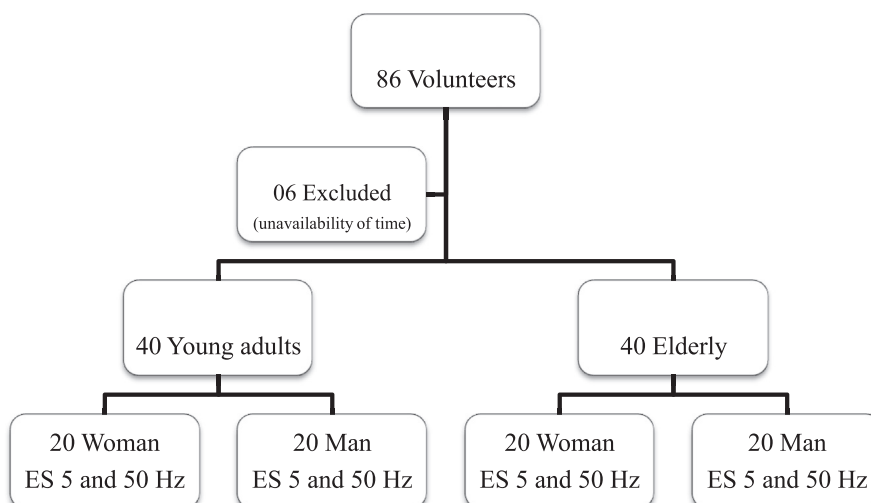


Figure 1. Chart of volunteer distribution and experimental procedures.

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