Objectives: Spasticity is defined as a pathological increase in muscle tonus, and increased muscle tonus of lower limbs is a major obstacle to the stroke rehabilitation. Foot baths are considered to provide beneficial thermal therapy for post-stroke patients with spasticity, but their anti-spastic effects have not been investigated comprehensively. The present study aimed to evaluate alterations in spasticity and motor function using foot baths in post-stroke patients with spastic hemiplegia.

Methods: We underwent two separate experiments each consisting of immersion in warm water up to the knee joint level, and measuring spasticity, physiological examination and motor function.

Experiment 1: Fourteen post-stroke patients with lower limb spasticity were enrolled in this study (nine males and five females; mean age 50.4 ± 12.9 years; range, 28–65 years). The subjects’ legs from below the knee joint were immersed in water at 41℃ for 15 min. Measurements of F-waves and a physiological examination were carried out immediately (within 5 min) after the foot-bath session, and again 30 min later, while the subject remained wrapped in blankets on the lift-bath stretcher.

Experiment 2: Six post-stroke patients with lower limb spasticity were enrolled in this study (five males and one female; mean age 55.2 ± 14.6 years; range, 39–68 years). The subjects’ legs from below the knee joint were immersed in the artificial high concentration carbon-dioxide (CO₂) water or tap water foot bath at 38℃ for 30 min. Measurements of muscle stiffness, motor function (active range of motion: A-ROM) and a physiological examination were carried out immediately (within 5 min) after the foot-bath session, and again 10 min later, while the subject remained wrapped in blankets.

Results: None of the subjects experienced discomfort before, during or after the foot-bath treatment. The physiological examination was completed safely in all subjects.

Experiment 1: The mean values of F-wave parameters were significantly reduced after foot-bath treatment (P<0.01). The anti-spastic effects of foot-bath treatment were indicated by decreased F-wave parameters, in parallel with decreases in modified Ashworth scale (MAS) score. The body temperature was significantly increased both immediately after, and 30 min following foot-bath treatment.

Experiment 2: The changes both in the body and surface skin temperature were higher in the artificial high concentration CO₂ water foot bath compared with the tap water foot bath. The changes in the MAS score, muscle stiffness and A-ROM were also higher in the high concentration CO₂ water foot bath than in the tap water foot bath.

Conclusion: These findings demonstrate that the use of foot baths is an effective non-
pharmacological anti-spastic treatment that might facilitate stroke rehabilitation. In addition, the high concentration $\text{CO}_2$ water foot baths appeared to play an important role in decreased spasticity.

**Keywords:** Foot bath, Spasticity, Motor function, High concentration carbon-dioxide, Muscle stiffness