

## **An Ergonomic Evaluation of Three Load Carriage Systems for Reducing Muscle Activity of Trunk and Lower Extremities during Giant Puppet Performing Tasks**

**Authors :** Cathy SW. Chow, Kristina Shin, Faming Wang, B. C. L. So

**Abstract :** During some dynamic giant puppet performances, an ergonomically designed load carrier system is necessary for the puppeteers to carry a giant puppet body's heavy load with minimum muscle stress. A load carrier (i.e. prototype) was designed with two small wheels on the foot; and a hybrid spring device on the knee in order to assist the sliding and knee bending movements respectively. Thus, the purpose of this study was to evaluate the effect of three load carriers including two other commercially available load mounting systems, Tepex and SuitX, and the prototype. Ten male participants were recruited for the experiment. Surface electromyography (sEMG) was used to collect the participants' muscle activities during forward moving and bouncing and with and without load of 11.1 kg that was 60 cm above the shoulder. Five bilateral muscles including the lumbar erector spinae (LES), rectus femoris (RF), bicep femoris (BF), tibialis anterior (TA), and gastrocnemius (GM) were selected for data collection. During forward moving task, the sEMG data showed smallest muscle activities by Tepex harness which exhibited consistently the lowest, compared with the prototype and SuitX which were significantly higher on left LES 68.99% and 64.99%, right LES 26.57% and 82.45%; left RF 87.71% and 47.61%, right RF 143.57% and 24.28%; left BF 80.21% and 22.23%, right BF 96.02% and 21.83%; right TA 6.32% and 4.47%; left GM 5.89% and 12.35% respectively. The result above reflected mobility was highly restricted by tested exoskeleton devices. On the other hand, the sEMG data from bouncing task showed the smallest muscle activities by prototype which exhibited consistently the lowest, compared with the Tepex harness and SuitX which were significantly lower on lLES 6.65% and 104.93, rLES 23.56% and 92.19%; lBF 33.21% and 93.26% and rBF 24.70% and 81.16%; lTA 46.51% and 191.02%; rTA 12.75% and 125.76%; lGM 31.54% and 68.36%; rGM 95.95% and 96.43% respectively.

**Keywords :** exoskeleton, giant puppet performers, load carriage system, surface electromyography

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