ANATOMICAL LOCATIONS FOR CAPTURING MAGNITUDE AND FREQUENCY DIFFERENCES IN FOOT-TRANSMITTED VIBRATION EXPOSURE

Katie A. Goggins[1,2], W. Brent Lievers[1,2], Tammy R. Eger[2,3]
[1]Bharti School of Engineering, Laurentian University, Sudbury, ON
[2]Centre for Research in Occupational Safety and Health, Laurentian University, Sudbury, ON
[3]School of Human Kinetics, Laurentian University, Sudbury, ON

Introduction: Prolonged occupational exposure to foot-transmitted vibration can result in neurological, vascular, or musculoskeletal symptoms in the feet and lower limbs [1]. Previously, transmissibility measurements were taken at 24 anatomical locations on the foot for 21 participants standing with their centre of pressure in a natural, forward and backward location [2,3]. Since 24 locations is impractical for field studies, it is desirable to identify the minimum number of measurements needed to characterize the biodynamic response of the foot to vibration exposure.

Methods: In order to reduce the number of measurement locations, the data set [2,3] was analyzed using two methods:

1. *Peak transmissibility:* Multiple correspondence analysis (MCA) was performed using the peak transmissibility magnitudes to identify clusters of behaviour. Two transmissibility thresholds were considered: 2.0 (100% amplification of the input signal), and 2.5 (150% amplification).
2. *Transmissibility curves:* A K-means analysis was conducted on the entire transmissibility response from 10-200 Hz to identify regions of equivalent behaviour.

Results: Results of the MCA indicated that transmissibility measurements at the nail bed of first phalange, distal head of first metatarsal, proximal head of second metatarsal, and the lateral malleolus (Figure 1) summarize the potentially tissue damaging transmissibility magnitudes. Results from the K-means analysis revealed measurements from three regions (toes, midfoot, and ankle) would sufficiently summarize the transmissibility response for the 10-200 Hz frequency range.

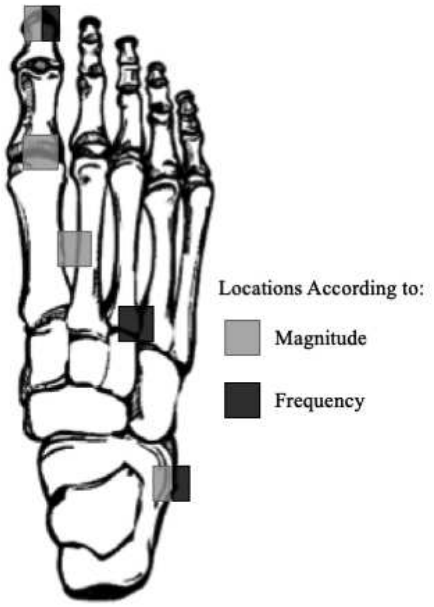

Figure 1: Anatomical locations for measuring FTV according to analysis based on transmissibility magnitude and frequency.

Discussion and Conclusions: The minimum anatomical locations required to capture differences in transmissibility magnitude and frequency (10-200 Hz) are summarized in Figure 1. These locations considered ease of identification and measurement, along with the vibration response. Thus, measuring transmissibility at the nail bed of first phalange, distal head of first metatarsal, proximal head of second metatarsal and the lateral malleolus, should capture the potentially tissue damaging transmissibility magnitudes and frequencies.

References:

[1] House, R. et al. (2010). Vasospasm in the feet in workers assessed for HAVS. *Occupational Medicine*, 1-6. doi:10.1093/occmed/kqq191
[2] Goggins, K. et al. (2018). Biomechanical response of the human foot when standing in a natural position exposed to vertical vibration from 10-200 Hz. *Ergonomics*. doi:10.1080/00140139.2018.1559362
[3] Goggins, K. et al. (2019). Standing centre of pressure alters the vibration transmissibility response of the foot. *Ergonomics*. (revision under review)