

TRANSMISSION OF WHOLE BODY VIBRATION IN CHILDREN WHILE STANDING

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INTRODUCTION

Whole body vibration has recently been used as a therapeutic intervention for the treatment of children with disabling conditions [1,2]. Researchers of these studies have observed encouraging results in terms of improved mobility and bone strength. However, the use of whole body vibration in children raises an important question regarding its safety as it is not clear how children attenuate vibration while standing. Occupational assessments while seated [3] indicate that children absorb less vibration than adults (i.e., 12-86% less) suggesting that adult vibration parameters while standing (e.g., 1 mm amplitude at 30 Hz) are not applicable to children and may produce different physiological effects. The purpose of this present study was to determine if children transmit vibration differently than adults while standing on a vibration platform. It was hypothesized that the transmissibility would be greater in children than adults. That is, children would display greater amplitudes of vibration (mm) in the upper and lower body when compared to adults.

METHODS

Twelve healthy children (age = 7.2 ± 3.1 yrs; mass = 22.6 ± 14.4 kg) and ten healthy adults (age = 25.9 ± 5.5 yrs; mass = 73.1 ± 10.0 kg) with no reported musculoskeletal injuries participated in the study. The experimental protocol required each participant to stand on a commercially available vibration platform (i.Tonic International B.V., Netherlands) with progressively greater frequencies of 28, 33, and 42 Hz. Participants stood on the platform for approximately 10 s at each frequency with no shoes and knees slightly bent (i.e., 10-25°; Figure 1). The transmissibility of vibration oscillation was assessed with a high speed motion analysis system (Vicon Motion Systems). Seven cameras sampling at 500 Hz tracked low mass reflective markers placed on

the vibration platform and on the skin over the following bony landmarks: Lateral malleolus (ankle), tibial tuberosity (tibia), anterior superior iliac spine (ASIS), sternum, and anteromedial frontal bone (forehead; Figure 1).

The Vicon system was calibrated according to manufacturer guidelines and its accuracy for tracking markers was assessed using a 'spot checking' technique described by Delia Croce and Cappozzo [4]. Three-dimensional position data from each reflective marker were computed from direct linear transformations and then exported to a Microsoft Excel spreadsheet for post analyses. The vertical amplitude of oscillation (z; Figure 1) for 20 cycles of data were computed and averaged between limbs. The mean amplitude for each marker was compared between groups (children and adults), across frequencies (28, 33, & 42 Hz) and markers using a repeated measures analysis of variance (ANOVA) with follow-up multiple comparisons: Type I error set at 0.05.

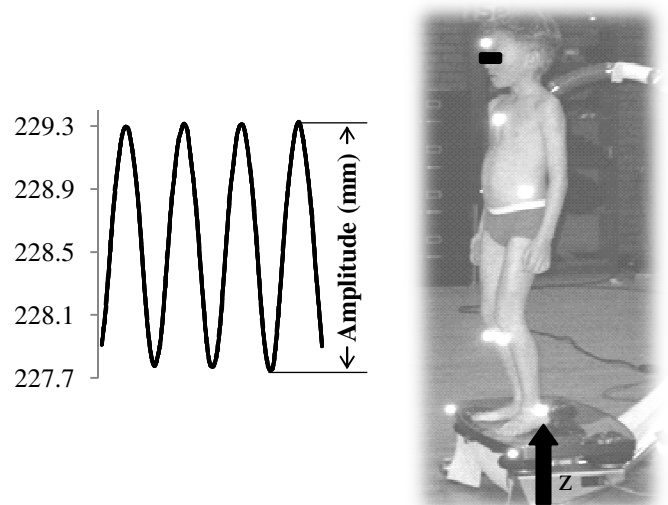


Figure 1. Vibration platform set-up and representative vertical (z) vibration waveform. Amplitude was calculated from peak to peak.

RESULTS AND DISCUSSION

No significant interactions were observed among factors ($p = 0.06 - 0.40$) indicating that children and adults respond similarly across vibration frequencies and marker positions. Figure 2 illustrates that platform vibrations were not substantially attenuated in the lower body since ankle and tibia markers were on average 53% greater than ASIS, sternum, and forehead markers ($p = 0.01-0.08$).

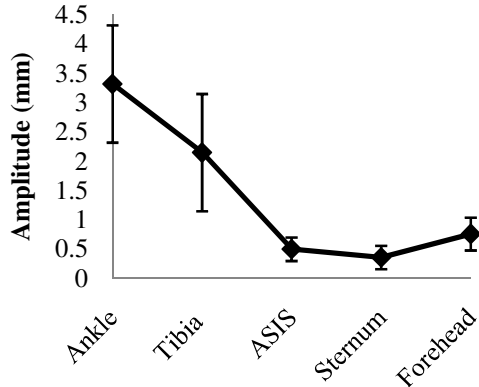


Figure 2. Pattern of vibration transmission from the ankle to forehead.

Regarding between group comparisons, markers on the tibia and ASIS of children were 171% and 86% greater respectively, than values for the adults (Table 1). Conversely, marker amplitudes on the vibration platform were 23% greater for the adults than children (Table 1).

The physiological effects of whole body vibration while standing are often based on how the platform is adjusted in terms of amplitude, frequency, and duration [1,2]. However, factors that include joint kinematics and body mass determine how the vibration is transmitted from the platform through the body [5]. Because children have less tissue mass to dampen the vibration and they display different

structural organization of bone and other tissues, the transmissibility is likely different from adults, which was observed in this study. However, the original findings of this study are that despite differences in mass and structural organization of tissues, children are able to use other mechanical factors (e.g., muscle activity level) to attenuate vibration by the time it reaches the upper body and head as evidenced by forehead amplitude values (Table 1). These findings are important from a safety perspective as excessive head vibration may have deleterious effects.

CONCLUSIONS

It may be concluded that children display greater amplitudes of vibration in the tibia and ASIS when compared to adults, despite the platform amplitude being uncontrollably lower for children (Table 1). In contrast to occupational assessments while seated [3], amplitudes of vibration in the upper body are similar between children and adults while in standing.

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Table 1: Marker amplitudes (mm) for adults and children standing on the vibration platform at 33Hz.

	Platform	Ankle	Tibia	ASIS	Sternum	Forehead
Adults	1.78 ±0.16	3.68 ±1.97	1.15 ±0.46	0.31 ±0.09	0.35 ±0.10	0.76 ±0.22
Children	1.45 ±0.26*	2.94 ±1.40	3.12 ±2.53*	0.67 ±0.39*	0.34 ±0.19	0.74 ±0.33

*Significantly different from adults, $p = 0.03-0.01$