ALL TERRAIN VEHICLE VIBRATION EXPOSURE IN NEW ZEALAND

Stephan Milosavljevic, Allan Carman, Poonam Pal.
School of Physiotherapy, University of Otago, Dunedin, New Zealand, stephan.milosavljevic@otago.ac.nz

INTRODUCTION

All Terrain Vehicles (ATVs) are used extensively by farmers exposing them to prolonged periods of whole-body vibrations (WBV), constrained postures and increased risk of lower back pain (LBP). Accelerometers measure WBV, and in accordance with ISO guidelines the Root Mean Square (RMS) and Vibrational Dose Value (VDV) quantify risk with Action values of 0.5 m/s^2 and 9.1 $m/s^{1.75}$ and Limit values of 1.15 m/s^2 and 21 $m/s^{1.75}$ respectively (Rehn). The vibration range of 2-100Hz has been shown to have physiological effects on the human body. However critical risk factors for LBP appear to be vibration along the spine (Z axis) and of low frequency including the adverse resonant frequencies of the spine at 2-12 Hz (Sandover).

METHOD

Participants were 30 farmers from the Otago region of New Zealand. Helmet and ATV chassis mounted triaxial accelerometers recorded vibration over the full working day by a data logger fitted to the ATV. Riding periods were extracted based on the helmet accelerometers, which were worn and plugged into the data logger whenever participants sat on the ATV. Shorter duration vibration was recorded for four participants with accelerometers mounted on the ATV and strapped over the lumbo-sacral junction ("pelvis").
The sampling frequency was 200Hz over a bandwidth of 0-100Hz, via an anti-aliasing filter. RMS, VDV (Rehn) and Fast Fourier Transforms (FFT) were calculated from vibration data. For each farmer the FFT was calculated for two second windows across all vibration samples of the ATV riding periods. For each farmer the peak magnitude at each discrete frequency was obtained.

RESULTS

The average daily ATV riding time was 97.5 ±50.3 mins, with a minimum of 13.3 mins and maximum of 210.1 mins. The short riding time was 13.1 ± 1.3 mins. The helmet daily VDV and RMS values for the 30 farmers, along with '1hr equivalent' VDV for the helmet and pelvis, are presented in Table 1. The vibration frequency spectrum for the helmet, pelvis and ATV are presented in Figure 1.

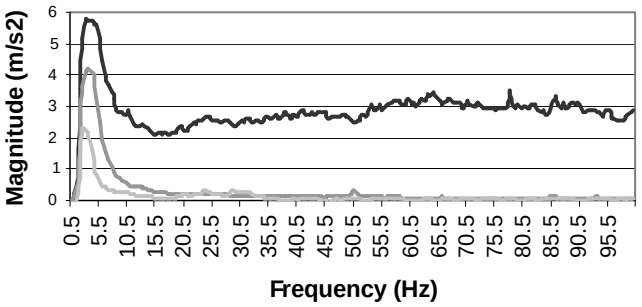

Figure 1. FFT Vertical vibration, ATV (dark), helmet (grey) and pelvis (light grey).

DISCUSSION

Large variations in farmer total riding time and VDV suggest an average daily VDV does not adequately describe individual vibration exposure. The VDV '1hr equivalent' still produced large variations indicating terrain, gradient, speed, and ATV may also play a significantly role in vibration exposure.
The average daily helmet VDV and RMS in the anterior, lateral and vertical directions were above the Action values. The average daily helmet RMS in the anterior and vertical directions was above the Upper Limit value. On average 1 hour of continual ATV farm use will reach the Limit value.
Higher frequency ATV vibrations (15-100Hz) were minimally transmitted to the pelvis and helmet. The ATV, pelvis and helmet experienced substantial vibrations at lower frequencies (2-15 Hz), including the resonant frequencies of the spine.

SUMMARY

In daily ATV use farmers were on average exposed to cumulative vibration in excess of recommended limits. The majority of this vibration fell in the 2-15Hz range including the resonant frequencies of the spine. These results indicate the need to reduce vibration exposure in rural ATV use and reduce potential risk of lower back pain.

REFERENCES

Rehn, B. (2004). Doctoral Dissertation, Umea Univ., Sweden.
Sandover, J. (1991). *Clinical Biomechanics*, 6: 173-178.

Table 1. Daily helmet RMS and VDV; with helmet and pelvis '1hr equivalent' VDV.

	Helmet VDV ($m/s^{1.75}$)			Helmet RMS (m/s^2)			Helmet '1hr' VDV ($m/s^{1.75}$)			Pelvis '1hr' VDV ($m/s^{1.75}$)		
	Anterior	Lateral	Vertical	Anterior	Lateral	Vertical	Anterior	Lateral	Vertical	Anterior	Lateral	Vertical
Min	8.2	5.3	7.9	0.83	0.50	0.82	11.8	7.7	10.7	14.1	8.6	12.0
Avg	19.2	14.2	18.3	1.30	0.94	1.17	17.3	12.9	16.5	15.5	10.3	12.2
StDev	(5.4)	(3.6)	(5.3)	(0.26)	(0.17)	(0.21)	(3.4)	(2.1)	(3.3)	(1.1)	(1.2)	(0.3)
Max	34.4	23.3	31.7	2.04	1.32	1.62	27.5	17.7	23.6	16.6	11.2	12.7