

Methodological development for in-field rest break intervention activity intervals to reduce exposure to occupational whole-body vibration during agricultural machinery use

Wadena Burnett^{1,2}, Stephan Milosavljevic¹

1. School of Rehabilitation Science, University of Saskatchewan; 2. Canadian Centre for Health & Safety in Agriculture

Background

- Agricultural machinery operators are exposed to high levels of whole-body vibration (WBV) during machinery operation¹
- High levels of WBV exposure is known to negatively affect:
 - Balance and proprioception^{2,3}
 - Musculoskeletal health^{4,5}
 - Reaction time and motor performance^{6,7}
 - Cognition and concentration⁸
- Intermittent rest breaks may mitigate the negative effects of extended WBV exposure⁹
- Majority of related research is lab-based
 - Provides a controlled environment
 - In-lab vibration exposure intensity and duration are not representative of typical in-field working conditions^{1,10}
- Before executing in-field studies, there is a need to evaluate current evidence to determine potentially effective rest break activities and determine break intervals
- Activities and intervals need to be practical and feasible for in-field use

Objective

To determine feasible and evidence-based rest break activities and intervals suitable for in-field evaluation of rest breaks during agricultural machinery operation

Methods

- Performed critical literature review of related studies from similar environments (e.g., construction, heavy equipment operation, mining) to determine plausible rest break activities
- Explored sensorimotor treatment (Fig 1) and related activities such as walking
- In-lab testing to evaluate rest break activities is ongoing (Fig 2)
- To determine rest break interval time (T)
 - Applied ISO 2631 vibration dose value (VDV) allowable limit (AL) and maximum permissible limit (MPL) values¹¹ to previously collected acceleration data (a_w)¹ (Eq 1, Table 1)

$$\frac{VDV}{a_w T^{1/4}} = 1.75 \quad \text{Eq 1. Ratio to evaluate vibration exposure}$$

Results

- Selected rest breaks will include a combination of activities
- Advisable rest break intervals based on ISO 2631:
 - For tractors: AL = 9.1m/s^{1.75}: 1.9h (95% CI: 1.3h – 3.2h)
MPL = 21.0m/s^{1.75}: 4.1h (95%CI: 3.4h – 5.3h)
 - For combines: AL = 9.1m/s^{1.75}: 1.8h (95% CI: 1.5h – 2.3h)
MPL = 21.0m/s^{1.75}: 4.3h (95%CI: 3.1h – 7.4h)

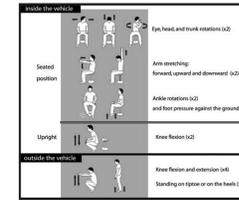


Fig 1. Sensorimotor treatment as described by Oullier et al.⁹, where bulldozer operators performed tasks in and out-of cab after 2h of machinery operation

Table 1. Vibration dose values (VDV) for allowable limit (AL) and maximum permissible limit (MPL) used to evaluate z-direction RMS acceleration values (a_w) collected during farm machinery operation

VDV	AL	9.1m/s ^{1.75}
	MPL	21.0m/s ^{1.75}
a_w	Tractor	0.41 (0.19 – 1.06)m/s ²
	Combine	0.30 (0.20 – 0.58)m/s ²

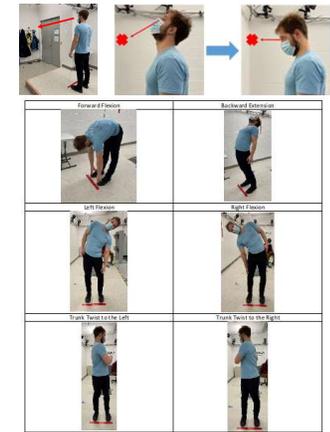


Fig 2. In-lab rest activity breaks include gaze stabilization treatment (GST) (top row) and trunk mobility exercises where participant stretches and holds position for 10s.

Conclusion

Conservatively, field trial rest breaks should be undertaken at 2-hour intervals, with a maximum permissible WBV exposure time of 4 hours between rest breaks.

References

1: Zeng, Ergon, 2017; 2: Mani, Int J Indust Ergon, 2010; 3: Pollock, Eu J Appl Physiol, 2011; 4: Seidel, Int Arch Occup Environ Health, 1986; 5: Savage, Int Arch Occup Environ Health, 2016; 6: Yung, PLoSOne, 2018; 7: Costa, Int J Ind Ergon, 2014; 8: Ljungberg, J Environ Psych, 2007; 9: Oullier, Eur J Appl Physiol, 2009; 10: Milosavljevic, Ann Occup Hyg, 2011; 11: ISO 2631-1, 1997