Göteborg, 2017

The impact of railway vibration and noise on sleep

Akademisk avhandling

Som för avläggande av medicine doktorsexamen vid Sahlgrenska akademin, Göteborgs universitet kommer att offentligen försvaras i hörsal Karl Isaksson, Arbets- och miljömedcicin, Medicinaregatan 16A, fredagen 13 oktober, klockan 9:00.

av Michael Smith

Fakultetsopponent:

Associate Professor Mathias Basner
Perelmen School of Medicine
University of Pennsylvania, USA

Avhandlingen baseras på följande delarbeten

I. Smith, M. G., Croy, I., Ögren, M. and Persson Waye, K. *On the influence of freight trains on humans: A laboratory investigation of the impact of nocturnal low frequency vibration and noise on sleep and heart rate.* PLOS ONE 2013; 8(2): e55829.

II. Smith, M. G., Croy, I., Hammar, O. and Persson Waye, K. *Vibration from freight trains fragments sleep: A polysomnographic study.* Scientific Reports 2016; 6: e24717

III. Smith, M. G., Croy, I., Ögren, M., Hammar, O., Lindberg, E. and Persson Waye, K. *Physiological effects of railway vibration and noise on sleep.* Journal of the Acoustical Society of America 2017; 141(5): 3262–3269

IV. Smith, M. G., Ögren, M., Hussain-Alkhateeb, L., Lindberg, E. and Persson Waye, K. *Physiological reaction thresholds to vibration during sleep.* Manuscript

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The impact of railway vibration and noise on sleep

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Abstract

Sleep is a vital component of good health, and sleep loss is associated with impaired cognition, decreased psychomotor performance, cardiovascular disease, adverse effects on endocrine and metabolic function, negative mood, impaired memory, and more. A growing burden of freight transportation on global railway networks will likely lead to an increase in nocturnal vibration and noise at nearby dwellings. However, there is currently limited knowledge on how railway freight vibration and noise may disrupt sleep.

Over a series of laboratory studies in young healthy adults, the effect of vibration and noise from railway freight was investigated. Objective sleep was recorded with polysomnography, cardiac activity was recorded with electrocardiography and subjective sleep quality and disturbance was recorded with questionnaires. Increased cardiac activation occurred at vibration amplitudes only slightly above wakeful perceptual detection thresholds. Arousals, awakenings and alterations of sleep structure began to manifest at only slightly higher vibration amplitudes. With increasing vibration amplitude, heart rate and the probability of event-related cortical response increased in a dose-dependent manner, with accompanying adverse effects on perceived sleep quality and sleep disturbance. Perceived disturbance was more pronounced among noise-sensitive individuals, although no significant physiologic differences were found relative to non-sensitive counterparts. Rather than affecting overall sleep architecture, vibration and noise interfered with the normal rhythms of sleep, although the impact of this on long-term physical and mental health is currently unclear. Cardiac response persisted with increasing number of events, indicating an absence of habituation. Vibration and noise were additive regarding their effect on cortical arousal and sleep stage change, demonstrating that both exposures differentially contribute to sleep fragmentation. From a public health perspective, interventions to protect the sleep of populations near railway lines should therefore consider both exposure types.

Keywords: railway vibration, noise, sleep disturbance, polysomnography, cardiovascular disease

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