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Impaired vigilance and increased accident rate in public transport operators is associated with sleep disorders

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ABSTRACT

Objectives: Sleep disturbances can impair alertness and neurocognitive performance and increase the risk of falling asleep at the wheel. We investigated the prevalence of sleep disorders among public transport operators (PTOs) and assessed the interventional effects on hypersomnolence and neurocognitive function in those diagnosed with obstructive sleep apnea (OSA).
Methods: Overnight polygraphy and questionnaire data from 101 volunteers (72 males, median age 48 range [22–64] years, 87 PTOs) employed at the Gothenburg Public Transportation Company were assessed. Treatment was offered in cases with newly detected OSA. Daytime sleep episodes and neurocognitive function were assessed before and after intervention.
Results: At baseline, symptoms of daytime hypersomnolence, insomnia, restless legs syndrome as well as objectively assessed OSA (apnea hypopnea index (AHI, determined by polygraphic recording) = 17[5–46] n/h) were highly present in 26, 24, 10 and 22%, respectively. A history of work related traffic accident was more prevalent in patients with OSA (59%) compared to those without (37%, $p < 0.08$). In the intervention group ($n = 12$) OSA treatment reduced AHI by −23 [−81 to −5] n/h ($p = 0.002$), determined by polysomnography. Reduction of OSA was associated with a significant reduction of subjective sleepiness and blood pressure. Measures of daytime sleep propensity (microsleep episodes from 9 [0–20.5] to 0 [0–12.5], $p < 0.01$) and missed responses during performance tests were greatly reduced, indices of sustained attention improved.
Conclusions: PTOs had a high prevalence of sleep disorders, particularly OSA, which demonstrated a higher prevalence of work related accidents. Elimination of OSA led to significant subjective and objective improvements in daytime function. Our findings argue for greater awareness of sleep disorders and associated impacts on daytime function in public transport drivers.
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1. Introduction

The ability to maintain alertness over time is important in order to perform adequately during wakefulness. The consequences of impaired alertness may be devastating in vehicle drivers, pilots or other subjects where fluctuations in performance may present significant occupational safety hazards. It has been estimated that between 15 and 20% of all motor vehicle accidents are attributable to fatigue and daytime sleepiness (Akerstedt, 2000). Sleep disorders as well as restricted sleep may compromise an individual's capability to maintain alertness over longer periods of time. Obstructive sleep apnea (OSA), a state of total or partial occlusion of the upper airway, resulting in hypoxia and sleep fragmentation is a prevalent disease (Young et al., 1993; Chervin and Aldrich, 1998; Stradling and Davies, 2004), which has been identified as a contributing factor to increased daytime sleepiness in the population and a risk factor for falling asleep at the wheel (George, 2001).

Indeed, the risk of motor vehicle accidents (MVAs) is elevated between 2 and 7 times in individuals with excessive daytime sleepiness (EDS) and OSA (Findley et al., 1988; Pack et al., 1995; Young et al., 1997; Teran-Santos et al., 1999; George, 2001). OSA treatment with continuous positive airway pressure (CPAP) eliminates apneas, improves subjective as well as objective daytime sleepiness, which has been shown to reduce the risk for motor vehicle accidents (George et al., 1997; Hack et al., 2000; George, 2001). While most studies focused on subjects with suspected OSA and complaints of daytime sleepiness referred to sleep laboratories (Findley et al., 1988; Findley et al., 2000; George, 2001), there is only limited data from cohorts of unselected public transport operators (PTOs) (Howard et al., 2004). In fact, a subgroup of OSA patients experiences little or no daytime somnolence. However, it remains unknown if even these "asymptomatic" individuals with OSA have vigilance and performance deficits which may be improved by treatment of their OSA and there is limited data on the impact of

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treatment on performance in those cohorts. This lack of knowledge prompted us to investigate the prevalence and functional consequence of sleep disorders and excessive daytime sleepiness among a group of public transport operators in the city of Gothenburg, Sweden, before and after treatment of OSA.

2. Materials and methods

2.1. Subjects and study procedure

Volunteers ($n = 101$) were recruited among bus and tram operators ($n = 550$) of the Gothenburg Public Transport Company (Fig. 1). The study was approved by the regional ethics review board and in accordance with the Helsinki Declaration. Written and signed informed consent was collected from all study participants.

At baseline, symptoms of EDS, insomnia severity, and restless legs syndrome (RLS) were assessed using standardized and validated questionnaires (Ware and Sherbourne 1992; Weaver et al., 1997a,b; Young et al., 1997; Bastien et al., 2001; Walters et al., 2003). In addition, a prior history of MVA was assessed. Subsequently, subjects underwent an overnight ambulatory polygraphic sleep recording (Embletta® X10 Portable Digital System, Embla, CO, USA) in order to detect sleep apnea. Analysis time was based on information in the sleep diary and confirmed from the lights off/on mark events in the polygraphy recording. All subjects with a suspected sleep disorder based on the subjective and objective sleep data were examined by a sleep specialist. A detailed history on concomitant disease, ongoing and previous medication, as well as on sleep/wake habits was obtained. Sleep disorders were classified according to the International Classification of Sleep Disorders (ICSD). Anthropometric data including office blood pressure were assessed. Patients with newly diagnosed OSA (AHI $\geq$ 5 n/h, $n = 22$) were included in the interventional part of the study. A baseline ambulatory polysomnography (PSG) (Embla® A10, Colorado, USA) was performed followed by a series of vigilance and neurocognitive tests (described below). Subsequently, subjects were treated with CPAP or a Mandibular Advancement Device (MAD) depending on OSA severity at baseline. Once treatment compliance (subjectively reported regular use of MAD, CPAP use at least 4.5 h/n) was achieved over a time period of minimum 2 months, patients were classified as successfully treated and the baseline procedures including ambulatory PSG and the neurocognitive tests were repeated.

2.2. Questionnaires

2.2.1. Excessive daytime sleepiness, fatigue and quality of life

Subjective daytime sleepiness was assessed by using the Epworth Sleepiness Scale (ESS) (Johns, 1993), and the Karolinska Sleepiness Scale (KSS) (Akerstedt et al., 2008). Symptoms of fatigue in cognitive, physical, and psychosocial domains were assessed using the validated Swedish version of the Functional Impact of Sleepiness scale (FIS) questionnaire (Fisk et al., 1994). Health related impacts on quality of life were assessed using the SF-36, which measures eight different dimensions (Physical Functioning, Role-Physical, Bodily Pain, General Health, Vitality, Social Functioning, Role-Emotional and Mental Health) (Ware and Sherbourne, 1992).

2.2.2. Insomnia and restless legs

The self-administered insomnia severity index (ISI) was used to assess insomnia severity (Bastien et al., 2001) with a cut-off threshold of >14 defining moderate to severe insomnia. The International Restless Legs Syndrome Scale (IRLSS) is a ten question scale, ranging from 0 to 40, measuring the severity of restless legs syndrome (RLS) (Walters et al., 2003). A score in the range of $\geq$11–20 was used to define mild to moderate RLS and a cut-off of $\geq$21 was used to define severe RLS.

2.2.3. Sleep diary and motor vehicle accidents

At baseline, a sleep diary over one week was used to evaluate habitual subjective total sleep time (time of falling asleep/waking up), quality of sleep (excellent, good, poor), sleep latency (time to fall asleep), sleep duration (hours: min of sleep) and sleep sufficiency (well rested, rested, not rested). By responding yes or no to the MVA questionnaire, patients were interviewed regarding previous motor vehicle accidents. Relevant accidents in the context of

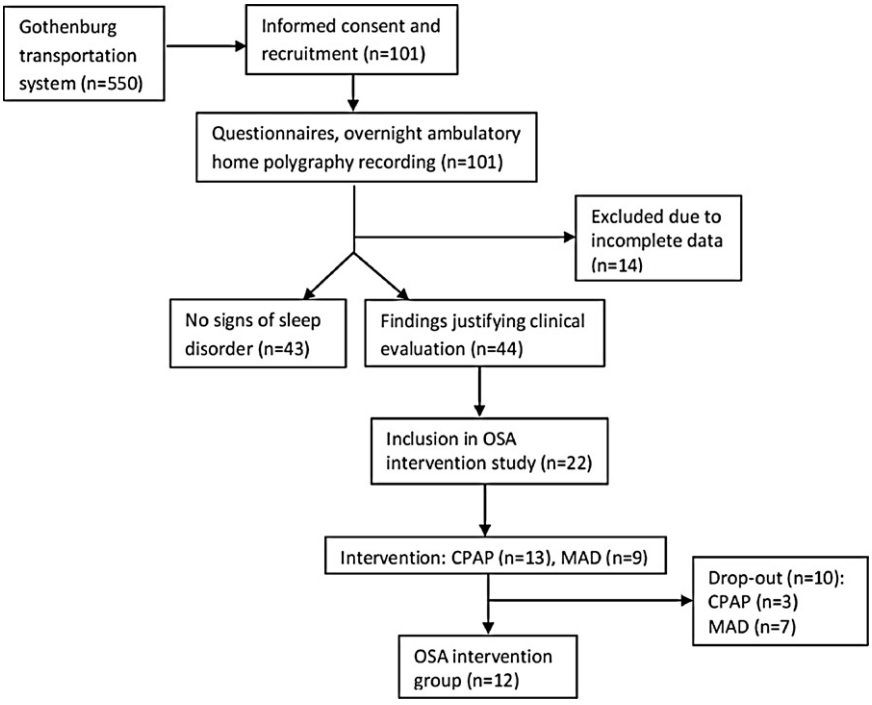

Fig. 1. An overview of study design and subject recruitment.

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