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Short sleep duration, sleep disorders, and traffic accidents

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ABSTRACT

Sleepiness is an important factor in traffic accidents caused by human error. The purpose of this paper is to review a number of studies conducted over the years regarding the effect of the lack of sleep on the incidence of traffic accidents as well as the individual effects of various sleep disorders on accidents. In addition, we discuss recent advances in methods of detecting sleepiness and strategies for preventing traffic accident by using these methods.

Contents

1. Introduction

In April 2012 a bus driver in Japan who fell asleep at the wheel caused a disastrous accident that took the lives of 7 people and injured a further 39. The bus, on its way from Kanazawa to Tokyo, hit a roadside wall on the Kanetsu Expressway around dawn. No brake or skid marks were found at the site of the accident; the Gunma Prefectural Police reported that the driver had “fallen asleep.” Around the same time in Kameoka City, Kyoto, a mini-car ran into a group of children walking to school with their guardians, hitting 10 people, of whom 3 died and 7 were severely injured. This accident reportedly involved an unlicensed 18-year-old driver who fell asleep at the wheel. Generally, accidents caused by drowsiness and falling asleep are the result of drivers being unable to control the brakes or steering due to their impaired state. Furthermore, because such accidents often occur at high speeds, there is a much greater mortality rate or risk of serious injuries [1].

Sleepiness is an important factor in traffic accidents caused by human error. One study of 19,000 subjects across five European

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countries [2], as well as another of 3000 Japanese adults [3], found that excessive daytime sleepiness (EDS) reached as much as 15%.

The main causes of EDS are (1) the lack of sleep, (2) deterioration in the quality of sleep, (3) disruption of circadian rhythms, and (4) primary hypersomnia. In terms of lack of sleep, it has been suggested that lifestyles requiring activity around the clock or late at night are the main cause of this condition. In 1960, 90% of people reportedly went to sleep at 11:00 PM and slept for an average of more than 8 h, but the number of people active late at night has gradually risen, resulting in shorter sleeping times. In 2010, half of the population was still awake at 11:00 PM and the mean sleeping time was only 7 h and 14 min, suggesting a reduction of around 1 h of sleeping time compared with 40 years ago [4] (Fig. 1). In a study conducted on the general population (n = 12,000) in Finland, 20.4% of participants were found to have insufficient sleep [5], while a study of 4000 adult subjects in Japan revealed that 28% had fewer than 6 h of sleep each night [6]. Thus, there appears to be a high rate of insufficient sleep in developed countries. Of course, people with chronically short sleeping times often have EDS. However, although an accumulated lack of nocturnal sleep can result in serious deficits in neurobehavioral function, the increase in subjective sleepiness under such conditions remains mild. That is, people with chronic lack of adequate sleep may underestimate their own sleepiness [7]. Unwanted sleepiness may also occur due to the disruption of circadian rhythms in situations such as jet lag or shift work, as well as primary circadian rhythm sleep disorders such as delayed sleep phase. People whose quality of sleep deteriorates as a result of sleep disorders that cause frequent interruption of nocturnal sleep, such as obstructive sleep apnea syndrome and periodic limb movement disorder, can develop secondary hypersomnia. In addition, while primary hypersomnia such as narcolepsy and idiopathic hypersomnia is relatively rare, it can cause serious problems with EDS [8].

In this report, we survey a number of studies conducted over the years regarding the effect of the lack of sleep on the incidence of traffic accidents as well as the individual effects of various sleep disorders on accidents. In addition, we discuss recent advances in methods of detecting sleepiness and strategies for preventing traffic accident by using these methods.

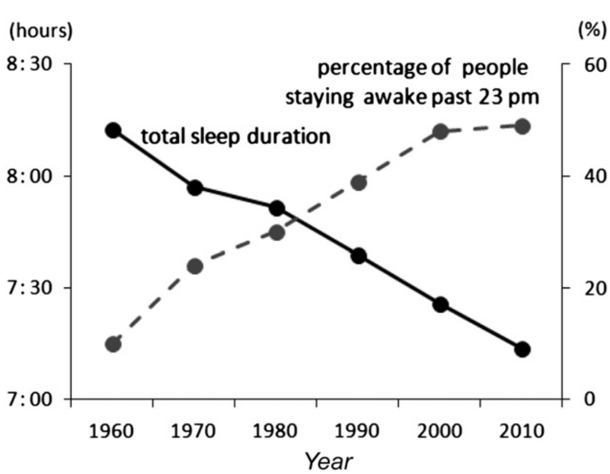

Fig. 1. Changes in Japanese sleep duration and percentage of people staying awake past 11:00 PM. This figure shows the percentage of Japanese people who stay awake past 11:00 PM on weekdays and the average subjective total sleep time from 1960 to 2010. In 1960, 90% of the population were already asleep at 11:00 PM and typically slept for over 8 h. However, sleeping times gradually fell over the surveyed period. In 2010, half of the population remained awake past 11:00 PM with an average sleeping time of 7 h and 14 min.
Created by the NHK National Time Life Survey.

2. Lack of sleep and accidents

In a previous study, we sought to identify a correlation between the occurrence of traffic accidents due to falling asleep at the wheel and sleep duration on the day before the accident. We analyzed 1772 of the 4871 traffic accidents that occurred in Tsukuba City from August 1993 to December 2003, excluding those caused by drunk driving [9]. First, accidents were categorized by type as rear-end collisions (n = 240), single-car accidents (n = 293), or other accidents (n = 1239). A rear-end collision was defined as a trailing car crashing into the rear of a leading vehicle. A single-car accident was defined as a car crashing against a structure on a road or shoulder such as a parked vehicle, wall, house, or telegraph pole. Accidents involving interaction with other vehicles or persons were classified as other accidents. Our analysis of the time of day that each accident occurred revealed that rear-end collisions most frequently occurred between 8:00 and 9:00 AM. On the other hand, single-car accidents occurred more frequently during the night than during the day (Fig. 2). These findings suggest that the time zone of accident occurrence differs by the type of accident. The risk of rear-end collisions grows with increased traffic density, especially during the morning rush hour, which may lead to less space between cars. In contrast, it was hypothesized that single-car accidents could be attributed to low nighttime traffic density that reduced driver alertness and increased driving speed.

For both rear-end collisions and single-car accidents, a higher percentage of subjects were found to have had less than 6 h of sleep on the day before the accident than for other accidents (11.3% in rear-end collisions, 10.2% in single-car accidents, 4.8% in other accidents). Multivariate logistic regression analysis showed that the occurrence of

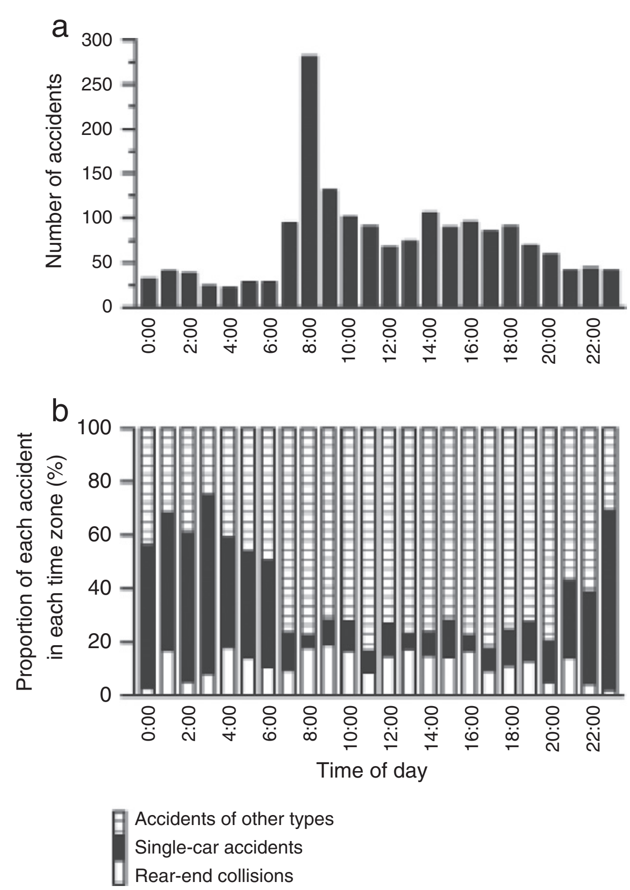

Fig. 2. (a) Time of day distribution of all accidents, and (b) proportion of rear-end collisions, single-car accidents and other accidents among all accidents in each time zone.
Abe et al., Journal of Sleep Research. 2010.