

Comparative Study of Fatigue and Drowsiness in the Night-time Passenger Transportation Industry in Japan

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Abstract—In this research, a questionnaire survey was conducted to measure nap, drowsiness and fatigue of drivers who work for long shifts, to discuss about the work environment and health conditions for taxi and bus drivers who work at night-time. The questionnaire sheet used for this research was organized into the following categories: tension/tiredness, drowsiness while driving, and the nap situation during night-time work. The number of taxi drivers was 127 and the number of bus drivers was 40. Concerning the results of a comparison of nap hours of taxi and bus drivers, the taxi drivers' nap hours are overwhelmingly shorter, and also the frequency of drivers who experience drowsiness is higher. The burden on bus drivers does not change because of the system of a two-driver rotation shift. In particular, the working environment of the taxi driver may lead to greater fatigue accumulation than the bus driver's environment.

Keywords—Bus and taxi, drowsiness, fatigue, nap.

I. INTRODUCTION

DURING driving work at night, it is necessary for the driver to maintain their own health condition and also to care for the passenger's safety and service. Fatigue of driving comes from the continuation of eye operation which requires tension to the brain, so producing mainly mental fatigue. Also, in many cases, there are no symptoms of the accumulated chronic fatigue to the driver's body.

In Japan, the law concerning road transportation was amended in 2002. With the deregulation of the amendment, new taxi companies and the number of vehicles increased significantly. On the other hand, related to the impact of the economic recession, the number of passengers reduced, and there is a very severe situation for the taxi companies [1]. Thus, the working situation has changed, and long working shifts lead to fatigue of the mind and body. Also, work at night leads to further fatigue, and physical condition management becomes difficult even in everyday life. On the other hand, the situation of long distance bus companies has been settled by the new law system in 2013. However, there are circumstances in which the number of new bus operators increased under the influence of the revised law of 2002, and price competition of the companies has become even more severe.

Workers engaged in passenger services must continue to maintain their concentration for driving and for the safety of passengers and, in terms of working at night, mind and body fatigue is greater than day-time work in general. With the new law in 2013, the upper limit of driving for one bus driver traveling on the highway was decided to be 500 km during the

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day and 400 km during the night. Therefore, by a system of a two-driver rotational shift, it is possible for them to alternately take a break and drive at regular intervals for long distances, so the bus company is able to manage the drivers' conditions. However, in the case of the taxi companies, regardless of the size of the company, work schedules are determined by the pace of the driver themselves. Passenger destination and time is uncertain, there are more irregular eating and sleeping habits, and also the life rhythm of day-to-day is disturbed by chronic stress and it is difficult to control the physical condition [2].

Passenger safety is necessary, but also the situation of the drivers' own health status cannot be ignored. In this research, a questionnaire survey was conducted to measure nap, drowsiness and fatigue of drivers who drive for long hours, for discussion about the work environment and health conditions for taxi and bus drivers who work at night-time.

II. METHOD

The questionnaire sheet used for this research was organized into the following categories: tension/tiredness, drowsiness while driving, and the nap situation during night-time work. The questionnaires were controlled by the taxi and bus companies, and they were given to the drivers at each working area. The drivers received the questionnaire on the day of work, and answered the questions after finishing work. Then, the completed questionnaires were inserted into envelopes, sealed, and returned.

Information on the drivers for this research is shown in Table I. The number of taxi drivers was 127. All were male, and the ages were 33-72 years old (average age: 59.3), and the experience of work was 0.2-45 years (average years: 13.2). The number of bus drivers was 40. All were male, and the ages were 30-55 years old (average age: 45.2), and the experience of work was 6-34 years (average years: 15.5).

TABLE I
INFORMATION OF TAXI AND BUS DRIVERS

Work type	Taxi	Bus
Number of subjects	127 persons	40 persons
Average age (range)	59.3 (33-72)	45.2 (30-55)
Average work experience (range)	13.2 years (0.2-45)	15.5 years (6-34)

III. RESULTS

A. Driving and Life Style Conditions

Fig. 1 shows a comparison of the differences of tension, tiredness, and health condition during driving work for taxi and bus drivers.

63.7% of the taxi drivers answered that night-time work

produces more tension than day-time work, and 66.4% of the drivers answered that tiredness is greater at night-time. The health condition in the day-time shift (58.1%) is better than the night-time (10.5%), every answer was about 60%. The negative implications of the night-shift were “degree of tension-fatigue”, and the plus factor was “in good health condition”, so the results of daytime work showed that physical and mental stress caused by night-work is higher than day-time work. On the other hand, for the bus drivers, the night-time shift has more stress than the day-time shift, and the percentage was 70.0%. Also, the answer “feel strongly tired” for the night-shift was 50.0%. The drivers who worked in the day-time shift had better health conditions than the night-time shift, and the percentage was 55.0%.

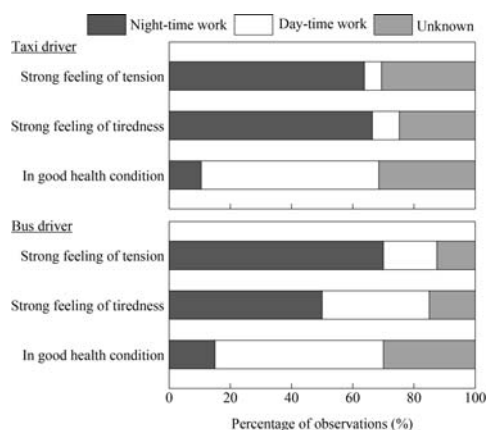


Fig. 1 Comparison of the drivers for tension, tiredness, and physical health condition

B. Effect of Nap for Drowsiness and Tiredness

Fig. 2 shows drowsiness during driving for taxi drivers in the night-time shift. Almost all drivers had an experience of drowsiness during driving. 14.9 % of drivers answered “often”. On the other hand, the bus drivers’ answer of “often” for drowsiness was 5.0 %, about one-third. From this result, there is a tendency that the taxi drivers are likely to feel sleepy. Horne [3] said that the reason of falling asleep while driving is a problem of the drivers’ sleeping rhythm, and monotonous driving on the highway does not produce drowsiness. The drivers in this research mainly worked on a highway shift. Next, the taxi drivers were asked about the effect of rest hours as a measure to prevent drowsiness. Fig. 3 shows the nap hours taken in the vehicle. 43.4% of the drivers answered “no-sleep”, and a total of 85.0% of drivers answered that they slept for less than 2 hours. The drivers felt drowsiness while driving, however, the nap time was insufficient.

The taxi drivers were asked about doze prevention and recovery from fatigue by taking a night-time nap. As shown in Fig. 4, the effect of a night-time nap in the vehicle had a greater effect on doze prevention than recovery from fatigue. The answer of “recover well” from fatigue was 13.4%, so this shows that it is difficult to recover from fatigue by taking a nap. Regarding the effect of reducing drowsiness, 30.4% of drivers answered “reduce well”, so the effect on doze prevention was greater than recovery from fatigue. On the other hand, in the

bus driver’s case, the company work shift which was targeted in this research included 2 naps during each shift. Fig. 5 shows the actual sleeping hours during the nap time in the bus cabin. 35.0% of the bus drivers were able to sleep for “3/4” of the nap time, and 50.0% of the drivers were able to sleep for “1/2”. Therefore, 85.0% of the total number of drivers was able to sleep to a certain extent during the night-time nap. The researches [4]-[7] show that there is a regular effect on recovery from fatigue and doze prevention by taking a night-time nap for bus drivers.

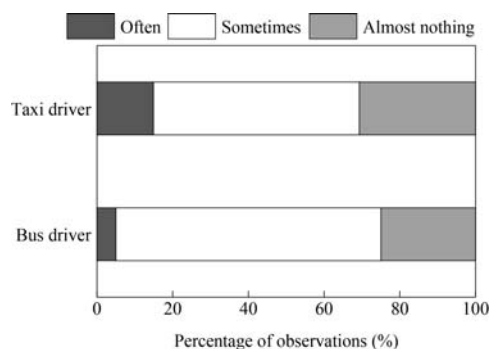


Fig. 2 Drowsiness during driving for taxi and bus drivers in the night-time shift

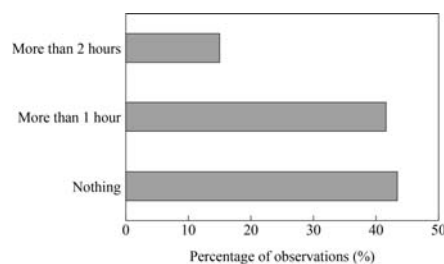


Fig. 3 The length of nap hours for taxi drivers

Fig. 6 shows the extent of doze prevention and recovery from fatigue by taking a night-time nap in the cabin for bus drivers. The answer of “reduce well” for reducing drowsiness was 37.5%, and “recover well” from fatigue was 15.0%. Also, the answer of “no reduction” for drowsiness was 2.5%, and “no recovery” from fatigue was 15.0%.

IV. DISCUSSION

As shown in Figs. 2 and 3, concerning the results of a comparison of nap hours of taxi and bus drivers, the taxi drivers’ nap hours are overwhelmingly shorter, and also the frequency of drivers who feel drowsiness is higher. On the other hand, in the case of bus drivers, a two-driver rotational shift-work system is adopted and there is a regulated nap time, therefore, safety management of bus drivers can be achieved well. In Japan, taxi company safety management is considerably uneven and working hours are changed by the intention of the driver. The bus driver’s income is not changed with the number of passengers, many or few, but in the case of taxi drivers, there are many cases of a commission system. Therefore, for taxi drivers, they have to work to increase

earnings, without sleep time and while experiencing drowsiness. On the other hand, for bus drivers, they do not need to increase earnings even if they use the time to take a nap. The number of bus companies is increasing due to the influence of legal reform; also, the number of users of long distance night-time buses is increasing too. Therefore, there is a price competition for each company; however, the burden on each driver does not change because of the rotational shift-work system. Recently, the number of passenger seats on buses has been reduced and the size of the seats has been made larger. Also, there is strong competition among the bus companies to provide a good service for the passengers; therefore, people of the younger generation can accept such a bus system for their needs. Of course, the companies know that a night-time nap is efficient in reducing drowsiness and recovering fatigue, however, the drivers have to work in the outdoor environment, not as a worker in a factory or indoors. In a factory, it is easier to prepare a room for napping, but in the case of taxi drivers, the only way to rest or nap is to recline the seat of the vehicle. Such a posture of extending the body in the seat does not provide relief. However, in the case of bus drivers, they can rest in the cabin as shown in Fig. 7. Therefore, they can sleep well even in a small space in the cabin. If the environment of the cabin is improved, the efficiency of a night-time nap will also probably be improved.

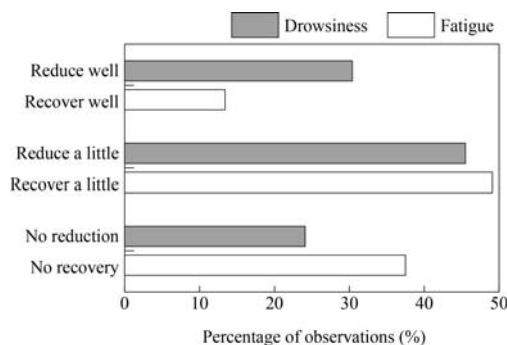


Fig. 4 Extent of doze prevention and recovery from fatigue by taking a night-time nap for taxi drivers

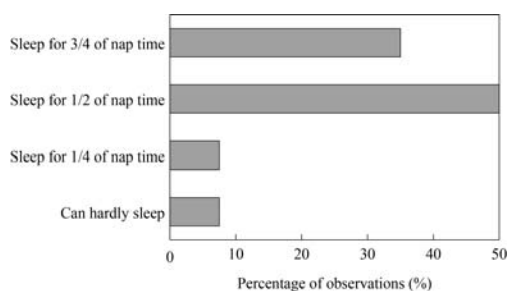


Fig. 5 Sleep conditions during nap time for bus drivers

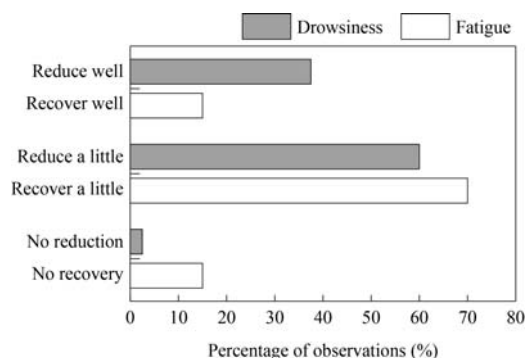


Fig. 6 Extent of doze prevention and recovery from fatigue by taking a night-time nap for bus drivers



Fig. 7 Photograph of an example of driver's rest room in the bus cabin which is modified from the luggage hold

V. CONCLUSION

Driving in a state in which attention becomes lost can cause major accidents. In other words, the safety of passengers depends on the health of the driver; the way of thinking "to ensure the safety of passengers" equals the "maintenance of the health of the driver" should be established. To continue driving without taking a nap during night-work means that there is a risk of developing various diseases as well as sleep disorders, and it will also compromise the passenger's safety.

In particular, the working environment of the taxi driver may lead to greater fatigue accumulation than the bus driver's environment. It seems that there is a problem with the work shift of taxi drivers; however, it is difficult to change the system. This is because, currently, competition is intense in the taxi industry, and income from passengers during night-work varies greatly, so it is important to get as many passengers as possible. It follows that without taking a nap during the night, sleeping during the day and repeating this cycle makes it difficult to have an effect as a night-time sleep, and also it is difficult to reduce tiredness. Hopefully, there will be future considerations on the legal measures to reduce the burden on taxi drivers, and also, it is hoped that taxi companies will revise conditions to facilitate the drivers' recovery from fatigue.

In this research, the purpose was to understand about the fatigue and drowsiness for taxi and bus drivers when they work a night-time shift, however, the results were based on only subjective research. Therefore, for further research, it is necessary to perform by an objective evaluation index. Also, it is necessary to research the situation of the night-time nap in the

vehicles in more detail.

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