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A CROSS-SECTIONAL STUDY ON INSOMNIA AMONG JAPANESE ADULT WOMEN IN RELATION TO NIGHT-TIME ROAD TRAFFIC NOISE

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In an effort to determine the contribution of night-time road traffic noise to insomnia in the general population, 3600 adult Japanese women living in urban residential areas were surveyed. Living near a road with a heavy traffic volume is one of the risk factors for insomnia. The risk for insomnia in the zones 0–20 m from the main roads increased linearly with the night-time traffic volume. This suggests that road traffic noise raises the sound level in bedrooms in such zones, and consequently the prevalence rate of insomnia among the residents, and that noise-induced insomnia is an important public health problem, at least in highly urbanized areas.

1. INTRODUCTION

Most population studies on noise and sleep have not defined "sleep disruption", its severity and persistence in detail, and have not sufficiently taken into account the other risk factors for sleep disruption [1–3]. In such studies, respondents are mainly asked about noise, which may lead to a tendency for them to attribute their sleep disruption to the noise [2]. The contribution of noise to sleep disruption in the general population remains unclear [4]. A population study on insomnia was carefully planned, taking into account the above problems, in order to investigate the contribution of night-time road traffic noise to insomnia in the general population.

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2. SUBJECTS AND METHODS

2.1. STUDY AREAS AND SUBJECTS

A self-administered questionnaire concerning sleep, demographic information, and possible risk factors for sleep disruption was distributed to adult women living in eight Japanese urban residential areas (see Table 1). Each area includes a major road, with the night-time road traffic volume (NRTV) varying among the areas, and was subdivided into three zones according to the distance from the major road (Zone A, more than 50 m; Zone B, 20–50 m; Zone C, 0–20 m). In Table 1, the night-time (2200–0600) traffic volume is represented as the number of vehicles/hr, assuming one heavy vehicle to be equivalent to ten automobiles, taking into account the difference in their acoustic power levels. The total number of subjects was 3600. They were aged between their twenties and their eighties. More than half were employed.

2.2. DIAGNOSIS OF INSOMNIA

According to information in standard classification manuals of sleep disorders [5–7], insomnia was defined as follows. The first criterion for insomnia is the presence of a sleep-related problem. The second criterion is the presence of any combination of the following four symptoms: difficulty in falling asleep, intermittent waking, premature morning waking, and feeling of light overnight sleep. These symptoms must occur one or more times per week, and have persisted for at least one month. The third criterion is the presence of one or more of the six after-effects of sleep disruption presented in the questionnaire, such as ''lethargy'', ''dozing or napping'', ''inefficiency in work'', etc. The results of a test–retest study confirmed the reproducibility of this diagnosis. The short term sleep quality assessed with actimetry [8, 9], etc., supported the validity of the diagnosis.

2.3. ANALYSIS

Multiple logistic analysis [10] was applied to the questionnaire data, and the association of the variables with the presence of insomnia was represented as an odds ratio (OR), adjusted for all other confounding variables. The questionnaire prepared for this study focused on sleep rather than on noise, and the road traffic noise was assessed as a function of NRTV.

TABLE 1

Outline of study areas

Area†	*N*	Age (yr)	NRTV‡
Tokyo-1	371	30 s–60 s	6000
Tokyo-2	345	30 s–60 s	2100
Maebashi	648	20 s–80 s	900
Nagasaki-1	1064	20 s–80 s	<50
Nagasaki-2	209	20 s–80 s	1100
Okinawa-1	409	20 s–80 s	2100
Okinawa-2	219	20 s–80 s	550
Kawasaki	335	30 s–60 s	2400
Total	3600		

† NRTV, Night-time road traffic volume (one heavy vehicle is equivalent to ten automobiles).

‡ Zoning according to distance from major road: Zone A, 50 m or more ($N = 2253$); Zone B, 20–50 m ($N = 817$); Zone C, 0–20 m ($N = 530$).

TABLE 2

Prevalence rates of insomnia by area and zone

Area	Zone (%) A	B	C	Comparison among zones†
Tokyo-1	8·2	12·1	23·1	A < C‡
Tokyo-2	9·0	13·3	13·7	N.S.
Maebashi	8·7	7·5	12·4	N.S.
Nagasaki-1	11·6	11·1	12·1	N.S.
Nagasaki-2	6·0	12·1	10·4	N.S.
Okinawa-1	8·2	16·3	11·1	N.S.
Okinawa-2	7·9	12·9	12·2	N.S.
Kawasaki	11·7	15.5	15.4	N.S.

† N.S., no difference among the three zones was statistically significant; ‡ $p < 0.001$.

3. RESULTS

Four hundred and three subjects (11·2%) were classified as insomniacs. The overall prevalence rate of insomnia was the lowest for the subjects in their thirties, and tended to be high in the elderly. Among the insomniacs, 13% were consulting a physician or other specialist because of their sleep disruption, and 27% were using a hypnotic. The insomniacs reported that outdoor noise was the most typical cause of sleep disruption (25%) next to distress (30%). They reported much more daytime sleepiness and tiredness than non-insomniacs.

Simple cross-tabulation (see Table 2) showed that the prevalence rate of insomnia in Zone C was significantly higher than that in Zone A in Tokyo-1. Multiple logistic analysis revealed that being aged 70 or older, the presence in the home of child(ren) aged six or younger, undergoing of medical care, experiencing one or more major life events within the last six months, irregularity of bedtime, a sleep–apnea-like symptom, and the combination of area and zone were associated with the presence of insomnia (see Table 3), whereas the variables such as job status, number of years living in the area, frequency of physical exercise, alcohol consumption, caffeine consumption, double-glazed windows, or sleeping in a room facing any roads was not. Since no difference in OR was found among

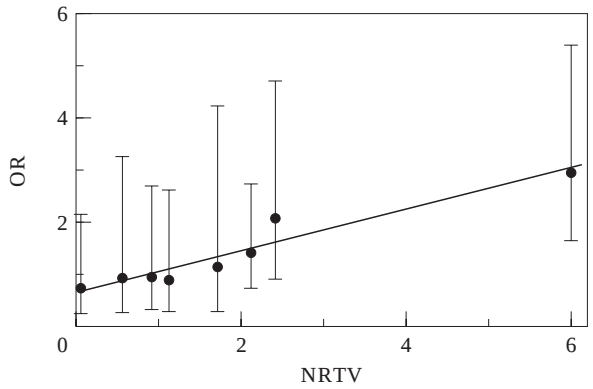

Figure 1. Level–response relationship between night-time road traffic volume and risk for insomnia in zones near roads. NRTV, nighttime road traffic volume (1000 vehicles/hr, one heavy vehicle is equivalent to ten automobiles); OR, odds ratio for Zone C adjusted for confoundings (see Table 3). Dots and bars represent ORs and their 95% confidence limits. The regression line was calculated from 8 data points ($y = 0{\cdot}384x + 0{\cdot}701$).

TABLE 3

Multiple logistic analysis of insomnia

Variable	Category	OR	95% C.L.
Age (yr)	20–29	1·5	0·9–2·5
	30–39	1·0	(Ref.)
	40–49	1·1	0·7–1·7
	50–59	1·1	0·8–2·0
	60–69	1·6	0·9–2·6
	70–	2·1	1·1–3·8
Child(ren) aged 6 or younger in home	Absent in the home	1·0	(Ref.)
	Present in home	1·5	1·0–2·1
Undergoing of medical care	No	1·0	(Ref.)
	Yes	2·1	1·6–2·8
Major life event(s) within the last 6 months	0	1·0	(Ref.)
	1	1·4	1·1–1·9
	2 or more	2·8	2·0–3·9
Bedtime	Regular	1·0	(Ref.)
	Irregular	2·6	2·0–3·3
Sleep-apnea-like symptom	Absent	1·0	(Ref.)
	Present	2·7	1·6–4·8
Area and Zone	All Zones A and B	1·0	(Ref.)
	Zone C in Tokyo-1	2·9	1·6–5·4
	Zone C in Tokyo-2	1·4	0·8–2·7
	Zone C in Maebashi	0·9	0·3–2·9
	Zone C in Nagasaki-1	0·8	0·3–2·2
	Zone C in Nagasaki-2	0·9	0·3–2·6
	Zone C in Okinawa-1	1·2	0·3–4·2
	Zone C in Okinawa-2	1·0	0·3–3·3
	Zone C in Kawasaki	2·1	0·9–4.7

OR, odds ratio adjusted for other variables in this table; 95% C.L., 95% confidence limits of OR; Ref., reference category. The variables not shown in this table were omitted from the multiple logistic model.

Zones A and B for any of the eight areas, they were combined into a reference category in Table 3. The OR for Zone C in Tokyo-1 was significantly higher than that for the above reference zones. There was a linear relationship between the ORs for Zones C in the eight areas and the NRTV of the major road in each area (see Figure 1).

4. DISCUSSION

The medical behavior and daytime adverse consequences of sleep disruption in the insomniacs indicate the severity of their sleep disruption. The risk factors identified for insomnia agree well with those reported by many previous clinical and epidemiological studies [5, 6, 11–14]. These results support the validity of our definition of insomnia.

Taking into account these risk factors for insomnia, the ORs in the Zones C linearly increased with the NRTV. The risk for insomnia tended to be higher if NRTV was 3000 or more vehicles/hr, and was significantly higher if NRTV was 6000 vehicles/hr, compared with Zones A and B. The night-time outdoor sound levels (L_{Aeq}) in Zone C depended mainly on the NRTV on the main roads (our measurements showed that the outdoor L_{Aeq} during sleep time was about 65 dB in Zone C of Tokyo-1 [15]). It is shown

that, if the NRTV exceeded 3000 vehicles/hr, the indoor sound level (L_{Aeq}) in Zone C was significantly higher than in Zones A and B [1, 16]. These findings suggest that, in areas such as Zone C in Tokyo-1, the night-time traffic noise raises the indoor sound levels, and consequently the prevalence rate of insomnia among the residents. This also suggest that noise-induced insomnia is an important public health problem, at least in highly urbanized areas.

To confirm the above results and examine the relationship between the personal sound exposure levels and the risk for insomnia in detail, we compared the indoor sound levels among insomniacs with those among non-insomniacs in two Tokyo areas. Although a brief report about this study has already appeared [15], details will be reported elsewhere.

5. CONCLUSION

A population survey in 3600 Japanese women revealed that living near a road with heavy traffic volume is one of the risk factors for insomnia. The risk for insomnia in the zones 0–20 m from the roads increased linearly with the night-time traffic volume. This suggests that noise-induced insomnia is an important public health problem in urbanized areas.

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