Relation between Sudden Infant Death Syndrome and Weather Factors in Japan

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We examined the relation between sudden infant death syndrome (SIDS) mortality and meteorological factors, specifically ambient temperature, sunshine duration, and atmospheric pressure, in Japan. Using both the data of daily SIDS mortality and meteorological factors for the years 1972 through 1995, we calculated the Mantel-Haenszel rate ratios of SIDS, controlling for selected covariates. We found an inverse association of SIDS mortality rate with daily mean temperature and daily mean sunshine duration. In conclusion, although this was an exploratory study, further investigation of the relation between SIDS and meteorological factors appears to be warranted.

Key words —— sudden infant death syndrome, ambient temperature, atmospheric pressure, sunshine duration, time-series analysis

INTRODUCTION

Sudden infant death syndrome (SIDS) is a disease which causes an infant's sudden death without any symptoms or anamnesis, and is known as the main cause of infant death in developed countries.

Seasonal variation in the incidence of SIDS with a peak incidence in the winter months was first reported by Wakley,[1] after which an excess of SIDS deaths during winter was attributed to suffocation or pressing by other children.[1,2] In the 1940s, researchers came to think that this seasonal effect was due to respiratory infections, which are frequent in winter.[3] Other explanations for seasonal difference include meteorological factors and melatonin secretion. The relation between SIDS and temperature has been studied in the US and European countries[4–6]; Sparks and Sturner[7,8] found a relation between SIDS and melatonin reduction in the pineal gland-melatonin system, a circadian photoneuroendocrine system. Since melatonin secretion is affected by exposure to light, it may also explain the seasonal difference.

Although many studies have been done in Europe or in the United States, the relation between SIDS and meteorological factors may be area- and race-specific, and there have been few studies in Japan. Thus, we decided to conduct a time-series study on SIDS in relation to meteorological factors in this country.

MATERIALS AND METHODS

The Ministry of Health and Welfare provided computerized mortality files for the years 1972 through 1995 that included sex, date of death, and area code. The General Administrative Agency of the Cabinet provided the annual age-group- and sex-specific populations for prefectures. The Meteorological Agency provided computerized daily meteorological data. (The names of the above agencies and ministry are those which were in use at the time of the data acquisitions.)

We selected the meteorological variables that were examined in previous studies,[9–14] *i.e.*, daily mean atmospheric pressure, daily mean temperature, and duration of daily sunshine. The measurements of an observatory station in a prefectural capital city were used as representative values for that prefecture. However, because the capital city of Saitama did not have an observatory station, we used the measurements of the closest urban station, located in Kumagaya. The level of each meteorological variable was divided approximately in six intervals as follows:

Using the data of all study prefectures for 1972–1995, we made 10% tile and 90% tile two cut points, in addition we divided the interval between the two points into four intervals equally.

The codes of the International Classification (ICD) of Diseases used were as follows: Eighth Revision 795 for 1972–1978; Ninth Revision 798.0 for 1979–1994; and Tenth Revision R95 for 1995.

Daily meteorological factor-specific mortality rate was computed with an approximation of the person-time method[15]: The numerator is the total

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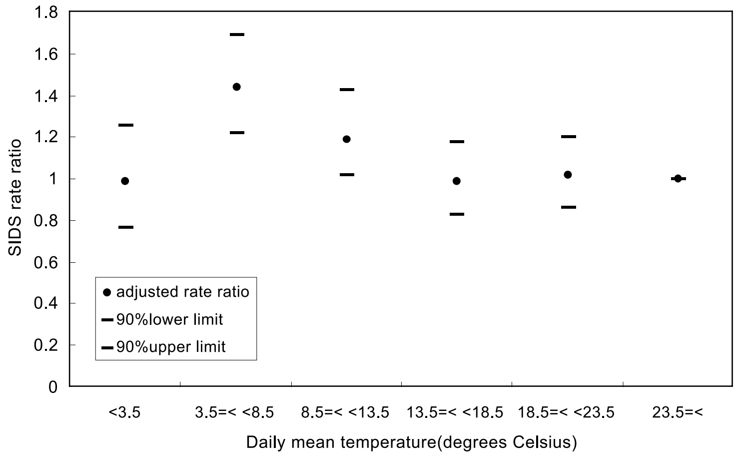

Fig. 1. Relation between Daily Mean Temperature and SIDS Mortality Rate

Table 1. The Total Number on the Category of Temperature

The category of temperature (°C)	Number of person-days	Number of SIDS deaths
< 3.5	3824778924	254
$3.5 \leq \ < 8.5$	3392641512	231
$8.5 \leq \ < 13.5$	2975766594	249
$13.5 \leq \ < 18.5$	4104097351	369
$18.5 \leq \ < 23.5$	1360578235	104
$23.5 \leq$	3634934807	201

number of deaths which occurred on the days during the study period with a certain category of the meteorological factor, and the denominator is the number of days with the same category multiplied by the population size; this calculation of denominator is the approximation of the actual person-days. For example, if the study period is 1977–1978, there were 20 days in 1977 and 12 days in 1978 on which the daily mean temperature level was 18.5–23.5°C, the total number of deaths during these 32 days was 200, and the population size was 100000 in 1977 and 105000 in 1978, then the mortality rate is calculated as

$$200/(20*100000 + 12*105000).$$

In Japan, the definition of SIDS allows that the age range can be between 0 and 4. More than 90% of the SIDS occurred, however, among infants. Thus, we included all the SIDS cases who were under 5 years of age.

Since the relation between a meteorological factor and SIDS mortality may be area dependent as shown in Honda *et al.*'s paper,[16] we decided not to utilize the data for the entire country. Instead, we selected the Kanto region and divided it into two areas, the metropolitan area (Tokyo, Kanagawa, Saitama and Chiba) and the rural area (Ibaraki, Gunma, Tochigi and Yamanashi). Officially, Yamanashi Prefecture is not a part of the Kanto region, but we included it because it surrounds the metropolitan area as other Kanto rural prefectures do and its inclusion increases the statistical stability of the rural area.

We used Mantel-Haenszel rate ratio as a measure of association, and Greenland and Robins' method[17] in obtaining 90% confidence interval. By this method, the statistical stability depends only on the total size of the study, however sparse each cell may be. We used the SAS program by Honda *et al.*[18] in calculating the M-H rate ratios and their confidence intervals. In an analysis for daily mean temperature, for example, the other two meteorological factors were treated as confounding factors. The other factors controlled for were sex, chronological periods characterized by ICD revision, *i.e.*, ICD-8 (1972–1978), ICD-9 (1979–1994), and ICD-10 (1995), and area.

In addition, we used Hakulinen's method for the trend tests.[19]

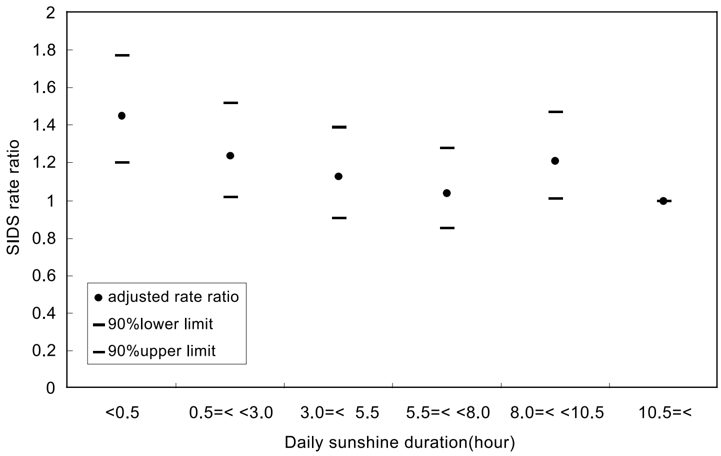

Fig. 2. Relation between Daily Sunshine Duration and SIDS Mortality Rate

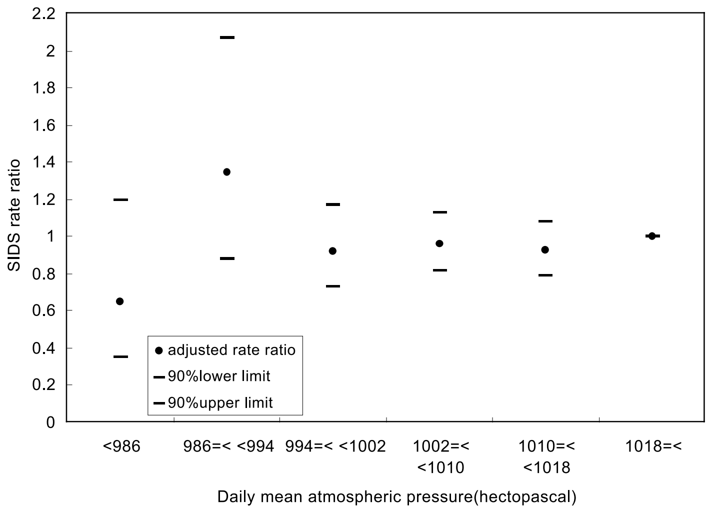

Fig. 3. Relation between Daily Mean Atmospheric Pressure and SIDS Mortality Rate

RESULTS

Figure 1 shows that the risk is higher than the reference category (23.5+°C) for the categories lower than 13.5°C, except for the < 3.5°C category, in which the M-H rate ratio was 0.99 [90% confidence interval (CI): 0.77–1.26]. For evaluating statistical stability, we show the number of both person-days and SIDS deaths by category of temperature (Table 1). As can be seen from Table 1, the 18.5 ≤ < 23.5°C category had the smallest number of deaths, but it still was more than 100.

Figure 2 shows that the shorter duration of sunshine yielded higher risks, with the < 0.5 hr category being the highest; the RR is 1.45 (90% CI: 1.20–1.77).

Figure 3 shows the relation between the mean atmospheric pressure and SIDS deaths. There was no elevated risk for the upper three categories, and the RR for the lower two categories were inconsistent; the RR for the 986 ≤ < 994 hpa category was 1.35 (90% CI: 0.88–2.07) and the RR for the < 986 hpa category was 0.65 (0.35–1.20).

The trend test revealed that Figs. 1 and 2 had linear patterns, but the test for Fig. 3 was not significant (significance level: 0.01).

In addition, we examined an effect of these associations by sex, but there was no meaningful difference between the patterns of the males and those of the females (Figs. 4 to 6).

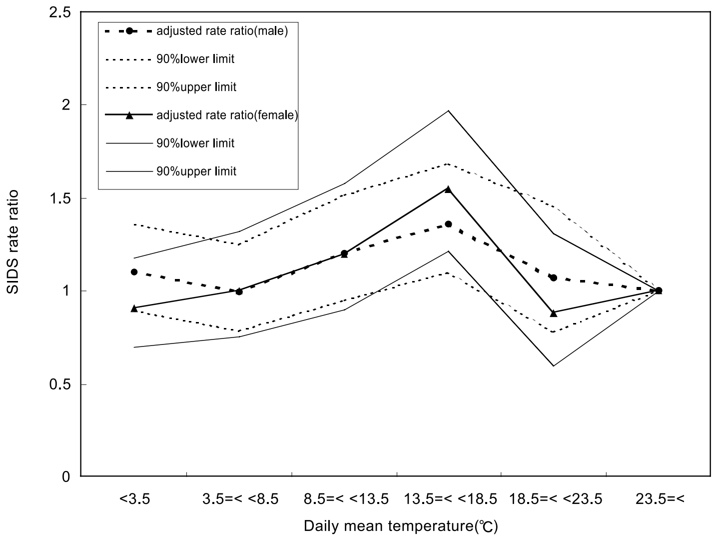

Fig. 4. Relation between Daily Mean Temperature and SIDS Mortality Rate by Sex

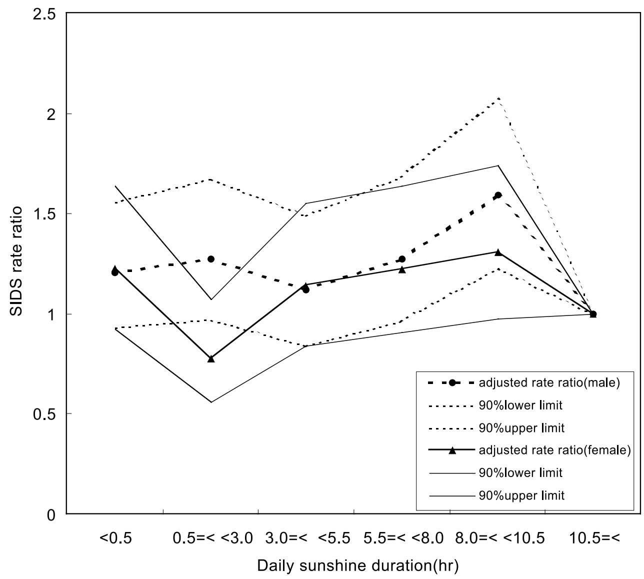

Fig. 5. Relation between Daily Sunshine Duration and SIDS Mortality Rate by Sex

DISCUSSION

This is the first epidemiological study to consider the relation between meteorological variables and SIDS mortality rate using daily mortality data and prefectural meteorological data.

Among the variables examined, daily mean temperature and duration of daily sunshine appeared to have an inverse relation with SIDS mortality, as shown in Figs. 1 and 2, except for the < 3.5°C temperature category and the 8.0 ≤ < 10.5 hr sunshine category, respectively; the shorter the duration of sunshine was, or the lower the daily mean temperature was, the higher the SIDS mortality rate was.

Also the trend was significant. Thus, it is suggested, as for Figs. 1 and 2, that there were linear relations.

These findings are consistent with the previous studies, *i.e.*, the SIDS mortality rate is higher during the winter.[20,21]

For temperature, the previous studies also reported that SIDS mortality is higher when the temperature is lower.[10–12] Thus, the present study confirmed the relation with statistical significance.

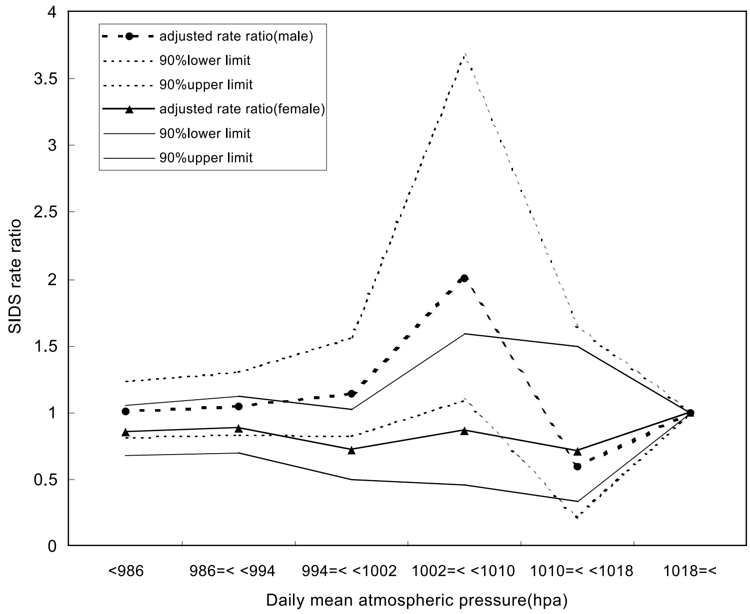

Fig. 6. Relation between Daily Mean Atmospheric Pressure and SIDS Mortality Rate by Sex

As for the exception in the present study, *i.e.*, the < 3.5°C category, it may be explained by the difference in temperature between inside and outside of the homes; when temperature levels become very low, the difference between inside and outside would become large.[22–24] As described in Methods section, most of the SIDS deaths occurred among the infants, and it was likely that they were at home when they died.

For duration of sunshine, the previous studies are different from the present study. Tamakoshi *et al*.[13] reported that monthly mean duration of sunshine was positively associated with the SIDS mortality rate. This finding is contrary to ours. However, they used monthly data, so the ability to detect the relation would be limited. Douglas *et al*.[14] reported that there was no relation between duration of daily sunshine and the SIDS mortality rate, but that latitude (diurnal periodicity) was inversely correlated with SIDS mortality. The discrepancy between their study and the present study may be due to difference in weather patterns or climate, but surely further investigation is necessary.

It is possible that the relation between daily mean atmospheric pressure and SIDS mortality is non-linear, and that only a specific range of atmospheric pressure is a risk for SIDS, but the apparent relation may be due to chance.

The present study has the following limitations: (1) We used only one meteorological station for each prefecture; (2) The meteorological data do not necessarily represent the corresponding indoor situation, especially with regard to temperature during very cold days; (3) We did not control for individual level confounders and effect-measure modifiers; (4) In most of the cases, the diagnosis of SIDS was not based on postmortem examination. As for (1), in order for the inverse relation to be spurious, there must be a correlation between the extent of differential misclassification and the meteorological factors, which appears unlikely. As for (2), we already discussed above. With regard to (3), the distributions of most potential confounders remain constant across the different levels of daily meteorological factors, and controlling for these confounders is not necessary as far as there is no effect-measure modification.[25,26] For further investigation, it is necessary to explore strong effect-measure modifiers. Concerning (4), we plan to investigate the relations by controlling for the proportion of SIDS autopsy cases.

In conclusion, we found that SIDS mortality is affected by temperature and duration of sunshine, and that further investigations are warranted.

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