B-13.3 Health Effects and Risk Evaluation of Global Warming.

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Abstract Studies on health effects and risk evaluation by global warming intend to develop health indices using database and its application. To localize the population at risk using climate information, and to demonstrate the dependence of the mortality rate on ambient temperature pushed the studies to analyse the factors of excess deaths. On the other hand, studies of the relationshipts between heat exposure and individual behavior in daily life, and that between ambient temperature in tropical highland and infantile mortaliy rate showed diverse mechanisms of heat effects. The database on health indices is under study and its application for risk evaluation was discussed in each chapter.

Key words Ambient Temperatute, Death Statistics, Heat Exposure, Adaptation, Air-conditioning,Risk ssessment

Contents:

1. Health Risk at Various Levels by Exposure to Environmental Temperature

Outdoor life in urban area in summer is effected by radiation, wind, buildings, cars, and trees. Indoor life is effected unevenly by air-conditioning. The characteristics of control system of the environmental temperature makes the risk of heat exposure so diverse by personal characteristics. The difference of living temperature from outdoor and comfortable temperatures may predispose mal-adaptation and worsening of preexisting diseases. For example of risk evaluation, we analyzed the regional difference of heat exposure during 1972-1990 in southern areas of Japan and possible risk of dapatation against the prolonged hot days. The result was unexpected for the people living there and it seemd to be difficult to prepare without the information on location and duration of hot days.

2. Development of GIS-based Information System for Assessing the Impacts of Global Warming on Human Health

To evaluate health effects on population by global warming, data linkage by graphic information system, calculation of the index, and supporting system for presentation by color images were developed. The area-related information and presentation units were transformed into administrative boundary, and the location of the observation and address codes of city, town, and village were input. On Kanto Area, non-excess probabilities of 50%, 75%, 90%, and 99% values were calculated from maximum daily outdoor temperature in August (Tx, 1976-1986) as the probability index of each location. From the relationship of Tx and mortality rate where the threshold value was set at 33 degrees C, the number of dying people was estimated under the three scenarios for present temperature and the increased temperature in the future by climate change. If the population of 65 years and over was stable when the CO2 concentration was twice, the prediction value of Tx was 75%, and temperature increase was uniform (2.87 degrees) in Kanto area, population at risk increases in general, but in the periphery of Kanto area it will decrease or remain stable. Its analysis was extended for representative areas of Japan.

3. Relationship between Ambient Temperature and Mortality Rate in Japan, and Preliminary Projection of the Effect of Global Warming on Human Mortality

Specific mortality rate at a temperature range in a prefecture was calculated for each year, and the temperature of least mortality rate (optimum temperature, OT) was set at 25.5, 30.5, and 35.5 degrees C. The mean of daily mean temperature between 1972 and 1990 was defined as climate index (AT). The relationship of temperature-mortality rate of the people over 65 years old showed V-shape in 94 cases (male and female) from 47 prefectures. The V-shape was mainly formed by the older group. In terms of the cause of death, circulatory diseases and respiratory diseases contributed the V-shape formation, whereas neoplasms did not (Table 1). Deaths due to "excessive heat" contributed less than 1% of total deaths in 33+ degrees C category. Temperature-mortality relationship was modified by influenza epidemic (Figure 4). The all-cause mortality difference is much larger than the difference of influenza mortality. The optimum temperature was higher when the climate was warmer and there is little difference in the all-cause mortality rate for 65+ years age group at the optimum temperature. The optimum temperature of a colder prefecture was lower than that of a warmer prefecture. We introduced the adaptation model that describes the temperature-mortality modification by the climate (Figure 5). It was based on 19-year average mortality rates for each Tx category and less susceptible to the effect of influenza epidemic.

4. Effects of Daily Meteorologic Conditions on Car Accident Deaths - Comparison between Tokyo, Hokkaido, Osaka, and Fukuoka Prefectures -

The effect of maximum temperature (Tx), mean humidity, uncomfortable index (UI) on the car accident death was described during 1979-1990 in Tokyo Metropolitan area. Daily mortality rate was calculated for each zone of these parameters, and the relationship with Tx was compared between Northern areas (Tokyo and Hokkaido) and Southern areas of Japan (Osaka and and Fukuoka prefectures). As shown in Figure 6, the mortality rate in Tokyo was lowest at less than 8 degrees and highest at 33 degrees (1.5-2.5/10,000,000 person-day). Hokkaido showed a similar pattern, though it was relatively stable between 8 and 33 degrees in Osaka and Fukuoka with small variation (1.8-2.0). UI showed a linear relationship with the mortality rate (lowest at 60 UI and highest at 85 UI), but mean humidity had two peaks at 60% and 85%. The effect of Tx on car accident may be complicated by geographical and cultural characteristics but it looks more direct in Northern area of Japan.

5. Relationship between Daily Maximum Temperature and Mortality Rate of Huli People in Papua New Guinea

Huli People living in the Southwest Highland of Papua New Guinea, has the only data on population dynamics and meteorology, which enables to think about health effect of tropical climate without four seasons. Though crude death rate is high during dry season, we analyzed the difference of mean life expectancy at zero year and infant mortality rate between areas of different height , and also the relationship between daily mortality rate and meteorological conditions. During 1980-1993, reporters of Papua New Guinea Institute for Medical Research surveyed the population and its dynamics (birth, death, marriage, and migration) every four weeks. Meteorological data was measured every day by one person of the institute (The values of Central Basin located at 1000 m above sea level is the midpoint of Tari district distributed from 800m to 1700 m above sea level). Mean life expectance of zero year was shorter in lower area than higher area, though the difference became smaller yearly. The infant mortality rate was different by area, however, it was not related with rain fall, maximum and minimum ambient temperatures of the day (Fig. 7). It is because yearly difference of climate was small and there were few hot days.

6 Relationship between Personal Living Temperature and Ambient Temperature in Various Activites and Conditions

To predict health risk by global warming, behavioral change in personal ambient temperature (Tm, measured at tie-pin position) was analyzed for subjects with mostly indoor life (sleep, eat, transport, work, house work, amuse/rest, bathing) but with specific characteristics in living conditions. Clerks of either natives of subtropical Miyako Island (islanders) or visitors living less than 18 months, and elderly people living in temporary houses after Hanshin Earth Quake had clear behavioral adaptation by experience and by preference of air-conditioning (AC). The differences in Tm and dT (To-Tm) were related with specific activities (Fig.8,9). Previous data were compared with those of Miyako Island to show the difference of Tm-activitiy (24-hr mean heart rate) relationship between groups rather than latitudes (Fig.10). Risk assessment of chronic and indirect health effects could be helped by these results in the modern indoor life with AC which is inevitably exaggerated by global warming.

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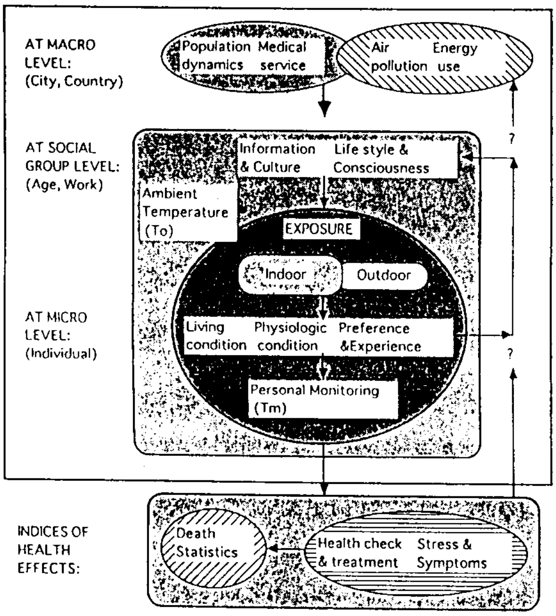

Fig. 1 Hypothetical Temperature Exposure and its Control System of the Living Environment and Indices of Health Effects in Relation to the Monitoring (To and Tm).

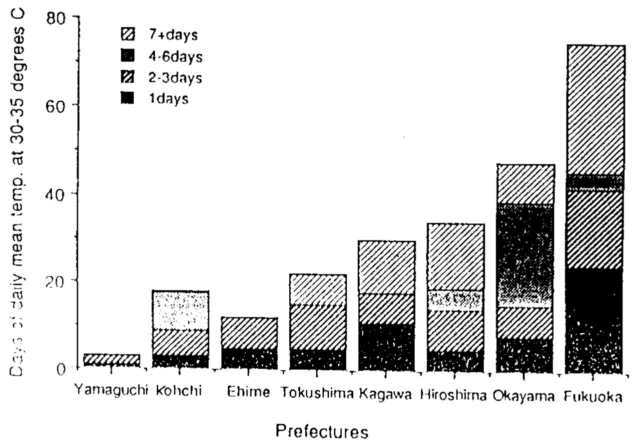

Fig. 2 Cummulated number of days (July and August, 1972-1990) with daily mean temperature at 30-35 degrees C prolonged various period (1 to 7+ days) in 8 prefectures sorted by total number of days of 30-35 degrees C.

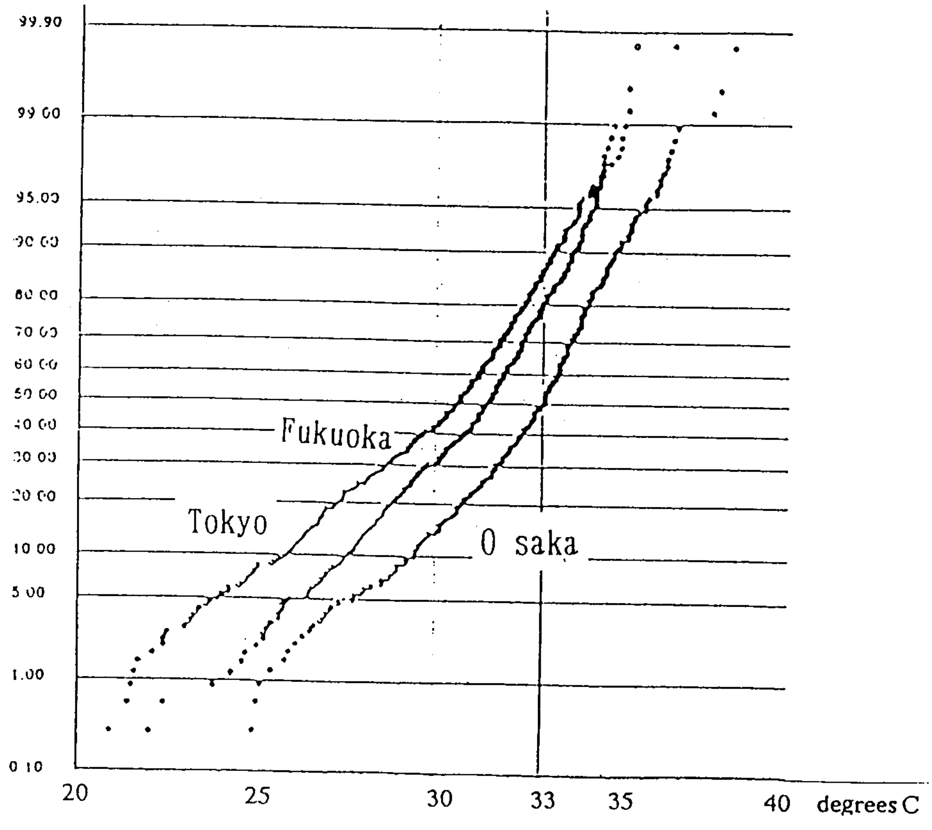

Figure 3 Probability distribution of 3 prefectures of daily maximum temperature (Tx) during August of 1976-1986. These lines will be shifted to the right when Tx is increased. The probabilities of Tx exceeding 33 degrees in Tokyo, Osaka, and Fukuoka are 0.14, 0.5, and 0.2 at present, and 0.60, 0.85, 0.80 at CO_2 doubling condition, respectively. Relative increase of the probability will be higher in Tokyo (+0.46) and Fukuoka (+0.6) than in Osaka (+0.35).

Table 1. Mantel-Haenszel rate ratio and its 95% confidence interval from selected disease categories by daily high temperature (Kyushu, males, 65+ years old, 1979- 1990) * Referent category

Daily high temperature	Neoplasms	Circulatory diseases	Respiratory diseases	External causos
< 8	1.00502 (0.97446-1.03653)	1.49793 (1.46505-1.53155)	1.47539 (1.41898-1.53403)	1.21012 (1.11221-1.31665)
8 <= < 13	0.99388 (0.97374-1.01444)	1.38670 (1.36501-1.40874)	1.38138 (1.34456-1.41921)	1.16069 (1.09537-1.22990)
13 <= < 18	0.98470 (0.96583-1.00395)	1.29036 (1.27081-1.31020)	1.27329 (1.24041-1.30704)	1.09427 (1.03497-1.15696)
18 <= < 23	0.98679 (0.96787-1.00609)	1.13932 (1.12146-1.15747)	1.14215 (1.11188-1.17325)	1.08209 (1.02322-1.14436)
23 <= < 28*	1.00000	1.00000	1.00000	1.00000
28 <= < 33	0.98489 (0.96629-1.00386)	0.92108 (0.90609-0.93631)	0.91558 (0.89017-0.94172)	0.97934 (0.92555-1.03626)
33 <=	1.00640 (0.97727-1.03640)	0.94053 (0.91657-0.96512)	0.96709 (0.92679-1.00914)	1.01479 (0.93042-1.10681)

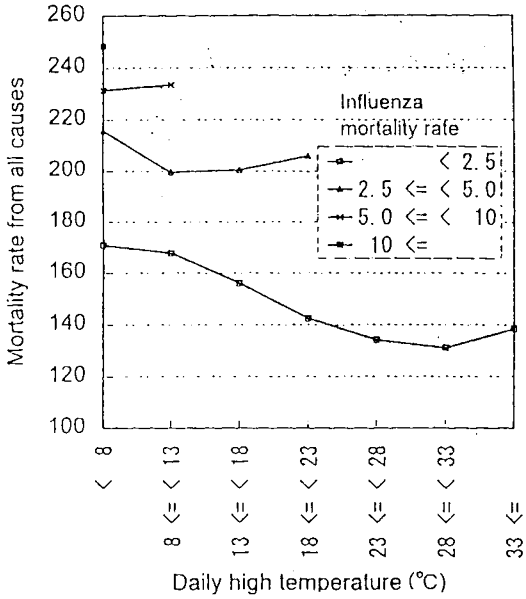

Fig. 4 Relationship between daily high temperature and the mortality rate from all causes calculated under the different conditions of mortality by influenza in males of 65+ years old (Japan, 1972-1990).

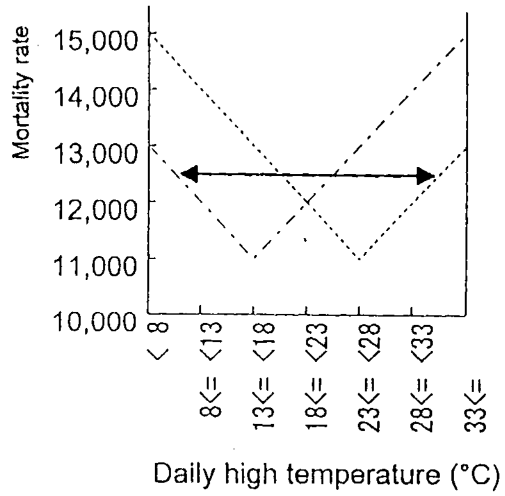

Fig. 5 A hypothetical model of adaptation (dashed line) of mortality rate against the increase in daily high temperature

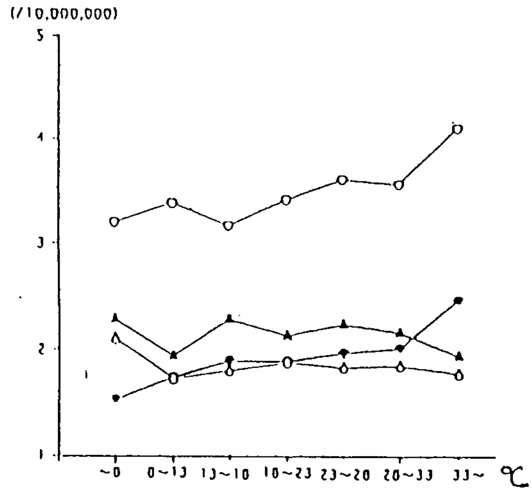

Fig.6 Comparison of Hokkaido (white circle), Tokyo (black circle), Osaka (white triad), and Fukuoka prefectures (black triad) of mortaloty rate during 1980-1990.

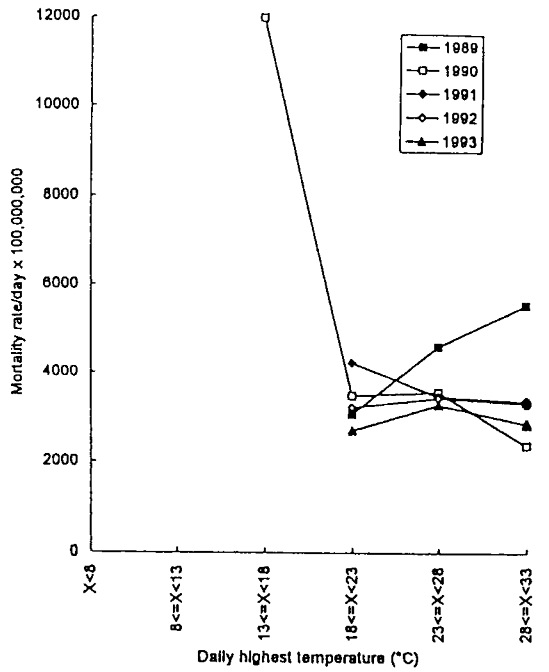

Figure 7 Mortality rate from all causes of the Hull according to daily highest temperature.

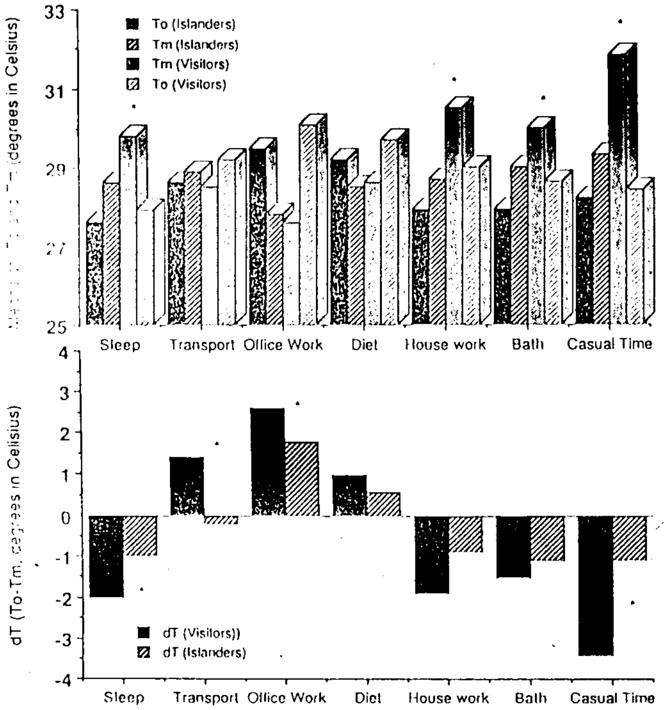

Fig. 8 Means of To, Tm, and dT (To-Tm) of Miyako Islanders and visitors from Okinawa Island during various activities in August 1-13, 1994. *Significant difference of Tm and dT between both groups.

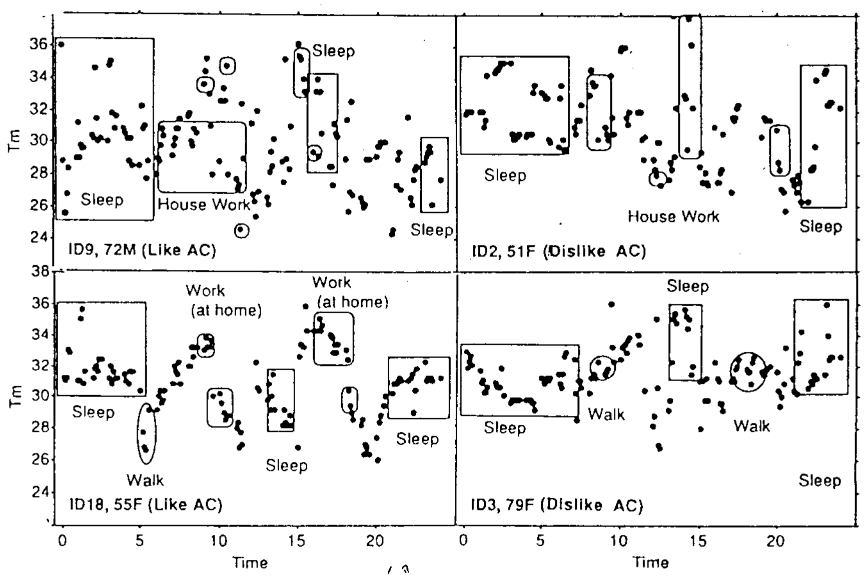

Fig. 9 24-hr distribution of Tm (deg C) in 4 aged people living in temporary houses after Hanshin Earth Quake like during August 15-22, 1995.
Tm in various activites was compared between those who like (left) and dislike (right) air-conditining (AC) but used it most of the day.

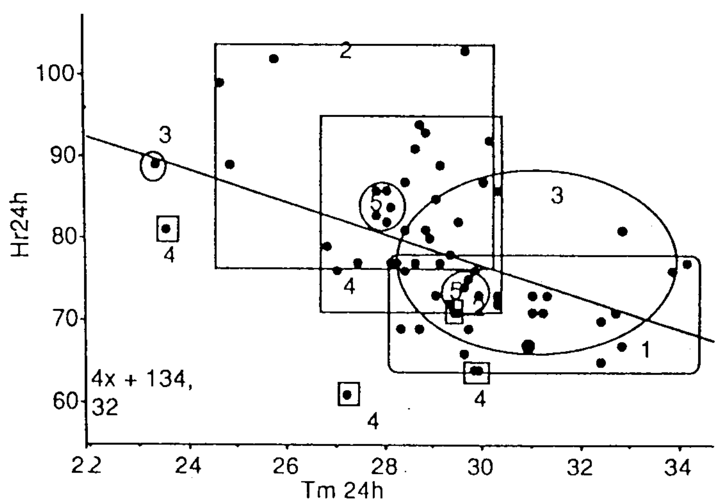

Fig. 10 Relationship between heart rate and Tm as 24 hour means in 5 groups.
1: Exercising people near Tokyo (36 N)
2: Ofice workers in Tokyo (36 N)
3: Taxi drivers in Okinawa Island (26 N)
4: Miyako Islanders (23 N)
5: Visitors from Okinawa Is to Miyako Is.