B-10 Studies on the Vulnerability of Community by Global Warming and Environmental Change to Proceed the Adaptive Risk Reduction

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1. Introduction

To assess the process of global warming on human health, it is necessary to combine epidemiological evidences and model experiments in order to predict the future risks. The scenario of global warming is based on Intergovernmental Panel for Climate Change (2001) third assessment reports (TAR) on climate change. The prediction on mortality rate at community level and vector-borne diseases caused by climate change has been reported in TAR.

It is assessed that temperature rise and change in humidity by global warming will directly affected on heat stress and indirectly influence on various habitats of vectors and pathogens. The study of heatstroke and excess death in elderlies caused by heat stress has assessed that the summer heat will more frequently attack to communities after global warming. It has been reported that during summer heat when temperature rises above the threshold value, mortality and morbidity of the residents in the communities remarkably increased.

A variety of diseases are influenced by weather condition or display strong seasonality, suggestive of a possible climatic contribution. Recently, temperature in Japan is gradually rising, by which prevalence of temperature dependent infectious diseases may be influenced.

For vector-borne infectious diseases, the distribution is influenced by the spread of vectors and the climate dependence of the infectious pathogens. In addition to the climate factors, the eradication areas and the epidemic areas of infectious diseases in the world are determined with environmental hygiene for vector control and well-equipped medical treatment facilities. Increasing environmental temperatures could expand the regions in which the incidence of vector-borne diseases is markedly high. The spread of vector-borne diseases into more northern latitudes would be an indirect impact on human health of climate change.

For assessment research on the health effects of global warming, it is necessary to accumulate the research evidences because health status in communities is important to evaluate the threshold temperature, spread vector-borne diseases and susceptibility for residents.

2. Research Objective

According to TAR of IPCC(2001), it is predicted that global surface temperature will rise between 1.4◦C to 5.8◦C by the year 2100, and higher scenario of warming is taken into account in Asian continental areas. Therefore, the greater frequency and duration of heat

stress in future will increase the incidence of heat related morbidity and mortality as functions of summer heat in Japan and Asian communities. Infrastructure of the communities mainly contribute to environmental temperature, international comparative study was implemented on the relationship between temperature and incidence of diseases. Furthermore, the chronic health damages on physiological functions, biochemical processes and immune systems are caused by heat stress.

Increasing environmental temperatures could expand the regions in which the incidence of infectious diseases and vector-borne diseases is markedly high. Some infectious diseases such as hand-foot-mouth disease / herpangina / aseptic meningitis have seasonality and could be influenced by future weather conditions in Japan. Therefore, the assessment research on the mortality and morbidity of the residents in various communities and the change of infectious diseases including vector-borne diseases has been carried out in Asian regional communities.

3. Research Method

The epidemiological research works were carried out in Japan and China to evaluate the direct health risk of heat stress in hot and humid summer in Asia-monsoon areas. The monthly mean temperature of the hottest month is 27.1 °C in August in Tokyo and 28.6 °C in July in Wuhan, respectively. Monthly average relative humidity of these months is 73 % in Tokyo and 79 % in Wuhan, respectively.

The patients of this study were analyzed using the database of emergency transportation record in Japan including Tokyo, Yamanashi, Kobe, Fukuoka, Okinawa and Wuhan, China. In the communities, heat stress in summer is different year by year. Therefore, epidemiological work on heatstroke has been carried out in summer season.

Furthermore to analyze the relationship between mortality and temperature, daily mortality data and daily temperature records have been collected. Mortality data in Japan has been caluculated according to gender and age. The relation between the number of death and the daily maximum temperature has also been evaluated using some researchs in the world.

Surveillance data in Japan from 1987 to 1997 were obtained from Infectious Disease Surveillance Center at National Institute of Infectious Diseases and the data of weather conditions were obtained from the Meteorological Agency. Since coverage and referral systems of surveillance were different in each prefecture, surveillance data from each prefecture cannot be compared and combined directly. Therefore, the ratios of case number relative to average of the period during 11 years in the prefecture were calculated, which enable to compare with local climate data and combined surveillance data in Japan.

To clarify the principal factors for transmission of infectious diseases and vector-borne diseases, the evaluation of epidemiological researchs on infectious diseases and vector-borne diseases in Japan and China has been carried out. In the researchs, medical and immunological examination on residents, weekly survey on infectious diseases, monthly mosquito survey and collection of meteorological data have been investigated. The assessment for the future spread of the important vector-borne diseases, the relationship between malaria epidemics and activities of mosqitos of genus Anopheles have been evaluated using several studies.

Furthermore, sympathetic nervous function to control body temperature against heat stress was compared in work, transit, and at home, by occupation in the hot season in Japan and Bangkok, Thailand. Environmental temperature in the car and health status of drivers were also measured in highways in Japan.

4. Result

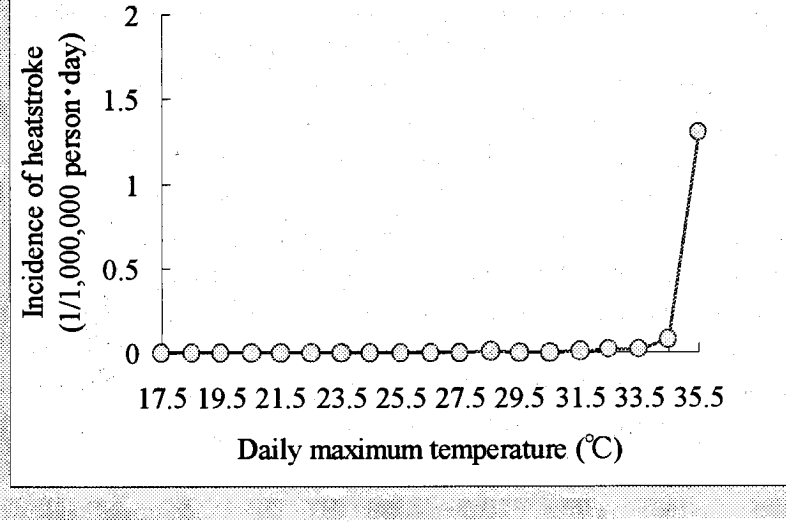
When environmental temperature rises, human body regulates core temperature through the metabolic activities, circulation systems and perspiration. Clinical syndromes such as heat cramps, heat exhaustion and heatstroke occur when thermoregulatory systems failure and body temperature increase (hyperthermia) after severe heat stress. In Japan, it has been considered that a conspicuous weather phenomenon, such as heatwave could not occur, because of the marine climate. Recently intense heat in summer is becoming more common in the center of large cities due to remarkable heat island phenomenon. When the intense heat in summer was observed, epidemiological investigation has been implemented on the relationship between summer heat and the occurrence of heatstroke in Japan and China.

In southern part of China, people suffered intense stress from summer heat. To detect the influence of heat stress on urban areas, cooperation study has carried out with Chinese scientists and the records of heatstroke patients have been collected on emergency hospitals in Nanjing and Wuhan, China. The epidemiological analysis has been implemented on the relationship between the summer temperature and the incidence of heatstroke patients.

The analytical results on relationship between summer temperature and the incidence of heatstroke patients in China and Japan proved that there has been a definite difference in the threshold temperature. As shown in Fig. 1, the incidence of heatstroke patients increased exponentially with temperatures of more than 30◦C in Japan including Tokyo, Yamanashi, Kobe, Fukuoka, Okinawa and 32◦C in Wuhan, China.

In Tokyo, it was proved that the increase in the incidence of heatstroke patients was exponential when the maximum daily temperature reached 35◦C. The maximum daily temperature in Wuhan also affected on the incidence of heatstroke patients exponentially when the maximum daily temperature reached 37◦C, however the threshold temperature causing heatstroke is about 2◦C higher than in Tokyo, Japan.

Fig.1 Heatstroke and daily maximum temperature in Tokyo



The results coincide with the epidemiological analysis of heatwave case in Nanjing in 1988. In heatwave case, when the intense heat exceeded maximum daily temperature at 36◦C, remarkable increase in the incidence of heatstroke patients and deaths caused by heatstroke was observed.

From the point of view of adaptation, a significant difference was observed in the threshold temperature of heatstroke between Tokyo, Japan and Nanjing/Wuhan, China. However, the relationship between the summer temperature and the incidence of heatstroke patients in these cities which are situated in the temperate latitude were completely similar. Therefore, medical records of heatstroke patient in emergency hospitals becomes an effective health index for illnesses caused by heat stress rather than mortality data in urban areas. For future global warming, the prevention of heat-related diseases caused by summer temperature increases, it will be necessary to analyze in detail on the technological application and social intelligence in the communities and biological adaptation in residents.

According to the mortality data of health statistics, the number of death of aged person in each prefecture also correlated to the maximum temperature of each local area. The mortality increased on the days when the local maximum temperature rose above certain threshold temperature, 33°C.

Relative ratios of herpangina increased steeply at 17C° of regional average temperature, peaked at 25 C°. In contrast, that of hand-foot-mouth disease showed linear increase dependency on regional average temperature, peaked at 22 C°. Aseptic meningitis also showed temperature dependency, which was similar pattern to that of hand-foot-mouth disease. After all, all of hand-foot-mouth disease / herpangina / aseptic meningitis showed seasonality. Cycle of herpangina was regular, while cycle of hand-foot-mouth disease was irregular, and correlation co-efficiency of relative ratios between herpangina and hand-foot-mouth disease was 0.44. In 1989 and 1991, outbreaks of aseptic meningitis were observed in some of prefectures. In addition to temperature, relative ratios of both hand-foot-mouth disease and herpangina increased in higher humidity, and decreased in higher total sunshine time and higher total precipitation. Similarly, relative ratios of aseptic meningitis were influenced by relative humidity and precipitation. Moreover, the more mean mass of cloud enhanced outbreaks of aseptic meningitis.

To predict the actual risk of vector-borne diseases, such as malaria and dengue fever, due to global warming and clarify the preventive measures by the following studies. Ecological study on malaria and dengue fever in southern China, Yunnan Province, Guandong Province, Guanxhi Autonomous Region and Hainan Province, were carried out to evaluate the validity of the model. Sero-epidemiological study has been carrying out in three pilot areas (high-, mid- and non- endemic area) in Yunnan Province. A clear seasonal fluctuation and a trend of slight increase in recent years only in winter season were observed. Laboratory experiments on growth rate and survival rate of *aedine and anopheline mosquito* were examined under several different temperature (22-36°C) conditions. Temperature dependency of growth rate and survival rate in both species were observed. The re-construction of a mathematical model of malaria and/or dengue fever transmission under global warming and the present status and the control of vector in Japan were discussed.

Health risk was assessed as the social vulnerability against heat, adaptive difference by region and culture, and possibility of mitigation. Heat adaptation and air-conditioning of Thai People and Japanese Young workers staying in air-conditioned office had 1.8°C lower environment than non-office workers. Their sympathetic nerve function did not increase until 33°C and heat adaptation should be low. Elderlies showed decreased sympathetic functions at 33°C and over, but responded better to the experimental heat (35°C, one hour) than Japanese elderlies. Thai elderlies also showed decreased vasodilatative perspiration compared with the youngs, and the rectal temperature easily increased by heat retention (though it was less than in Japanese elderlies).

5. Discussion

The temperature rise and changes in precipitation due to global warming will have adverse effects on human health in regional communities in Asia. Since there could be greater frequency and duration of heat stress, typical hyperthermia occurs during severe thermal stress in hot summer in Okinawa, Fukuoka, Kobe, Yamanashi, Tokyo, Japan and Wuhan, China. The incidence of heat related disease increased according to hot temperature in summer. Regression models were used to examine morbidity as functions of maximum daily temperature. The incidence of heat related morbidity increases according to the hot summer temperature in Japan and Wuhan, China. Heat stress developed degeneration in various tissues therefore, global warming may have profound impacts on antibacterial systems in lung during heat stress in hot summer.

For human health, the change of seasonal weather pattern caused by global warming is more important than mean temperature increase. Human health is more affected by extreme weather phenomena such as high temperature, high humidity and non breath of air in summer than average temperature. When temperature increase is added to high summer temperature, heat load and heat stress become serious on human body. Because of low tolerance to heat stress, it is important to evaluate the impacts of high temperature above 30°C on the health status of elderlies. Some infectious diseases such as hand-foot-mouth disease / herpangina / aseptic meningitis should be influenced by the hygienic circumstance of environment and the climate dependence of the infectious pathogens. Risk assessment of infectious diseases is carried out using the record of surveillance system in Japan to evaluate the instability in future community environment.

Currently the highest incidences of infectious diseases including vector-borne diseases are confirmed to tropical regions of the world. Increased temperature and precipitation change could increase the range of infectious diseases including vector-borne diseases such as malaria and dengue, particularly in regions where minimum temperatures may currently limit pathogen (plasmodium) and/or vector (anopheline mosquitoes) development.

Since global warming may increase temperature and change the patterns of rainfall, the prevalence of vector species of malaria will change. According to the researchs on field studies of vector-borne diseases in southern parts of China, it has been confirmed that global warming may have principal impacts on the epidemics of malaria and other vector-borne diseases. The malaria vectors, mosquitos of genus Anopheles may shorten their life cycles and increase the biting activities with adequate conditions of temperature, humidity and rainfalls.

Epidemiological study including sero- epidemiological study on malaria and dengue fever in southern China showed a clear seasonal fluctuation and a trend of slight increase in recent years only in winter season. Laboratory experiments on growth rate and survival rate of *aedine and anopheline mosquito* confirmed temperature dependency of growth rate and survival rate in both species. The re-construction of a mathematical model of malaria and/or dengue fever transmission under global warming were considered.

For the heat adaptation and limitation, evaluation studies were carried out under various options. Heat-induced death of children left in the car depended on ambient temperature (>25°C) and solar radiation (>1.5 MJ/m2). Hourly rate of car accidents during non-rain daytime in Niigata City (1992-1996) increased during the time over 28 □ but not with solar radiation. Heat reduction in the sedan by the adiabatic film (heat reflexive or absorptive) put rear three windows was about 2°C (black bulb). During daytime highway run in Joban-highwar (mid-July, 2000) with air-conditioning (25°C), the filmed car showed one degree lower temperature than non-filmed car. Mean skin temperature of 30 years old males

was not related with the temperature in the cars. The temperature was highest in right arm and left thigh irrespective of the direction and the time of run. Complaints (hot or uncomfortable) were more in non-filmed car than in filmed car. Mean rate of EEG alpha-wave showed significant difference in day 2 and day 5. Secretory IgA in saliva increased in the afternoon sessions of day 1 to day 4, and more weakly in the morning sessions.

Global warming reduce the environmental resistence (capacity of local adaptation depending on culture, rule, technology, economy, and psychology). Health risk can be calculated as time-space integrated products of three conditions (heat exposure, environmental conditions, and diverse responses) and social dimensions (population, disease prevalence, and sensitivity). In the communities in Japan, quadratic curve were fit in each prefecture to the relationship between daily maximum temeprature and mortality rate. Elderlies may show slow and delayed responses to personal environmental temperature, based on cultural and behavioral adaptation mechanisms supplied in retired lifestyle and urbal environment in Tokyo and Bangkok.

From the point of view of adaptation, a significant difference was observed in the threshold temperature of heatstroke between the residents in Japan and those in southern parts of China. Still the relationship between the summer temperature and the incidence of heatstroke in these areas located in temperate latitude is completely similar. For prevention of heat-related diseases and infectious diseases caused by global warming, it will be necessary to analyze in detail on the hygienic application and social intelligence in the communities and biological adaptation in residents. Summer heat caused by global warming will bring remarkable increase of heat stress, therefore the mitigation option to improve urban circumstances, such as alteration of street surface color and extending green belt zones for urban cooling. Furthermore, education and mass media have important contribution to prepare knowledge about preventive activities under increasing hot temperature in the future and establish the risk reduction procedure.