

A-4.4.1 Epidemiological study on the occurrence of cataract due to ultra-violet radiation (Final Report)

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Abstract

To elucidate the association between exposure to ultra-violet radiation (UV) and occurrence of cataract, we carried out long term measurements of residential UV exposure and population-based epidemiological studies on cataract.

(1) Longitudinal UV exposure measurement was carried out through out a year at 4 places in Japan, Sapporo, Tsukuba, Noto and Naha. Residential UV exposure nearly corresponded to UV irradiance level at ground in each area. And we tried to estimate residential UV exposure based on ground level UV irradiance and time spent outdoors of subject.

We established a new system for UV exposure assessment at lenses (target organ in cataract) by using mannequin head model.

(2) Population-based epidemiological studies on cataract were carried out at Hokkaido, Noto and Okinawa. We found some relationships between UV exposure and cataract prevalence. The higher percentage of nuclear cataract was seen in subjects at Okinawa (southern island in Japan).

A case-control study on glass wearing and its preventive effect on cataract formation was carried out in one survey area (Noto). Wearing glasses outdoors in any life stage showed no preventive efficacy on cortical cataract.

Key Words cataract, epidemiology, exposure to ultra-violet, life style

1. Introduction

To discuss the relationship between UV exposure and cataract formation epidemiologically, it is very important and essential to evaluate residential UV exposure in their life history. Japan Meteorological Agency has been monitoring UV-B irradiance at ground level at 4 monitoring stations from 1990 and the geographical distribution of UV irradiance was determined. But for residential UV exposure, there was very few research evidence.

On the other hand, cataract is becoming more important issue in ophthalmic health care because of increase of aged people in developed countries and because of decrease of infectious diseases, which had been major causes of blindness, in developing countries. It is recognized that many factors affect on cataract occurrence. But in recent years, UV-B related cataract is becoming an exciting research theme in the world.

2. Research Objective

In this study we aimed to discuss the relationship between UV exposure and cataract occurrence epidemiologically. For that purpose we carried out some epidemiological studies.

To assess personal UV exposure, it is necessary to obtain basic information on residential UV exposure in their life, so we carried out some field surveys on UV exposure. Recently it is recognized that UV irradiance level at ground is not sufficient as the indicator of UV exposure at lens. So we developed a new system to evaluate UV exposure level at lens.

In order to investigate UV-B related cataract formation from the standpoint of epidemiology, population-based surveys are being performed in three climatically different places in Japan. Among many aspects of this topic, cataract prevalence study was performed.

Although wearing glasses is recommended as a preventive measure against cataract formation, there has not yet been any report on its efficiency. This study aimed to clarify the efficacy of wearing glasses against cortical cataract development through a case-control study.

3. Research Method

1) UV exposure measurement

To assess personal UV exposure level, we carried out some field survey and experiment. To measure UV exposure, we used watch-like simple device with 260~400 nm sensitivity. Field survey were conducted in 4 places (Sapporo, Tsukuba, Noto and Naha) throughout a year, and in each area 20 outdoor workers (caddies in golf links) were selected as participants. Daily amount of UV exposure were measured and time spent outdoors were recorded.

We established a new system to assess UV exposure level at different points on face. In the system, we used mannequin head and measured UV exposure directly by small UV sensors attached at different points on the model. Data was automatically collected by personal computer.

Daily UV exposure of subjects were estimated by formula (1). Hourly UV-B intensity (UV_i) at monitoring station and individual outdoor activity ($Tout_i$) were used for estimation.

$$UV_{est} = \sum_{i=5}^{19} (UV_i \times Tout_i) \quad (1)$$

2) Population-based epidemiological study on cataract

Two villages in Okinawa, a subtropical island, and a village in Hokkaido, the northern island of Japan, and a town in the middle part of the main land were selected as survey area. The number of subjects was 1,615 over age 40. Before the examination, an interview of about 30 items was given. Ophthalmic examination included documentation of lens findings by an anterior eye segment analysis system on all of the subjects. Grading of cataract progression was evaluated objectively through documented images.

Among the survey participants, 299 cases of pure cortical cataract (grading I ~ III) and 249 controls with clear or initial senile lens change were included in case-control study. Interview and ophthalmological examination were performed. Unconditional logistic regression analysis was applied in order to calculate the relative risk of non-wearing glasses.

4. Results

1) General situation of UV irradiance in Japan

Japan Meteorological Agency (JMA) has been monitoring UV-B irradiance at ground level with Brewer spectrophotometer at four monitoring stations from 1st January 1990. UV-B irradiance level show clear geographical gradient, and it well corresponds to latitude. Annual mean level of UV-B irradiance at Naha is nearly two times stronger than that at Sapporo.

UV-B irradiance at ground level shows seasonal fluctuation, strong in summer and weak in winter, and diurnal fluctuation, the peak of hourly intensity of UV-B irradiance are observed at near noon. From these results we can easily guess that the amount of residential UV exposure reaches nearly 70% within summer season (April to September) and 80 to 90 % in mid daytime (10 to 14 o'clock).

2) UV exposure measurement

Figure 1 shows 1 week moving average of mean daily UV exposure and Figure 2 shows cumulative dose of mean UV exposure. From these figures we can that residential UV exposure show seasonal trend, daily fluctuation and geographical gradient just same as that of JMA's monitoring data. Not shown in these figures, the variation of UV exposure among subjects in same place is very large.

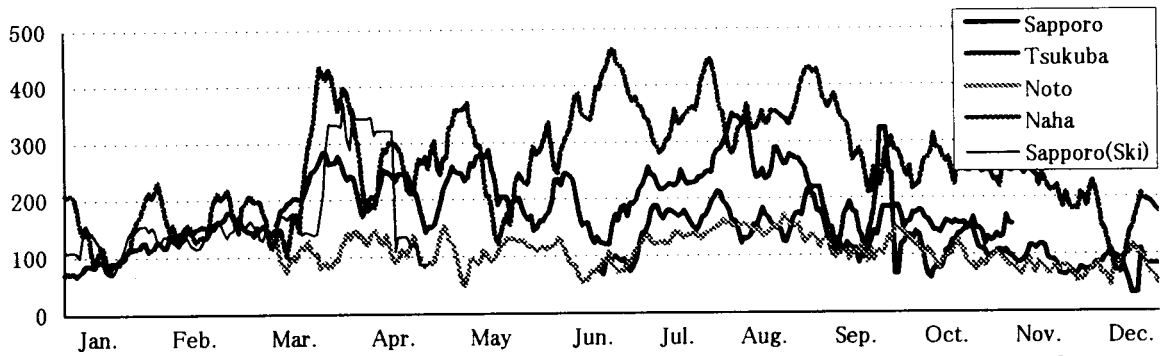


Fig.1 Seasonal fluctuation of UV exposure (1 week moving average, KJ/m^2)

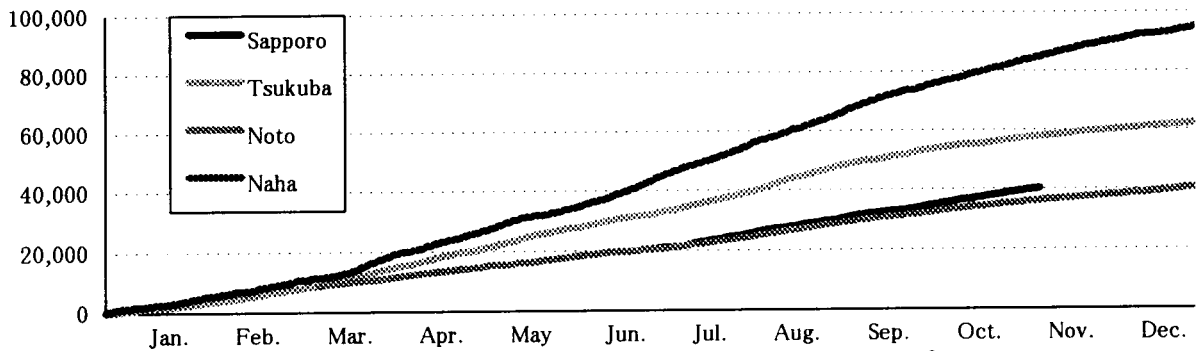


Fig.2 Cumulative Dose of UV exposure (KJ/m^2)

Figure 3 shows a relationship between observed and estimated personal UV exposure level in Tsukuba. Observed and estimated personal UV exposure level well correlate each other.

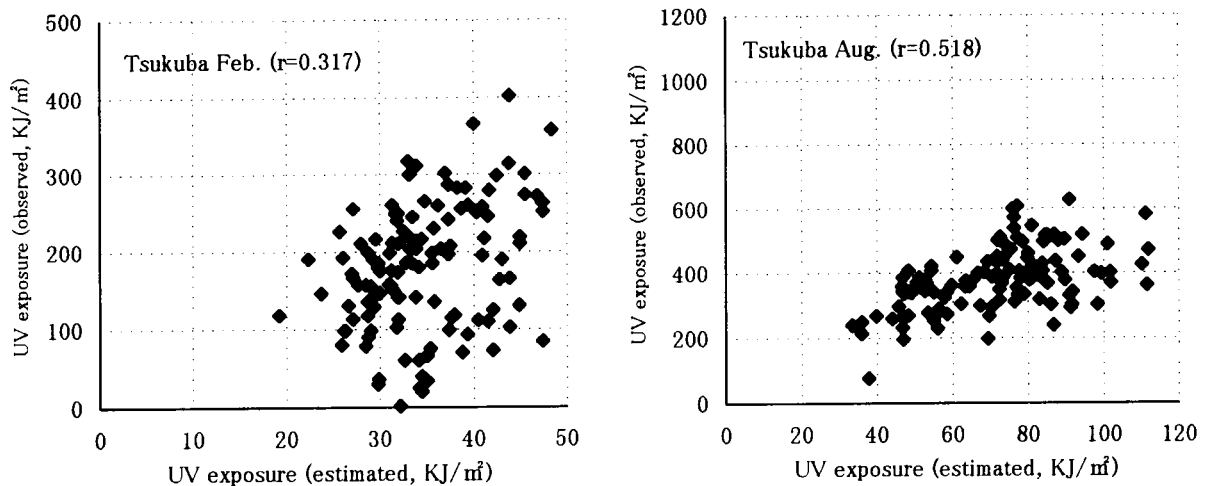


Fig.3 Relationship between observed and estimated UV exposure

From the experiment by mannequin head, UV exposure level at different points show nearly same tendency. UV exposure level is highest at the top of head and forehead, and they are nearly same as the UV level at ground. UV exposure level at eye (in front of cornea) with glasses is 70 to 80% of that at forehead.

3) Population-based epidemiological study on cataract

Investigation has been made on the lens opacification prevalence, lens transparency changes with aging, localization of cortical opacities and others. And we discussed correlation between cortical cataract and time spent outdoors, the influences of wearing glasses on cataract formation. The average percentage of lens opacification in all subjects was 53.8% and it increased with aging in all three survey places. Small but significant differences were detected in the examined items between three places.

No correlation was found between wearing glasses outdoors and preventive efficacy on cortical cataract (**Table 1**). The relative risk of longer time (more than 5 hours) spent outdoors during the 40~50s and at the subjects' present ages with reference to shorter time (less than 4 hours) was 3.88 (1.11~13.53) and 2.20 (1.03~4.71) respectively in males.

Table 2 Relative risk of non-wearing glasses

		Relative Risk (95% confidential interval)	
		Male	Female
20~30s	wearing	1.0	1.0
	non-wearing	0.86 (0.17 - 4.39)	0.74 (0.12 - 4.38)
40~50s	wearing	1.0	1.0
	non-wearing	1.09 (0.19 - 6.07)	1.07 (0.29 - 3.88)
at present age	wearing	1.0	1.0
	non-wearing	1.11 (0.37 - 3.37)	0.76 (0.36 - 1.59)

5. Discussion

1) Assessment of UV exposure

Residential UV exposure of our field examination show seasonal fluctuation (strong in summer and weak in winter), daily fluctuation mainly depending on meteorological condition and geographical gradient according to latitude. These phenomenon are just same as those of monitoring data. There are many factors which affect residential UV exposure, but our results show that personal UV exposure well corresponds to UV irradiance level at ground.

In this study, we selected caddies in golf links as study subjects, and their behavior seems to be not so different each other. But personal UV exposure showed great variation within subjects in same golf links even after adjusting the time spent outdoors. This means that personal UV exposure may be strongly influenced by individual activity pattern.

As for the association between observed and estimated UV exposure, we can find good correlation. In the estimation of personal UV exposure, hour and time spent outdoors were considered as explanatory variables. The location factors such as latitude and zenith angle of the sun were not in consideration. Only from **Figure 3**, we can not guess the influence of these factors on residential UV exposure.

2) Epidemiological findings in cataract survey

In our population-based epidemiological studies, only few results indicate an influence of UV exposure on cataract formation. The data shown is rather sophisticated and reliable but not so many cases. Future research applying our approach will be comparable with our data.

As for the efficacy of glasses, it could not be concluded epidemiologically in this study.