A-4(2) Assessment of exposure to ultraviolet radiation within a lifetime

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Abstract The purpose of our study is to estimate the level of ocular exposure to UVR within a lifetime and to clarify the relationship between UVR exposure level and occurrence of cataract, based on population-based field surveys. We conducted following studies:
(1) We developed a new mannequin head model for UVR dosimetry. It is controlled by personal computer and is able to simulate the movement of human head which is obtained and installed into computer previously. We utilize this system for UVR exposure experiments.
As the results we clarified that glasses use may reduce the exposure level of UVR against the eye to 17% of that without glasses. And we estimated the reduction rate of hat use about 40%.
(2) We discussed the effectiveness of short questionnaire to estimate UVR exposure within the time spent outdoors and we found that the length of the time spent outdoors within 9:00 to 15:00 will give the best estimate of the whole day UVR exposure.
(3) We tried to estimate the ocular UV exposure of participants who attended the epidemiological study using short questionnaire. And we found weak correlation between the prevalence rate of cataract formation and the estimated ocular UV exposure.

Key Words mannequin model, exposure assessment, ultraviolet radiation (UVR), outdoor activity, life style

1. Introduction

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 formation. But in recent years, UV-B related cataract is becoming an exciting research theme in the world.

To discuss the relationship between UV exposure and its health effects such ascataract formation epidemiologically, it is very important and essential to evaluate residential UV exposure in their life history. But for residential UV exposure, there was very few research evidence.

To estimate the life-time UV exposure following steps are necessary and important. They are to evaluate the life-history in particular residencial history, outdoor activity and the effect of some protect measures such as hat and glasses.

2. Objective

UV exposure of the subjects is mainly determined by the location (latitude), the time spent

outdoor at each time and place and use of protect measure. To estimate UV exposure of the subjects exactly, we aimed to establish the model to estimate life-time UV exposure using simplified questionnaire and to evaluate the protect measure in particular against occular UV exposure

In this study, first we targeted how to estimate outdoor activity of the subjects, such as the participants of epidemiologic study: Second, in order to evaluate the effect of protect measures, we conducted experimental studies using maannequine model in defferent condition and discussed the effectiveness of those protect meaure.

At the final step we tried to estimate the life-time UV exposure for the participants to our ophthalmic-epidemiologic study and discussed the relation between UV exposure and cataract formation.

3. Method

1) Experimental study to evaluate protect measure (Mannaequin model)

To evaluate the effect of protect measure against UV exposure to the eys we developped a mannaequin model. Using this model we conducted the experiment in different condition.

2) Modelling for UV exposure assessmemt

To establish the assessment of personal UV exposure level, we carried out some field survey and experiment. Within a successive 7 days (a week) in four seasons, daily outdoor activity pattern were collected from school-children in different places using diary-like record form.

3) Estimation of occular UV exposure of participants of epidemiologic survey

On the participants of epidemiologic survey in an area in Japan UV exposure were assessed using above model and discussed the relation between the occurrence of cataract and estimated ocular UV exposure.

4. Results and Discussion

1) Experimental study to evaluate protect measure (Mannaequin model)

Fig.1 shows the view of experiment for UV exposure. These two mannaequin are controled by personal computer and move synchroniously on the senario of an actual movement of human head.

Fig.1 A view of the experiment for UV exposure

We performed some experiments in different condition, with and without protect measures, and evaluated the effect of protect measure against UV exposure to the eye. The results of an experiment were shown in Fig.2 (1 - time series of UV intensity at the eye with and without glasses: the glasses used can reduce the UV intensity to less than 1%) and in Fig.2 (2 - with and without hat).

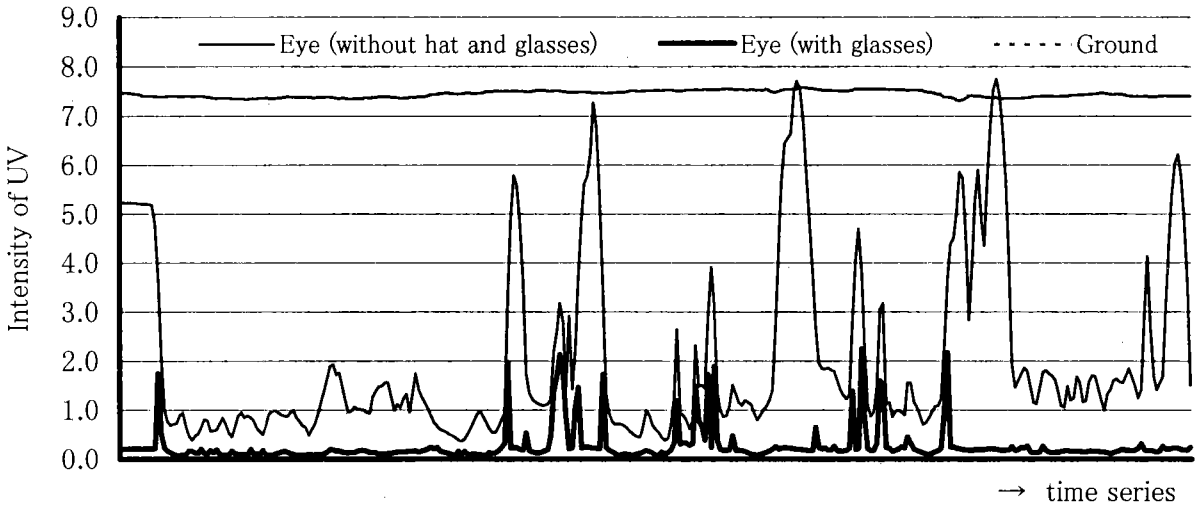

Fig.2 Time series of relative UV intensity at the eye (1)

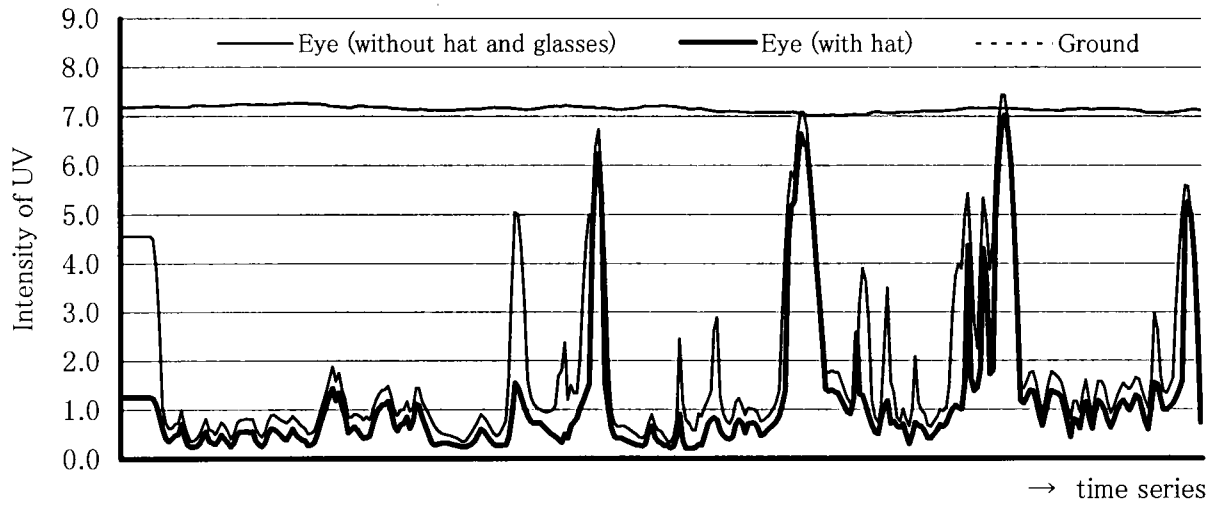

FIg.2 Time series of relative UV intensity at the eye (2)

Table 1 Protection effect of hat and glasses against UV exposure to the eye

	relative UV intensity	(protection rate)
without hat and glasses	100.0%	
with glasses	17.3%	(-82.7%)
with hat	61.2%	(-38.8%)
with hat and glasses	4.3%	(-95.7%)

Comparing to the ocular UV exposure level without glasses nor hat, ocular UV exposure level with glasses was 17.3% and it with hat was 61.2% in the 30 minutes average (Table 1). Thus glasses use and/or hat use has great effectiveness against ocular UV exposure in the outdoor activity (Fig.3). The effectiveness of glasses use and/or hat use against ocular UV exposure differed in season (zenith angle) and in experimental condition (reflection rate of surroundings).

Further, only hat use showed great effectiveness of reduction of UV exposure against the upper part of the face such as forehead.

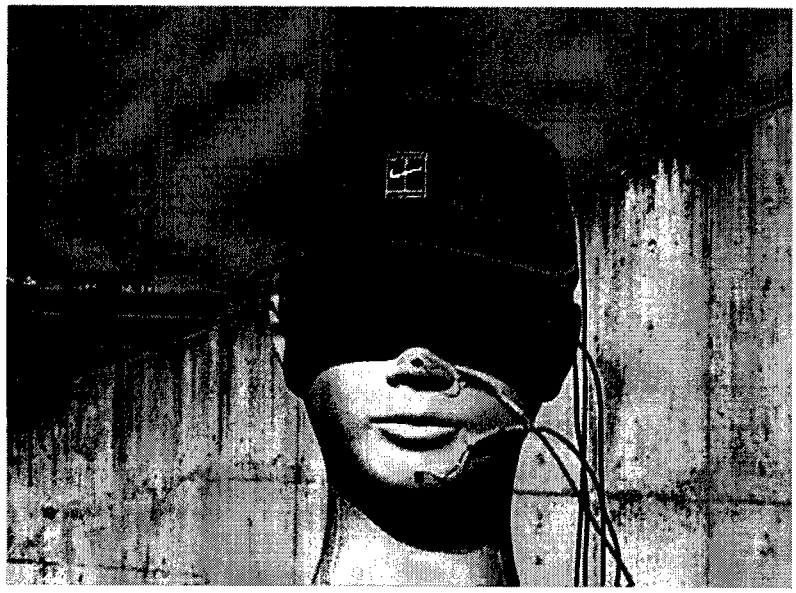

Fig.3. UV protection by hat and glasses

2) Modeling for UV exposure assessment

Within a successive 7 days (a week) in four seasons, daily outdoor activity pattern were collected every 15 minutes from school-children using diary-like record forms. Using those data we analized the effectiveness of short questionnaire to estimate UVR exposure on behalf of gathering information of actual outdoor activity pattern. As in Fig.4(1) the estimate by the duration of time spent outdoors in a whole day will give smaller estimate than that by actual outdoor activity pattern. And we found that the duration of time spent outdoors within 9:00 to 15:00 will give the best estimate (correlation and dose) of that by actual outdoor activity pattern (Fig.4(2)).

The estimate of daily UV exposure is calculated by formula (1).

$$UVest = (\sum_{t=9}^{15} Tout_t) \times UVave_{9-15} \quad --- \quad (1)$$

$UVest$: UV estimate

$UVave_{9-15}$: average UV intensity within 9 : 00 to 15 : 00

$Tout_t$: outdoor activity at the time (t)

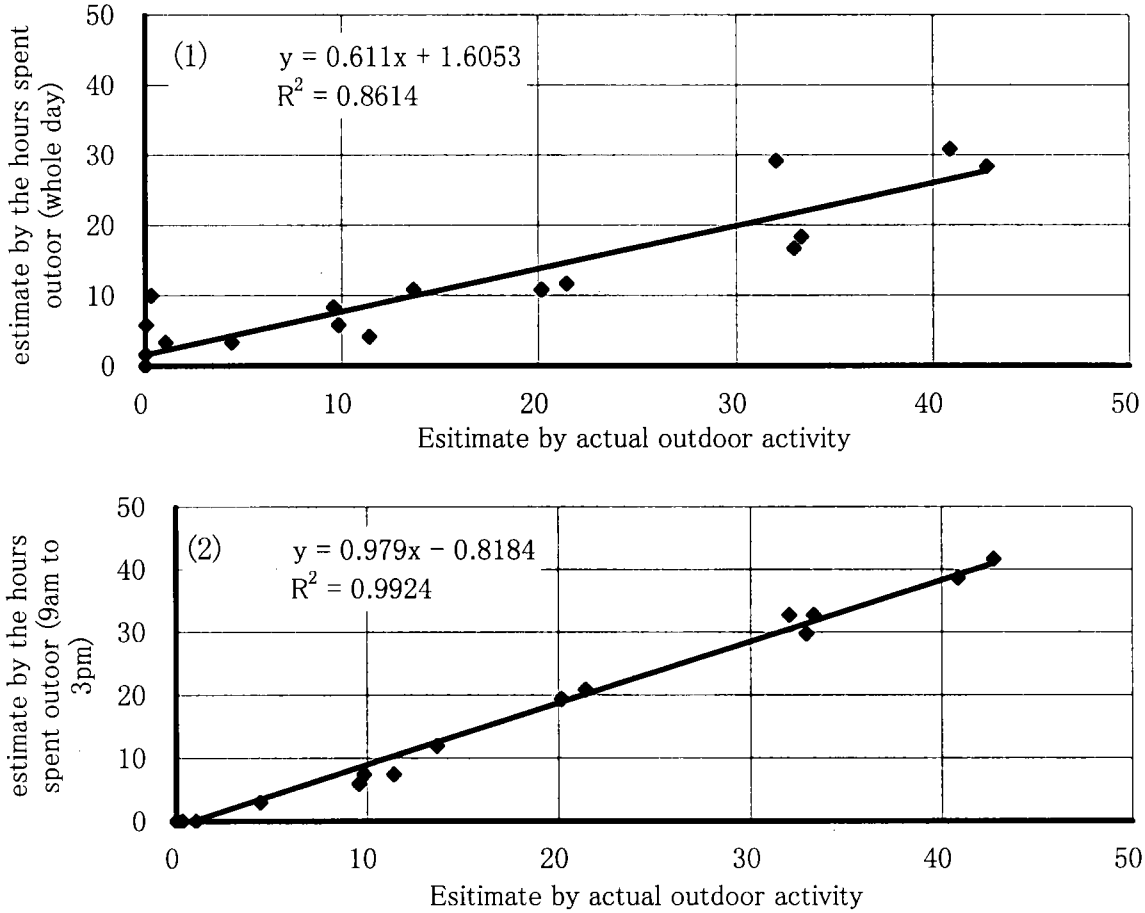

Fig.4 Comparison of the estimates of UV exposure by different two methods

3) Estimation of ocular UV exposure of participants of epidemiologic survey

On the participants of epidemiologic survey in an area (Kikai Island, Kagoshima) in southern Japan, UV exposure were assessed using above mentioned model and analized the relation between the occurrence of cataract and cumulative UV exposure level. As shown in Fig.5 estimated cumulative UV exposure were widely distributed.

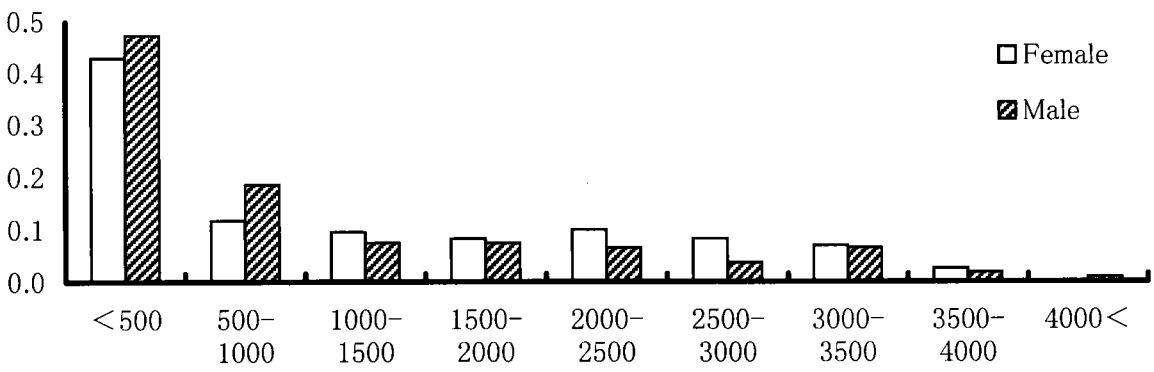

Fig.5 Distribution of cumulative UV exposure (Kikai Island)

Higher prevalence rate of cataract over grade III were observed in highly UV exposed group both in cortical cataract and in nuclear catatract in aged group, 70 years and over (Fig.6).

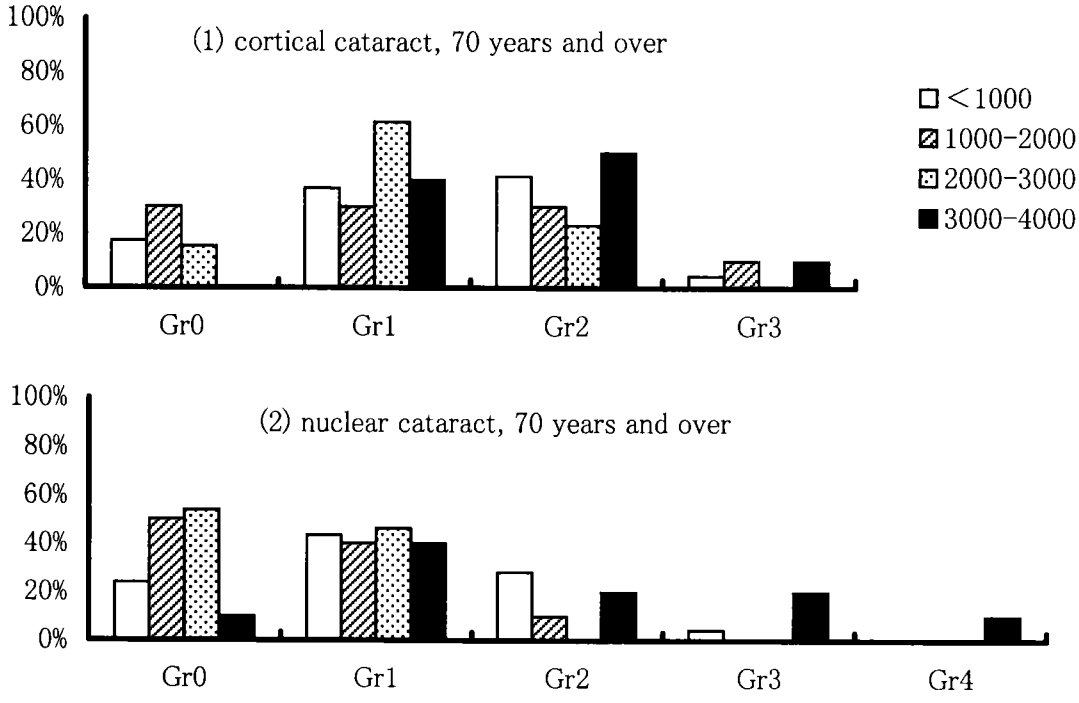

Fig.6 Prevalence rate of cataract