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*Conference Proceedings*

# Observation of Clothing Color and UV Transmission in Hot Environments : A Pilot Study on Playing Golf in Mid-Summer in Japan

Tetsuro Kita <sup>1</sup>, Takeru Suzuki <sup>1 2</sup>, Taishi Asai <sup>1 3</sup>, Yukio Hattori <sup>1 4</sup>, and Takeo Hashiguchi <sup>5</sup>

<sup>1</sup> Studies in Design and Configuration, Graduate School of Musashino Art University

<sup>2</sup> The Professional Golfers' Association of Japan

<sup>3</sup> Faculty of Human Sciences, Takachiho University

<sup>4</sup> Faculty of Life Network Science, Seisa University

<sup>5</sup> Faculty of Education & Human Sciences, Teikyo University of Science

## 1. Introduction

Stenner et al. (2023) report that people who play golf in Australia have a 2.42 times higher lifetime incidence of skin cancer compared to those who do not. They conclude that the lifetime incidence of skin cancer among those who play golf at least once a month is 2.4 times higher than the general population, and measures need to be taken to prevent prolonged UV exposure. Traditionally, Australians have had high rates of skin cancer, with more than 2,000 deaths from skin cancer each year, and it is said that more than two out of three Australians will be diagnosed with skin cancer in their lifetime. Therefore, there is widespread public awareness of the need to prevent health damage from UV radiation. The high incidence of skin cancer is attributed to Australia's location in the Southern Hemisphere, where the UV intensity is said to be comparable to that at the equator. According to data published by the Japan Meteorological Agency, the UV index values in Japan during the summer of 2023 has risen to levels comparable to those in Australia. The UV index is an indicator that shows the degree of impact ultraviolet rays have on the human body. The UV index in Japan is observed in Tsukuba City, Ibaraki Prefecture, and this data is available on the Meteorological Agency's website. Looking at the trends for 2023, it is evident that there were several days classified as "extremely high." This indicates that the UV radiation in the summer of 2023 was particularly strong compared to the past three years. For example, compared to the data from 2005, the overall UV levels are lower. In recent years(2022,2021,2020), not only has there been an upward trend, but days with UV index values around 14, reaching levels similar to those in Australian summers, have also started to appear.

Generally, low lightness colors such as black are less likely to transmit UV rays. However, these colors have high solar absorption rates and can easily retain heat making them potentially unsuitable for wear during extreme heat. Additionally, regarding the material, polyester fabrics, due to their coarse creases, are expected to have higher UV transmission compared to cotton or cotton-polyester blends.

In this study, driven by these concerns, an attempt was made to collect UV transmission data based on clothing characteristics during golf play in Japan's midsummer. The ultimate goal is to provide recommendations for appropriate golf wear based on these findings. This study serves as a pilot study for this purpose.

## 2. Methods

Field data was collected as follows:

- Experiment location: A golf course in the Kanto region of Japan
- Experiment date: July 28, 2024
- Meteorological conditions at the start of the experiment: WBGT 27.6° C, TA 28.7° C, Humidity 81.2%, Wind speed 0.15 m/s

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\* Correspondence: [kita@musabi.ac.jp](mailto:kita@musabi.ac.jp)

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- Meteorological conditions at the end of the experiment: WBGT 27.8° C, TA 29.2° C, Humidity 83.1%, Wind speed 0.18 m/s
- Subjects: Four healthy adult men with skill levels that did not hinder smooth rounds
- Clothing colors: Subjects wore polo shirts in white, pink, navy, and gray
- Data collection: The amount of UV radiation inside the clothing was collected every 10seconds using a TR74Ui during 9hole play (9:28–12:36).

### 3. Results

The highest UV detection was found with the pink polo shirt. The sensor placed on the chest of the subject wearing pink detected an average value of 0.017mW/cm<sup>2</sup> and a maximum value of 0.095mW/cm<sup>2</sup>. The second highest UV transmission was with the gray polo shirt. The sensor placed on the chest of the subject wearing gray detected an average value of 0.003mW/cm<sup>2</sup> and a maximum value of 0.019mW/cm<sup>2</sup>. However, only the gray polo shirt was made of polyester. The third highest UV transmission was with the white polo shirt. The sensor placed on the chest of the subject wearing white detected an average value of 0.002mW/cm<sup>2</sup> and a maximum value of 0.013mW/cm<sup>2</sup>. Additionally, the navy polo shirt did not detect any UV transmission at all.

Table1. UV transmission during 9hole golf play(mW/cm<sup>2</sup>)

	Max.	Mean	SD.
Pink	0.095	0.017	0.0139
Dark Blue	0	0	0
Gray	0.019	0.003	0.0039
White	0.013	0.002	0.0024

### 4. Discussions

On the day of the experiment, the weather was hot and humid (with a maximum temperature of 29.2°C and maximum humidity of 91.4%), and in terms of physical sensation, it was a climate where direct sunlight was not easily felt. The navy polo shirt showed the greatest increase in surface temperature, but it did not transmit UV rays at all. The grey sample, which had a low lightness color, was a polyester polo shirt. Due to its coarse creases, high breathability, and elasticity, it is presumed that it allowed more UV to pass through. In a previous study by Kita et al. (2022), the usefulness of pink in reducing heat retention in hats was pointed out, but the UV transmission was the highest with pink.

### 5. Conclusions

Considering recent amounts of UV radiation in Japan, it is desirable to use clothing that not only minimizes heat retention but also has low UV transmission. In a round of golf, which typically takes over two hours to complete a half, designs should be actively chosen that have colors reflecting sunlight, such as white or pink, on the surface, and colors that are less likely to transmit UV rays, such as black or navy, for the inner layers.

### References

- Japan Meteorological Agency. (2023). Annual trend graph of UV index (observed value). [https://www.data.jma.go.jp/gmd/env/uvhp/link\\_daily\\_uvindex\\_obs.htm](https://www.data.jma.go.jp/gmd/env/uvhp/link_daily_uvindex_obs.htm)
- Kita, T., et al. (2022). The effect of the hat material, color, and shape on physiological indicators as well as temperature and humidity inside the hat during sports activities in a hot environment, *DESCENTE Sports Science* (Vol. 42)
- Masaaki, M., (2023). Ranked 4th in the world for the number of papers related to ultraviolet rays and health: *Australian Science and Technology Series I*. [https://spap.jst.go.jp/oceania/experience/2023/topic\\_eo\\_01.htm](https://spap.jst.go.jp/oceania/experience/2023/topic_eo_01.htm)
- Stenner, B., et al. (2023). Golf participants in Australia have a higher lifetime prevalence of skin cancer compared with the general population, *BMJ Open Sport Exerc Med.* 9(3)