Assessment of the skin’s sensitivity to ultraviolet (UV) light radiation is an important issue in phototherapy, photodermatoses, photo-aging, photoprotection, and photocarcinogenesis. One current laboratory method for measuring an individual’s UV sensitivity is referred to as the minimal erythema dose (MED), which is defined as the dose of UV radiation that induces minimally perceptible erythema on exposed skin. At present, the most frequently used means of predicting UV sensitivity, without doing phototesting, is to determine an individual’s skin phototype. The classification of sun reactive skin types was introduced by Fitzpatrick in 1975; it is based on the history of an individual’s tendency to sunburn and tan.

Several investigators have shown that the MED is closely related to skin phototypes. However, it is still a matter of debate as to whether MED is related to the skin phototypes of Asian populations. In addition, no previous study has investigated the MED of broadband UVB in the Taiwanese population; this information would be useful in diagnosing photodermatoses. Thus, the main purpose of this study was to assess the cutaneous response of Taiwanese subjects to UV radiation by determining the MED for broadband UVB exposure. In addition, the relationships among skin phototypes, skin color, and MED were investigated in Taiwanese subjects.

**Subjects and Methods**

**Subjects**

Between June 2005 and August 2005, 61 healthy male and female Taiwanese volunteers, between the ages of 21 and 58 years, were enrolled. None of the subjects had a history of photodermatoses.
or had received phototherapy; none were taking any medications. This study was approved by the clinical ethics committee of National Taiwan University Hospital. Written informed consent was obtained from all subjects before enrolment. Each patient’s skin phototype was classified according to the Working Classification of Sun Reactive Skin Type introduced by Fitzpatrick.11

**Skin color measurement**

Subjects’ skin colors were determined using the Mexameter MX18 (Courage + Khazaka, Cologne, Germany). This device is based on the logarithm of inverse reflectance (LIR) method. Each measurement yields two values, A and E, which represent the melanin and erythema levels, respectively.12 In each subject, the buttock color was taken as representative of the constitutional skin color, while the cheek color was taken as representative of the facultative skin color.13

**Light sources**

The broadband UVB light source consisted of an array of four TL 20 W/12 fluorescent tubes (Philips, Eindhoven, The Netherlands) in parallel within a UV 801KL (Waldmann, Villingen-Schwenningen, Germany). The emission spectrum extended from 285 nm to 350 nm, with the peak at 310–315 nm. The UV irradiance was 0.9 mW/cm² at a target distance of 21 cm, as measured using a Waldmann radiometer model PUVA/UV21/UV6 (UV meter).

**MED measurements**

The back of each subject was exposed to 12 graded doses of UVB ranging from 20 to 240 mJ/cm², with an increment of 20 mJ/cm². The MED was defined as the smallest exposure dose needed to produce a minimally perceptible erythema with well-defined borders 24 hours after irradiation.1

**Data analysis**

Student’s t test and analysis of variance (ANOVA) were used to evaluate differences in the MED by gender, age and skin phototypes. Microsoft Office Excel® 2003 (Microsoft Co., Redmond, WA, USA) and SAS version 8.02 (SAS Institute, Cary, NC, USA) were used for analysis. To evaluate the relationship between skin color and MED, a simple regression coefficient was determined using linear regression (SAS version 8.02; SAS Institute).

**Results**

Among the 61 subjects, 30 (49%) were men and 31 were women (51%). Their mean age was 37.7 years (range, 21–58 years). None of the subjects had Fitzpatrick’s skin phototype I or VI; seven (11.5%) were phototype II, 21 (34.4%) were phototype III, 29 (47.5%) were phototype IV, and four (6.6%) were phototype V.

The mean MED was 142.3 ± 37.6 mJ/cm². The mean MED was 138.7 ± 35.2 mJ/cm² for men and 145.8 ± 40.1 mJ/cm² for women; the difference was not statistically significant (p = 0.4623). The mean MED increased from skin phototype II to V; the mean MEDs with skin phototypes II, III, IV and V were 122.9 ± 29.3 mJ/cm², 136.2 ± 33.8 mJ/cm², 148.3 ± 38.7 mJ/cm² and 165.0 ± 52.6 mJ/cm², respectively. In addition, the lower limits of MEDs increased with higher skin phototypes (Table 1).

The constitutional and facultative skin colors were not well correlated with MED. There were no significant differences in the skin colors among

<p>| Table 1. Results of minimal erythema dose (MED) levels in various skin phototypes |</p>
<table>
<thead>
<tr>
<th>Skin type</th>
<th>n (%)</th>
<th>MED range (mJ/cm²)</th>
<th>MED (mJ/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>7 (11.48)</td>
<td>80–160</td>
<td>122.9 ± 29.3</td>
</tr>
<tr>
<td>3</td>
<td>21 (34.43)</td>
<td>80–180</td>
<td>136.2 ± 33.8</td>
</tr>
<tr>
<td>4</td>
<td>29 (47.54)</td>
<td>100–220</td>
<td>148.3 ± 38.7</td>
</tr>
<tr>
<td>5</td>
<td>4 (6.56)</td>
<td>120–240</td>
<td>165.0 ± 52.6</td>
</tr>
</tbody>
</table>
phototypes II, III and IV. However, subjects with phototype V had higher constitutional and facultative melanin levels than those with phototypes II, III and IV ($p < 0.05$).

**Discussion**

Several investigators have shown that the MED increases with increasing skin phototype.\(^3\)\(^-\)\(^6\) However, most of these studies were done in Caucasians; the few studies that were conducted in Asians reported various findings (Table 2).\(^7\)\(^,\)\(^8\)\(^,\)\(^14\) Wee et al suggested that the normal range varies among different populations, and that each center needs to establish its own reference values.\(^8\) There have been no previous studies examining the MED of broadband UVB in Taiwanese subjects.

In the present study, skin phototype was well correlated with MED, but there were some overlaps in the results with different skin phototypes. Nevertheless, about a twofold difference between the highest and lowest MED values was found in each phototype; these results differ from those in Caucasians in whom the difference is at least threefold.\(^6\) Furthermore, the MEDs determined in the present study are considerably higher than those reported from the USA and Korea, but they are similar to those noted in Singapore, where 47\% of the subjects were Chinese.\(^7\)\(^,\)\(^8\)\(^,\)\(^14\) This discrepancy could be due to the variations in the instruments and measurement methods used; there may have been differences in the size and shape of the light source, and in the type and number of fluorescent tubes. However, genetic differences could also have played an important role. It is uncertain whether the different results could be due to acclimatization of the skin to constant UV radiation exposure in some populations.\(^3\)

Constitutional skin color is the genetically determined color of healthy skin unaffected by solar irradiation in areas such as the buttocks and the upper arm.\(^6\) Some authors have reported a good correlation between UV sensitivity and constitutional skin color.\(^6\)\(^,\)\(^9\) In the present study, neither facultative skin color nor constitutional skin color was a good predictor of the MED. In the Taiwanese population, skin phototype is still the best predictor of the MED.

In the present study, the MEDs of broadband UVB in Taiwanese subjects were established. Both the mean MEDs and the lower MED limits increased with increasing skin phototype (Table 1). One previous report dealt with the MED of narrowband UVB in Taiwanese subjects.\(^15\) However, the MED of broadband UVB determined in the present study is more useful for diagnosing photodermatoses. Physicians could use these lower MED limits as reference values when identifying abnormal photosensitivity in patients with suspected photodermatosis. In addition, different starting doses of broadband UVB phototherapy could be chosen for subjects with different skin phototypes. As this study was limited by its small sample size, further studies involving more participants with all skin phototypes (I–V) are required to provide us with more detailed information about the normal MED values for UVB in the Taiwanese population.

### Table 2. Comparison of the minimal erythema dose (MED) levels in several studies

<table>
<thead>
<tr>
<th>Skin type</th>
<th>MED (mJ/cm²)</th>
<th>USA(^{14})</th>
<th>Korea(^7)</th>
<th>Singapore(^8)</th>
<th>Taiwan</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20–30</td>
<td>59</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2</td>
<td>25–35</td>
<td>73</td>
<td>79</td>
<td>122</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>30–50</td>
<td>72</td>
<td>108</td>
<td>136</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>45–60</td>
<td>69</td>
<td>163</td>
<td>148</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>60–100</td>
<td>72</td>
<td>169</td>
<td>165</td>
<td></td>
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<tr>
<td>6</td>
<td>100–200</td>
<td>–</td>
<td>220</td>
<td>–</td>
<td></td>
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References