Differences of Minimum Erythema Dose (MED) in Fitzpatrick IV Skin Type Adults and Elderly with an Exposure of Narrowband Ultraviolet B (NB-UVB)

Arini Astasari Widodo[1], Tjut Nurul Alam Jacoeb[1], Aria Kekalih[2], Endi Novianto[1]
[1]*Dermato-venereology Department, Faculty of Medicine, Universitas Indonesia/Dr. Cipto Mangukusumo National General Hospital, Jakarta*
[2] *Community Medicine Department, Faculty of Medicine, Universitas Indonesia*

Keywords: *Minimal Erythema Dose, Fitzpatrick Skin Type IV, Narrowband Ultraviolet B, elderly*

Abstract: The skin of the elderly is different compared to that of an adult due to aging, where such changes could influence the skin's response to ultraviolet exposure, including erythemal response. This difference could lead to MED change, which in turn affects the effectiveness of treatment modalities for skin diseases. This study aims to determine the difference between average MED in the elderly and adults with Fitzpatrick IV skin type, as well as the difference between 24 hours-MED and 48 hours-MED. MED calculations were based on skin erythemal responses relative to six different exposure doses of NB-UVB in elderly people aged over 60 years and adults aged 18-45 years. The irradiation is done with a Waldmann UV109 lamp with dosages starting from 300, 500, 700, 900, 1100, and 1300 mJ/cm^2. Responses were examined at 24 hours and 48 hours post-irradiation by three different assessors. In the adult group, the mean of 24 hours-MED was 554 ± 182 mJ/cm^2 and 48 hours-MED was increased to 606 ± 167 mJ/cm^2. In the elderly group, the mean of 24 hours-MED was 702 ± 340 mJ/cm^2 and 48 hours-MED was increased to 836 ± 341 mJ/cm^2. The 24 hours-MED in the elderly group is higher compared to that of the adult group; however, the difference is not statistically significant (p=0.158). There is a statistically significant difference between 24 hours-MED and 48 hours-MED was found (<0.001) in the elderly group. The mean of 24 hours-MED in elderly and adults in this study could be applied clinically.

1 INTRODUCTION

Elderly is defined as a person who has reached the age of 60 (sixty) years old or above, while adult age is defined as 18-45 years old and 45-59 years old is defined as pre-geriatrics age (Peraturan Menteri Kesehatan Republik Indonesia, 2016). According to a report detailing visits to the Geriatric Division of Dermatovenereology Department of Dr. Cipto Mangunkusumo General Hospital, psoriasis vulgaris and atopic dermatitis are included in the top 10 diagnoses (Legiawati et al., 2016), and these diseases frequently require phototherapy modalities, including phototherapy using NB-UVB.

The assessment of initial dose for phototherapy may be approximated based on skin types or on MED irradiation test (Taylor and Stern, 1991). MED refers to a radiation dose used to produce just perceptible erythema (JPE) or the minimum energy required to produce a pink erythema response with clearly-defined border (Cafardi et al., 2012; Morrison W, 2005).

The skin of the elderly is different compared to that of an adult due to aging. These changes may affect the skin's response to ultraviolet light exposure (Gilchrest et al, 1982), and may include changes in inflammatory response and its mediators, changes in the immune system (immunosenescense), changes in the morphology of keratinocytes, and changes in the size of blood vessels. These may lead to a reduced erythema response triggered by UV exposure (Raschke and Elsner, 2010). Changes in erythema response due to aging is expected to affect MED in the elderly group.

Studies on MEDs in the elderly yield varying results. This may be due to difference of light source and measurement in differing phases, resulting in the difficulties to conclude the erythematous effect of NB-UVB exposure in the elderly (Thomas and Bergoend, 1977). Studies on MED in the elderly with

Widodo, A., Jacoeb, T., Kekalih, A. and Novianto, E.
Differences of Minimum Erythema Dose (MED) in Fitzpatrick IV Skin Type Adults and Elderly with an Exposure of Narrowband Ultraviolet B (NB-UVB).
DOI: 10.5220/0008151100730077
In *Proceedings of the 23rd Regional Conference of Dermatology (RCD 2018)*, pages 73-77
ISBN: 978-989-758-494-7

the most frequent skin types in Indonesian population has never been conducted and it is deemed necessary to study the MED with the exposure of NB-UVB in the elderly, compared to adult population with the same skin type (Fitzpatrick IV and V being the most frequent in Indonesians) (Bernadette et al., 2002).

This study aims to determine the difference of MED in adults and elderly with Fitzpatrick IV skin type, to determine the average MED for Fitzpatrick IV skin type for both adults and elderly, and to determine the difference of 24 hours- and 48-hour-MEDs in the elderly.

2 METHODS

This study is a clinical trial that compares the MED of adults and the elderly. The subject of the study are geriatric residents of Tresna Werdha Nursing Home (Cilandak, South Jakarta, Indonesia) with Fitzpatrick IV skin type who consented to participate in the study, as well as Nursing Home workers aging 18-45 years old with no history of diseases affected by UV lights or causing photosensitivity. Thirty-eight subjects from the adult group and 36 subjects from the elderly group was exposed with narrowband ultraviolet light on their backs using Waldmann UV109 lamp on the opened window with dosages starting from 300, 500, 700, 900, 1100, and 1300 mJ/cm^2. This study has been approved by the Health Research Ethical Committee of the Faculty of Medicine, Universitas Indonesia.

Responses were examined at 24 hours and 48 hours post-irradiation by 3 individuals, namely the principal investigators and 2 dermatovenereologist with ICC approaching 1.00 (0.98).

Data analyses were conducted in two phases, i.e. descriptive phase and inferential phase. The descriptive phase was performed to compare MED of adults and elderly population using Mann-Whitney due to abnormal distribution. A Wilcoxon test was conducted to compare the 24 hours- and 48 hours-MED in both adults and elderly. All analyses were performed using SPSS program version 20.

3 RESULTS

Of 36 elderly subjects, 17 (47.2%) were male, and 19 (52.9%) were female. In the adult group, 14 (42.4%) were male, and 19 (57.6%) were female. There is no significant difference in the number of male between the adult and elderly groups. Although the percentage of female is higher in both groups, this is not significant; thus, both groups can be considered homogenous in terms of gender. Based on the data from 69 subjects included in the analysis, other than gender, there are no significant difference in terms of ethnicity and level of dependency.

In the adult population, the median of 24 hours- and 48 hours-MED are 500 mJ/cm^2 (300 – 900 mJ/cm^2) and 700 mJ/cm^2 (300 – 900 mJ/cm^2), respectively; while the mean 24 hours-MED and 48-hours MED are 554 ± 182 mJ/cm^2 and 606 ± 167 mJ/cm^2, respectively. The 24 hours-MED in the elderly group is higher compared to that of the adult group; however, the difference is not statistically significant (p=0.158). Table 1 presents the comparison of 24 hours- and 48 hours-MED in the adult and elderly groups. Figure 1 presents the distribution of 24 hours- and 48 hours-MED in both adults and elderly.

In terms of the 24 hours-MED, we failed to reject null hypothesis despite the fact that our sample size indicates adequate power.

Table 1. Comparison of 24 hours- and 48 hours-MED in the adult and elderly groups

Variable		Adult	Elderly	p
24 hours-MED (mJ/cm^2)	Median (min – max) Mean	500 (300-900) 554 ± 182	550 (300-1300) 702 ± 340	0.158
48 hours-MED (mJ/cm^2)	Median (min – max) Mean	700 (300-900) 606 ± 167	700 (400-1300) 836 ± 341	0.026

*Due to the abnormal distribution of MED data in this study, a non-parametric test, i.e. Mann-Whitney Test was used in data analysis.

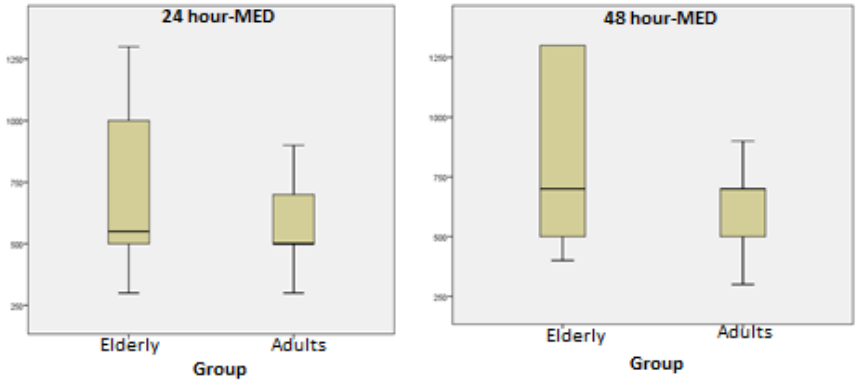

Figure 1. Distribution of 24 hours- and 48 hours-MED in the adult and elderly groups

In the elderly group, the median of 24 hours-MED and 48 hours-MED are 550 (300 – 1300) mJ/cm^2 and 700 (400 – 1300) mJ/cm^2, respectively; while the mean 24 hours-MED and 48 hours-MED are 702 ± 340 mJ/cm^2 and 836 ± 341 mJ/cm^2, respectively. Based on the Wilcoxon test, there is a statistically significant difference between 24 hours- and 48 hours-MED in the elderly group ($p < 0.001$). Table 2 presents the comparison of median 24 hours- and 48 hours-MED in the elderly group.

Table 2. Comparison of median 24 hours- and 48 hours-MED in the elderly groups

Variable		Elderly	p
24 hours-MED (mJ/cm^2)	Median (min-max) Mean	550 (300-1300) 702 ± 340	<0.001
48 hours-MED (mJ/cm^2)	Median (min-max) Mean	700 (400-1300) 836 ± 341	

* Due to the abnormal distribution of MED data in this study, Wilcoxon Test was used in data analysis

4 DISCUSSION

This study found a higher percentage of female compared to male in both groups. However, the difference is not significant; thus, both groups can be considered homogenous in terms of gender. This is likely due to the fact that there is more female elderly compared to male in the location where the study was conducted. This is also consistent with the female to male elderly ratio in Indonesia, which is 9:8, and with the higher life expectancy for female elderly compared to male elderly (Pusat Data dan Informasi Kementerian Kesehatan Republik Indonesia, 2016).

This study found a difference in 24 hours-MED between adult and elderly groups. However, this difference is not statistically significant ($p=0.158$). Some literatures have found that the erythema response in the elderly differs from that of adult population (Gilchrest at al., 1982; Gloor and Scherotzke, 2002; Guerrera, 1989).

This is due to various factors, including differences in anatomical and physiological aspects, vascular response, immune response, and so on. Previous studies also found varying results. Cox found that in the 24 hours after irradiation, no statistically significant difference was observed in the mean MED of adult group compared to elderly. However, this study used different UVB source, leading to difficulties in comparing the dosages received by subjects. The study also included subjects with Fitzpatrick I-V skin types (Cox et al., 1989).

Amblard performed an analysis of 2 quantitative variable, namely age and MED, and found a good correlation ($r=0.78$, $P<0.001$) in 303 patients aged 5-89 years old. The study found that the MED lowers with the increase of age. However, the study was conducted on patients with lighter skin, which may confound the result. Differ to the current study, Amblard exposed their subjects to UVB using different light source and measure the erythema response using different methods as well. These differences may contribute to the different results yielded by that study and the current study (Amblard et al., 1982).

Gloor conducted a study on 20 subjects aged 20-40 years old and 20 subjects aged 70 and above with Fitzpatrick I – IV skin types, where the MED was

measured 48 hours after irradiation using narrowband UVB. The study found no statistically significant difference in 48 hours-MED between both groups (Gloor and Scherotzke, 2002). All differences in erythema response in the elderly descibed above explains the finding of higher MED in the elderly group compared to the adult group. However, considering that the difference of 24 hour-MED is not statistically significant, one can interpret that in practice, the initial dose of phototherapy does not need to be different between adults and the elderly.

Despite previous literatures showing various evidences that the biological and physiological erythema response are different in adults and in the elderly, this alone does not affect the MED for NB-UVB which may be useful to determine the initial dose of phototherapy.

This study is also the first to compare the MED between adults and elderly population in Indonesia, where the majority of skin type is Fitzpatrick IV. Even with the same skin type, considering the wide range of minimum and maximum value as presented in Table 2, determining initial dose for phototherapy based on skin type might not always lead to a uniform result; therefore, it is more recommended to use MED as a reference for initial dose for phototherapy.

When a comparison is made between 24 hours- and 48 hours-MED in the elderly, we found a statistically significant difference with a p value of <0.001). This indicates that significant erythematous changes occur over time in the elderly. From this finding, it can be interpreted that exposure to NB-UVB with a mean radiation dose of 836 ± 341 mJ/cm^2 will result in an erythema with a higher intensity than MED definition at 24 hours, and result in clinical features of erythema consistent with the definition of MED at 48 hours.

In clinical application, the lowest dose to produce a pink erythema response with clearly-defined border should be used in determining MED. Based on the findings of the current study, the lowest dose for MED is obtained at 24 hours; therefore, 24 hours-MED should be used in determining the initial dose for phototherapy.

This study is the first study that compares 24 hours- and 48-hour MED in the elderly. Gloor were the first to observe the 48 hours-MED in the elderly. This observation was conducted in the 48th hour following irradiation due to a theory stating that erythema response in the elderly is expected to be delayed, as confirmed in the findings of a previous study (Gloor and Scherotzke, 2002; Guerrera, 1989). Gloor's study did not compare the 24 hours- and 48-hour MED; however, despite finding that there are no significant difference in terms of 48-hour MED between adults and elderly populations, they found a higher erythema intensity in the elderly population at 48 hours after irradiation.

Considering that this study is performed on subjects with Fitzpatrick IV skin type, it is also important to remember that the photoprotection effect of melanin might also be a contributing factor to the differences between the current study and previous studies conducted on subjects with lighter skin. It remains possible that the findings of this study are due to the photoprotection effect of melanin, which is a stronger determinant factor compared to age. In darker skin, erythema resulting from UVB exposure will subside after 1-3 days, while in individuals with lighter skin, the response may persist for 1-2 weeks (Weichenthal and Schwarz T., 2005).

5 CONCLUSION

The mean 24 hours-MED in the adult group with Fitzpatrick IV skin type is 554 ± 182 mJ/cm^2 and the mean 24 hours-MED in the elderly group with Fitzpatrick IV skin type is 702 ± 340 mJ/cm^2. The 24 hours-MED of the elderly group is higher compared to that of the adult group; however, this difference is not statistically significant. There is significant difference between 24 hours-MED and 48 hours-MED in the elderly group with Fitzpatrick IV skin type. The mean of 24 hours-MED in elderly and adults in this study could be applied clinically.

REFERENCES

Amblard, P., Beani, J., Gautron, R., Reymond, J., Doyon, B., 1982. Statistical study of individual variations in sunburn sensitivity in 303 volunteers without photodermatosis. *Archives of Dermatological Research* 274, 195–206. doi:10.1007/BF00403722

Bernadette I, Daili S, Soedharmono S., 2002. *Dosis eritema minimal (DEM) regio infraskapula dan regio gluteal dengan penyinaran Narrowband UVB pada individu normal tipe kulit IV dan V*. Media Dermato-venereologica Indones.

Cafardi J, Pollack B, Elmets C. Phototherapy. In: Goldsmith L, Katz S, Gilchrest B, Paller A, Leffell D, Wolff K, editors., 2012. *Fitzpatricks Dermatology in General Medicine*. McGraw Hill Companies., 8th Editio., pp. 2841–50.

Cox, N.H., Farr, P.M., Diffey, B.L., 1989. A Comparison of the Dose-Response Relationship

for Psoralen-UVA Erythema and UVB Erythema. *Archives of Dermatology* 125, 1653–1657. doi:10.1001/archderm.1989.01670240053012

Gilchrest, B.A., Stoff, J.S., Soter, N.A., 1982. Chronologic aging alters the response to ultraviolet-induced inflammation in human skin. *Journal of Investigative Dermatology* 79, 11–15. doi:10.1111/1523-1747.ep12510417

Gloor, M., Scherotzke, A., 2002. Age dependence of ultraviolet light-induced erythema following narrow-band UVB exposure. *Photodermatology Photoimmunology and Photomedicine* 18, 121–126. doi:10.1034/j.1600-0781.2002.00756.x

Guerrera M., 1989. Age and skin response to ultraviolet radiation. *J Cutan Aging Cosmet Dermatol* 1, pp. 135–44.

Legiawati L, Yusharyahya S, Sularsito S, Margaretha S., 2016. The incidence of dermatologic disease at dermatology clinic, department of dermatovenereology university of indonesia, ciptomangunkusumo hospital in 2008-2013. *In: 22nd Regional Confrence of Dermatology (Asian-Australasian)*. Raffles City Convention Centre, Singapore.

Morrison W, 2005. *Phototherapy and photochemotherapy of skin disease*. Boca Raton: Taylor and Francis Group.

Peraturan Menteri Kesehatan Republik Indonesia, 2016. *Rencana Aksi Nasional Lanjut Usia Tahun 2016-2019,* 25.

Pusat Data dan Informasi Kementerian Kesehatan Republik Indonesia. *Situasi Lanjut Usia (Lansia) di Indonesia*., 2016. Jakarta: Kementerian Kesehatan Republik Indonesia.

Raschke C, Elsner P. Skin aging: A brief summary of characteristic changes. In: Farage M, Miller K, Maibach H, editors., 2010. *Textbook of Aging Skin*. Verlag Berlin Heidelberg: Springer., pp. 37–47.

Taylor, C.R., Stern, R.S., 1991. Magnitude and Duration of UV-B—Induced Tolerance. *Archives of Dermatology 127*, 673–677. doi:10.1001/archderm.1991.01680040081007

Thomas P, Bergoend H., 1977. Principles and techniquess de l'exploration photobiologique. *Ann Dermatol Venereol* 104., pp. 513–24.

Weichenthal M, Schwarz T., 2005. Phototherapy: how does UV work?. *Photodermatol Photoimmunol Photomed* 21, pp. 260–6.