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# Skin color parameters and Fitzpatrick phototypes in estimating the risk of skin cancer: A case-control study in the Polish population

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**Background:** Light skin pigmentation is a known risk factor for skin cancer.

**Objective:** Skin color parameters and Fitzpatrick phototypes were evaluated in terms of their usefulness in predicting the risk of skin cancer.

**Methods:** A case-control study involved 133 individuals with skin cancer (100 with basal cell carcinoma, 21 with squamous cell carcinoma, 12 with melanoma) and 156 healthy individuals. All of them had skin phototype determined and spectrophotometric skin color measurements were done on the inner surfaces of their arms and on the buttock. Using those data, prediction models were built and subjected to 17-fold stratified cross-validation.

**Results:** A model, based on skin phototypes, was characterized by area under the receiver operating characteristic curve = 0.576 and exhibited a lower predictive power than the models, which were mostly based on spectrophotometric variables describing pigmentation levels. The best predictors of skin cancer were R coordinate of RGB color space (area under the receiver operating characteristic curve 0.687) and melanin index (area under the receiver operating characteristic curve 0.683) for skin on the buttock.

**Limitations:** A small number of patients were studied. Models were not externally validated.

**Conclusions:** Skin color parameters are more accurate predictors of skin cancer occurrence than skin phototypes. Spectrophotometry is a quick, easy, and affordable method offering relatively good predictive power. (J Am Acad Dermatol 2016;74:716-23.)

**Key words:** erythema index; International Commission on Illumination L\*a\*b\* color space; melanin index; red/green/blue color space; skin cancer; skin phototype.

Previous research has clearly shown a relationship between skin, hair, and eye pigmentation and the risk of developing certain kinds of skin cancer.<sup>1-13</sup> Most researchers to date have used the skin phototypes proposed by Fitzpatrick<sup>14</sup> in 1988. His classification reflects, to some extent, the degree of skin color intensity and the extent of skin sensitivity to damage generated by ultraviolet radiation.<sup>11,14,15</sup> Many authors have found this method useful in identifying photoinduced skin cancer risk.<sup>2,5,6,8-10,12-14</sup> In contrast to descriptive methods,

#### Abbreviations used:

AUC:	area under the receiver operating characteristic curve
BCC:	basal cell carcinoma
CIELab:	International Commission on Illumination L*a*b* color space
RGB:	red/green/blue color space
EI:	erythema index
MI:	melanin index
OCP:	optimum cutoff point
SCC:	squamous cell carcinoma

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spectrophotometry offers objective measurements, considerably increases repeatability, and enables exact, quantitative assessment of skin color. Contemporary dermospectrophotometers offer wide possibilities of quantitative characterization of skin color (melanin index [MI], erythema index [EI], mathematical color coordinates in International Commission on Illumination L\*a\*b\* color space [CIELab], and RGB color space systems). Out of this abundance of parameters, one should select the metric characteristics that are best suited for estimating the risk of skin cancer, thus enhancing prevention options, which is the main objective of the presented work.

## METHODS

The study was approved by the Bioethical Committee of the University of Lodz (KBBN-UŁ/II/8/2010) and conducted on Polish subjects during the years 2011 through 2014. The data set included test results for 133 individuals with skin cancer, aged 41.8 to 92.9 years (100 patients with basal cell carcinoma [BCC], 21 with squamous cell carcinoma [SCC], and 12 with melanoma). Among them, 9 (6.8%) had secondary skin cancer. The age of the primary lesion onset ranged from 35.0 to 91.0 years. The patients with skin cancer were treated at the Plastic, Reconstructive and Aesthetic Surgery Clinic of the Medical University. In all patients, the diagnosis was confirmed by histopathological examination.

A control group consisted of 156 healthy individuals, aged 45.2 to 93.1 years.

## Skin color

The dermospectrophotometer used in the study was DSM II (Cortex Technology, Hadsund, Denmark), measuring the MI and the EI, and skin color in the CIELab and RGB color space (Fig 1 and Table I). Skin color measurements were done on the medial regions of the right and left arms and on the right buttock. In each region, the measurements were done in triplicate, each time at a slightly different location, avoiding birthmarks and visible discolorations. A statistical analysis was conducted on individual arithmetic means of MI and EI and the coordinates L, a, b, and R, G, B were calculated for the arms, based on all the 6 measurements, whereas those for the buttock were based on 3 measurements. In addition, each subject

was assigned a phototype, according to the classification by Fitzpatrick<sup>14</sup> in 1988.

## Statistical analysis

Statistical analysis included the  $\chi^2$  test, Student *t* test, analysis of variance, and Pearson linear correlation. Because of the low number of patients with SCC and melanoma, the applied prediction models were built for the overall group of patients with skin cancer, using logistic regression. The quality of classifiers was characterized by the area under the receiver operating characteristic curve (AUC). In addition, the optimum cutoff point (OCP) was determined, for which the following measures of prediction quality were determined: sensitivity, specificity, and accuracy. The models with the highest predictive power were subjected to 17-fold stratified cross-validation.

Multiple regression analysis was used to determine the influence of the sex and age of the studied subjects on the predicted likelihood of skin cancer in the testing set. The same statistical method was used to determine whether the values, as predicted by the models, were correlated with skin cancer types, ordered ascendingly according to malignancy level. All the statistical tests were performed using the Statistica software package, Version 10 (StatSoft, Krakow, Poland).

## RESULTS

The proportions of male and female individuals were similar in the patient and control groups. In the patients, the type of skin cancer was not sex-related. At the time of the study, the patients with skin cancer were, on average, older than the control subjects. Patients with melanoma were on average younger than those with SCC and BCC. No statistically significant difference was found between the age of the control subjects and the age of patients at the time of disease onset. In turn, the age at onset was different among patients with different types of skin cancer. The onset of disease in patients with melanoma was significantly earlier than in patients with nonmelanoma skin cancer (Table II). Patients with skin cancer were characterized by an increased prevalence of phototypes II and III, whereas the control subjects exhibited a higher prevalence of phototype

## CAPSULE SUMMARY

- The risk of skin cancer is estimated using descriptive assessments of human pigmentation, especially Fitzpatrick skin phototypes.
- It was found that spectrophotometric parameters of skin color offer more accurate prediction possibilities.
- Spectrophotometry can be used as an accurate tool for predicting the risk of skin cancer.

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