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Analysis of Surgical Masks Adverse Effects on Facial Skin in Long Term Usage during COVID-19 Pandemic

Short Title: Surgical Mask Effects on Facial Skin

Levent Alparslan[1*], Kivanc Yuksel[2], Khaetthareeya Sutthanut[3]
1Department of Pharmaceutical Technology, Faculty of Pharmacy, Istinye University, Istanbul, Turkiye.
2Center for Drug Research and Development and Pharmacokinetic Applications (ARGEFAR), Ege University, Izmir, Turkiye
3Department of Pharmaceutical Chemistry, Faculty of Pharmaceutical Sciences, Khon Kaen University, Khon Kaen, Thailand

Corresponding Author Information
905423134516
levent.alparslan@istinye.edu.tr
https://orcid.org/0000-0003-0113-6850
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Abstract
Background: During the COVID-19 pandemic, masks have become mandatory to be protected against the virus transmitted by breathing. This study aimed to examine the impact of surgical masks used daily on civilians' facial skin.
Method: Moisture, Elasticity, Pore, Melanin, Acne, Wrinkle, and Sensitivity parameters of 83 volunteers were measured numerically with an API-100 skin analyzer and camera recordings. Numerical values were compared following the device's algorithm calibrated according to age, gender and race. Finally, the obtained data were statistically evaluated compared to the averages.
Results: It was observed that Pore, Melanin, Acne, and Wrinkle parameters were higher without gender discrimination while Moisture and Elasticity parameters were low. While a significant increase was observed in women for sensitivity, the increase was not statistically significant in men.
Conclusion: The negative effects of long-term daily wearing of surgical masks on the facial skin were statistically significant. Therefore, taking outdoor breaks in mask use, washing the face intermittently, using moisturizing and purifying cosmetic products, and anti-wrinkle effects have been proposed to reduce the possible defects.
Keywords: Surgical mask, COVID-19, Acne, Moisture, Wrinkle

Introduction

Social protection methods are being investigated with the coronavirus (COVID-19) pandemic. Since the virus is transmitted through respiration, it is scientifically recommended to use masks and protective equipment. Studies analyzing the effect of masks on the general population have concluded that masks are associated with a reduction in transmission and cases (1-4). Surgical masks can prevent the inhalation of large droplets. They are useful to avoid from infection by noticing distance. Surgical mask has also been shown to intercept other human coronaviruses during coughing to filter submicron-sized airborne particles (5,6). It has been stated that the rate of virus transmission is significantly lower in countries with mask mandatory requirements. Furthermore, it has been reported in studies conducted in different countries that the use of masks causes significant decreases in mortality rates (7-9).
People who work, spend time and travel in closed places wear masks on their faces for a long time. Long-term use of masks can create negative effects both in terms of hindering fresh air ventilation on the areas they cover. In addition, the mask used to prevent the virus from being transmitted through the respiratory tract may cause some undesirable effects on the face as it prevents the outflow of breath from the mouth and nose simultaneously. The types and duration of masks differently affect the intact skin. The increased skin temperature and incident adverse effects such as acne, redness or erythema, drying, itching, allergies, burning and wounds have been reported when it was long-term covered by masks (10-13).
Although N95 masks' impact on healthcare professionals during the COVID-19 pandemic has been studied extensively, the effect on the skin of the surgical mask has been limited widely used by civilian users for a

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prolonged period. Although labor-intensive healthcare staff wear masks longer than civilians, this study was conducted on. The data were evaluated statistically according to the measurement values by making analysis, not based on surveys and observations.

High moisture at the mask-covered facial skin lesion due to low breathability and deficit air ventilation can lead to dermatological disorders from accumulated sweat, dirt, and oil on the skin surface. The severity is varied by multiple factors, resulting in acne, hyperpigmentation, irritation, etc., as signs of skin problems that only can be investigated clinically using a specific skin analyzer. Therefore, this study aims to examine the impact of prolonged use of surgical masks in the Istanbul metropolitan city civilians who live and spend a lot of time indoors. The obtained results are expected to deliver the statement and beneficial information for hygienic and preventive practices and suitable skincare and cosmetic products of choice.

Material Method

API-100 skin analyzer is used in the scientific evaluation of Moisture, Elasticity, Pore, Melanin, Acne, Wrinkle and Sensitivity parameters on the skin according to categories of age, gender and race. According to the device algorithm, the parameters can be measured with numerical values and compared with the average of parameters in same categories. By measuring from the same point on face, it is ensured that the comparison is realistic and optimized (14-16).

The technical specifications of the API100 device are given below.

Image Sensor 1/4 inch Color CMOS UXGA (2 Mega Pixel)

Pixel Effective Pixel : 1,624 x 1,212 Pixel

Image Capture size WI-FI Video Streaming VGA (640x480) | 2M (1,600x1,200)

Image Frame Rate VGA (640x480) - 30Frame Max 2M (1,600x1,200) - 15Frame Max

LED Dip LED X8 & UV - Chip LED X8 (NICHIA / Japan) Dip LED X8 (NICHIA / Japan) Dip LED X8 (NICHIA / Japan)

In the evaluation of the elasticity parameter; The skin is categorized by low, normal, high levels. The looseness of the skin structure and the width of the pores are evaluated. In the graph, moisture and elastic parameters are scored depending on the image and compared with the average age. The state of the porosity structure of the skin was defined as good, normal and porous. The pores in the camera image are shown as dots and compared with a good skin image of the same age, gender and race. In the evaluation of melanin, an interpretation is made depending on the width and tone of the black spot spots. In the acne evaluation, sebum density and brightness are determined. Acne areas are scored and shown by color. Wrinkle assessments are scored according to their deepness and intensity. Wrinkle-detected places are shown as dots. In the sensitivity assessment, the thickness of the skin layer and physical resistance are interpreted. Where coloration is intense, the sensitivity parameter is scored low.

In the study, healthy subjects with age ranged from 18 to 61 years old were included from the domestic and foreign students studying and working at Istinye University. Ratio of Turkish volunteers to foreign attendees was 8.2. Distribution of ages, gender and nationality was demonstrated in Figure 1: the percentages of male and female subjects were 16.9 and 83.1%, respectively. The obligatory inclusion criteria were no use of colored cosmetics or dermocosmetic products at the application site throughout the study. Subjects were informed about research in accordance with the Declaration of Helsinki. People with chronic diseases, used drugs, COVID-19 infection, and cosmetic products on their faces were excluded from the study. The skin measurements were taken at the designated points using an API-100 skin analyzer. Points are shown in Figure 2. Then, data comparison was conducted according to the algorithm of the skin analyzer device. This study was accepted by Istinye University Human Research Ethics Committee on 22.12.2021 with protocol number 21-103.

Statistical evaluations were carried out in the SAS Version 9.4 program. Type I error was accepted as 0.05. In statistical evaluation, each individual's difference scores (Δ) calculated for hydration, elasticity, pore, melanin, acne, wrinkle, and sensitivity measurements were taken into account. For each category, the difference score of the subjects (Δ) was calculated by subtracting the measurement score of each subject from the average score: $\Delta=X-X_{mean}$.

Descriptive statistics (n, mean, standard deviation, median, 25th and 75th percentiles), depending on gender grouping, for difference scores (Δ) for moisture, elasticity, pore, melanin, acne, wrinkle, and sensitivity measurements). Statistical evaluation was carried out in the following two sections:

Comparison with Normal Value

Depending on the distribution of the data, it was investigated whether the mean (arithmetic mean / median) of the difference scores (Δ) of the subjects (n=83) was different from zero. The evaluation was made with the one-sample t-test (arithmetic mean) in the data suitable for the normal distribution and with the Wilcoxon signed rank test (median) for non-normal distributed data.

Comparison by Gender

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Depending on the distribution of the data, two-sample t-test (arithmetic mean) was used for data with normal distributions and Wilcoxon rank sum test (median) was used for non-normal distributions—the comparison of the mean (arithmetic mean/median) difference scores of female (n=64) and male (n=19).
In case of statistical difference according to gender, separate evaluations were made for the male and female groups when the subtraction scores differed from zero. While comparing the means (arithmetic mean / median) in these evaluations, one-sample t-test (arithmetic mean) was used for data that were suitable for normal distribution and the Wilcoxon signed rank test (median) was used for non-normal distributions.

Results

Descriptive statistics (n, mean, standard deviation, median, 25th and 75th percentiles) for the difference scores (Δ) of elasticity, pore, melanin, acne, wrinkle, and sensitivity measurements were demonstrated depending on gender grouping (Table 1). The data distribution differed among the studied categories: the pore(Δ) and wrinkle(Δ) scores showed normal distribution ($p>0.05$), and arithmetic mean values were taken into account in the evaluations; in contrast, the other scores were not normally distributed ($p<0.05$), the median (median) values were taken into account in the evaluations.
In the skin analyzes performed on 83 volunteers, the images of the two volunteers with the highest and lowest scores of the device were compared. In addition to the statistical difference, visual differences were also recorded. The highest and lowest humidity comparison profiles determined by age and gender of the volunteers were demonstrated (Fig.3). The highest and lowest scored elasticity profile were indicated on the graph (Fig4). The porous skin with the highest score according to the pore status was compared with the skin that appeared to be better than the average (Fig.5). In the comparison of melanin balance, the skin with the highest score and black pigment, with a large spot area, and a healthy skin without significant coloration were observed (Fig.6). Skin with excess sebum turns into acne with porous blackheads versus healthy skin with high moisture and sebum balance were compared (Fig.7). Wrinkle assessment is important for the youthful and healthy appearance of the skin. Young and healthy skin should have a low wrinkle score. Low and high score wrinkles were compared (Fig.8). In the sensitivity assessment, the thickness of the skin layer was interpreted. A low score indicates high physical resistance. Low and high score skin images were compared (Fig.9)
Comparison with Normal Value: the medical-mask use induced significant changes —an increation of the pore, melanin, and wrinkle but a reduction of moisture and elasticity of facial skin. The arithmetic mean values of the pore(Δ), melanin(Δ), acne(Δ), and wrinkle(Δ) scores were 6.93, 66.0, 43.0, and 20.95 respectively, which statistically increased and differed from zero ($p<0.05$). While the median values of moisture(Δ) and elasticity(Δ) scores were -40.0 and -44.0, respectively, which statistically decreased and differed from zero ($p<0.05$). In contrast, the median sensitivity(Δ) of -8.0 indicated the change with no statistically different from zero ($p>0.05$) (Table 1).
Gender Comparison: The impact of surgical mask use between male and female groups was significantly different for sensitivity, acne and wrinkle long-term surgical mask wearing induced acne and wrinkle developing in both male (with zero-different (Δ) scores of 61.0 and 33.05 respectively) and female facial skin (with Δ scores of 31.5 and 17.35, respectively), however, in male rather than female group; while, there was no significant change on facial skin sensitivity in both genders.
The arithmetic mean / median of pores (Δ), moisture (Δ), elasticity (Δ) and melanin (Δ) did not significantly differ between the groups of male and female ($p>0.05$). The arithmetic mean / median of pore (Δ), moisture (Δ), elasticity (Δ), and melanin (Δ) were 9.68, 6.12, - 40.0 - 40.0 for male; - 44.0, - 44.0, 65.0, and 67.0 for female, respectively (Table1).
The statistically significant difference between the arithmetic mean / median of sensitivity(Δ), acne(Δ) and wrinkle(Δ) scores depending on gender ($p<0.05$) was exhibited with the arithmetic mean / median sensitivity(Δ), acne(Δ) and wrinkle(Δ) of 0.0, 61.0, and 33.05 for the male group; -9.0, 31.5, and 17.35 for the female group, respectively.
Since sensitivity(Δ), acne(Δ) and wrinkle(Δ) scores statistically differed in terms of gender, comparison with normal value was performed separately for male and female. The arithmetic mean / median increase in sensitivity (Δ) and acne (Δ) and wrinkle (Δ) in female were -9.0, 31.5, and 17.35, respectively, compared to the normal value and it was found to be significantly different from zero ($p<0.05$). In the male, the difference for sensitivity (Δ) was found to be 0.00, and it was not significantly different from zero ($p>0.05$); the median for acne (Δ) and mean for wrinkle(Δ) were 61.0 and 33.05, respectively, and both are significantly different from zero ($p<0.05$) (Table1).

Discussion

The overall results indicated the impact of prolonged surgical mask usage could cause superficial maceration and damage the skin barrier. The influence of surgical masks on long-term use in 83 volunteers during the COVID-19 pandemic was significantly demonstrated. The adverse effects were detected as the significant incretion of skin pore numbers and acne formation, which was presumed to anticipate by skin cell damage associated with limited air ventilation during surgical-mask wearing, followed by oil and bacteria deposit. Thus, the enlargement of skin pores and the formation of pimples, acne, and blackheads have been developed. Furthermore, the

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increased melanin pigment represented skin-darkening induction. In addition, the relationship between parameters of decreation in skin elasticity and higher wrinkles was also suggested. Interestingly, a more significant influence on males than females was found.

The obtained results have suggested the undesirable effects of prolonged mask usage, which could lead to more severe dermatological and cosmetic problems depending on wearing duration and personal hygiene factors. Furthermore, the significant incretion of skin pore numbers, melanin pigment, and acne formation has suggested the disorder of dermal physiology throughout the dermis and epidermis layers. In addition, melanin pigment incretion has indicated the potential for skin blemish (17). Therefore, preventive practice is crucial, including periodic unmask in open environments between prolonged usage, cleansing facial skin, and applying skin barrier creams to prevent skin deterioration. In addition, suitable choices of skincare and cosmetic products are also important: facial skin washing every morning and night with an oil-free, fragrance-free cleanser and treatment with non-comedogenic facial moisturizers or gels one hour before being on masks are recommended (18). Conversely, skincare and cosmetic products with high contents of oils and pigments should be avoided to avert skin spore formation and obstruction worsening.

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Conflicts of interest: Authors have no conflicts to declare

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Table 1: Descriptive statistics for difference scores (Δ) for elasticity, pore, melanin, acne, wrinkle and sensitivity measurements

Parameters		Numbers (n)	Arithmetic Mean	Standard Deviation	Median	75th percentile	75th percentile
Pore (Δ)	**Male**	19	9.68	11.25	7.0	1.0	19.0
	Female	64	6.12	12.71	7.5	-2.0	15.5
	Total	83	6.93	12.41	7.0	-1.0	16.0
Sensitivity(Δ)	**Male**	19	19.57	31.48	0.0	-7.0	52.0
	Female	64	-1.42	17.62	-9.0	-9.0	1.5
	Total	83	3.38	23.13	-8.0	-9.0	3.0
Moisture(Δ)	**Male**	19	-39.53	2.874	-40.0	-40.0	-40.0
	Female	64	-38.02	5.799	-40.0	-40.0	-35.0
	Total	83	-38.36	5.297	-40.0	-40.0	-35.0
Elasticity(Δ)	**Male**	19	-42.16	5.580	-44.0	-44.0	-44.0
	Female	64	-40.30	8.337	-44.0	-44.0	-35.0
	Total	83	-40.72	7.801	-44.0	-44.0	-38.0
Melanin(Δ)	**Male**	19	60.15	17.57	65.0	54.0	72.0
	Female	64	59.37	18.15	67.0	50.0	72.0
	Total	83	59.55	17.92	66.0	50.0	72.0
Acne (Δ)	**Male**	19	52.57	25.46	61.0	43.0	73.0
	Female	64	27.15	34.44	31.5	-4.5	58.0
	Total	83	32.97	34.19	43.0	2.0	61.0
	Male	19	33.05	23.69	29.0	23.0	41.0

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Wrinkle (Δ)	**Female**	64	17.35	18.21	19.0	2.0	35.0
	Total	83	20.95	20.54	23.0	2.0	38.0

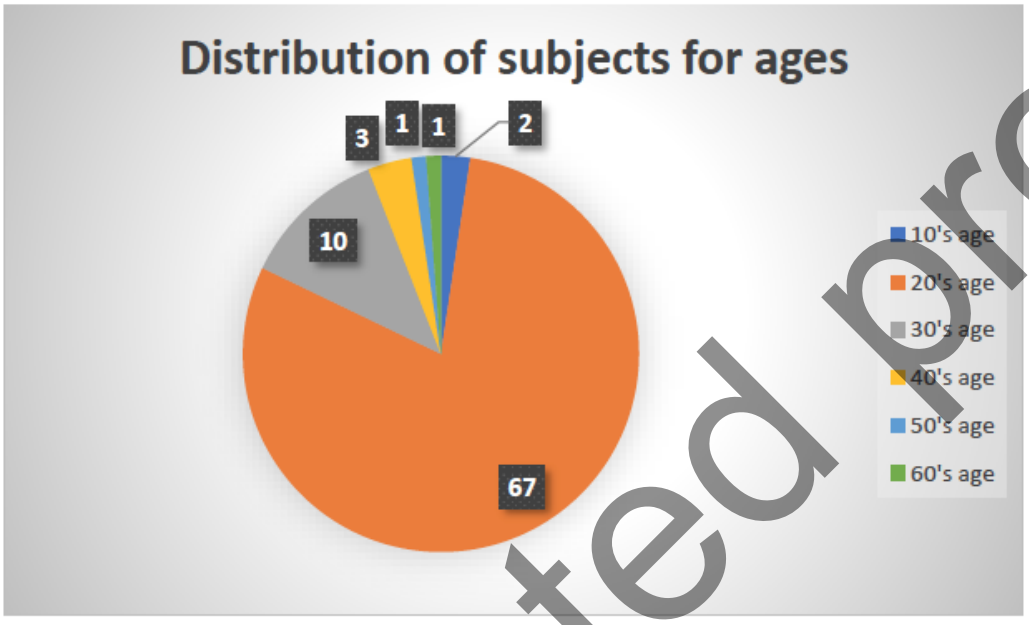

Figure 1: Age distribution of subjects for skin analysis study.

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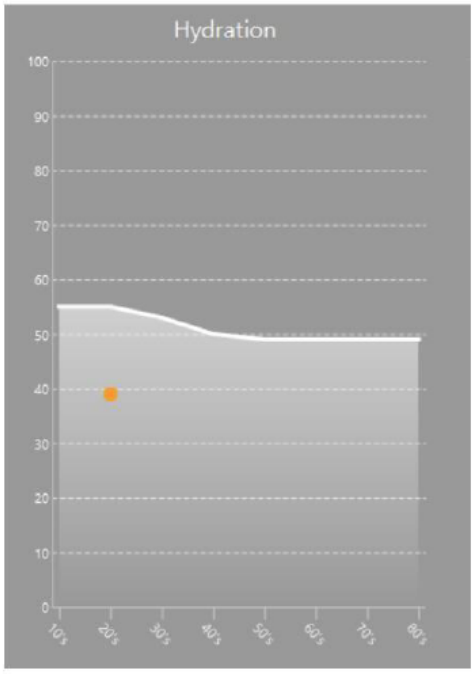
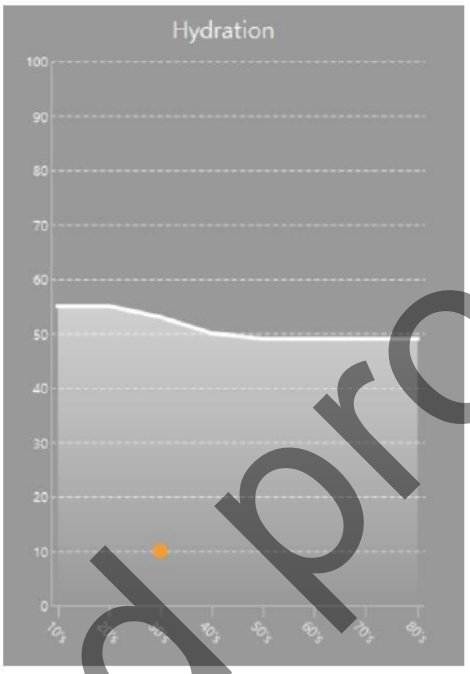
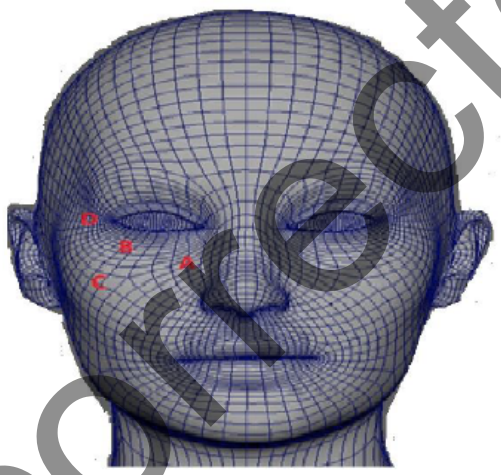




B.B. Age:20 Female Score:39	G.A. Age:35 Female Score:10

Figure 3 The best and the worst scored hydration analysis of volunteers.



A: Pore, Acne
B: Melanin, Sensitivity
C: Moisture, Elasticity
D: Wrinkle

Figure 2 Analyze points for skin parameters

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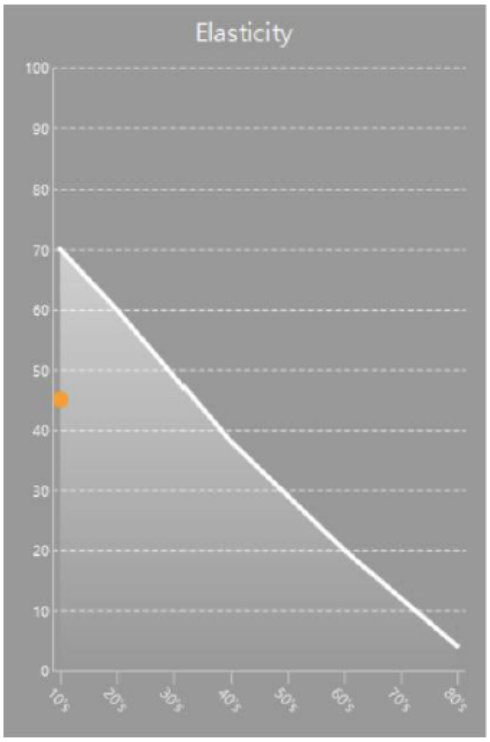
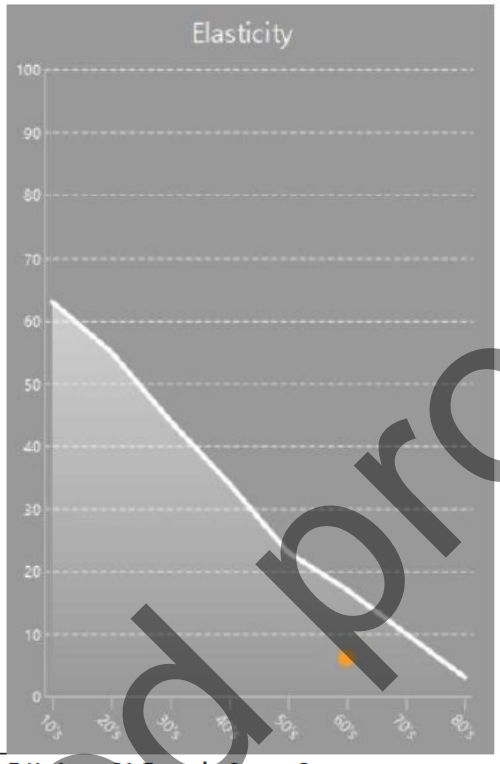


M.B. Age:19 Female Score:45



F.K. Age: 61 Female Score:6

Figure 4 The best and the worst scored elasticity analysis of volunteers

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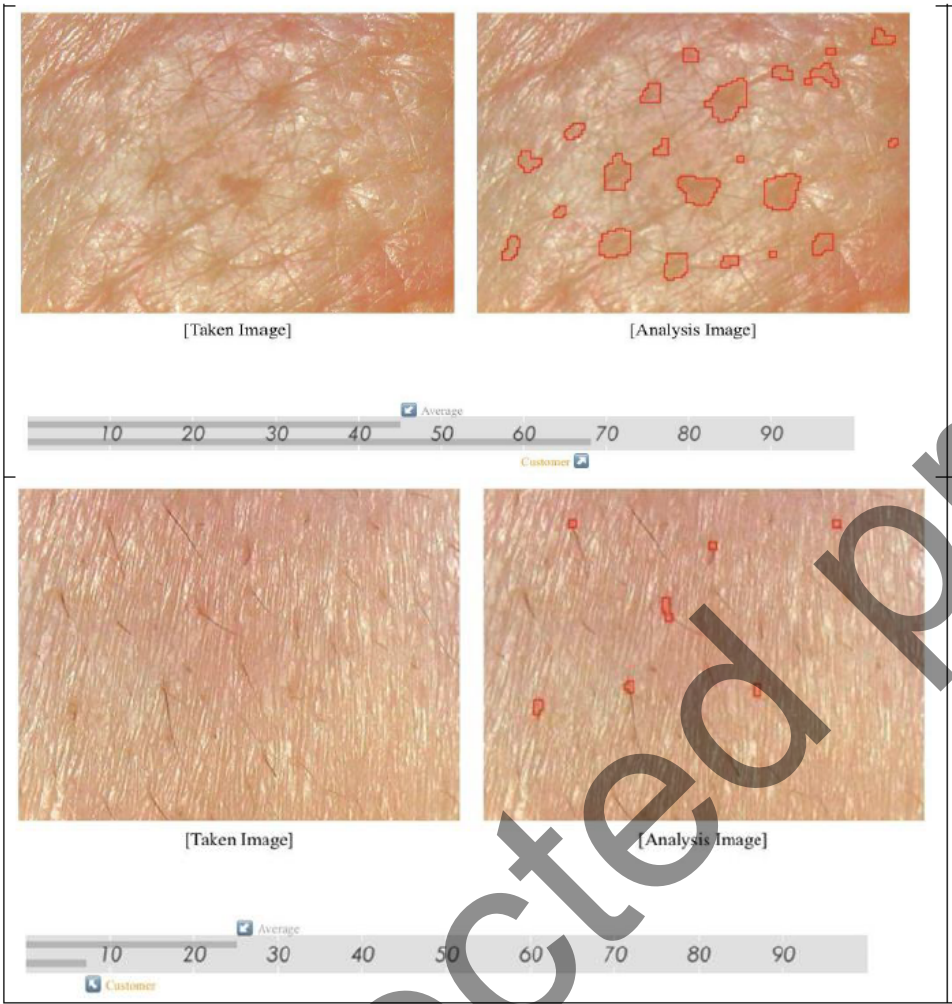

F.K
Age:61
Female
Score:68

N.D.
Age: 32
Female
Score: 7

Figure 5 The best and the worst scored pore analysis of volunteers

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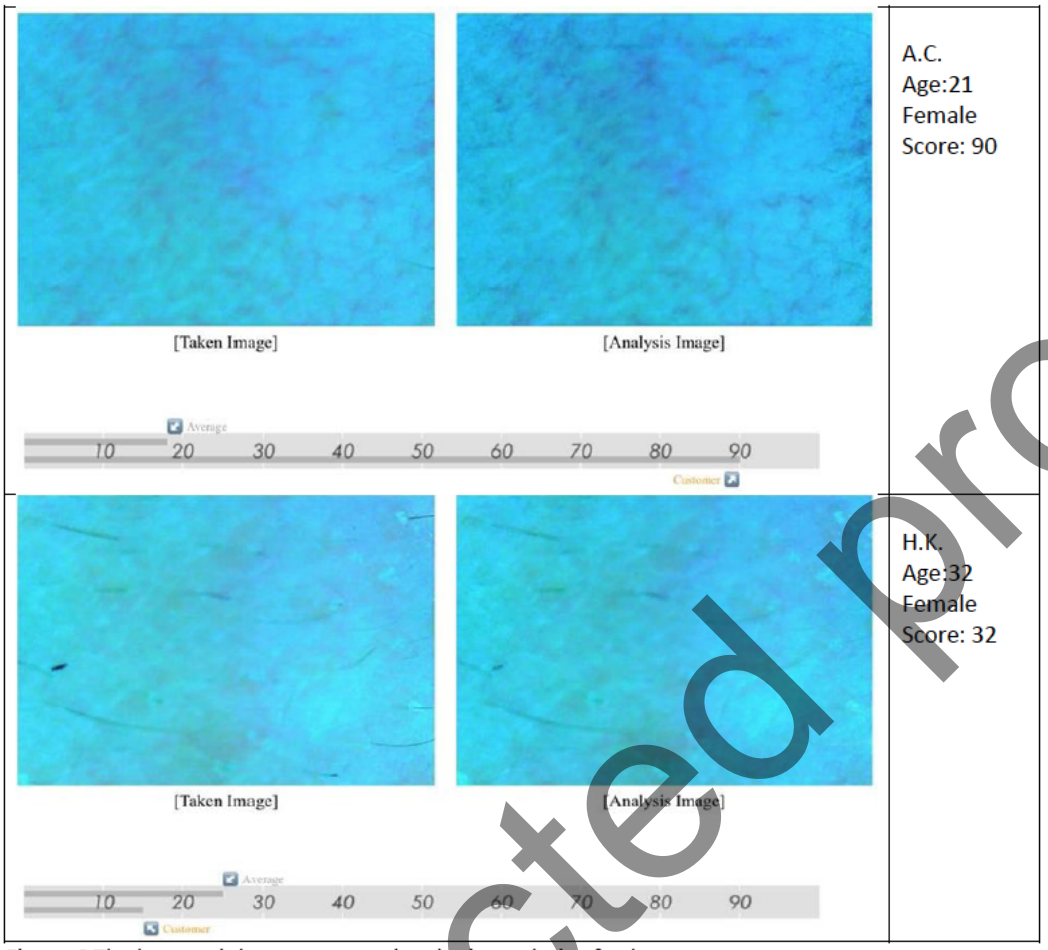

Figure 6 The best and the worst scored melanin analysis of volunteers

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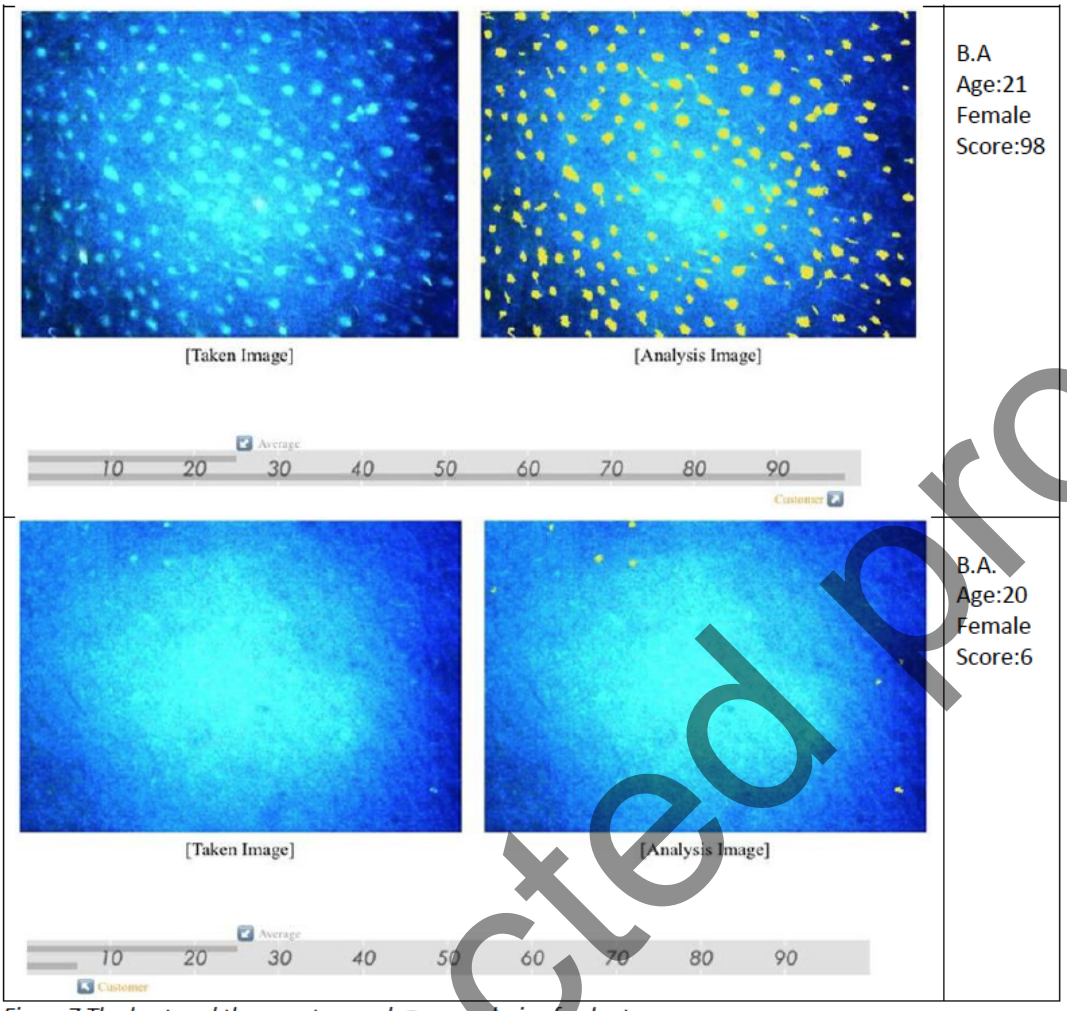

Figure7 The best and the worst scored acne analysis of volunteers

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A.B.
Age:22
Male
Score:98

S.S.
Age:23
Female
Score:2

Figure 8 The best and the worst scored wrinkle analysis of volunteers

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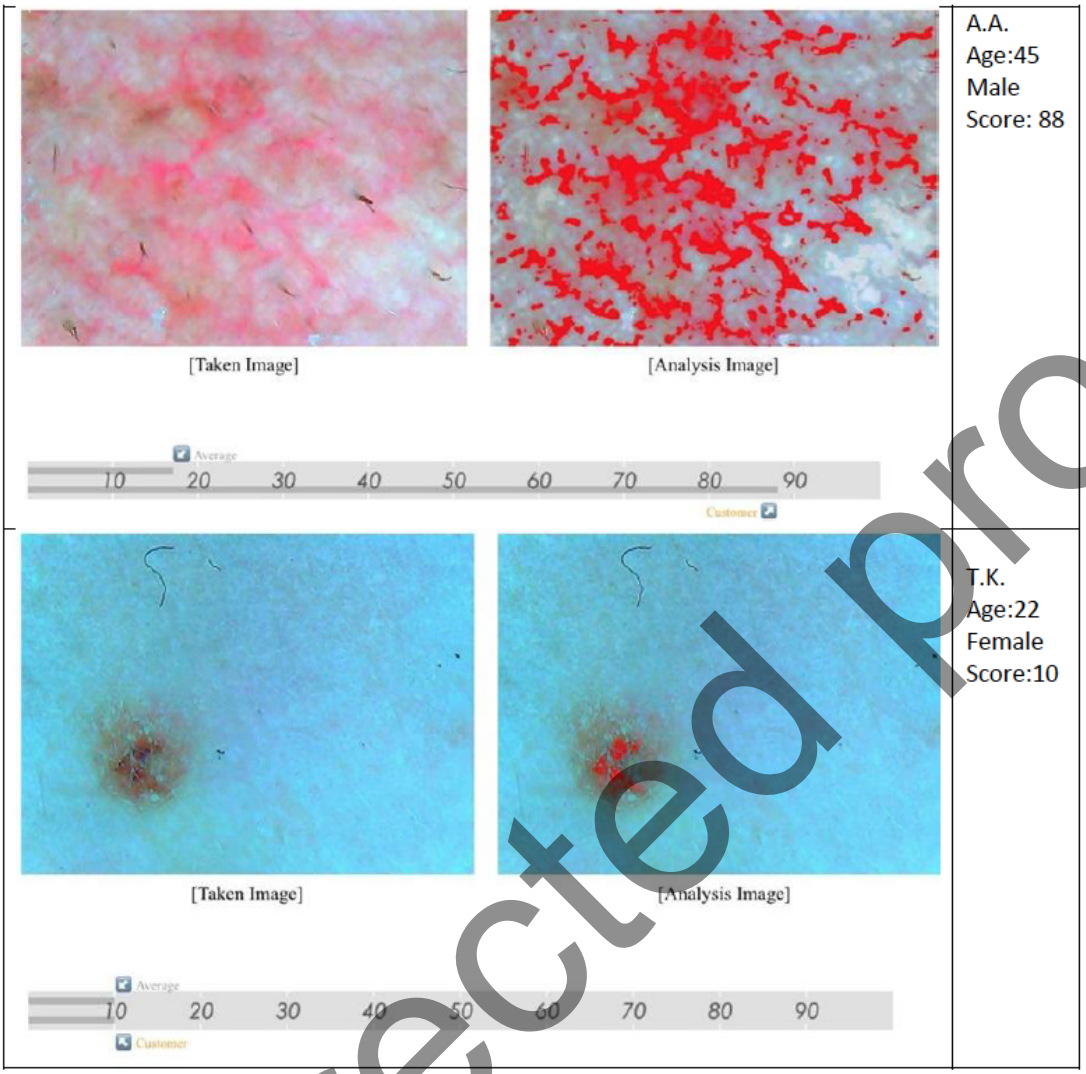

	A.A. Age:45 Male Score: 88
	T.K. Age:22 Female Score:10

Figure 9 The best and the worst scored sensitivity analysis of volunteers

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