The Effectiveness of Several Sunscreen Products in Protecting Skin Exposed to Sun UV Rays

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Abstract

Sunscreen is a skincare product that functions to protect the skin from exposure to ultraviolet (UV) radiation, which can cause skin damage such as premature aging and hyperpigmentation. This study aims to compare the effectiveness and satisfaction level of using three sunscreen products from beauty clinics in Medan City, namely clinic A, clinic B, and clinic C. This study uses a quantitative approach with a quasi-experimental design. The research was conducted at Tjut Nyak Dhien University, Medan, with a total sample of 50 people. Measurements were taken using a Skin Analyzer (Aramo®) device and analyzed using the Paired T-Test to analyze the differences before and after treatment, along with the distribution of questionnaires for respondent satisfaction using the R-Studio software program. The results of the Paired T-Test showed that the negative control group experienced significant changes in all parameters ($p < 0.05$). The sunscreens from clinic A, clinic B, and clinic C also showed varying effectiveness. The sunscreen from clinic C showed significant changes in all parameters ($p < 0.05$), while the sunscreens from clinic A and clinic B did not show significant changes in the sensitivity parameter ($p = 0.131$ and $p = 0.216$, respectively). However, the sunscreen from clinic A had the highest preference score (39.10%).

Keywords: *Effectivity, Skin, Sun, Sunscreen, UV Ray.*

A. INTRODUCTION

People use cosmetics to enhance their appearance, especially women. Excessive exposure to sunlight can cause the skin to become dull, dry, and develop dark spots. In addition, sun exposure can lead to fine lines and loss of skin elasticity (Guan et al., 2021). Therefore, a product that can address these issues is needed.

Sunscreen and sunblock are popular choices among the public. However, these two products have different mechanisms of action. Sunscreen works by being absorbed into the skin so that ultraviolet (UV) rays cannot penetrate the deepest layers of the skin (dermis). The effectiveness of sunscreen is maximized if applied about 15–30 minutes before going outside. Sunblock works by reflecting UV rays so that they do not directly touch the skin. The effectiveness of sunblock provides immediate benefits because it directly forms a physical protection layer on the skin's surface (Araki & Baby, 2025).

Different social groups and backgrounds lead to varying usage of sunscreen in Indonesia. As much as 85.9% of the research report by Fauziyyah et al., (2023) on students at Padjadjaran University used sunscreen with SPF ≥ 15. The research report by Ahnafani et al., (2024) showed that the routine use of sunscreen among high school students in Palangkaraya was 82.8%. However, other studies indicate that sunscreen

use among young adult males tends to decrease. Research by Wadoe et al., (2019) showed that 46.9% of respondents, involving 720 men aged 18–25 years, reported having used sunscreen. From the results of these studies, it can be concluded that sunscreen use is more common among university and high school students, so awareness and compliance need to be improved among young adult males.

One of the largest cities in Indonesia is Medan. Furthermore, Medan has many beauty clinics. A report by Leman & Syahrin, (2024) states that there are 50 beauty clinics in Medan. This indicates that the high public awareness of self-care in Medan is directly proportional to the number of beauty clinics established in the city. Some of the clinics with the most branches in Medan include Clinic A, Clinic B, and Clinic C, which produce sunscreen products with compositions formulated independently according to the standards and characteristics of each clinic. Given the importance of self-care, the objective of this study is to evaluate the effectiveness of several sunscreen products for skin protection from several beauty clinics in Medan.

B. METHODS

1. Population and Sample

The researcher took the population from students of the Faculty of Pharmacy, Universitas Tjut Nyak Dhien, Medan. The selected population also consisted of those who were willing and met the predetermined inclusion criteria. There were 304 students at Universitas Tjut Nyak Dhien.

A portion of the population that can represent the characteristics of the population in a study is called a sample. A total of 50 students who were willing and met the inclusion criteria were selected. The collected sample was a minimum of 30 respondents to analyze parametric and multilevel statistics. Furthermore, one fundamental concept in statistics (the Central Limit Theorem) states that a sample size is considered sufficiently large if the sample is ≥ 30, so that the distribution of the sample mean will tend to be normally distributed (Arachige, 2025; Mursa et al., 2025).

The selected samples were those aged > 18 years who were willing to use sunscreen products on their skin. In addition, respondents were willing to complete a questionnaire and sign an informed consent form. However, samples were rejected as respondents if they were aged < 18 years, or were unwilling to apply sunscreen products to their skin, or were unwilling to sign the informed consent form, or were unwilling to complete the questionnaire.

2. Application of Sunscreen

Products Each respondent used the 3 sunscreen products, estimating a relatively equal volume of sunscreen equivalent to the tip of a mask spatula. This aimed to reflect the actual usage performed by consumers. There were 3 sunscreen products from three clinics, namely Clinic A, Clinic B, and Clinic C.

3. Sample Application

The samples were applied to the inner forearm area, which had been marked to indicate where each sunscreen product would be applied (Figure 1). Each mark measured 2 x 3 cm. After application, the respondents remained indoors to allow the sunscreen to be fully absorbed into the skin. The time required was 5 minutes. Then, the respondents were exposed to sunlight for 7 hours. Afterward, the skin was checked using a skin analyzer (Aramo®), and each indicator was tested, including moisture, elasticity, pores, melanin, and skin sensitivity (Fukumoto et al., 2021).

Figure 1. Application Sites of the Sunscreen Products

4. Data Analysis

The questionnaire was tested for validity and reliability. Then, the total respondent scores were checked for normality to ensure that the total respondent scores were normally distributed. After each test indicator was measured, a paired t-test was performed by comparing the results before and after the testing in this study. Each statistical test was conducted using R-Studio software.

C. RESULTS AND DISCUSSION

1. Validity and Reliability

Testing There were 10 questions given to each respondent. This validity test examined the Pearson correlation with the total score for each question. If the calculated R-value is greater than the significant R-table value, then the question is declared valid (Slamet & Wahyuningsih, 2022) (Table 1).

A total of 10 questions were given to each respondent. The validity test results stated that all questions were valid, so they were suitable for use as a measurement of respondent satisfaction with the tested sunscreen products. Then, it was necessary to conduct a test to ensure that these questions could be measured repeatedly on respondents to produce consistent results. The Cronbach's Alpha method was used in this study, using R-Studio software (Setyaedhi, 2024). An alpha value ≥ 0.70 indicates

successful reliability testing. The alpha value from the satisfaction questionnaire was 0.92, so it was declared reliable.

The function of validity and reliability testing is to ensure the quality of research data, improve the accuracy and objectivity of the research, and reduce measurement errors (SÜRÜCÜ & MASLAKÇI, 2020). Both are critical procedures that must be performed in quantitative research using questionnaires to ensure that the research findings are meaningful, accurate, and trustworthy.

Table 1. Validity Test of the Respondent Satisfaction Questionnaire

Question	Value	
	R-calculated	R-table (0.05)
P1*	0,718	0,631
P2*	0,752	0,631
P3*	0,658	0,631
P4*	0,626	0,631
P5*	0,789	0,631
P6*	0,705	0,631
P7*	0,700	0,631
P8*	0,758	0,631
P9*	0,668	0,631
P10*	0,904	0,631

Note: *=Valid

2. Distribution of Respondent Characteristics

The respondents involved in this study were counted by gender and age. From the calculation results, it can be seen that the majority of respondents participating in this study were females aged 21–23 years (Table 2). A total of 47 respondents (94%) were female, and 47 people (94%) were aged 21–23 years.

From these distribution results, it can be concluded that the interest and concern for skin care using sunscreen among the female group is higher than among males. Research conducted by Hilmi et al., (2022) also highlights that the level of concern among women is higher than among men in terms of skin care. This may occur because of the tendency for men to choose women based on physical appearance, leading women to focus more on skin care (Han et al., 2023). At the age of 21–23 years, these are active final-year university students. At this age, they prioritize skin care to increase their attractiveness to the opposite sex (Li, 2021).

Based on the findings of the study by Sujith, (2024), a tendency for gender differences in the level of concern for skin health was identified. Women show a more dominant level of involvement compared to men. This empirical evidence is clearly reflected in the sample composition of the study, with the proportion of female participants reaching 86%, while male participants accounted for only 14%. This quantitative dominance represents the high level of interest and awareness among

women regarding skin care issues, while also reflecting the social reality in which cosmetic and self-care products are still often dominated by women.

Based on physiological findings from various cross-country studies, it can be concluded that men naturally need and tend to choose self-care products tailored to their distinctive skin characteristics. Not because they are following trends, but as a direct response to skin conditions that have higher sebum production and hydration levels, as well as a tendency toward lower pH compared to women. Men's skin tends to be oilier and have larger pores, thus requiring cleansers that effectively control oil without disrupting the skin's pH. Therefore, men's choice of self-care products is driven by functional needs to address the specific conditions of their skin, which differ from those of women (Rahrovan et al., 2018).

Table 2. Distribution of Respondent Characteristics

Parameters	**Total**
Sex	
Men	3
Women	47
Age	
18 - 20	1
21 – 23	47
24 – 26	1
27 - 29	1

3. Results of Data

Analysis The sunscreen products were tested using a skin analyzer (Aramo®) with predetermined indicators. The effectiveness of the tested products was evaluated by comparing the results before using the product and after using the product followed by exposure to sunlight. The test results were also analyzed statistically using the Paired T-Test approach to see the differences in effectiveness of each sunscreen product across indicators (Table 3). For the moisture indicator, Clinic C showed the smallest decrease in moisture compared to the other sunscreen products. This indicates that Clinic C's product is better able to maintain water content on the skin's surface. Ingredients such as dimethicone act as an emollient that forms an occlusive layer, thereby maintaining skin hydration (Franco-Gil et al., 2024).

For the elasticity indicator, Clinic A produced the highest skin elasticity value after ultraviolet exposure. This advantage is influenced by its content of aloe vera and vitamin E (tocopheryl acetate), which are known to have antioxidant activity and support collagen regeneration processes. The combination of these ingredients helps maintain the integrity of skin tissue more effectively than other sunscreens (Rahman et al., 2017; Rocha et al., 2024).

For the pore indicator, Clinic B showed the smallest pore size after ultraviolet exposure. This advantage is related to the presence of sunflower seed oil, which helps maintain skin hydration without causing pore blockage (Lin et al., 2018). Additionally,

the content of Methylene Bis-Benzotriazolyl Tetramethyl-butylphenol (MBBT) as a broad-spectrum UV filtering agent also plays a role in maintaining the stability of the skin surface structure (Y. Li et al., 2024). For the melanin indicator, Clinic C showed effectiveness in preventing melanocyte stimulation due to UV radiation, resulting in very little melanin production. The benzophenone-3 (oxybenzone) content functions as a UV filter that helps inhibit excessive melanin formation (Wnuk et al., 2022).

For the sensitivity indicator, Clinic A showed the minimal increase in skin sensitivity after ultraviolet exposure. Ingredients such as aloe vera are known to have anti-inflammatory properties and a soothing effect on the skin, thus contributing to reducing the likelihood of irritation or adverse skin reactions following UV exposure (Matei et al., 2025). Each sunscreen product was fully capable of inhibiting physiological changes, as the statistical test results showed significant differences ($p = 0.000$). However, for the sensitivity indicator, Clinic A ($p = 0.131$) and Clinic B ($p = 0.216$) did not show significant changes.

Table 3. Results of the Sunscreen Product Testing

Indicator	Test Sample							
	Negative Control		Clinic A		Clinic B		Klinik C	
	Before	After	Before	After	Before	After	Before	After
Moiisture	43,36	22,72	42,22	31,84	43,02	23,22	42,48	31,16
Paired T-Test	0,000		0,000		0,000		0,000	
Elasticity	48,46	25,98	45,50	34,68	40,56	26,46	42,08	30,04
Paired T-Test	0,000		0,000		0,000		0,000	
Pores	18,12	38,24	16,42	28,98	12,78	25,14	15,86	26,00
Paired T-Test	0,000		0,000		0,000		0,000	
Melanin	35,32	48,28	34,78	45,42	34,78	46,22	35,76	46,18
Paired T-Test	0,000		0,000		0,000		0,000	
Sensitivity	75,18	82,86	76,84	79,70	78,54	80,30	78,64	82,46
Paired T-Test	0,000		0,131		0,216		0,000	

The normality test showed that the total respondent scores were normally distributed, thus meeting the requirements for the use of parametric statistical analysis (Sharma & Jha, 2023). Respondents preferred Clinic A as the most liked sunscreen product (Figure 2). The reason respondents chose this product was the ease of application onto the skin surface. Ease of application of a cosmetic product is one indicator of consumer preference for that product (Rodríguez et al., 2025). Therefore, ease of application of a sunscreen product serves as an indicator of product quality.

According to Sujith, (2024), it can be concluded that consumer preferences in purchasing cosmetic products are dominated by functional considerations and direct experience. Quantitative data reveals that product quality (95.3%) and prior experience (91.6%) are the primary determinants, indicating that consumers prioritize effectiveness and the proven track record of products. In addition, economic and reputational factors also play a significant role, with price (86%) and brand or company reputation (70.1%) being subsequent considerations in the purchase decision hierarchy. Meanwhile, external factors such as dermatological recommendations

(57.9%), climatic conditions (63.6%), and social media influence (62.6%) also contribute to shaping preferences, albeit with a lower level of influence compared to the primary factors. Interestingly, aesthetic factors such as attractive packaging (45.8%) and celebrity endorsements (23.4%) occupy the lowest positions, indicating that consumers tend to be more rational and oriented toward functional value rather than superficial appeal in the cosmetic product selection process.

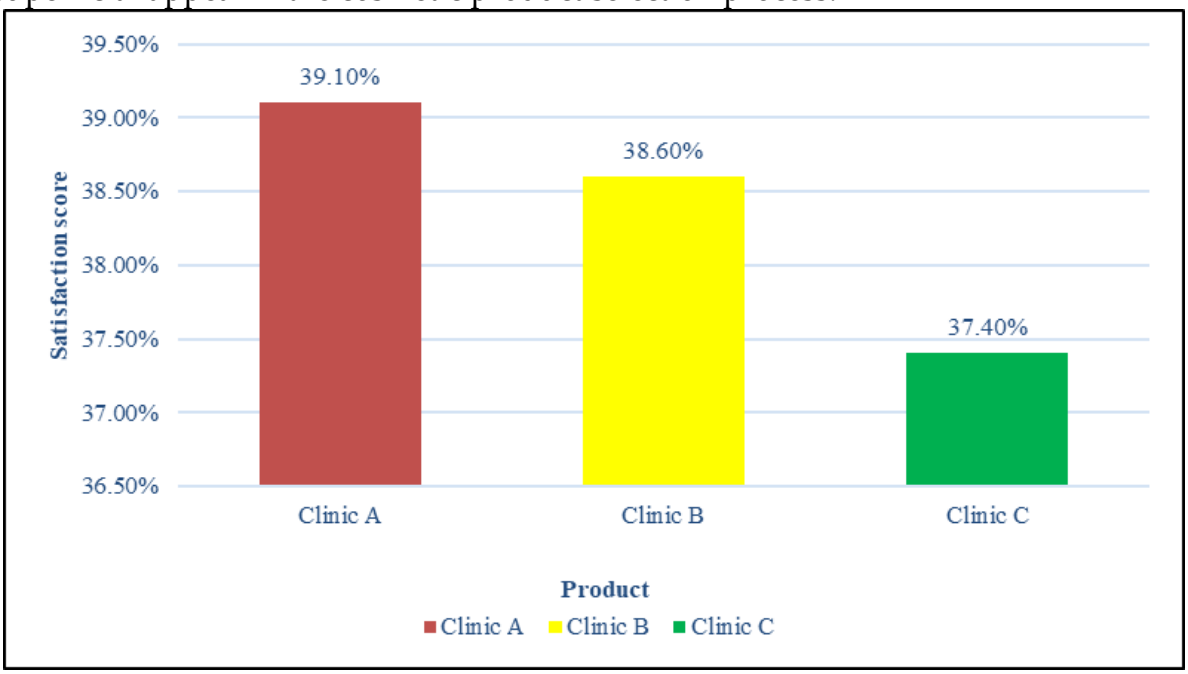

Figure 2. Results of the Respondent Satisfaction Survey on Sunscreen Products

D. CONCLUSION

Based on the objective test results using a skin analyzer (Aramo®), Clinic A's sunscreen showed the most stable performance in maintaining skin moisture, improving elasticity, and reducing skin sensitivity after sun exposure. Clinic A's sunscreen has a balanced composition between effectiveness and safety, with clinically proven UV protection content and additional ingredients that pose minimal risk. From the subjective test results through the questionnaire, respondents were most satisfied with Clinic A's sunscreen, with an average satisfaction score of 39.1%. Clinic A's sunscreen excelled in comfort during use, product texture, and the final result on the skin. This study can be further developed with a larger number of respondents, a longer observation period, and by considering other factors such as skin type, outdoor activities, or environmental conditions where respondents live. Furthermore, the use of more sophisticated measuring instruments or laboratory tests such as in vitro SPF testing could strengthen the objective results of sunscreen effectiveness.

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