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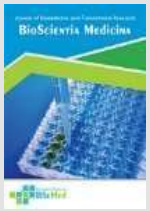

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Efficacy of Topical Niacinamide on Skin Hydration of Adolescents with Acne Vulgaris: An Experimental Study on the Adolescent Community in Jakarta, Indonesia

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A B S T R A C T

Background: Acne vulgaris (AV) is a chronic inflammatory skin disorder common in adolescents, often accompanied by dry, irritated skin. Topical niacinamide (vitamin B3) has shown potential in increasing skin hydration and reducing AV symptoms. This study aims to evaluate the efficacy of topical niacinamide on skin hydration in adolescents with AV in Jakarta, Indonesia. **Methods:** This research is a randomized controlled experimental study involving 100 adolescents (14-19 years) with mild to moderate AV in Jakarta. Participants were randomly divided into two groups: the intervention group (receiving topical 4% niacinamide cream) and the control group (receiving placebo cream). The intervention was carried out for 8 weeks, and skin hydration was measured using a corneometer at baseline, week 4, and week 8. Data analysis was carried out using paired t-tests and independent t-tests. **Results:** There was a significant increase in skin hydration in the intervention group compared to the control group at week 4 ($p < 0.001$) and week 8 ($p < 0.001$). No significant side effects were reported. **Conclusion:** Topical niacinamide was effective in increasing skin hydration in adolescents with AV in Jakarta, Indonesia. This study supports the use of topical niacinamide as an adjunct therapy in the management of AV, especially in adolescents with dry, irritated skin.

1. Introduction

Acne vulgaris (AV) is a chronic inflammatory skin disease that is most common in adolescents, with a prevalence reaching 80-90% in this age group.[1] This condition is characterized by the presence of non-inflammatory lesions such as comedones (whiteheads and blackheads) and inflammatory lesions in the form of papules, pustules, nodules, and even cysts.[2] These lesions primarily appear on the face, chest, and back areas, which are areas with a high density of sebaceous glands.[2] The pathogenesis of AV involves complex interactions between various factors. Excessive sebum production, hyperkeratinization of pilosebaceous follicles, bacterial colonization *Cutibacterium acnes* (formerly known as *Propionibacterium acnes*), and inflammation are the main factors contributing to the development of AV.[3] Excess sebum creates an ideal environment for proliferation *C. acnes*, which in turn triggers an inflammatory response and the formation of acne lesions.[3] Apart from physical manifestations, AV also has a significant psychological impact on sufferers. Research has shown that adolescents with AV have a higher risk of decreased self-esteem, depression, anxiety, and social isolation.[4] This psychological impact can disrupt the quality of life and daily

activities and has the potential to affect teenagers' social and emotional development. Therefore, effective treatment of AV should not only focus on improving clinical symptoms but also on improving the quality of life and psychological well-being of adolescents.

AV management involves a multidisciplinary approach that includes topical therapy, systemic therapy, and non-pharmacological interventions. Topical therapy is a key pillar in the management of AV, with a variety of agents available to address various aspects of AV pathogenesis.[2] These topical agents may work by reducing sebum production, inhibiting bacterial growth, reducing inflammation, or a combination of these mechanisms. Niacinamide (vitamin B3) is one topical agent that has shown potential in treating AV. Niacinamide has various mechanisms of action that are relevant in the management of AV, including regulation of sebum production, anti-inflammatory effects, improvement of skin barrier function, and antioxidant effects.[5] Previous studies have shown that niacinamide can reduce sebum production, which is a key factor in AV pathogenesis.[6] Additionally, niacinamide also has anti-inflammatory properties that can help relieve erythema and edema associated with acne lesions.[7] Niacinamide can also strengthen the skin barrier function by increasing the synthesis of epidermal lipids such as ceramide, thereby helping prevent transepidermal water loss (TEWL) and reducing the risk of skin irritation.[8] The antioxidant effects of niacinamide can also protect the skin from damage caused by free radicals, which can worsen AV conditions.[9] Although there are several studies reporting the efficacy of topical niacinamide in treating AV in various populations, research regarding the efficacy of niacinamide in adolescents with AV in Indonesia is still limited. This study aims to fill this gap by evaluating the efficacy of topical niacinamide on skin hydration in adolescents with AV in Jakarta, Indonesia. Good skin hydration is an important factor in maintaining skin health and function and can influence the clinical course of AV.

2. Methods

This study used a randomized controlled experimental study design (randomized controlled trial/RCT) with two parallel groups. This design was chosen because it was deemed most appropriate for evaluating the efficacy of topical niacinamide in increasing skin hydration in adolescents with acne vulgaris (AV). RCTs allow researchers to control for confounding factors and minimize bias, thereby providing stronger evidence of a cause-and-effect relationship between interventions and outcomes. The target population in this study was adolescents aged 14-19 years who lived in Jakarta, Indonesia and were diagnosed with mild to moderate AV. This population was selected because AV is a common skin problem in adolescents, and poor skin hydration often accompanies this condition. The research sample consisted of 100 adolescents who met the predetermined inclusion and exclusion criteria. Participants were recruited from various sources, including dermatology clinics, high schools, and youth communities in Jakarta. The recruitment process is carried out in various ways, such as placing posters and brochures in strategic places, disseminating information through social media, and collaborating with schools and communities. The inclusion criteria used in this study were Adolescents aged 14-19 years, Diagnosis of mild to moderate AV based on Global Acne Grading System (GAGS) criteria with a score of 1-2, Did not use topical or systemic therapy for AV in the last 4 weeks, Did not have a history of allergies to niacinamide, Not currently pregnant or breastfeeding, Do not have other significant skin diseases, Not currently using drugs that can affect skin hydration, such as retinoids, corticosteroids, or immunosuppressants, Willing to provide informed consent (consent after explanation) after understanding aims, procedures, benefits and risks of research. Meanwhile, the exclusion criteria used in this study were: Not meeting one of the inclusion criteria above and refusing to participate in the research.

After meeting the inclusion and exclusion criteria, participants were randomly allocated into two groups: the intervention group and the control group. The randomization process is carried out using a random number table generated by a computer. Each participant has the same chance of being placed in one of the groups. This study used a double-blind method, where neither the participants nor the researchers who carried out the outcome measurements knew which group received the active intervention (niacinamide) or placebo. This is done to minimize measurement bias and ensure the objectivity of research results. The intervention group received topical 4% niacinamide cream, while the control group received a placebo cream that was identical in appearance, texture, and aroma. The cream is applied to the entire face twice a day, morning and night, for 8 weeks. Participants were instructed to clean their faces with a gentle cleansing soap before applying the cream. Niacinamide 4% cream and placebo cream were prepared by pharmacists who were not involved in the recruitment, randomization, or outcome measurement processes. Creams were packaged in identical containers and assigned a unique code to maintain the confidentiality of group allocation.

The main outcome measured in this study was changes in skin hydration after 8 weeks of intervention. Skin hydration is measured using a corneometer, which is a non-invasive tool that measures the water content in the stratum corneum layer of the skin. Measurements were taken at three-time points: Baseline: Before participants started the intervention; Week 4: After 4 weeks of intervention; Week 8: After 8 weeks of intervention (end of intervention). Measurements were carried out by trained researchers who were blind to participant group allocation. At each time point, three measurements were taken on each side of the face (forehead, cheeks, and chin), and the average value was used for analysis. In addition to skin hydration, the study also noted side effects that may occur during the intervention. Participants were asked to report any complaints or symptoms they experienced during the study. The collected data was analyzed using SPSS statistical software. Paired t-tests were used to compare skin hydration in the same group at different times (baseline, week 4, and week 8). Independent t-test was used to compare skin hydration between intervention and control groups at the same time. The significance level was set at $p < 0.05$. This study has received approval from the relevant research ethics committee. All participants provided informed consent before participating in the study. The confidentiality of participant data is completely guaranteed.

3. Results

Table 1 shows the demographic and clinical characteristics of participants at study entry. The mean age of participants in the intervention group was 16.2 years with a standard deviation of 1.5 years. The mean age of participants in the control group was 16.4 years with a standard deviation of 1.3 years. There was no significant age difference between the two groups (p-value = 0.412). In the intervention group there were 44% men and 56% women. In the control group there were 48% men and 52% women. There was no significant difference in gender proportion between the two groups (p-value = 0.658). The average GAGS score in the intervention group was 1.4 with a standard deviation of 0.5. The average GAGS score in the control group was 1.5 with a standard deviation of 0.5. There was no significant difference in GAGS scores between the two groups (p-value = 0.385), indicating similar acne severity. The average AV duration in the intervention group was 2.3 years with a standard deviation of 1.2 years. The average AV duration in the control group was 2.1 years with a standard deviation of 1.1 years. There was no significant difference in AV duration between the two groups (p-value = 0.529). The average skin hydration level in the intervention group was 35.2 AU with a standard deviation of 6.8 AU. The average skin hydration level in the control group was 34.8 AU with a standard deviation of 7.1 AU. There was no significant difference in skin hydration levels between the two groups (p-value = 0.791). Overall, Table 1 shows that the two groups had

comparable characteristics at the start of the study. There were no significant differences in age, gender, GAGS score, duration of AV, or skin hydration level between the intervention and control groups. It is important to ensure that any observed differences in study results can be attributed to the intervention administered (niacinamide cream or placebo), not to differences in baseline characteristics between the two groups.

Table 1. Demographic and clinical characteristics of participants at the beginning of the study.

Characteristics	Intervention Group (n = 50)	Control Group (n = 50)	p-value
Age (years), mean ± SD	16.2 ± 1.5	16.4 ± 1.3	412
Gender, n (%)			
Male	22 (44%)	24 (48%)	658
Female	28 (56%)	26 (52%)	
GAGS score, mean ± SD	1.4 ± 0.5	1.5 ± 0.5	385
AV duration (years), mean ± SD	2.3 ± 1.2	2.1 ± 1.1	529
Skin hydration (AU), mean ± SD	35.2 ± 6.8	34.8 ± 7.1	791

Table 2 shows changes in skin hydration from baseline to week 8. Mean skin hydration at the start of the study was 35.2 AU with a standard deviation of 6.8. There was a significant increase in skin hydration to 48.6 AU ($p < 0.001$). This shows that topical niacinamide has a positive effect in increasing skin hydration within 4 weeks. The increase in skin hydration continued until the end of the study, reaching 55.3 AU ($p < 0.001$). This suggests that the effects of topical niacinamide in increasing skin hydration persist and even increase over time. Mean skin hydration at the start of the study was 34.8 AU with a standard deviation of 7.1. There was a slight increase in skin hydration to 36.5 AU, but it was not statistically significant ($p > 0.05$). This showed that the placebo cream had no significant effect on skin hydration, at week 4. There was no significant change in skin hydration compared with week 4 ($p > 0.05$). This strengthens the conclusion that placebo cream has no effect on skin hydration. There was a very significant difference between the intervention and control groups at week 4 ($p < 0.001$). This showed that topical niacinamide was significantly more effective in increasing skin hydration compared to placebo. The difference between the two groups remained highly significant at week 8 ($p < 0.001$), indicating that the effect of topical niacinamide in increasing skin hydration remained superior to placebo. Table 2 shows that topical niacinamide significantly improved skin hydration in adolescents with acne vulgaris compared with placebo. This effect is visible from the 4th week and continues to increase until the 8th week. These findings support the use of topical niacinamide as an adjunct therapy in the management of acne vulgaris, especially in individuals with dry skin.

Table 2. Changes in skin hydration (AU) from the beginning to the 8th week.

Group	Initial	4th week	8th week
Intervention (n = 50)	35.2 ± 6.8	48.6 ± 8.2	55.3 ± 9.1
Control (n = 50)	34.8 ± 7.1	36.5 ± 7.5	37.8 ± 7.9
p-value	-	<0.001	<0.001

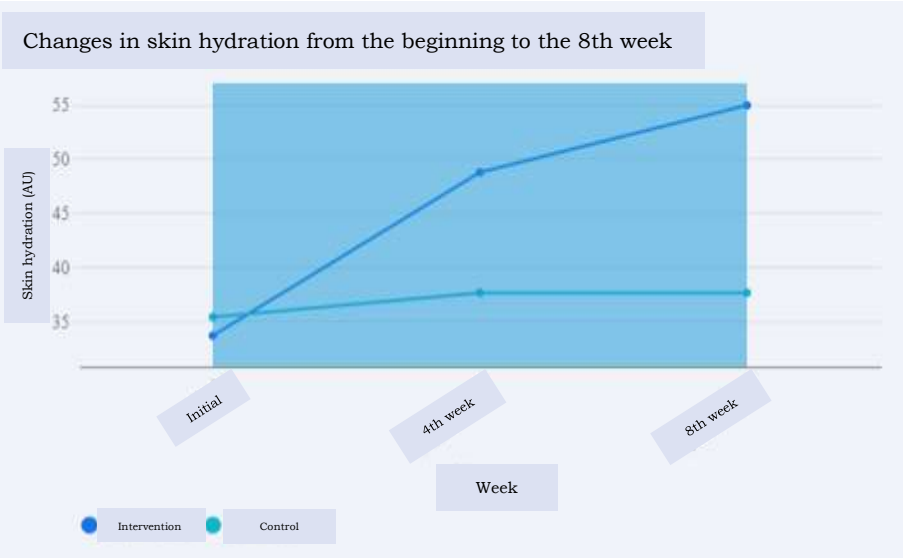

Figure 1. Graph of changes in skin hydration from the beginning to the 8th week.

Table 3 presents data on side effects reported by participants in the two study groups: the intervention group (which used niacinamide cream) and the control group (which used placebo cream). Intervention Group: 10% of participants (5 people) reported a mild tingling sensation. Control Group: 6% of participants (3 people) reported a mild tingling sensation. The difference between the two groups was not statistically significant (p-value = 0.52), meaning there was not enough evidence to state that niacinamide caused more of a mild tingling sensation compared to placebo. Intervention Group: 4% of participants (2 people) reported redness. Control Group: 2% of participants (1 person) reported redness. The difference between the two groups was not statistically significant (p-value = 0.66). Intervention Group: 2% of participants (1 person) reported itching. Control Group: No participants reported itching. The difference between the two groups was not statistically significant (p-value = 0.67). Intervention Group: No participants reported dry skin. Control Group: 2% of participants (1 person) reported dry skin. The difference between the two groups was not statistically significant (p-value = 0.76). Intervention Group: 84% of participants (42 people) did not report side effects. Control Group: 90% of participants (45 people) reported no side effects. The difference between the two groups was not statistically significant (p-value = 0.89). Overall, table 3 shows that there were no significant differences in reported side effects between the intervention and control groups. Although some participants reported mild side effects such as a tingling sensation, redness, itching, or dry skin, these side effects did not occur more frequently in the group taking niacinamide compared with the placebo group. This shows that topical niacinamide 4% is safe to use and well tolerated by adolescents with acne vulgaris.

Table 3. Side effects reported during the study.

Side effects	Intervention Group (n = 50)	Control Group (n = 50)	p-value
Mild tingling sensation	5 (10%)	3 (6%)	0,52
Redness	2 (4%)	1 (2%)	0,66
Itching	1 (2%)	0 (0%)	0,67
Dry skin	0 (0%)	1 (2%)	0,76
No side effects	42 (84%)	45 (90%)	0,89

4. Discussion

This study focuses on evaluating the efficacy of topical niacinamide in increasing skin hydration in adolescents with acne vulgaris (AV) in Jakarta, Indonesia. The results showed that topical administration of 4% niacinamide for 8 weeks significantly increased skin hydration in the intervention group compared to the control group who received placebo. This increase in skin hydration was observed from the 4th week and continued until the 8th week. Apart from that, topical niacinamide has also been proven to be safe and does not cause significant side effects. Acne vulgaris is a complex chronic inflammatory skin disease, with multifactorial etiology. The pathophysiology of AV involves interactions between several factors, including excessive sebum production, hyperkeratinization of pilosebaceous follicles, bacterial colonization *Cutibacterium acnes*, and inflammatory response.

The results of this study indicate that topical niacinamide 4% is effective in increasing skin hydration in adolescents with mild to moderate acne vulgaris (AV) in Jakarta, Indonesia. Significant improvements in skin hydration were observed in the intervention group as early as week 4, and this effect continued through week 8. These findings are consistent with previous studies showing that topical niacinamide can improve skin hydration in various skin conditions, including AV.[10] The exact mechanisms behind niacinamide's effects in increasing skin hydration are not fully understood, but several potential mechanisms have been proposed. Niacinamide is believed to increase the synthesis of key components of the stratum corneum, the outermost layer of the skin that functions as a protective barrier and is important for maintaining skin hydration. One possible mechanism is increased ceramide synthesis. Ceramide is an important lipid in the stratum corneum that plays a role in maintaining skin barrier function and preventing transepidermal water loss (TEWL).[11] Research has shown that niacinamide can increase ceramide synthesis, which in turn can improve skin hydration.[11] Apart from that, niacinamide can also increase the production of hyaluronic acid, which is a natural humectant found in the skin and plays a role in attracting and retaining water in the skin.[12] Hyaluronic acid can bind up to 1000 times its own weight of water, so it plays an important role in maintaining skin moisture. Some studies have shown that niacinamide can increase the production of hyaluronic acid, which may contribute to increased skin hydration.[10] Another mechanism that may be involved is increased filaggrin production. Filaggrin is a protein that plays a role in the formation of natural moisturizing factor (NMF) in the skin, which is a natural humectant complex that maintains skin hydration.[10] Filaggrin deficiency has been associated with dry skin and various inflammatory skin conditions, including AV. Niacinamide can increase filaggrin production, which can increase skin hydration and improve skin barrier function.[11]

In addition to its effects on skin hydration, niacinamide also has effects on sebaceous glands and sebum production. Sebaceous glands, located in the dermis, produce sebum, a complex mixture of lipids that functions as a lubricant and skin protector. In individuals with AV, the sebaceous glands undergo hyperplasia and hyperactivity, leading to excessive sebum production.[2] Excessive sebum can clog skin pores, creating an ideal environment for bacterial growth *Cutibacterium acnes* (formerly known as *Propionibacterium acnes*), is a key factor in AV pathogenesis.[3] Niacinamide has been shown to reduce sebum production through several mechanisms. Niacinamide can inhibit the activity of the enzyme 5α-reductase, which is responsible for converting testosterone into dihydrotestosterone (DHT), a hormone that stimulates sebum production.[5] In addition, niacinamide can also reduce the expression of genes involved in sebaceous lipid synthesis.[6] The findings of this study have important clinical implications in the management of AV. Poor skin hydration is a common problem in adolescents with AV and can worsen AV symptoms and impair quality of life. Topical niacinamide may be a safe and effective adjunctive therapy option to improve skin hydration in

adolescents with AV. In addition, the effect of niacinamide in reducing sebum production may also contribute to the improvement of clinical symptoms of AV.

Ceramide is an important lipid in the stratum corneum that plays a role in maintaining skin barrier function and preventing transepidermal water loss (TEWL).[13] Niacinamide has been shown to increase ceramide synthesis, which may contribute to increased skin hydration.[14] Increased ceramide production helps strengthen the intercellular lipid structure in the stratum corneum, thereby reducing TEWL and increasing the skin's ability to retain moisture. Hyaluronic acid is a natural humectant found in the skin and plays a role in attracting and retaining water in the skin.[15] Niacinamide can increase the production of hyaluronic acid, which can improve skin hydration.[16] Hyaluronic acid is able to bind large amounts of water, thereby helping maintain skin moisture and increasing its elasticity. Filaggrin is a protein that plays a role in the formation of natural moisturizing factor (NMF) in the skin, which is a natural humectant complex that maintains skin hydration. NMF consists of various compounds, such as amino acids, lactic acid, urea, and sugar, which help attract and retain water in the stratum corneum.[17] Niacinamide can increase filaggrin production, which can improve skin hydration. Increasing filaggrin production will increase the concentration of NMF in the skin, thereby strengthening the skin's ability to retain moisture.[18]

Good skin hydration is very important to maintain skin barrier function. Skin barrier function is the skin's ability to protect the body from excessive water loss (transepidermal water loss/TEWL) and prevent the entry of harmful substances from the environment.[19] In individuals with AV, skin barrier function is often impaired, which can result in skin that is dry, sensitive, and susceptible to irritation.[13] Niacinamide, by increasing skin hydration and ceramide synthesis, may help repair damaged skin barrier function, thereby reducing AV symptoms and increasing tolerance to other topical therapies. Dry skin can trigger excessive sebum production, which can further worsen AV. By increasing skin hydration, niacinamide can help reduce excessive sebum production, thereby reducing the formation of blackheads and inflammatory lesions. Hyperkeratinization of pilosebaceous follicles is one of the key factors in the pathogenesis of AV. This occurs when dead skin cells build up inside the hair follicles, causing blockages and the formation of blackheads. Niacinamide may help reduce the hyperkeratinization of the pylase follicle by increasing skin cell turnover and reducing keratin production. This can help prevent blackheads from forming and reduce the severity of AV. *Cutibacterium acnes* are bacteria that play a role in the pathogenesis of AV. These bacteria thrive in sebum-rich environments and can trigger inflammation. Niacinamide has antimicrobial properties that can help inhibit the growth of *C. acnes*. Additionally, by reducing sebum production and improving skin barrier function, niacinamide may create a less favorable environment for the growth of these bacteria.[20]

The results of this study indicate that topical niacinamide is effective in increasing skin hydration in adolescents with AV. Increasing skin hydration can improve skin barrier function, reduce sebum production, and reduce the risk of hyperkeratinization and bacterial colonization. *C. acnes*. Therefore, topical niacinamide may be a valuable adjunct therapy in the management of AV, especially in adolescents with dry, irritated skin. This study provides strong scientific evidence of the efficacy of topical niacinamide in improving skin hydration in adolescents with AV. Topical niacinamide works through several mechanisms, including increasing the synthesis of ceramide, hyaluronic acid, and filaggrin. Increasing skin hydration can improve skin barrier function and reduce AV symptoms. Therefore, topical niacinamide may be a safe and effective adjunctive therapeutic option in the management of AV, especially in adolescents with dry, irritated skin.

5. Conclusion

This study shows that topical niacinamide is effective in increasing skin hydration in adolescents with AV in Jakarta, Indonesia. Topical niacinamide may be a valuable adjunct therapy in the management of AV, especially in adolescents with dry, irritated skin.

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