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THE EFFECT OF VITAMIN C INTAKE ON SKIN MOITURE IN YOUNG ADULTS

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Abstract :
a) Background: In Indonesia, the prevalence of dry skin ranges from 50% to 80%. Data from the dr. Cipto Mangunkusumo Hospital (RSCM) in Jakarta, collected between 2008 and 2013 by the geriatric division of the dermatology and venereology outpatient clinic, showed dry skin to be among the top ten most common diseases, **b) Objective:** This study aimed to investigate the effect of Vitamin C on skin moisture in young adult subjects, **c) Method:** This quasi-experimental, one-group pretest-posttest study involved 60 medical students (aged 19–29) at Maranatha Christian University, Bandung, stratified by gender. Skin barrier function was assessed by measuring Transepidermal Water Loss (TEWL) with a Skin Moisture Analyzer FCM-1 at baseline and post-intervention. Total Vitamin C intake, including supplementation and diet, was quantified via a Food Frequency Questionnaire (FFQ) and analyzed using Nutrisurvey 2007. This design allowed for the longitudinal analysis of TEWL variations relative to Vitamin C consumption within a single cohort., **d) Results:** The research variable was the effect of Vitamin C intake on skin moisture. Statistical analysis using the paired T-test yielded a p-value of <0.001 in the young adult group, indicating a significant difference in skin moisture before and after Vitamin C intake. **e) Conclusion:** There is an effect of Vitamin C intake on skin moisture in young adults.

Key words: quasi experimental study; skintue; Vitamin C; xerosis; young adults

Introduction

The skin constitutes the body's largest organ, executing the crucial function of a protective barrier against various environmental hazards, including ultraviolet radiation, temperature extremes, and fluctuations in ambient humidity (1, 2). A fundamental measure of skin integrity and health is its hydration level. Xerosis, or clinically dry skin, is defined by inadequate water content within the stratum corneum (SC), the outermost epidermal layer (3). Optimal skin function requires the SC to maintain approximately 30/ water. When water content falls critically below the 10\% threshold, typically due to excessive evaporation, it results in an increase in Transepidermal Water Loss (TEWL) (3). Elevated TEWL measurements are consequently utilized as a reliable, objective metric for quantifying a compromised skin barrier and reduced SC hydration (4). The maintenance of the skin barrier is non-negotiable for overall physiological well-being, and its dysfunction, frequently presenting as xerosis, is a widespread dermatological concern.

Skin moisture and TEWL values are not uniform across populations but are modulated by a confluence of variables, notably geographical climate, chronological age, and biological sex (5). For instance,

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observed differences exist between genders, with certain investigations reporting higher baseline skin moisture in females compared to males (6).

The Republic of Indonesia, characterized by a tropical climate, consistently reports a high incidence of skin disorders, affecting an estimated 20\% to 80\% of the population (7). Specifically, the national prevalence of dry skin is significant, ranging between 50% and 80%. The clinical importance of this condition is evident in institutional data: between 2008 and 2013, the Geriatric Division of Dermatology and Venereology at Dr. Cipto Mangunkusumo Hospital (RSCM) in Jakarta classified dry skin as one of the ten most prevalent diseases recorded in their outpatient clinic (3). Although most dermatological conditions, including xerosis, are not life-threatening, their non-lethal nature often leads to them being underestimated and inadequately managed by affected individuals (8). This neglect can have tangible negative consequences, substantially impairing daily activities and degrading the quality of life if appropriate intervention is withheld (9). Consequently, a better understanding of preventable factors influencing common conditions like xerosis is vital for public health initiatives. Dietary intake of fruits and vegetables provides essential micronutrients, including a wide array of vitamins and minerals. Vitamin C, or ascorbic acid, stands out as a crucial nutrient for skin health (10). Its biological significance lies in its dual functionality: it operates as a potent, water-soluble antioxidant, neutralizing damaging free radicals generated by environmental stress, and serves as an obligatory cofactor for enzymes involved in the biosynthesis of collagen (5). Collagen is the primary protein responsible for providing the skin's structural integrity, firmness, and elasticity. Healthy skin naturally accumulates high concentrations of this vitamin, with the epidermis typically harboring concentrations of approximately 64\text{ mg}/100 \text{ grams} (5). Crucially, the human body lacks the necessary enzyme to synthesize ascorbic acid, making its daily acquisition through nutritional sources or supplementation an absolute requirement (11).

Despite its necessity, there are widespread shortfalls in Vitamin C consumption. Recommended Dietary Allowances (RDAs) generally advise an intake of 50 to 90 mg/day for adult males and 50 to 75 mg/day for adult females (12). However, national data from Indonesia's 2018, Basic Health Research (Riskesdas) revealed that an alarming 95.5 % of the adult population did not meet the recommended daily intake of fruits and vegetables (13). This prevalent dietary deficit presents a compounding factor that could exacerbate the high rates of xerosis observed in the country.

Previous clinical research on xerosis and nutritional interventions has predominantly focused on the elderly, a

group inherently susceptible to dry skin due to age-related compromises in barrier function, reduced moisture retention capacity, and impaired antioxidant defenses (5). This study, however, opts to focus on the young adult demographic. This cohort is selected for its potentially higher physiological responsiveness to nutritional modifications and its capacity for rapid adaptation compared to older populations. The findings in this younger, more resilient group can establish baseline evidence for the efficacy of early nutritional intervention as a preventative strategy.

Existing literature on the link between oral Vitamin C and skin moisture yields inconsistent results, particularly when comparing different age cohorts. For instance, studies on middle-aged and older subjects (40 to 65 years) have failed to find a significant association (15). In contrast, research on subjects aged 30 to 45 years receiving 54 mg of Vitamin C daily demonstrated a clear benefit, significantly increasing both collagen production and skin moisture (16). The diminished efficacy observed in older groups is likely attributable to cumulative age-related factors, such as sustained environmental stress, reduced nutrient absorption, and the natural decline of SC hydration mechanisms (15, 17).

Given these complexities and the need to validate the role of nutrition in skin hydration in a responsive population, this quasi-experimental research was conceived. The study was executed in Bandung, West Java, an area characterized by a cool, mountainous climate, further contextualizing the environmental factors influencing the subjects (14). The analysis specifically utilized Vitamin C intake, encompassing both dietary (fruit and vegetable) and supplemental sources. This research was designed with the sole and specific aim, to investigate the relationship between the level of Vitamin C intake and skin moisture in young adults.

Method

This research employed a quasi-experimental analytic design. to investigate the effect of vitamin C supplementation and nutritional education on skin moisture. The study was conducted at Maranatha Christian University from March 2022 to April 2023. The study's target population consisted of Medical Faculty students aged 19–29 years at Maranatha Christian University. Research subjects were selected from this population based on specific inclusion and exclusion criteria. The inclusion criterion for participation was being a young adult aged 19–29 years. Exclusion criteria were applied to ensure the validity of the intervention and

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outcomes, specifically, use of oral retinoids or oral steroids within 6 months prior to the study, use of topical retinoids or cosmetic products for skin moisturization within 3 months prior to the study., and undergoing skin care therapy within 3 months prior to the study, experiencing skin irritation or allergies, currently ill or pregnant, consumption of systemic medications, history of severe gastritis or peptic ulcers, excessive alcohol consumption, history of chronic skin diseases, lack of willingness to participate, demonstrated by the absence of informed consent.

The sample size was determined using the formula for the Paired T-test and resulted in a total of 60 participants. The sampling technique used was purposive sampling, selecting subjects who met all the established criteria. Vitamin C intake was measured in grams and was sourced from both food sources and supplementation. The dietary vitamin C intake was determined using a validated Food Frequency Questionnaire (FFQ), which listed common food sources of vitamin C. The FFQ data was subsequently analyzed using the Nutrisurvey-2007 program. Vitamin C derived from supplementation was added to this figure. Previous research suggests that vitamin C intake, essential for its antioxidant role and collagen formation, should ideally be increased by 300–500% of the daily requirement, corresponding to 150–450 mg/day (18). The study protocol was reviewed and approved by the Research Ethics Committee (KEP) of the Faculty of Medicine, Maranatha Christian University, Bandung, Indonesia (Protocol Number: 084/KEP/VII/2022). The research was conducted in strict accordance with the ethical principles of the Declaration of Helsinki. All participants were fully informed regarding the study's objectives, procedures, and potential risks. Written informed consent was obtained from all individual participants included in the study prior to the commencement of the intervention. Data confidentiality was maintained throughout the research process.

The research subjects were administered Protecal C200 (200mg Vitamin C), taken once daily for a period of 4 weeks (21). The product has a BPOM (Indonesian National Agency of Drug and Food Control) registration number: SD201581551. The selection of a 200 mg daily dosage of Vitamin C for enhancing skin moisture in young adults is strategically grounded in the principle of biochemical saturation. Unlike higher pharmacological doses, a 200 mg intake aligns with the physiological threshold at which human plasma and cellular levels reach near-maximal concentration.

Research in nutritional pharmacokinetics indicates that at this specific dosage, the bioavailability of ascorbic acid remains high, whereas doses exceeding 500 mg to 1,000 mg often result in a significant decrease in absorption

efficiency and a proportional increase in urinary excretion.

In the context of dermatological health, 200 mg provides a sufficient substrate to support the hydroxylation of proline and lysine residues, a critical enzymatic step in collagen biosynthesis. By maintaining optimal collagen density, the skin's structural integrity is fortified, which in turn enhances its transepidermal water loss (TEWL) regulation and natural moisturizing factor (NMF) production. Furthermore, this dosage effectively bolsters the skin's antioxidant defense system without inducing the pro-oxidant risks sometimes associated with megadoses.

Daily adherence to the supplementation was monitored by the researcher through WhatsApp messages, and the remaining supplements were counted weekly to ensure compliance with the prescribed dosage. The FFQ procedure required subjects to self-administer the questionnaire under the direct supervision of the researcher. Participants recalled the frequency of consuming the listed foods over the last one month, choosing options such as 'rarely or never', 'once or twice a month', or specific days per week (1, 2, 3, 4, 5, 6, 7 days per week). Information regarding the amount consumed was also recorded by specifying the daily serving size for each food item equating to two measuring units. Food portions were determined by referencing a food photo book (20).

Upon completion of the treatment period, subjects filled out the FFQ again, recalling their intake over the last four weeks. Daily, weekly, or monthly vitamin C intake from food sources was then calculated and converted to grams/day. Food sources not found in the Nutrisurvey-2007 program were manually entered into the software using data from the USDA Food Composition (22). Skin moisture was assessed by measuring the Transepidermal Water Loss (TEWL) using a Skin Moisture Analyzer FCM-1. The measurement was expressed in percent (%) and compared between the baseline (pre-intervention) and one month after the balanced nutrition diet education and 200mg vitamin C supplementation. The skin moisture results were also analyzed separately based on gender (male and female) (6).

The procedure for measuring skin moisture was carried out by the researcher at the Faculty of Medicine, Maranatha Christian University. Prior to measurement, the skin was not to be washed or treated with any topical substances. The TEWL measurement was performed on the face. The Skin Moisture Analyzer FCM-1 was held vertically on the designated measurement

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area. The device automatically started measuring upon contact with the skin. The measurement duration was 10 seconds, after which the value of the skin barrier function (TEWL) was displayed. The examination of Transepidermal Water Loss (TEWL), which served as the objective measure for skin moisture, was conducted by a combination of personnel.

The baseline skin moisture test (pre-intervention) was performed solely by the researcher following the completion of the initial Food Frequency Questionnaire (FFQ). However, the final skin moisture test (post-intervention) was conducted by the researcher and a team of dermatologists. The procedure for measuring skin moisture was consistently carried out at the Faculty of Medicine, Maranatha Christian University a detailed explanation of the research's objectives, procedures, and potential benefits, and subsequently provided informed consent to participate. Before the intervention began, the subjects, under the researcher's supervision, completed the initial FFQ detailing their vitamin C-containing food intake over the last month, measured in servings. Following the FFQ, the researcher performed the baseline skin moisture test using the Skin Moisture Analyzer FCM-1 and recorded the results for each participant. The intervention period spanned 4 weeks, during which the subjects were given the Protecal C200 (200mg Vitamin C) supplementation to be taken once daily (21). Daily reminders and weekly compliance checks were conducted as described in the supplementation protocol. After the 4-week treatment period, the subjects completed a second FFQ detailing their vitamin C intake over the preceding four weeks. The researcher and a team of dermatologists then conducted the final skin moisture test using the Skin Moisture Analyzer FCM-1 and recorded the results.

Data processing and analysis were performed using Microsoft Excel and the SPSS software version 25. Skin moisture data before and after the intervention were analyzed in relation to vitamin C intake. Both variables were numerical data that were confirmed to be normally distributed (p-value > 0.05) based on the Kolmogorov-Smirnov test. The collected data were statistically analyzed using the Paired T-test with a significance level of \alpha = 0.05. Data processing and analysis were performed using Excel and SPSS version 25 software. Data on skin moisture levels before and after were then analyzed in relation to vitamin C intake levels. Both variables were normally distributed numerical data (p-value > 0.05) based on the Kolmogorov-Smirnov test. The collected data were analyzed using a paired t-test with $\alpha = 0.05$.

Results

A quasi-experimental approach was used to investigate how young adults' intake of vitamin C affected skin moisture. The research participants filled out a vitamin C

intake questionnaire, had a skin moisture check, then received instruction and another skin moisture test after one month of treatment. For men over 10 years old, the suggested vitamin C intake according to the Ministry of Health 2019 is 50–90 mg per day; for women over 10 years old, it is 50–75 mg per day. Table 4.1 shows the comparison of average vitamin C intake before and after treatment, separated by gender.

Table 4.1 Summary of Average Vitamin C Intake Results Before and After Treatment

Gender	Before Treatments (grams/day)	After Treatments (gram/hari)	Total (n)	*p value*
Women	163,68	371,78	30	<0,001
Men	147,09	313,72	30	<0,001
Total			60	

Uji Chi-Square; p = 0.000 (<0.05). PR = *Progesterone Receptor*.

Table 4.1 demonstrates a statistically significant increase in Vitamin C consumption across both gender groups following the intervention ($p < 0.001$). Baseline mean intakes were recorded at 147.09 mg/day for men and 163.68 mg/day for women; these increased to 313.72 mg/day and 371.78 mg/day, respectively, post-treatment.

Qualitative data from the Food Frequency Questionnaire (FFQ) identified guava, lemon, and papaya as primary fruit sources, while water spinach, bean sprouts, and Chinese cabbage were the most frequently consumed vegetables result in a plateau effect where intestinal absorption decreases and renal excretion increases significantly. By targeting this intermediate threshold, the study ensures optimal bioavailability and intracellular efficacy, particularly for collagen synthesis and antioxidant defense within the epidermis while avoiding the confounding variables of gastrointestinal intolerance or the diminished metabolic returns associated with supra optimal supplementation.

Consequently, this dosage provides a precise physiological window to observe the vitamin's impact on Transepidermal Water Loss (TEWL) and skin barrier integrity. The data collected revealed that the most often eaten fruits were guava, lemon, papaya, and

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banana; the most consumed veggies were water spinach, bean sprouts, Chinese cabbage, and carrot.

Table 4. 2 Comparison of Skin Moisture Before and After Vitamin C Intake

Gender	Before Treatment	After Treatment	Grand Total (n)	*p value*
Women	33,60	37,90	30	<0,001
Men	33,16	36,36	30	<0,001
Total			60	

In Table 4.2, the results of the skin test on women before treatment showed an average of 34%, and after treatment, it was 38%. For men, the average skin test results before treatment were 33%, and after treatment, it was 36%. Skin moisture levels of 34–37% are classified as dry skin, 38–42% as normal skin, and 43–46% as moist skin. The average skin moisture level after treatment was higher than before treatment. The classification of skin moisture levels before and after vitamin C supplementation was differentiated based on gender. After performing a normality test on the data, the result was $p > 0.05$, so data analysis using a paired t-test could be conducted. The results of the paired t-test in Table 4.2 showed that in women, the effect of vitamin C intake on skin moisture yielded a p-value < 0.001. This indicates a highly significant difference between skin moisture levels before and after vitamin C supplementation, with skin moisture levels increasing after treatment.

The results of the statistical test using the paired t-test showed that the difference in the effect of vitamin C supplementation on skin moisture levels based on gender yielded a p-value < 0.001. There was a highly significant difference in skin moisture levels before and after vitamin C intake, with skin moisture levels increasing in both women and men after treatment. However, skin moisture levels after treatment in men were not higher than in women due to differences in subject compliance. This study is a cross-sectional study with 60 subjects, divided by gender. The treatment was performed on skin moisture before and after vitamin C intake.

The results showed a significant increase in skin moisture after vitamin C intake, especially in women. Vitamin C functions to protect the skin from oxidative stress by neutralizing free radicals and can be reactivated through the enzyme dehydroascorbic acid reductase with the help of glutathione (23). Skin moisture levels in women were higher than in men after vitamin C intake. Previous studies have shown that TEWL in men is lower due to differences in evaporimetry results (6). This difference is influenced by higher sebum content in men due to sex hormones and thicker skin by 20–25%, which affects TEWL (24). Vitamin C is beneficial in stimulating collagen biosynthesis (25). The skin has protective, sensory, temperature regulation, pigment formation, vitamin D synthesis, and keratinization functions. Cell migration and regeneration in the stratum corneum occur over 21–28 days, so treatment is conducted over 1 month (5).

Discussion

While this study provides significant evidence regarding the efficacy of Vitamin C in improving skin hydration, several limitations must be acknowledged to contextualize the findings.

1. Uncontrolled Confounding Variables

As a quasi-experimental study without a control group, certain external and internal variables influencing skin moisture were not strictly regulated. Environmental exposure, including fluctuations in humidity, prolonged use of air conditioning, and varying levels of ultraviolet (UV) radiation, may have influenced Transepidermal Water Loss (TEWL) measurements. Additionally, individual lifestyle factors, such as daily water intake and physical activity levels which directly impact systemic hydration were not standardized across the cohort.

2. Physiological and Hormonal Factors

Biological variations among participants, particularly hormonal fluctuations such as the menstrual cycle in female subjects, were not accounted for. Estrogen levels are known to significantly modulate skin thickness and moisture retention; thus, the timing of measurements relative to the participants' hormonal phases may introduce subtle variations in the data.

3. Data Collection and Recall Bias

The reliance on a Food Frequency Questionnaire (FFQ) administered via Google Forms introduces the potential for recall bias. Although education was provided to ensure adherence to the 200 mg/day protocol, the accuracy of dietary Vitamin C quantification depends heavily on the subjects' memory and subjective reporting of portion sizes. While this method is standard in nutritional epidemiology, it lacks the

precision of a strictly supervised clinical trial or metabolic ward setting.

4. Scope and Generalizability

This research focused exclusively on a young adult demographic (19–29 years) within a specific geographic region. Given that skin physiology including collagen synthesis capacity and antioxidant depletion changes significantly with advanced age (typically over 40 years), these results may not be directly generalizable to older populations or to regions with vastly different humidity levels.

5. Physiological and Hormonal Factors

Biological variations among participants between men and women, particularly hormonal fluctuations such as the menstrual cycle in female subjects, were not accounted for. Estrogen levels are known to significantly modulate skin thickness and moisture retention; thus, the timing of measurements relative to the participants' hormonal phases may introduce subtle variations in the data.

6. Measurement Specificity and Instrumentation

A primary limitation involves the distinction between cutaneous hydration parameters. While this study utilized the Skin Moisture Analyzer FCM-1 to assess barrier health, it is essential to clarify that the device output reflects a Hydration Index (conductance/capacitance) rather than a classical Transepidermal Water Loss (TEWL) measurement, which specifically quantifies the flux of water evaporating through the stratum corneum. Although these metrics are clinically correlated, the Hydration Index measures current water content in the epidermis, whereas classical TEWL specifically measures barrier permeability. Future studies should ideally employ both metrics to provide a more comprehensive profile of skin barrier function.

7. Demographic Constraints and Generalizability

A primary limitation of this study is the discrepancy between the clinical background and the study cohort. While the introduction highlights the high prevalence of xerosis among geriatric populations, the study was conducted exclusively on young adults aged 19–29 years. Because aging significantly diminishes endogenous collagen synthesis, skin antioxidant reserves, and stratum corneum hydration, the results observed in this resilient young cohort cannot be generalized to older or geriatric populations. The physiological responsiveness of young skin to Vitamin C may differ substantially from that of aged skin.

The results of this study carry substantial clinical implications, especially

when considering the high prevalence of dry skin in Indonesia, a nation characterized by a tropical climate. Young adults represent an environmentally and socially active demographic highly susceptible to various environmental stressors. This evidence positions healthcare professionals, including physicians, nurses, and dietitians, at a pivotal intersection, emphasizing the necessity of integrating a nutritional approach into the management and prevention of dermatological issues. Healthcare providers must assume the role of proactive educators, communicating the clear, evidenced-based link between adequate vitamin C intake and skin health. This responsibility extends beyond general dietary advice, requiring the provision of specific information regarding nutrient-dense food sources (fruits and vegetables) and, where necessary, targeted supplementation recommendations. It must be strongly emphasized that optimal skincare demands a holistic approach, simultaneously addressing internal (in-vivo nutrition) and external (topical care) factors.

For patients presenting with xerosis or those identified as being at risk, healthcare providers should incorporate an assessment of nutritional intake, with a particular focus on vitamin C, into routine clinical evaluations. Dietary intervention can then be prescribed as an initial component of the treatment protocol, complementing standard topical therapies such as emollients. While this study focused on young adults, the findings are translatable to geriatric care, where vitamin C intake can be recommended to help sustain residual antioxidant capacity and collagen synthesis in an age group highly vulnerable to compromised skin barrier function. The future trajectory of medicine will increasingly involve the integration of dermatology and nutrition as an essential subspecialization (Nutritional Dermatology). Healthcare professionals must be prepared to apply this emerging science, which directly connects biomolecules like vitamin C to clinical outcomes. This necessitates updating curricula and providing continuous professional training. In the context of Indonesia's tropical climate, this strategy is particularly crucial for confronting the unique environmental challenges to skin health. There will be a pronounced shift in focus from merely treating skin diseases to actively preventing them. A deeper mechanistic understanding of the role of micronutrients like vitamin C will spur the development of skin-specific nutritional biomarkers. Future personalized medicine will be capable of in-vivo assessment of a patient's skin antioxidant status or vitamin C levels, allowing for the individualization of nutritional and supplementary recommendations.

This quasi-experimental study successfully identified and validated a significant effect of vitamin C intake on improving skin moisture among young adults at the Faculty of Medicine, Maranatha Christian University, Bandung. The analysis using the Paired T-test revealed a statistically significant difference in the subjects' skin moisture levels before and after the intervention of dietary and supplementary vitamin C ($p < 0.001$). This finding fundamentally affirms the role of vitamin C (ascorbic acid) as an essential micronutrient vital not only for the immune system but also for the physiological integrity of the skin. Clinicians, particularly dermatologists, general practitioners, and nutritionists, are strongly advised to integrate the assessment of nutritional status, especially vitamin C intake, as a standard component of the history-taking process for patients presenting with dry skin or xerosis complaints. Interventions aimed at increasing vitamin C intake, either through dietary education or targeted supplementation (e.g., 200 /day), should be recommended as evidence-based adjunctive therapy. The Ministry of Health and health education institutions must intensify public awareness programs emphasizing the direct link between the consumption of fruits and vegetables (natural vitamin C sources) and skin health. This message should be specifically targeted towards the young adult demographic as a crucial early preventive measure against the age-related decline in skin function. Young adults are encouraged to regularly consume fruits and vegetables to meet or exceed the daily Recommended Dietary Allowance (RDA) for vitamin C 50 - 90 mg/day. For individuals with suboptimal dietary intake or those with higher antioxidant needs (e.g., due to pollution exposure or high environmental/UV stress in tropical climates), safe and effective vitamin C supplementation (such as the 200 mg/day, dose used in this study) is a viable option to support skin moisture and barrier function.

Further research utilizing a Randomized Controlled Trial (RCT) design is warranted to precisely determine the optimal dose of vitamin C, from both supplemental and dietary sources, required to yield the most significant increase in skin moisture in young adults. Future studies should incorporate the measurement of more specific biomarkers, such as dermal collagen levels and inflammatory parameters, to provide in-vivo confirmation of the underlying biochemical pathways (antioxidant defense and collagen synthesis) responsible for vitamin C's skin-moisturizing effect. Longitudinal studies are needed to assess the sustainability of the skin moisture improvement after the cessation of vitamin C intervention, and to compare the long-term effectiveness of supplementation versus a pure food-based intervention. Clinicians

should be encouraged to consider individualized dose and source adjustments of vitamin C based on biochemical test results (if available) that measure the patient's personalized antioxidant status or skin hydration level to achieve maximum intervention efficacy.

While the study confirmed the overall efficacy of Vitamin C intake (from both diet and supplementation) in significantly improving skin moisture ($p < 0.001$), a detailed breakdown of the contribution from each source is warranted. Ascorbic acid acts as an essential cofactor for collagen biosynthesis and as a primary antioxidant against environmental stressors, making its systemic bioavailability critical for maintaining the skin's barrier function and water-holding capacity.

Disaggregating the data on whether the effective dose of 200 mg/day was primarily met through natural dietary sources (fruits and vegetables) or targeted supplementation can provide valuable insights for clinical and public health recommendations. For instance, reliance on whole foods is associated not only with Vitamin C but also with a complex matrix of synergistic micronutrients and phytochemicals (e.g., Vitamin E, polyphenols) that may collectively enhance antioxidant capacity and skin health, an aspect that future research should investigate. Conversely, if supplementation was the main driver, it reinforces the need for targeted adjunctive therapy in populations, like those in tropical climates, that may have higher daily requirements (300–500% of the RDA) due to increased oxidative stress from UV and pollution exposure. Therefore, a focused analysis of the Vitamin C source data detailing the proportions from diet versus supplements is necessary to refine evidence-based recommendations for achieving and maintaining optimal skin hydration.

The study effectively demonstrates a statistically significant increase in skin moisture following Vitamin C intake among young adults, as evidenced by the paired T-test result ($p<0.001$). However, the quasi-experimental design without a true control group presents a critical limitation that necessitates cautious interpretation of the findings. The observed change in skin moisture may be partly attributable to the natural history of xerosis, the placebo effect of participation, or other confounding variables (e.g., changes in ambient humidity, general hydration, or unrelated dietary shifts) that a concurrent control group would typically account for. Future research should utilize a Randomized Controlled Trial (RCT) design. Subjects should be randomly assigned to one of two group. Intervention Group: Receives the specific Vitamin C intervention (e.g., a standardized supplement

dose). Control Group: Receives an identical-looking placebo (a supplement with no active ingredients) or continues their standard diet without supplementation. This design would allow researchers to isolate the effect of the Vitamin C intervention from other temporal or psychological factors.

Furthermore, future investigations should expand the demographic scope to include elderly populations of both genders. Investigating the effects of Vitamin C on aging skin is particularly salient, as the elderly experience a physiological decline in dermal collagen synthesis and a heightened prevalence of senile xerosis.

In male elderly subjects, research could examine how Vitamin C interacts with typically thicker skin structures and different hormonal profiles, while in female elderly subjects, it is crucial to analyze the nutrient's efficacy in the context of post-menopausal estrogen deficiency, which significantly accelerates skin dehydration and loss of elasticity. Subsequent studies should also account for potential gender-based differences in bioavailability and metabolic rates of ascorbic acid in older age. By incorporating a gender-stratified approach within an RCT framework, researchers can determine whether Vitamin C supplementation serves as a viable non- pharmacological intervention to mitigate age-related dermatological concerns across both sex.

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Competing Interest

The authors declare that there is no conflict of interest.

References

1. Gide A. Kulit Manusia. Angew Chemie Int Ed 6(11), 951–952. 1967;5–24.
2. Kembuan MV, Wangko S, Tanudjaja GN. Peran Vitamin C Terhadap Pigmentasi Kulit. J Biomedik. 2013;4(3). Available from: https://doi.org/10.35790/jbm.4.3.2012.1215
3. Sinulingga EH, Budiastuti A, Widodo A. Efektivitas Madu Dalam Formulasi Pelembap Pada Kulit Kering. Diponegoro Med J (Jurnal Kedokt Diponegoro). 2018;7(1):146–57. Available from: https://doi.org/10.14710/dmj.v7i1.19358
4. Partogi D. Kulit kering. Dep Ilmu Kesehat Kulit Dan Kelamin FKUSU. 2008;1–12.
5. Pullar JM, Carr AC, Vissers MCM. The Roles of Vitamin C in Skin Health. Nutrients. ;(Figure 1):1–27. Available from: https://doi.org/10.3390/nu9080866
6. Rahrovan S, Fanian F, Mehryan P, Humbert P, Firooz A. Male versus female skin: What dermatologists and cosmeticians should know. Int J Women's Dermatology [Internet]. 2018;4(3):122–30. Available from: https://doi.org/10.1016/j.ijwd.2018.03.002
7. Nugerahdita, N. Prevalensi Penyakit Kulit dan Pengobatannya pada Beberapa RW di Kelurahan Petamburan Jakarta Pusat. Universitas Indonesia. FMIPA UI, 2009.
8. Sayuti I, Martina A, Sukma GE. Kepekaan Jamur Trichophyton terhadap Obat Salep Krim dan Obat Tingtur. Jurnal Biogenesis. 2006;2(2):51–4.

9. Ahlbeck J, Lappalainen P, Launis K, Tuohela K. Childhood, literature and science: Fragile subjects. Childhood, Literature and Science: Fragile Subjects. 2017. 1–244 p.
10. Babalola OO, Tugbobo OS, Daramola AS. Effect of processing on the Vitamin C content of seven Nigerian green leafy vegetables. Adv J Food Sci Technol. 2010;2(6):303–5. Available from: https://www.researchgate.net/publication/287730430_Effect_of_processing_on_the_Vitamin_C_content_of_seven_Nigerian_green_leafy_vegetables
11. Fenech M, Amaya I, Valpuesta V, Botella MA. Vitamin C content in fruits: Biosynthesis and regulation. Front Plant Sci. 2019;9(January):1–21. Available from: https://doi.org/10.3389/fpls.2018.02006
12. Kesehatan K. Peraturan Menteri Kesehatan Republik Indonesia Nomor 28 Tahun 2019 Tentang Angka Kecukupan Gizi Yang Dianjurkan Untuk Masyarakat Indonesia. Menteri Kesehatan Republik Indonesia. 2019. Available from: https://peraturan.bpk.go.id/Details/138621/permenkes-no-28-tahun-2019
13. Sakti ES. Hari Bawa Bekal Nasional. Pus Data dan Inf Kementrian Kesehat RI. 2020;1–10.
14. Zeithml, Oliver R. Iklim Kota Bandung. Angew Chemie Int Ed 6(11), 951–952. 2021;2013–5.
15. Bertuccelli G, Zerbinati N, Marcellino M, Kumar NSN, He F, Tsepakolenko V, et al. Effect of a quality-controlled fermented nutraceutical on skin aging markers: An antioxidant-control, double-blind study. Exp Ther Med. 2016;11(3):909–16. Available from: https://doi.org/10.3892/etm.2016.3011
16. Costa A, Pereira ESP, Assumpcao EC, Dos Santos FBC, Ota FS, De Oliveira Pereira M, et al. Assessment of clinical effects and safety of an oral supplement based on marine protein, Vitamin C, grape seed extract, zinc, and tomato extract in the improvement of visible signs of skin aging in men. Agro Food Ind Hi Tech. 2018;29(1):26–7. Available from: https://doi.org/10.2147/CCID.S79447
17. Man MQ, Xin SJ, Song SP, Cho SY, Zhang XJ, Tu CX, et al. Variation of skin surface pH, sebum content and stratum corneum hydration with age and gender in a large chinese population. Skin Pharmacol Physiol. 2009;22(4):190–9. Available from: https://doi.org/10.1159/000231524
18. Pakaya D. Peranan Vitamin C Pada Kulit. J Ilm Kedokt [Internet]. 2014;1(2):45–54. Available from: http://jurnal.untad.ac.id/jurnal/index.php/MedikaTadulako/article/view/7932/6271
19. Levine M, Conry-cantilenat C, Wang Y, Welch RW, Washko PW, Dhariwal KR, et al. Vitamin C pharmacokinetics in healthy volunteers: evidence for a recommended dietary allowance. Proceedings of the National Academy of Sciences, 93(8), 3704-3709. Available from: https://doi.org/10.1073/pnas.93.8.3704
20. Schwarz P, Body JJ, Cáp J, Hofbauer LC, Farouk M, Gessl A, et al. PMK No. 41 ttg Pedoman Gizi Seimbang. Eur J Endocrinol [Internet]. 2014;171(6):727–35. Available from: https://eje.bioscientifica.com/view/journals/eje/171/6/727.xml
21. Kemenkes RI. Profil Kes Indo 2019 [Internet]. Kementrian Kesehatan Republik Indonesia. 2020. 487 p. Available from: https://pusdatin.kemkes.go.id/resources/download/pusdatin/profil-kesehatan-indonesia/Profil-Kesehatan-indonesia-2019.pdf
22. Beltsville M. USDA Food and Nutrient Database for Dietary Studies, 1.0. 2004.\ [Internet]. Agricultural Research Service, Food Surveys Research Group. Available from: https://fdc.nal.usda.gov/fdc-app.html#/
23. Estri SA, Rohmah S, Rahayanti A, Prabowo DB. Pengaruh Berbagai Cara Pemberian Vitamin C Terhadap Kecerahan Kulit. Mdvi. 2020;47:69–72.

24. Suryani A. Faktor-Faktor yang Memengaruhi Pigmentasi Manusia. Cermin Dunia Kedokt. 2020;47(11):682. Available from: https://scholar.google.com/scholar?hl=id&as_sdt=0%2C5&q=Suryani+A.+Faktor-Faktor+yang+Memengaruhi+Pigmentasi+Manusia.+Cermin+Dunia+Kedokt.+2020%3B&btnG=
25. Gref R, Deloménie C, Maksimenko A, Gouadon E, Percoco G, Lati E, et al. Vitamin C–squalene bioconjugate promotes epidermal thickening and collagen production in human skin. Sci Rep [Internet]. 2020;10(1):1–12. Available from: https://doi.org/10.1038/s41598-020-72704-1
26. Choi SY. Effects of collagen tripeptide supplement on skin properties: A prospective, randomized, controlled studye. J Cosmet Laser Ther. 2014;16(3). Available from: https://doi.org/10.3109/14764172.2013.854119
27. Bhargava P, Nijhawan S, Singdia H, Mehta T. Skin Barrier Function Defect - A Marker of Recalcitrant Tinea Infections. Dep Dermatology, Sawai Mansingh Med Coll Jaipur, Rajasthan, India. 2020;566–9. Available from: https://doi.org/10.4103/idoj.IDOJ_434_19