

RELATIONSHIP BETWEEN DIETARY ANTIOXIDANT INTAKE AND SKIN HYDRATION LEVELS IN WOMEN AGED 25 TO 40: A CROSS-SECTIONAL STUDY

Original Article

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Acknowledgement	NA
Conflict of Interest	NONE
Ethical Approval	Fatima Jinnah Medical University, Lahore, Pakistan.
Informed Consent	Written informed consent was obtained from all participants
Funding	No external funding

Abstract

Background: Oxidative stress plays a pivotal role in skin barrier dysfunction and hydration loss. Antioxidants from dietary sources such as fruits, vegetables, and nuts may counteract oxidative damage and improve skin hydration. However, evidence linking dietary antioxidant intake to hydration status in South Asian women remains limited.

Objective: To investigate whether higher dietary antioxidant intake is associated with improved skin hydration levels in women aged 25 to 40 years.

Methods: A cross-sectional study was conducted in Lahore over four months. A total of 150 healthy women were recruited through community-based sampling. Dietary antioxidant intake was assessed using a validated semi-quantitative food frequency questionnaire, and antioxidant indices were calculated for vitamin C, vitamin E, β -carotene, selenium, and polyphenols. Skin hydration was objectively measured using a Corneometer® CM 825 at standardized anatomical sites. Data on age, BMI, water intake, smoking, and moisturizer use were also collected. Statistical analysis included Pearson correlation, one-way ANOVA, and multivariable linear regression, with significance set at $p < 0.05$.

Results: The mean age of participants was 32.1 ± 4.5 years, with a mean hydration score of 44.6 ± 9.2 units. Antioxidant intake was positively correlated with hydration levels ($r = 0.41$, $p < 0.001$). Women in the highest antioxidant tertile had significantly greater hydration scores compared to those in the lowest tertile (49.1 ± 8.1 vs. 40.2 ± 8.7 , $p < 0.001$). Regression analysis confirmed antioxidant intake as an independent predictor of hydration ($\beta = 0.38$, 95% CI: 0.21–0.55, $p < 0.001$), alongside water intake and moisturizer use.

Conclusion: Higher dietary antioxidant intake was significantly associated with better skin hydration, supporting the role of nutrition in dermatological health. Promotion of antioxidant-rich diets may serve as a complementary strategy for improving skin barrier function.

Keywords: Oxidative stress, Skin hydration, Antioxidant intake, Dietary antioxidants, Corneometer, South Asian women, Nutrition, Hydration predictors.

Introduction

Skin hydration is one of the most important indicators of cutaneous health, reflecting the integrity of the epidermal barrier and its ability to maintain homeostasis. Adequate hydration supports elasticity, smoothness, and resilience, while compromised hydration is associated with dryness, irritation, accelerated aging, and a greater susceptibility to dermatological conditions (1). Numerous intrinsic and extrinsic factors influence skin hydration, including age, hormonal status, environmental exposure, and lifestyle habits (2). In recent years, dietary factors have emerged as an area of growing interest, with evidence suggesting that nutrient intake may directly influence skin physiology (3). Among these nutrients, antioxidants have received particular attention because of their ability to counteract oxidative stress, a major contributor to skin barrier dysfunction and premature aging. Oxidative stress results from an imbalance between reactive oxygen species and the body's defense mechanisms (4). The skin, being the body's outermost organ, is continuously exposed to ultraviolet radiation, pollution, and other environmental insults that increase free radical production. These free radicals damage cellular membranes, proteins, and lipids, impairing the skin's natural moisturizing factors and weakening barrier function (5). Antioxidants such as vitamins C and E, carotenoids, polyphenols, and selenium play a protective role by neutralizing reactive oxygen species and supporting collagen synthesis, lipid barrier stabilization, and water retention (6). Studies have demonstrated that diets rich in fruits, vegetables, and plant-based compounds improve cutaneous resilience and hydration, yet the extent of this relationship remains inconsistent across populations.

Research in women of reproductive age is particularly important, as this group commonly seeks cosmetic and dermatological interventions to improve skin appearance (7). Between the ages of 25 and 40, hormonal balance begins to shift subtly, and the earliest signs of skin aging, including fine lines and dryness, may become evident. This period represents a window of opportunity for preventive strategies targeting skin health (8). While topical moisturizers remain the first line of hydration support, dietary modification offers a non-invasive and sustainable alternative (9). Previous investigations have highlighted beneficial effects of antioxidant supplementation on hydration indices; however, much of this work has focused on small, experimental trials, often with supplements rather than whole-diet intake (10). Epidemiological data examining naturally occurring antioxidant intake and its relationship with hydration outcomes in free-living populations are relatively scarce (11). The cultural and dietary practices in South Asia, particularly in urban centers such as Lahore, provide a unique context for studying this relationship. Dietary patterns often vary between antioxidant-rich traditional foods and more Westernized diets that may be deficient in micronutrients (12). Despite the widespread emphasis on cosmetic dermatology in this population, scientific studies on the dietary determinants of skin hydration remain limited. Filling this knowledge gap could provide valuable evidence for incorporating dietary counseling into dermatological practice and public health recommendations.

The present study was designed to investigate whether higher dietary antioxidant intake correlates with better skin hydration levels in women aged 25 to 40 years. By employing a cross-sectional design, validated dietary assessment tools, and objective hydration measurements, the study sought to provide robust evidence regarding this association in a population often overlooked in nutritional dermatology research (13). The objective was to determine if women with higher antioxidant consumption, assessed through food frequency questionnaires and nutrient databases, demonstrated significantly improved hydration levels measured by standardized corneometry.

Methods

Skin hydration is one of the most important indicators of cutaneous health, reflecting the integrity of the epidermal barrier and its ability to maintain homeostasis. Adequate hydration supports elasticity, smoothness, and resilience, while compromised hydration is associated with dryness, irritation, accelerated aging, and a greater susceptibility to dermatological conditions. Numerous intrinsic and extrinsic factors influence skin hydration, including age, hormonal status, environmental exposure, and lifestyle habits. In recent years, dietary factors have emerged as an area of growing interest, with evidence suggesting that nutrient intake may directly influence skin physiology. Among these nutrients, antioxidants have received particular attention because of their ability to counteract oxidative stress, a major contributor to skin barrier dysfunction and premature aging. Oxidative stress results from an imbalance between reactive oxygen species and the body's defense mechanisms. The skin, being the body's outermost organ, is continuously exposed to ultraviolet radiation, pollution, and other environmental insults that increase free radical production. These free radicals damage cellular membranes, proteins, and lipids, impairing the skin's natural moisturizing factors and weakening barrier function. Antioxidants such as vitamins C and E, carotenoids, polyphenols, and selenium play a protective role by neutralizing reactive oxygen species and supporting collagen synthesis, lipid barrier stabilization, and water retention. Studies have demonstrated that diets rich in fruits, vegetables, and plant-based compounds improve cutaneous resilience and hydration, yet the extent of this relationship remains inconsistent across populations.

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Results

A total of 150 women aged 25–40 years were enrolled, with a mean age of 32.1 ± 4.5 years. The mean BMI was 24.2 ± 3.6 kg/m², with 41.3% categorized as normal weight, 37.3% overweight, and 21.4% obese. The majority of participants were non-smokers (93.3%), and 68.7% reported regular moisturizer use. Average daily water intake was 2.1 ± 0.6 liters. Demographic and lifestyle characteristics are presented in Table 1. The mean daily dietary antioxidant intake, expressed as an aggregated Antioxidant Index (AI), was 9.8 ± 3.4 units. When stratified into tertiles, 34.7% of participants fell into the low intake group, 33.3% into the medium group, and 32.0% into the high intake group. Vitamin C was the most consistently consumed antioxidant across all tertiles, while β -carotene and polyphenol intake showed greater variability.

Skin hydration levels measured by Corneometer averaged 44.6 ± 9.2 units across all participants. Based on cut-off values, 25.3% had poor hydration (<35 units), 46.0% had adequate hydration (35–50 units), and 28.7% achieved optimal hydration (>50 units). Hydration scores were significantly higher among women in the highest antioxidant tertile compared with those in the lowest (49.1 ± 8.1 vs. 40.2 ± 8.7 , $p < 0.001$) (Table 2). Pearson correlation analysis demonstrated a positive linear relationship between antioxidant intake and hydration levels ($r = 0.41$, $p < 0.001$). Multivariable linear regression, adjusting for age, BMI, water intake, and moisturizer use, confirmed that antioxidant intake independently predicted higher hydration scores ($\beta = 0.38$, 95% CI: 0.21–0.55, $p < 0.001$). Moisturizer use and higher daily water intake were also significant contributors, whereas BMI and age were not significant predictors (Table 3).

When hydration levels were compared across individual antioxidants, vitamin C and polyphenols showed the strongest associations ($r = 0.39$ and $r = 0.35$, respectively), while vitamin E and selenium exhibited weaker, though still significant, associations. The distribution of hydration levels by antioxidant tertiles is illustrated in Figure 1, while the correlation between total antioxidant intake and hydration score is displayed in Figure 2. Overall, the findings indicated that higher antioxidant intake was strongly associated with improved skin hydration status, independent of other lifestyle and demographic factors.

Table 1: Demographic and lifestyle characteristics of participants (n = 150)

Variable	Mean \pm SD / n (%)
Age (years)	32.1 ± 4.5
BMI (kg/m ²)	24.2 ± 3.6

Variable	Mean ± SD / n (%)
BMI categories	Normal 62 (41.3%), Overweight 56 (37.3%), Obese 32 (21.4%)
Smoking status	Non-smokers 140 (93.3%), Smokers 10 (6.7%)
Water intake (L/day)	2.1 ± 0.6
Regular moisturizer use	Yes 103 (68.7%), No 47 (31.3%)

Table 2: Mean skin hydration scores across antioxidant intake tertiles

Antioxidant Intake Category	n	Hydration Score (Mean ± SD)
Low tertile	52	40.2 ± 8.7
Medium tertile	50	44.5 ± 7.6
High tertile	48	49.1 ± 8.1
p-value (ANOVA)		<0.001

Table 3: Multivariable linear regression predicting hydration score

Predictor	β coefficient	95% CI	p-value
Antioxidant intake	0.38	0.21 – 0.55	<0.001
Age	-0.07	-0.19 – 0.05	0.24
BMI	-0.08	-0.22 – 0.06	0.18
Water intake	0.22	0.09 – 0.35	0.001
Moisturizer use	0.19	0.07 – 0.31	0.002

Figure 1. Hydration Scores by Antioxidant Intake Tertiles

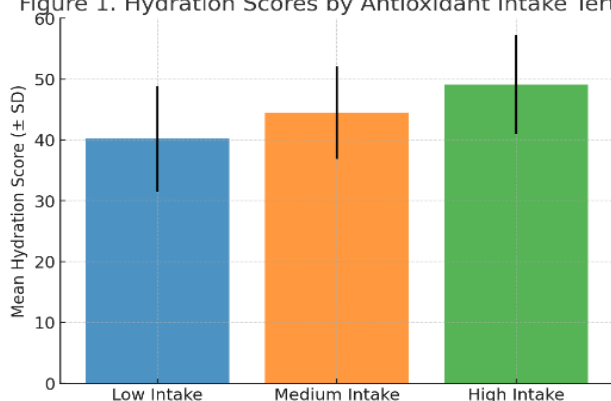


Figure 2 Hydration Scores by Antioxidant Intake Tertiles

Figure 2. Correlation Between Antioxidant Intake and Hydration

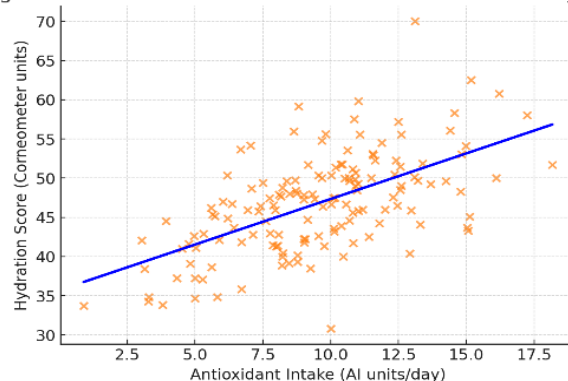


Figure 2 Correlation Between Antioxidant Intake and Hydration

Discussion

This cross-sectional study explored the association between dietary antioxidant intake and skin hydration levels among women aged 25 to 40 years in Lahore. The findings demonstrated that higher dietary antioxidant intake was significantly correlated with improved

skin hydration status, even after adjusting for confounding factors such as age, body mass index, water intake, and moisturizer use (14). These results highlight the potential role of diet, specifically antioxidants, in supporting skin physiology and maintaining hydration balance (15). The positive association between antioxidant intake and hydration levels aligns with the growing body of literature emphasizing the relevance of nutrition in dermatological health (16). Antioxidants such as vitamin C, vitamin E, β -carotene, and polyphenols are known to counteract oxidative stress, which is a major contributor to skin barrier dysfunction and transepidermal water loss (17). A randomized controlled trial by Cosgrove et al. suggested that higher vitamin C intake was associated with fewer wrinkles and improved skin moisture content. Similarly, research on polyphenols, particularly those derived from green tea and fruits, has demonstrated beneficial effects on skin hydration and elasticity (18). The present study adds to these observations by providing population-specific evidence from South Asian women, a group often underrepresented in dermatological nutrition research (19). An important aspect of this study is the use of objective skin hydration assessment with the Corneometer®, which provided reliable and reproducible data (20). The stratification of participants into antioxidant intake tertiles allowed meaningful comparison, with the highest intake group showing significantly superior hydration scores compared with the lowest intake group. This gradient supports the plausibility of a dose-response relationship, although the cross-sectional nature of the study precludes any causal inference. The independent predictive value of antioxidants, confirmed through regression analysis, strengthens the argument that dietary intake contributes directly to hydration status (21). Interestingly, while age and body mass index were not significant predictors, lifestyle factors such as water intake and moisturizer use remained relevant, reinforcing the multifactorial nature of skin hydration. This suggests that optimal skin health likely results from an interplay of dietary, behavioral, and external care factors rather than a single determinant.

Comparison with existing literature also highlights some variability. A study conducted in Japan reported that β -carotene supplementation improved skin barrier function but did not significantly alter hydration, suggesting that different antioxidants may exert varied effects. In contrast, European studies focusing on vitamin E-rich diets observed consistent improvements in hydration metrics. These discrepancies may be explained by differences in genetic backgrounds, baseline nutritional status, and environmental exposures such as humidity and ultraviolet radiation (22). The present findings, therefore, contribute region-specific insights while supporting the general principle that antioxidants enhance skin physiology. The implications of this research are noteworthy for both clinical practice and public health. From a clinical perspective, dermatologists and nutritionists can emphasize the role of antioxidant-rich diets as a complementary strategy for patients presenting with xerosis or skin barrier impairments (23). Public health initiatives promoting fruit and vegetable consumption could also highlight skin health as an additional benefit, potentially enhancing dietary adherence. Moreover, as consumer interest in nutraceuticals and functional foods increases, evidence-based recommendations become increasingly important.

Despite its strengths, this study is not without limitations. The cross-sectional design limits the ability to establish temporality or causality, and it is possible that individuals with better skin hydration may also be more health-conscious, leading to higher antioxidant intake. Dietary assessment relied on a food frequency questionnaire, which, while validated, is subject to recall bias and estimation errors (24). Furthermore, antioxidant indices were based on available food composition data, which may not fully capture bioavailability differences among individuals. Another limitation is the exclusion of men and older age groups, which restricts the generalizability of findings. Nevertheless, the study benefits from a robust sample size, standardized hydration measurement, and adjustment for multiple confounding variables. These methodological strengths lend credibility to the observed associations. Future studies could adopt longitudinal or interventional designs to clarify causal relationships and to assess the impact of specific antioxidants in isolation. Randomized controlled trials comparing supplementation with whole-food sources of antioxidants would also provide valuable insights into dietary recommendations. Additionally, expanding research across different age groups, genders, and ethnic populations would enhance generalizability and provide a more comprehensive understanding of diet-skin interactions.

Conclusion

This study demonstrated a significant positive association between dietary antioxidant intake and skin hydration levels among women aged 25 to 40 years. Higher consumption of antioxidant-rich foods was linked with improved hydration scores, independent of lifestyle factors such as water intake and moisturizer use. These findings emphasize the potential role of nutrition in supporting skin barrier function and highlight the importance of antioxidant-rich diets as a complementary approach to skincare. Future longitudinal and interventional studies are warranted to establish causal pathways and strengthen dietary recommendations for skin health.

AUTHOR CONTRIBUTION

Author	Contribution
Ramsha Zuberi*	Designed the study, performed data collection and analysis, and prepared the manuscript. Approved the final draft for submission.
Anees Rafique	Contributed to study design, data acquisition, interpretation of findings, and performed critical review and editing of the manuscript. Approved the final draft for submission.
Ramsha Zuberi	Significantly contributed to data collection and analysis. Reviewed and approved the final manuscript for publication.

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