

Ethnic Variation in Skin Properties: Quo Vadis?

PART I

Sarika Saggar, Naissan O. Wesley, MD,
and Howard I. Maibach, MD

Clinical differences in dermatologic disorders may be influenced by ethnic variation in skin properties. Previous investigations by objective methods have provided evidence of ethnic differences in skin properties, but the data has often been contradictory.¹ Although it remains difficult to establish clinically applicable ethnic trends, recent investigations have further emphasized the need for distinct research on disease processes and treatment responses in ethnic skin when defining appropriate clinical management. Thus, the direct question: Should the skin care industry provide one product line for all, or is there sufficient ethnic dermatopharmacologic and dermatotoxicologic information to justify research and development toward providing tailored products acknowledging ethnic variations in skin properties? Surely, certain consumer groups would argue for the latter.

This chapter explores and attempts to clarify recent objective data that has become available in the context of transepidermal water loss (TEWL), water content (WC) [via conductance, capacitance, resistance and impedance], blood vessel reactivity (BVR), pH gradient, microtopography, sebaceous function, vellus hair follicle distribution, morphology and distribution of melanosomes, and resistance to photodamage to differentiate skin properties of different ethnic groups.

As an aside, because the definitions of race, ethnicity or skin of color are not well-established, different researchers may use different terms to describe ethnicity, complicating the comparison of studies on ethnic differences. In this examination, the term used by the authors of each referenced study has been maintained and thus is not necessarily consistent from one study to the next.

Transepidermal Water Loss

TEWL is one method of measuring the skin's barrier function and is currently defined as the total amount of water vapor loss through the skin and appendages under nonsweating conditions.² Measured in various studies, it is the most studied objective measure in defining differences between the skin of different ethnicities both at baseline and in response to topical irritants;¹ an increase in TEWL after application of a topical irritant often indicates an increased susceptibility to the irritant due to disruption of barrier integrity.

Overall, the data regarding TEWL remains inconsistent (see **Table 1.1**). Most studies have shown a greater TEWL in Blacks compared with Whites, suggesting lower barrier strength.³⁻⁷ Berardesca and Maibach⁴ and Kompaore et al.⁵ also found that Blacks showed higher TEWL levels than Whites after topical application of sodium lauryl sulfate (SLS) or topical methyl nicotinate (MN), respectively, suggesting an increased susceptibility of Blacks to irritation.

However, based on tape-stripping studies, darker skin (skin type V/VI) has increased baseline barrier strength and quickly recovers water barrier function, contradicting increased susceptibility of Black skin to irritants.⁸ Furthermore, findings by Berardesca et al.,⁹ Hicks et al.¹⁰ and Grimes et al.¹¹ do not support any statistically significant difference in TEWL between Black and Caucasian skin, and Warriier et al.¹² and Astner et al.¹³ (after stress with household irritant) found TEWL to be less in Blacks than Whites. Astner et al.¹³ also observed that the relative increments of increase in response to the graded irritant concentrations were higher in Caucasians, suggesting increased sensitivity.

TEWL measurements with regard to Asian skin remain inconclusive as well, as previous studies observed baseline measurements in Asian skin to be equal to Black skin and greater than Caucasian skin,⁵ less than all other ethnic groups,⁶ or no different than other ethnic groups.¹⁴⁻¹⁶

Recently, Pershing et al.¹⁷ found an increase in TEWL of Caucasians but a decrease in TEWL of Asians in response to high potency capsaicinoids, the results of which are difficult to categorize.

Of note, based on a study of Caucasian subjects showing that TEWL values vary by anatomic location, irritant susceptibility may depend on anatomic site, making it difficult to compare differences in TEWL between the sites examined by separate studies.¹⁸ Further clarification of both baseline and post-irritant TEWL in different ethnic groups should be a priority item if formulators are to provide more science-based, ethnicity-directed formulations. There is sufficient research experience in TEWL metrics to devise and execute clarifying experiments.

One could summarize these findings by study (as in **Table 1.1**) or by race as shown here:

- TEWL for Blacks and Whites. All of the evidence supports TEWL for Blacks > Whites, except:
 - Berardesca et al.,⁹ Hicks et al.¹⁰ and Grimes et al.¹¹ all found no significant difference;
 - Warrier et al.¹² and Astner et al.¹³ found Blacks < Whites.
- TEWL measurements of Asian skin are inconclusive. They have been found to be:
 - Equal to Black skin and greater than Caucasian skin (Kompaore et al.⁵);
 - Equal to Caucasian skin (Aramaki et al.¹⁴ and Tagami¹⁶) and less than all other ethnic groups (Sugino et al.⁶).
- TEWL of Caucasians increased in response to high concentrations of topical capsaicinoids, whereas in Asians it decreased (Pershing et al.¹⁷).

Water Content

WC or hydration of the skin is measured by skin capacitance, conductance, impedance or resistance based on the increased sensitivity of hydrated stratum corneum to an electrical field.¹⁹ The SLS-induced irritation studies by Berardesca and Maibach^{4,20} revealed no significant differences in WC between the ethnic groups at baseline or after SLS stress, and Manuskiatti et al.²¹ found no baseline difference in WC

Table 1.1. Transepidermal water loss

Study	Technique	Results
Tagami ¹⁶ (2002)	In vivo	TEWL Japanese < French but not statistically significant
Hicks et al. ¹⁰ (2003)	In vivo—topical SLS (irritant)	TEWL Whites > Blacks but not statistically significant
Grimes et al. ¹¹ (2004)	In vivo—topical SLS (irritant)	<ul style="list-style-type: none"> • Baseline: No significant difference • After SLS stress: Immediate increase in TEWL of White subjects, but increase no longer evident after 24 hr and found to be similar to African-Americans (not statistically significant)
Pershing et al. ¹⁷ (2006)	In vivo—topical capsaicinoid analogs	<ul style="list-style-type: none"> • Increasing concentrations of total capsaicinoid not associated with proportional change in TEWL, in all subjects. • Capsaicinoid concentration of 16 mg/mL produced higher mean TEWL in Caucasians, lower mean TEWL in Asians ($P < 0.05$)
Astner et al. ¹³ (2006)	In vivo—topical Ivory Soap ^a (irritant)	<ul style="list-style-type: none"> • Positive dose-dependent correlation between TEWL and irritant concentration: Mean TEWL Caucasians > African-Americans ($P \leq 0.005$) • Relative increment of increase in TEWL after irritant: Caucasians > African-Americans ($P \leq 0.005$)

^a Ivory Soap is a registered trademark of the Procter & Gamble Co.

between Blacks and Whites on nine different anatomic sites. Although a few studies later demonstrated ethnic variability in WC,^{6,9,12} the values varied by anatomic site.

Sivamani et al.²² and Grimes et al.¹¹ recently reported no significant ethnic variation in WC, baseline and after various topical interventions, further supporting Berardesca and Maibach^{4,20} and Manuskiatti et al.²¹ Thus, despite varying TEWL, the majority of studies indicate that similar skin hydration is maintained in different ethnic groups. Of interest, Sivamani et al.²² concluded little variation in volar forearm skin across gender, age and ethnicity, providing an adequate site for testing of therapeutic and cosmetic products.

Blood Vessel Reactivity

Measurements of cutaneous blood flow facilitate the objective evaluation of skin physiology, pathology, irritation and response to treatment.²³ Objective techniques for the estimation of blood flow include laser doppler velocimetry (LDV) and photoplethysmography (PPG); measurements may differ according to anatomic sites.

Berardesca and Maibach^{4,20} found no significant differences in LDV between Black and White skin (recently confirmed by Hicks et al.¹⁰) or between Hispanic and White skin, at baseline or after topical SLS. Similarly, Aramaki et al.¹⁴ found no difference in LDV at baseline or after SLS-induced irritation between Japanese and German women. A subsequent study by Berardesca and Maibach,²⁴ however, measured a decrease in BVR of Blacks compared with Whites in response to corticosteroid application. Kompaore et al.⁵ added a different element of physical stress by evaluating LDV before and after tape stripping. After application of MN, but before tape stripping, there was no difference between the groups in basal perfusion flow, but BVR was decreased in Blacks and increased in Asians as compared with Caucasians.⁵ After eight and 12 tape strips, though BVR increased in all three groups, it increased significantly more in Asians, suggesting increased sensitivity in this group.

Therefore, there do not appear to be any baseline differences in BVR, but such variation could be explained either by differences in absorption, receptor distribution or receptor sensitivity. Investigating