Skin Barrier Response to Rapid Environmental Shifts: Modulation of Filaggrin and Aquaporin-3 in an Ex Vivo Model

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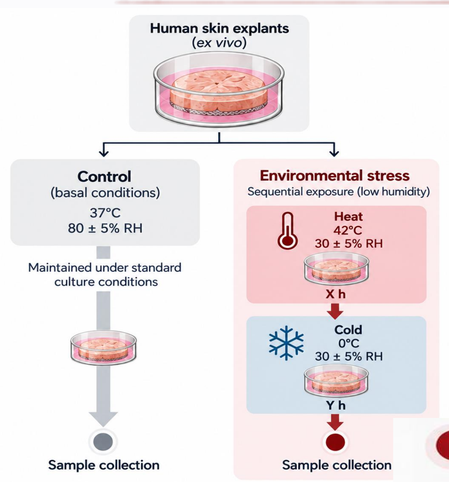
INTRODUCTION

Rapid and recurrent shifts in temperature and humidity are increasingly common in modern urban environments and may challenge skin homeostasis. As the primary interface with the environment, the epidermis is particularly vulnerable to these fluctuations, which can compromise barrier integrity and hydration. Although the effects of individual stressors such as heat, cold, and low humidity are well documented, the impact of abrupt and sequential environmental changes, which better reflect real-life exposure, remains poorly understood. These stressors can modulate thermosensitive TRP channels, inflammatory pathways, and epidermal differentiation, which potentially affecting key structural proteins and barrier function. However, their combined and sequential effects on epidermal biomarkers remain unclear.

OBJECTIVES

Evaluate the effects of acute sequential thermal and humidity fluctuations on the expression of two critical epidermal markers: filaggrin, for barrier integrity and natural moisturizing factor formation, and aquaporin-3 (AQP3), a membrane channel involved in epidermal hydration.

MATERIALS AND METHODS



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RESULTS

Filaggrin | **Aquaporin 3**

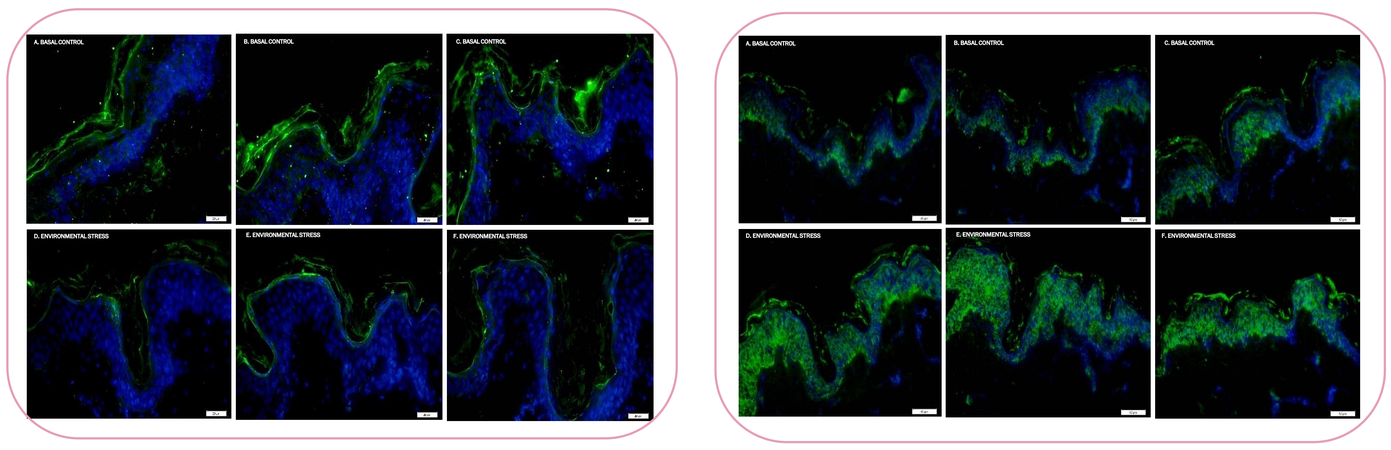
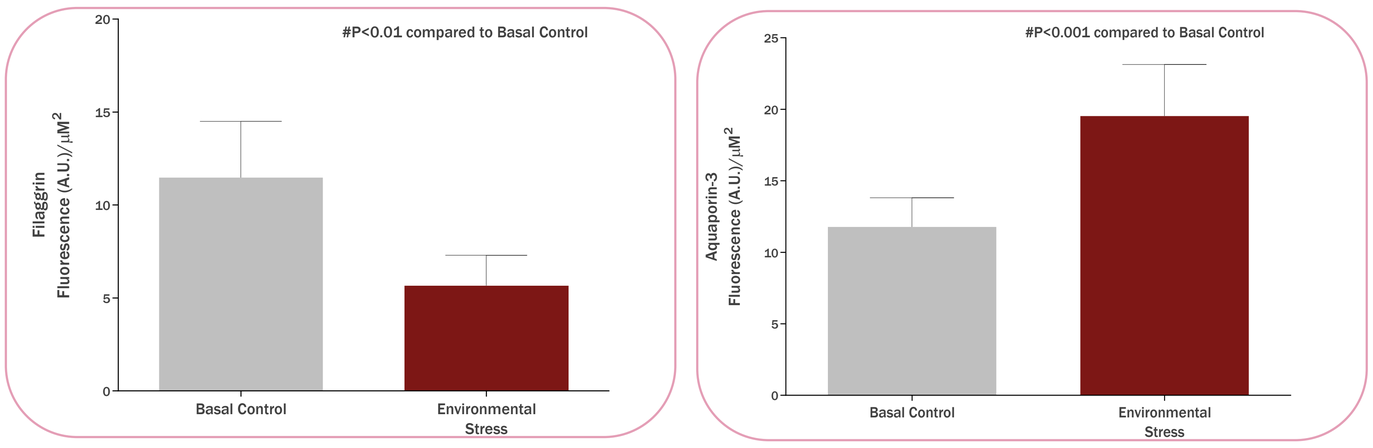


Figure 1: Micrographic evaluation of filaggrin (left) and aquaporin 3 (right) labeling in human ex-vivo skin fragments exposed to the environmental shifts. A-C: Untreated skin fragments (Basal Control). D-F: Skin fragments exposed to the environmental shifts. The filaggrin and aquaporin 3 are marked in green and the blue marking represents the nucleus of the cell (DNA; DAPI). The reference bar corresponds to 50µm.

Filaggrin | **Aquaporin 3**



50.63% ↓ 65.83% ↑

Figure 2: Effect of the environmental shifts on the production of filaggrin (left) and aquaporin 3 (right) in human ex-vivo skin fragments. Data represent the man ± standard deviation of 06 replicates (Student's T-test).

DISCUSSION

These findings demonstrate a dual biological response to rapid environmental transitions: structural barrier compromise accompanied by activation of acute adaptive hydration mechanisms. This imbalance may contribute to increased skin vulnerability under fluctuating environmental conditions, particularly in urban settings characterized by high thermal amplitude and low humidity exposure. Overall, this study provides novel insights into the effects of sequential climate-related stressors on epidermal physiology. Understanding these mechanisms is essential to antecipate the impact of environmental instability on skin health and supports the development of targeted dermatological and dermocosmetic strategies aimed at reinforcing barrier function, improving skin resilience, and mitigating damage induced by rapid environmental fluctuations.

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