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Review

Pollutant-Induced Human Skin Barrier Damage

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Background

Air pollution spreads harmful gases, other chemicals, and particles which can cause acute and chronic illness and skin barrier damage (Fadadu et al.., 2021).

Purpose

To understand the negative effects of pollutants on skin water barrier function. Environmental damage to skin integrity may lead to transepidermal water loss changes and solutions to protecting skin against such damage are explored.

Methods

Utilize scientific search engines for publications that help understand the environmental damage to the skin. Twelve recent (n=12) articles were reviewed.

Results

Kim et al. show increased TEWL and skin pH in the control and experimental groups, but atopic dermatitis (AD) group had a higher baseline. (Kim et al., 2015). Pollution yielded an unexpected reduction in stratum corneum trypsin-like enzyme activity, catalase activity, and total antioxidant capacity (Huang et al., 2019). Visscher et al. concluded that their oil massage was beneficial to the smallest infants due to resulting lower skin irritation and high heat index which can be protective (Visscher et al., 2021). The results suggested an increase in skin hydration due to the 19% decrease in TEWL levels, 7% significant improvement of dark spots, and squalene peroxidase levels decreased by 16% (Milani et al., 2019). An attenuated decrease in skin moisture for the astaxanthin oral medication group was observed after 7 days (Ito et al., 2018).

Conclusion

Pollutants such as gases and oxidants, UV -induced damage, and overall change in environment can cause skin barrier function to change, but recent studies found oral and topical treatments like oils and serums may help minimize the negative effects. Protection of the stratum corneum may allow for healthier skin and protection from dermatological damage.

BACKGROUND

Air pollutants can be harmful to skin water barrier function in healthy skin, but more damaging to diseased skin. Air pollution harmful gases/chemicals, and particles can cause acute and chronic illness and skin barrier damage.[2] Pollutants contribute to skin aging characterized by wrinkles, thinner epidermis, dark spots, and elasticity loss.[2] Outdoor pollution includes gases such as O_3, CO_2, SO_2, and NO. The respiratory tract is negatively affected and can lead to fatal diseases. Other pollutants include volatile Organic Compounds (VOCs), but even climate conditions can affect skin aging and barriers such as humidity and temperature. In neonates, strong skin water barrier function can reduce mortality.[3] Oxidative stress from the environment is a cause of skin aging and damage, topicals and oral medications are being tested to protect the skin barrier function.

METHODS

Most studies were found on Pubmed, Science Direct, and Google Scholar. To identify findings on the topic one word or a short phrase used. We focus on recent studies determining the effects of pollutants and heat on skin integrity and transepidermal water loss and information regarding the protective tools against pollutants, heat, and ultraviolet rays. Twenty-one (21) articles were reviewed by understanding the abstracts. Keywords including transepidermal water loss, pollutants, airborne, and skin integrity were used with publications post-2015. Only human studies were

included. Only 12 articles primarily focused on the above. Although all the articles had an important contribution, only n=6 studies had a larger experimental sampling pool.

DIFFERENCE IN SKIN INTEGRITY AND TEWL DUE TO POLLUTANTS

Kim et al., explored the effects of short-term (1 to 2 hours) exposure to formaldehyde as evaluated with TEWL levels. A group of 41 children with atopic dermatitis (AD) and 34 without AD (control group) were exposed to formaldehyde for 1 to 2 hours and assessed for TEWL levels, skin pH, and baseline change.[4] Kim et al. show an increase in TEWL overall between both groups, but the AD group had a higher baseline change.[4] Skin pH had a higher baseline change in the AD group as well.[4]

Huang et al., 2019 examined on traffic pollution effects on taxi drivers. Middle-aged taxi drivers (100 in urban Shanghai and 66 in rural Chongming) was enrolled.[5] Showed no significant difference in TEWL change, but there was an unexpected reduction in stratum corneum trypsin-like enzyme activity, catalase activity, and total antioxidant capacity.[5] There were no significant changes at the end of the study, excess due to the reduction of catalase and enzyme activity, Huang suggested that the exposed skin might age faster in the future.

PROTECT THE EPIDERMAL BARRIER FROM POLLUTANTS

Visscher et al. studied the effects of neonates receiving oil massages in rural Nepal to help protect against pollutants. Infants were grouped from 1 to 10 with group one being the smallest.[3] Skin pH was the lowest at group 1 and increased with infant size after oil massage to protect against the environment. Erythema was lowest for group 1, but at a higher heat index erythema increased and pH levels reduced. Visscher et al. concluded that the oil massage was beneficial to the smallest infants due to resulting lower skin irritation and high heat index.

Milani et al. in 2019 performed single-blind study for 28 days with 20 women with Deschampsia antartica extract an average age of 42 years that lived in high population areas of Rome.[6] Milani et al. observed an increased skin hydration due to the 19% decrease in TEWL levels.[6] An overall 7% significant improvement of the dark spots was documented by colorimetry. Squalene peroxidase levels decreased by 16%.

Ito et al experimented with astaxanthin for skin protection; 23 participants with 12 in the supplemental group and 11 in the placebo group were enrolled for 9 weeks.[7] It suggest that the minimal erythema dose (MED) had a significant decrease in the supplementation group compared to the placebo and an attenuated decrease in skin moisture for the supplementation group which was noticed after 7 days. No significant differences were found in TEWL levels before and after astaxanthin usage.

DISCUSSION AND CONCLUSION

Recently, studies have explored the effect of pollutants on skin barrier function and found formulas that protect against pollutants. Formaldehyde exposure tested in children with and without atopic dermatitis resulted in damage to the barrier function and increased skin pH and TEWL. This information is valuable to patients with compromised skin such as AD patients and spreading awareness that AD patients are more likely to have increased barrier damage to pollutants. Traffic pollution on taxi drivers showed a decrease in stratum corneum trypsin enzyme activity, catalase activity, and total antioxidant capacity, and this indicates damage to potential cell turnover rate since the enzyme and catalase activity rate has decreased. TEWL did not indicate significant changes in the taxi drivers but, due to the other findings, might be important to have a longitudinal study.

Oil massage is a popular technique to protect premature infants from harmful pollutants and Visscher et al. showed positive results were with her smallest infants. This can be done with a future study to assess if oil massaging can prevent certain skin conditions like dermatitis in children who received oil massaged as infants.

Deschampsia antartica showed promise in a high Rome population location. Studying the serum in a larger population sample and multiple trials might be the next step in the analysis.

The new oral medication, astaxanthin, resulted in reduced skin hydration loss, but showed no significant TEWL change interesting because skin hydration changes so does TEWL. A larger subject size and multiple trials might be beneficial.

In conclusion, pollutants such as gases and oxidants, UV -induced damage, and overall change in environment can cause skin barrier function to change; but recent studies suggest that oral and topical treatments like oils and serums may help minimize the negative effects. Skin aging is inevitable, but it can be slowed.

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Table

Study	Purpose	Sample size	Outcome measures	Relevant Findings
Kim et al.[4]	Understand effects of formaldehyde in the environment on skin barrier function ad AD patients	41 patients with AD and 34 healthy children	Measure TEWL, skin pH, and calculate overall baseline change	• Increasing in TEWL after 2 hours of exposure • Percentage change of TEWL in AD group was higher than the healthy children due to formally being much more penetrable to damaged skin. • AD group had a higher skin pH increase after exposure than the healthy group (control).
Huang et al.[5]	Evaluate effect of traffic pollution on taxi drivers	100 middle-aged male taxi drivers in urban shanghai and 66 men from rural Chongming	TEWL levels were tested after tape stripping	No significant detrimental effect of traffic pollution on skin aging. • Stratum corneum Trypsin-like enzyme activity was much lower for men exposed to heavy traffic pollution, they also had a decreased catalase activity, and total antioxidative capacity.
Visscher et al.[3]	Study the helpful effects of neonates receiving oil massages in rural Nepal	991 premature and full-term infants	Measured erythema, rash, dryness, oH, protein concentration, and TEWL	• Skin pH was higher for the smallest group of infants and increases as the infant grows. • Erthyma was lower for group 1 (smallest infants). • pH reduced and erythema increased at higher heat index environments
Milani et al.[6]	Understand the efficiency of new serum, Deschampsia antarctic extract against pollutants	Single-blind, 28-day study with 20 women (mean age 42 years) I	TEWL levels using Tewatmere and dark spot appearance using colorimetry	• The product increased skin hydration by decreasing TEWL by 19% • 7% significant improvement dark spots
Ito et al.[7]	Test Astaxanthin for UV and pollutant induced skin damage	23 healthy Japanese participants (12 participants in Astaxanthin group and 11 in placebo group)	Skin moisture and TEWL at baseline and after 9 weeks of supplementation	• Supplementation group showed a significant increase in minimal erythema dose (MED) from baseline compared to the placebo group. • Decrease of skin moisture was attenuated in the astaxanthin group after 7 days of radiation. • No significant difference measured between astaxanthin and the placebo group, but subjective results suggested improvement in rough and textured skin.

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