Summary of the white paper:

Background to humidity and skin: Temperature and ultraviolet radiation levels are known to have an impact on the skin's health and function. Several studies have examined the role of another variable climatic factor - humidity - on healthy and diseased skin in human, with varying results.

Evidence suggests that humidity, and changes therein, can have an impact on a range of parameters involved in skin health. Further studies examining the effect of humidity on diseased skin could provide evidence to support new treatment regimens for patients, helping to alleviate the burden of dry skin associated with many common skin disorders.

What is humidity?

Relative humidity is the most common way of measuring the moisture content of the air. It is the amount of water vapour (moisture) in the air compared to the maximum amount that the air could hold at a given temperature and is expressed as a percentage.

The hotter the air is, the more water it can contain, and for this reason outdoors humidity decreases in colder seasons and climates. Where the humidity is expressed as a percentage in this paper, this demonstrates that the relative, rather than the absolute, humidity is being studied, and unless otherwise specified, we will refer to relative humidity throughout.

A good range for relative humidity within the home is between 30 per cent and 60 per cent and this level of humidity minimizes the indoor growth of allergenic or pathogenic organisms such as dust mites and moulds. They further advise that a wider range of humidity levels, from a low of 25 per cent to a high of about 80 per cent, can be acceptable in terms of thermal comfort depending on the type of clothing worn and the level of physical activity.

You and your skin:

Human skin is made up of three core layers: subcutaneous fat (lower layer), dermis (middle layer) and epidermis (outermost layer). Ninety per cent of cells in the epidermis are keratinocytes, which multiply and migrate upwards from the basal cell layer.

The stratum corneum, which is in the epidermis, is made up of dead keratinocytes, which provide a highly impermeable membrane. It is this layer that, in healthy skin, effectively provides the skin's barrier function, regulating water loss from tissue inside the body and preventing irritants and substances from the external environment from permeating the skin.

Past research studies:

1. By comparing mice kept in conditions of low versus high humidity, one such study demonstrated that the desquamation process was impaired in skin exposed to dry air (low humidity). Dry air decreases the water content of the stratum corneum, which is responsible for disrupting the degradation of desmosomes, meaning there is failure of the cohesive bonds holding the skin cells together to adequately weaken. The implication here is that exposure to a dry environment could cause scaly skin.

2. A study exploring the effect of low relative humidity on healthy human skin. The results demonstrated a significant decrease of water content of the stratum corneum at both test sites from the time points zero hours to three hours and six hours. Changes of skin surface pattern on exposure to low humidity were observed through the roughness parameters measurements. Thus a short exposure of skin to a low humidity environment induced changes in the moisture content in the stratum corneum and skin surface

pattern. This led the authors to consider that a dry environment in daily life might induce aggravation of skin texture and formation of fine wrinkles related to lack of water in the stratum corneum.

Even a 30 per cent difference in relative humidity can affect skin properties in just 30 minutes, according to a study measuring skin conductance, elasticity and fine wrinkles on the eyelids of 20 volunteers, first after acclimatization for 30 minutes in a high humidity room (70 per cent relative humidity) and again after acclimatization for 30 minutes in a room with lower humidity (40 per cent). The temperature was maintained at 23C in both rooms. The study found significant decreases in skin surface conductance, signifying lower moisture levels, and decreases in elasticity, as well as significant increases in fine wrinkles, after acclimatisation to 40 per cent humidity compared with a high humidity environment.

Eczema

It can start at any age but Eczema is most common in children, with a prevalence of up to 20 per cent in children in western populations. The term atopic is used to describe a group of disorders which include asthma, eczema and hay-fever.

These conditions are linked by an increased activity of the allergy component of the immune system. In atopic eczema, a defect in the gene which is important for maintaining the skin barrier makes the skin in affected subjects much more susceptible to infection and irritation, and allows potentially allergy-inducing substances to enter the skin, with symptoms of itch and inflammation.

Measurement of skin roughness has revealed a significant linear relationship with skin dryness.

Studies have shown - (meaning increased skin roughness and signifying increased dryness) in patients with atopic eczema, but not in the controls, after the being subjected to lower humidity (30 per cent) for three hours in a climatic chamber.

The International Study of Asthma and Allergies in Childhood (ISAAC) programme was developed in 1991, with one of its key aims being to measure the prevalence and severity of atopic diseases (including atopic eczema) in children at 155 study centres in over 50 countries.

A study examining data taken from Phase One of ISAAC, involving children aged either 6-7 years or 13-14 years, looked specifically at the relationship between climate and atopic diseases, implying a connection between low indoor humidity and the prevalence of the skin disorder in this age group.

Both studies looked specifically at outdoor humidity, therefore not including the impact of indoor humidity as might be affected by central heating and air conditioning.

Unites States where data from 91,642 children aged 0-17 years included in the 2007 National Survey of Children's Health were cross referenced with the 2006-2007 National Climate Data Center and Weather Service measurements of relative humidity, indoor heating degree days, clear-sky UV indices, ozone levels, and outdoor air temperature16.

The study revealed a reduced eczema / skin allergy prevalence in areas with high relative humidity, high UV index, high mean temperature, reduced precipitation and fewer days of central heating use. In addition to possibly demonstrating that higher outdoors humidity may reduce eczema prevalence, the US data around indoor heating degree days might reflect the ISAAC Phase One study findings of an association between low indoor humidity and eczema, given that central heating use is known to reduce humidity.

Low humidity may also be a risk factor for irritant eczema, another common form of the disorder, in which external irritants perturb the skin's barrier function.

Analysis including known determinants of irritant hand dermatitis in this setting, showed that low temperature and low relative humidity tended to be risk factors and also confirmed that absolute humidity significantly influenced the occurrence of irritant hand eczema.

Moving from a high to low humidity level room

Changes in environmental humidity are believed to contribute to the onset, aggravation or - conversely - the improvement of various dry skin disorders that involve barrier deficiency. Patients with the common skin disorders psoriasis and atopic eczema, for example, frequently report exacerbation of their symptoms during the winter months when ambient humidity is lower.

However, despite this suggested barrier improvement, evidence implies that low humidity can cause skin scaling in normal, otherwise healthy skin, and could worsen existing dry skin diseases19,20. Studies examining changes to the skin following sudden shifts from environments with high humidity to low humidity, suggest that it is these significant fluctuations in air moisture, and a lack of regularity in the ambient humidity, that may be responsible for the exacerbation of dry skin disorders in winter when people move between dry, heated indoors environments and the outdoors.

Free amino acid content is pivotal to correct skin function and repair, playing a crucial role as a natural moisturizing factor in the stratum corneum. A decrease in free amino acids has been found in various dry, scaly skin types. In the above study, the free amino acid content in the stratum corneum significantly decreased 24 hours after transfer of the mice from a normal to a dry condition, then it recovered to the original level within three days, while the mice transferred from a humid to a dry condition still showed a significantly lower amino acid content seven days after the transfer. This suggests that a drastic decrease in the environmental humidity reduced the total free amino acid generation

How humidity is delivered to you:

Evidence also suggests that the mode of delivery of humidity into an indoors environment is important. As the authors of a study into water nanodroplets (mist) and skin hydration explain, humidifers are used to improve air dryness, but this often induces excess humidity and thermal discomfort.

They therefore analysed the effects of mist on skin under air conditioning, by measuring biophysical parameters, such as skin conductance, transepidermal water loss and sebum levels, in 12 healthy volunteers with normal skin. They also examined the biomechanical parameters of skin distension and retraction, which measure skin elasticity and viscosity, before and after suction at the forehead, lateral canthus (corner of the eye), and cheek.

Participants spent the first 60 minutes in an air conditioned test area without mist, maintained at 24C and 35 per cent relative humidity. Transepidermal water loss values at the three skin sites were found to decrease in the control group, but not in the mist group, for which the values were maintained at the initial values throughout the test.

In the control group, transepidermal water loss values significantly decreased at the forehead and at the lateral canthus at 120 minutes, and at the cheek at 90 minutes, compared with the initial values.

A significant difference was also observed between the measurements at 150 minutes and 180 minutes at the cheek. According to the authors, the findings relating to the mist group suggest that some of the mist was absorbed into the stratum corneum while some remained on the skin surface
and evaporated as a part of the transepidermal water loss process, and the change in transepidermal water loss values in the mist group indicate that the mist supplies water to the stratum corneum. The authors suggest

that the increase in water in the surface of the stratum corneum supplied by the mist, reduced the evaporation of internal stratum corneum water, which helps to preserve the skin water content. There were no significant differences between the mist and control groups in terms of skin conductance or sebum levels.

In terms of the biomechanical parameters, skin distension was significantly increased in the group with mist compared with that in the control group at the forehead and cheek. This suggests that the mist caused hydration of the stratum corneum and produced a subsequent softening effect.
Conventional room humidifiers supply excess water droplets to the air to moisturize it, but this causes other problems including dew condensation in winter or thermal discomfort in summer.
To address this issue, we examined the use of generated mist, which aimed to protect the skin from dryness without increasing humidity in the air. These data indicated that a mist of water
nanodroplets played an important role in softening skin in an air conditioned room without increasing excess humidity."

Conclusion:

A review of evidence around major climate conditions on skin integrity and function found that under dry conditions, surface roughness increases, while conductance decreases, indicating increased skin dryness. In summary, the studies outlined demonstrate that low humidity may effect the skin in a number of ways, for example by decreasing the water content of the stratum corneum, causing dry skin scales, aggravating skin texture, reducing elasticity and causing fine wrinkles.