



HUMIDITY, HEALTH AND WELLBEING

Humidification and Evaporative Cooling



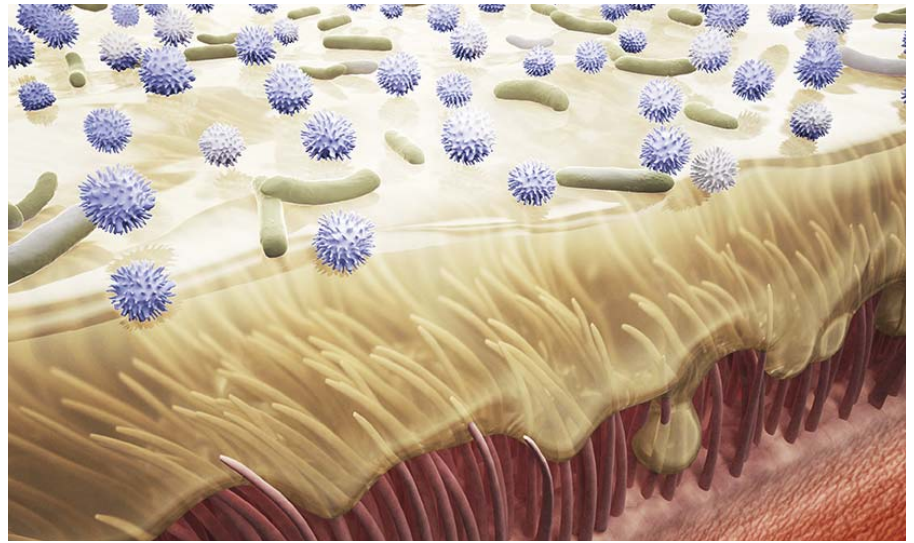
THE EFFECTS OF DRY AIR ON THE HUMAN BODY

People can tell whether an atmosphere is hot or cold the moment we experience it but air that has a low or high humidity is not obvious to us. Our senses are not so refined as to “feel” the moisture content of the air we breathe into our lungs or which touches our skin and bodies.

However, the effects of air’s humidity on us are significant and can be damaging when extremes are experienced over a long period.

Dry air will draw moisture from any available source it comes into contact with, including our bodies. Water can evaporate from our eyes, skin, hair, nails and any other exposed surface. This dehydration can cause initial discomfort, such as sore eyes or contact lens irritation, but can also lead to more serious symptoms, such as dry, itchy skin and dermatitis.

Even more serious is the effect it has on our respiratory and immune system. When we breathe air below 40%RH, the mucous membranes in our nose, throat and bronchi dry. These elements play a vital role in our body’s defence against airborne pollutants, such as viruses and bacteria.



Drying of the mucous membranes in our nose and bronchi inhibits our body’s natural defence mechanism against airborne pollutants. This leaves us vulnerable to infections from airborne germs, such as the flu and common cold.

These moist membranes capture airborne particles before they enter our lungs. Tiny hairs, called cilia, transport these pollutants to our throats where they are either coughed out or swallowed and destroyed. This process is referred to as mucociliary clearance.

When our mucous membranes dry out, this natural defence mechanism is inhibited, leaving us more susceptible to airborne infection from viruses and bacteria.



Sore eyes is a symptom of long term exposure to a dry atmosphere



Drying of the skin’s upper epidermal layer through exposure to dry air can lead to itchiness, cracking and dermatological problems.

SCIENTIFIC EVIDENCE

There have been many studies and reviews carried out over the years demonstrating how humidity affects the human body. Here is a concise summary from some of these studies' abstracts illustrating the compelling case for maintaining an optimum humidity for physical health and wellbeing.

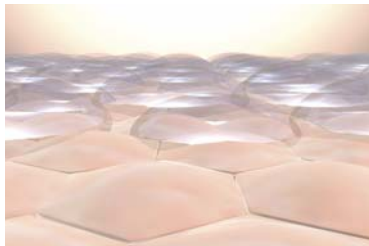
Study: **Physiological and subjective responses to low relative humidity**

Author: Sunwoo Y et al, 2006

Citation: J Physiol Anthropol. 2006 Jan;25(1):7-14

Method: 16 healthy subjects were monitored in controlled conditions of 25°C and 10%RH, 30%RH and 50%RH. The subjects' physical conditions were monitored, including mucociliary clearance time, frequency of blinking, hydration of skin and transepidermal water loss. Subjects were also asked to subjectively judge temperature, dryness and comfort sensations.

Summary result: Low relative humidity detrimentally affects mucous membranes, the dryness of the eye's mucosa and the stratum corneum (outer layer) of the skin and causes a decrease in mean skin temperature. Interestingly, subjects immediately felt cold after a drop in humidity but had only a slight perception of dryness.



Study: **Nasal mucociliary transport in healthy subjects is slower when breathing dry air**

Author: Salah B et al, 1998

Citation: Eur Respir J. 1988 Oct;1(9):852-5

Method: Assessed the effect of breathing dry air on nasal clearance in 11 healthy test subjects by depositing 250 micrograms of saccharin into their nostrils, while they breathed either dry or room air. Saliva was swallowed every 30 seconds and the time measured between deposition and first perception of saccharin taste.

Summary result: Breathing dry air results in excessive water loss by the nasal mucosa, which may in turn reduce nasal mucociliary clearance rate through changes in the rheological properties or adhesiveness of nasal mucus and/or slowing of ciliary beating.



Study: **On the mucus flow rate in human nose**

Author: Ewert G, 1965

Citation: Acta Otolaryngol Suppl. 1965;200:SUPPL 200:1-62

Method: Measured the mucus flow rate in the human nose at differing levels of humidity by observing how long it took powder particles to travel 2mm once inserted into a subject's nostril.

Summary result: The mean flow rate was significantly correlated to the relative humidity of the ambient air. Optimal flow rate occurred >70%RH and continuously diminished with decreasing humidity.



Review: **The dichotomy of relative humidity on indoor air quality**

Author: Wolkoff P, Kjargaard SK, 2007

Citation: Environ Int. 2007 Aug;33(6):850-7. Epub 2007 May 17

Method: Reviewed various epidemiological, clinical and human exposure studies relating to relative humidity.

Summary result: Studies indicate that low relative humidity plays a role in the increase of reporting eye irritation symptoms and alteration of the precorneal tear film. These effects may be exacerbated during visual display unit work. Relative humidity of about 40% is better for the eyes and upper airways than levels below 30%.



40-60%RH is the optimum humidity for our body and immune system

THE EFFECTS OF LOW HUMIDITY ON THE AIR WE SHARE

Low air humidity below 40%RH acts as a conduit for viruses and airborne bacteria to disperse and travel around a building. This occurs due to a combination of an increased virus survival time at lower humidity and the enhanced suspension of the infectious particle in dry air.

Whenever an infected person breathes, talks, coughs or sneezes they release aerosolized droplets that contain elements including saliva, mucus, salts, germs and viruses into the air. Large droplets fall to the ground or settle on surfaces but droplets less than 4 microns in size have been shown to remain airborne for hours.

In room air, expelled droplets lose more than 90% of their moisture content rapidly by evaporation after they are released. At a humidity level of above 40%RH, elements like salts and proteins are still dissolved in the droplet but become highly concentrated. They attack viruses and bacteria, rendering them inactive, reducing the risk of secondary infection.

However, below the critical level of 40%RH, further evaporative moisture



Droplets less than 4 microns expelled during breathing, speaking, coughing or sneezing can remain airborne and infectious for hours.

losses result in these elements crystallising out of solution. The internal environment of the airborne droplets changes from aggressive to protective towards the transported germs inside. This enables airborne viruses and bacteria to remain infectious for longer.

The lower humidity also causes more droplets to evaporate down to a size capable of remaining airborne. So dry air has the double effect of creating a greater quantity of airborne droplets and prolonging the infectivity of the germs they carry, significantly increasing the potential risk of secondary infection.



At above 40%RH, droplets remain larger and more fall to the ground, reducing airborne infection. For those particles small enough to remain airborne, their internal salts stay in solution and attack the germs, reducing their infectious capability.



At below 40%RH, more droplets become smaller through evaporation and remain airborne, increasing the risk of infection. Internal salts crystallize out of solution and are no longer a threat to the transported germs, prolonging their infectivity.

Maintaining 40-60%RH is an effective way to reduce airborne infection

SCIENTIFIC EVIDENCE

There have been many studies and reviews carried out over the years demonstrating how humidity affects the transmission and survival rates of airborne germs, such as cold and flu viruses. Here is a concise summary from some of these studies' abstracts illustrating the compelling case for maintaining an optimum humidity to improve indoor air quality and human health.

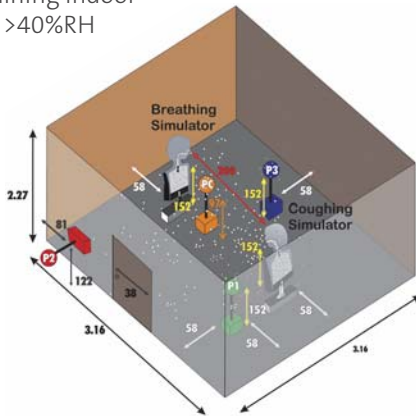
Study: **High humidity leads to loss of infectious influenza virus from simulated coughs**

Author: Noti JD et al, 2013

Citation: PLoS One. 2013; 8 (2):e57485

Method: Influenza was "coughed" using manikins fitted with nebulizers in a room at different humidity levels between 7-73%RH. Air samplers collected suspended aerosol particles to assess their continued infectious nature at the different room conditions.

Summary result: At low relative humidity, influenza retains maximal infectivity. Inactivation of the virus at relative humidity above 40%RH occurs rapidly after coughing. Maintaining indoor relative humidity >40%RH will significantly reduce the infectivity of an aerosolized virus.



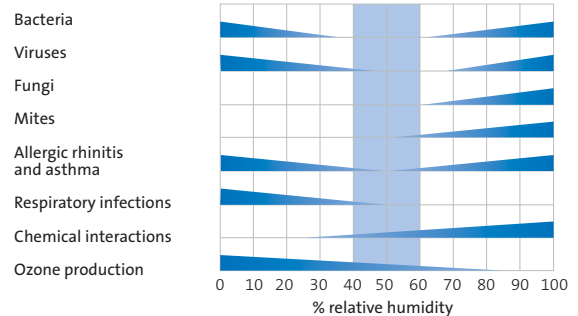
Review: **Criteria for human exposure to humidity in occupied buildings**

Author: Sterling EM et al, 1985

Citation: ASHRAE Transactions, Vol. 91, Part 1, CH85-13 No. 1, 1985

Method: Reviewed the health literature of relevant biological and chemical interactions in order to define an optimal range of humidity where the overall health risks may be minimised. Humidity effects at normal indoor temperatures of between 19-27°C were reviewed for biological contaminants, pathogens causing respiratory problems and chemical interactions.

Summary result: The optimal humidity to minimise risks to human health from biological contaminants, pathogens and chemical interactions occur in the narrow range between 40-60%RH at normal room temperatures.



Study: **Dynamics of airborne influenza A viruses indoors and dependence on humidity**

Author: Yang W, Marr LC

Citation: PLoS ONE, 1 June 2011 | Volume 6 | Issue 6 | e21481

Method: Modelled the size, distribution and transformation of aerosol droplets carrying influenza A virus (IAV) emitted from a cough, over humidity levels ranging from 10-90%RH.

Summary result: Humidity is an important variable in aerosol transmission of IAV because it both induces droplet size transformation and affects IAV inactivation rates. The virus inactivation rate increases linearly with relative humidity. At the highest %RH inactivation can remove up to 28% of IAV in 10 minutes.



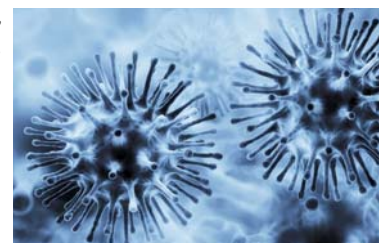
Review: **Influenza and humidity - why a bit more damp may be good for you!**

Author: Jane A. Metz, Adam Finn

Citation: Journal of Infection (2015) 71, S54eS58

Method: Review of investigations since 1960 on absolute humidity and temperature and its impact on the survival, transmission and infection rates of influenza.

Summary result: Mathematical modelling of in vitro experiments investigating influenza virus survival at different levels of absolute humidity showed improved survival of the influenza virus at lower absolute humidity levels. The prospect of reducing influenza-associated morbidity and mortality by increasing the absolute humidity in nurseries, classrooms, hospitals, homes for the elderly and general public spaces is an exciting and novel potential strategy for disarming 'flu.



PUBLISHED REGULATIONS ON HUMIDITY LEVELS

There are many governing bodies and professional organisations who publish regulations and recommendations on humidity levels. Most agree the optimum level for health and wellbeing is between 40-60%RH.

HSE: Work with display screen equipment Health and Safety (Display Screen Equipment) Regulations 1992 as amended by the Health and Safety (Miscellaneous Amendments) Regulations 2002

Heat and humidity

- 35.** Electronic equipment can be a source of dry heat which can modify the thermal environment at the workstation. Ventilation and humidity should be maintained at levels which prevent discomfort and problems of sore eyes.



BSRIA: Applications Guide AG10.94.1 Efficient Humidification in Buildings, March 1995

Thermal comfort

- 1.1** Extremes of RH are undesirable and affect human comfort, productivity and health. For most applications, therefore, indoor relative humidity should not exceed 60% nor be less than 40%.

Health

- 1.4** Low humidity can have an impact on the health of occupants. Low humidities often cause dry skin, nose, eyes, throat and mucous membranes, whereas consistently high humidities are likely to provide conditions suitable for the growth of organisms that are harmful.

CIBSE: Guide A, Environmental design, 8th edition, March 2015

- 1.3.1.3** For the purposes of designing air conditioning systems, a maximum room relative humidity of 60% within the recommended range of summer design operative temperatures would provide acceptable comfort conditions for human occupancy and minimise the risk of mould growth...

...If possible, at the design temperatures normally appropriate to sedentary occupancy, the room humidity should be above 40% RH. Lower humidity is often acceptable for short periods. Humidity of 30% RH or below may be acceptable but precautions should be taken to limit the generation of dust and airborne irritants and to prevent static discharge to or from occupants. Shocks due to static electricity are unlikely with humidities above 40% RH or at lower humidities if precautions are taken in the specification of materials and equipment to prevent the build-up of static electricity....



CIBSE: Knowledge Series, KS19: Humidification, Oct 2012

Health and comfort

- 3.1.1** CIBSE recommends that, for human comfort and health, humidity be maintained between 40 and 70%, maintaining a normal maximum of 60 % for air-conditioned spaces. It is accepted that in naturally ventilated buildings, humidity can be allowed to drop to 30 % for short periods, and that naturally ventilated buildings will inevitably operate at lower humidities than air-conditioned buildings.



ASHRAE: Position Document on Airborne Infectious Diseases, 19/01/2014, p14

ASHRAE recommends the following:

New health-care facilities, including key points of entry such as emergency, admission, and waiting rooms; crowded shelters; and similar facilities should incorporate the infrastructure to quickly respond to a pandemic. Such infrastructure might include, for example... the ability to humidify the air...

I THINK MY WORKPLACE HUMIDITY IS LOW! WHAT SHOULD I DO?

How do I find out what my workplace humidity level is?

A hygrometer will measure the humidity level in the air and will typically provide a %RH value, which means % relative humidity (100%RH being air that is saturated and cannot hold any more moisture). A thermo-hygrometer will measure temperature as well as humidity.



If nobody at your place of work is able to provide support, the environmental health services of your local authority or your local Health & Safety Executive office will be able to give advice.

What should I do about improving my humidity?

Monitor and record temperature and humidity levels regularly. Bear in mind that indoor humidity will typically be lowest during the winter months when the heating is on.

Talk to work colleagues to see if they are suffering from symptoms such as sore eyes, itchy skin, dermatological complaints, frequent electro-static shocks or respiratory problems. If you are suffering from health problems yourself, having your doctor confirm they may be caused or exacerbated by dry air could also help convince your employer to act.

If your humidity is consistently falling below 40%RH, discuss your findings with your line manager. They should be able to take the matter up with the health and safety representative or the human resources manager. Investigations are likely to also involve the building's facilities manager, who is responsible for the operation of the climate control equipment. You could also provide them with this booklet as a reference.

What are the possible solutions?

For small rooms of up to 1,000m³ mobile humidifiers capable of providing around three litres of humidification per hour may be sufficient to increase the humidity to the recommended level.

For rooms larger than this, or for areas that require a more permanent solution, a commercial humidification system should be considered. These can either provide humidity to a centrally ducted air conditioning system or directly to a room's atmosphere. Typically these systems inject steam, evaporate moisture from a wetted surface or spray a fine mist to raise the humidity.



Do we already have a humidifier?

It is not unusual for an office building's humidification system to be turned off in order to save energy or simply because it is in need of maintenance. As building occupants often fail to recognise the drop in humidity levels, and may not associate the symptoms of dry air they are suffering with a low humidity, a humidifier's deactivation can go somewhat unnoticed.

A building's facilities manager will be able to verify the situation and confirm whether there is any provision to manage the building's humidity levels. If the property is being rented, the required humidity is frequently included as part of the tenancy agreement, so it's worthwhile checking to see if the agreement is being adhered to.



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