

The Best and Worst Cities for Your Skin Research Methodology

Table of Contents

Introduction

City Selection

Criteria Selection

Weighting

Sun (40 % of total score):

Air (40 % of total score):

Stress (20 % of total score):

Clusters and their factors:

Cluster: Sun

Average yearly temperature (°C):

Number of days of sunlight (per year)

Average UV Radiation Index (per year)

Cluster: Air

Air pollution over a year (weight of particulate matter ug/m³ of air):

Average wind speed over a year (km/h)

Average Humidity over a year (% vapour water in atmosphere)

Cluster: Stress

Average working hours per week per person

Traffic Congestion during rush hour (% Increase in travel time during rush hour)

Average daily cigarette consumption per smoker

Scoring

Introduction

In order to identify the impact of environmental factors on skin health in cities, we analysed 80 cities according to 9 different factors to determine which metropolitan areas are the best and worst for your skin.

The sources used for the research can be found in the table provided [here](#).

City Selection

The cities chosen for the research were picked based on the number of inhabitants. Up to three cities with the highest populations from all the members of the Organisation for Economic Co-Operation and Development (OECD) and from some of the most populous countries in the world were selected for the study. The cities that were left out of the ranking were removed due to a lack of available data.

Criteria Selection

The factors for each cluster were chosen based upon conditions that are known to have an effect on the skin. These conditions and their effect on the skin must be stated in a white paper research documents in order to be featured in our ranking.

Each cluster was limited to 3 factors each, in order to maintain an element of simplicity to the ranking. This means that the factors that were chosen were based upon the strength of the data source and how strong the impact on the skin is.

Weighting

The research was made up of 3 different data clusters with their own factors. A different weighting was assigned to each cluster according to the impact of the factors on skin health, in order to obtain the most accurate final scoring and ranking.

The weighting is assigned as follows:

- ❑ **Sun** (40 % of total score):
 - **Average temperature (°C)** is measured in degrees Celsius (°C) and makes up 25 % of the cluster score
 - **Number of days of sunlight (per year)** are accounted per year and make up 25 % of the cluster score

- **Average UV Radiation Index (per year)** makes up 50 % of the cluster score
- **Air** (40 % of total score):
 - **Average air pollution over a year (weight of particulate matter $\mu\text{g}/\text{m}^3$ of air)** makes up 50 % of the cluster score
 - **Average wind speed over a year (km/h)** makes up 25 % of the cluster score
 - **Average humidity over a year (% of vapour water in the atmosphere)** is measured in percent and makes up 25 % of the cluster score
- **Stress** (20 % of total score):
 - **Average working hours per week per capita** makes up 25 % of the cluster score
 - **Traffic congestion (extra travel time experienced across the year)** makes up 25 % of the cluster score
 - **Average daily cigarette consumption per smoker** makes up 50 % of the cluster score

Clusters and their factors:

Cluster: Sun

Research shows that the conditions associated with the sun play a big part in the health of skin. Therefore, 3 factors strongly associated with the sun were chosen for this factor.

- **Average yearly temperature (°C):**

The average yearly temperature in the Celsius scale was included in the research due to many studies stating its effect on the skin, such as "The effect of environmental humidity and temperature on skin barrier function and dermatitis" by Kristiane Aa. Engebretsen et al. In this study it is stated that "*We conclude that low humidity and low temperatures lead to a general decrease in skin barrier function and increased susceptible towards mechanical stress*".

Another study which states the effect of temperature on the skin is called "Seasonal aggravation of acne in summers and the effect of temperature and humidity in a study in a tropical setting" by Narang. L et al, which states that high temperatures are also bad for your skin - "*Both temperature and humidity have a contributing role in pathogenesis of acne*".

and are causes of acne flare. In our study, the aggravation of acne was more in summer and the rainy season”.

The most desired temperature for health and productivity was deemed to be room temperature, which is 22 °C. This was stated by O. Seppänen et al with their paper called “Room Temperature and Productivity in Office Work”. This was therefore taken into account in our calculation, with an average temperature of 22 °C scoring the highest and the further the average temperature lies away from it, the lowest.

It is known that weather extremes change depending on location. Therefore, an average yearly temperature for each location was deemed the most accurate way to represent each city.

- **Number of days of sunlight (per year)**

The number of days of sunlight per year was included in this study since the correlation between sunlight exposure and skin diseases has been widely stated in several studies, such as “Chemiexcitation of melanin derivatives induces DNA photoproducts long after UV exposure”, published in the journal Science, and an article in The Guardian.

This factor was obtained by dividing the data of the total hours of sunlight by 24 (the number of hours per day).

The data was found by searching for the cities on the following websites:

- ❑ weather-and-climate
- ❑ worldweatheronline

- **Average UV Radiation Index (per year)**

A recent study determined that UV exposure damages skin and analyzed its implications on the epidermis.

This research article titled “Ultraviolet light degrades the mechanical and structural properties of human stratum corneum”, published by the Journal of the Mechanical Behavior of Biomedical Materials, clearly demonstrates the correlation between UV exposure and skin health issues.

Therefore the strength of the sun’s ultraviolet (UV) radiation was researched mainly from WeatherAtlas and worldweatheronline.

The UV index describes the expected daily peak level of the erythemal UV irradiance at ground level.

UV Index	Exposure category
1-2	low
3-5	moderate
6-7	high
8-10	very high
11 and higher	extreme

Source for table : [BundesAmt für Strahlenschutz](#)

Cluster: Air

Research shows that air conditions play a big part in the health of skin. Therefore, the following 3 factors were chosen due to the size of the impact they can have on the skin when they change.

- **Air pollution over a year (weight of particulate matter ug/m3 of air):**

Air pollution is defined by the concentration of particulate matter (PM) in the air. This data was taken from an air pollution study conducted by the [World Health Organisation](#). The data shown in the study was on a global city level, presenting 2 sets of numerical data for each city. These 2 sets are concentrations of differently sized particles “2.5PM” and “10PM” - “Annual mean concentration of particulate matter of less than 10 microns of diameter (PM10) [ug/m3] and of less than 2.5 microns (PM2.5) in cities and localities”.

A study called “[Air Pollution, Autophagy, and Skin Aging: Impact of Particulate Matter on Human Dermal Fibroblasts](#)” by Seo-Yeon Park et al states “*Particulate matter (PM) is one of the main components of air pollution, and there is increasing evidence that PM exposure exerts negative effects on the human skin*”.

For our study we added these concentrations together in order to get the total mean concentration of particulate matter in the air for each city. The cities with the lowest concentrations scored the highest.

This factor was deemed to be important and therefore makes up 50 % of the Air cluster score.

- **Average wind speed over a year (km/h)**

Wind speed is measured in km/h, the data was taken from [Weatherspark](#), by calculating the average of average wind speeds taken throughout the year.

The study called "[Effects of Wind on Skin Surface](#)" published by the Journal of the Society of Cosmetic Chemists of Japan states that wind force has a direct impact on skin health. In particular, [an article by the Skin Cancer Foundation](#) claims that windy conditions can draw moisture out of the epidermis and promote inflammation. Therefore, the higher the average wind speed, the lower scoring in our ranking.

- **Average humidity over a year (% vapour water in atmosphere)**

The average humidity over a year is defined as the percentage of vapour water in the atmosphere and was researched mainly on [Weather & Climate](#). The average humidity was included in the research due to many studies stating its effect on the skin, such as "[The effect of environmental humidity and temperature on skin barrier function and dermatitis](#)" by Kristiane Aa. Engbretsen et al. In this study it is stated that "*We conclude that low humidity and low temperatures lead to a general decrease in skin barrier function and increased susceptible towards mechanical stress*".

Another study which analyses the effect of humidity on the skin is called "[Seasonal aggravation of acne in summers and the effect of temperature and humidity in a study in a tropical setting](#)" by Narang. L et al, which states that high humidities are also bad for your skin - "*Both temperature and humidity have a contributing role in pathogenesis of acne and are causes of acne flare. In our study, the aggravation of acne was more in summer and the rainy season*".

Therefore, the best range of humidity was deemed to be 30% - 50% according to [hvac](#). The further the humidity levels lie outside of this range, the lower the scoring.

Cluster: Stress

According to research, high levels of stress can have an undesired effect on the skin. The factors chosen for this cluster were not only picked by their well known correlation with stress levels, but also the direct implications they can have on the skin.

- **Average working hours per week per person**

According to “[The impact of long working hours on psychosocial stress response among white-collar workers](#)” provided by the National Institute of Occupational Safety and Health in Japan, there is an association between long work hours and stress levels (stress levels are linked to affecting skin health according to “[The Response of Skin Disease to Stress : Changes in the Severity of Acne Vulgaris as Affected by Examination Stress](#)” by Alexa. B et al).

This was taken into account in the ranking by making the cities with the lowest average working hours score the highest, and the ones with the longest working hours score the lowest.

The data on average working hours per year was mainly taken from [Feenstra et al \(2015\), “The Next Generation of the Penn World Table”](#) with the missing values taken from the links provided below:

- ❑ Cairo - [Egypt independent](#)
- ❑ Panama city - [Nations Encyclopedia](#)
- ❑ Riyadh - [The National](#)
- ❑ Dubai - [Gulf Business](#)

The average working hours were then divided by the number of weeks there are in a year to give the average working hours per week. It should also be considered that this data is averaged on a country level and matched for each city and their respective country.

- **Traffic Congestion during rush hour (% Increase in travel time during rush hour)**

This factor represents the average amount of extra travel time in minutes (expressed in %) per city experienced by drivers due to intense traffic conditions across the entire year. The information was obtained mainly from [TomTom](#).

Individuals experience high levels of stress during traffic jams, as stated by the study “[Traffic noise increases stress by driving up cortisol](#)”. Stress



levels are affecting skin health according to “The Response of Skin Disease to Stress : Changes in the Severity of Acne Vulgaris as Affected by Examination Stress” by Alexa B. et al. Congestion during rush hour was therefore taken representatively as one of the many factors to measure the impact of stress on skin health.

A study called “Brain-Skin Connection: Stress, Inflammation and Skin Aging” which was published in the Journal of Allergy & Inflammation, reveals that psychological stress has a direct impact on the aggravation of multiple skin diseases.

However, as some cities did not appear in TomTom’s index, traffic congestion was calculated as the comparison (in %) of the average yearly duration in minutes of a certain route during rush hour (determined as 8:00 - 10:00), with its average yearly duration during another time of day in freed up conditions (10:00 - 12:00) using Google Maps.

This calculation was applied to the following cities:

- Hanoi
- Ho Chi Minh City
- Nicosia
- Panama City
- Valletta

- **Average daily cigarette consumption per smoker**

The average daily cigarette consumption per smoker was analysed as recent studies reveal that smoking not only increases the probability of developing lung cancer, but also has negative effects on the health of skin, teeth, and even hair, among others. The study “Acne and smoking”, published in the Journal of Dermato-Endocrinology, states a clear example of this by showing that there is data proved evidence of a correlation between smoking and acne. In fact, there is even a specific name for this smokers disease and it is APAA or smoker’s acne.

The average daily cigarette consumption per smoker was considered as a factor in the Stress cluster, as the research paper “Perceived stress, quitting smoking, and smoking relapse” provides evidence for a relation between changes in stress levels and changes in smoking status.

The average daily cigarette consumption per smoker at country level includes all ages and genders and was sourced from the Institute for Health Metrics and Evaluation (IHME). Global Smoking Prevalence and Cigarette

Consumption, the country level data was matched up to their respective cities.

Research states that smoking does not only affect those that have a smoking habit. Second and thirdhand smoke causes undesired effects on the skin.

Carmela Protano and Matteo Vitali state in their research that “*Thirdhand smoke is a complex phenomenon resulting from residual tobacco smoke pollutants that adhere to the clothing and hair of smokers and to surfaces, furnishings, and dust in indoor environments. These pollutants persist long after the clearing of secondhand smoke*”. “*Exposure can even take place long after smoking has ceased, through close contact with smokers and in indoor environments in which tobacco is regularly smoked*”.

Therefore, it can be said that countries where the average cigarette consumption per smoker is high, chances of being exposed to second-and thirdhand smoking is high as well.

This factor was deemed to be important and therefore makes up 50 % of the stress cluster score.

Scoring

The factors were classified in different clusters which when combined represent the overall impact on skin health. In order to obtain the overall score for the best and worst cities for a healthy skin, a different weighting was assigned to all the clusters and factors according to the importance of the impact on skin health. Refer to the beginning of the methodology under the title “Weighting” for the weighting figures.

The research was standardized by rating each factor within each cluster on a scale of 0-10, where 0 represents a negative effect on skin health and 10 a positive one. It is to be noted that for skin damaging factors, such as **UV**, the maximum value equals 0.

The calculation of the score of each factor per city was carried out by using the following normalisation formula:

$$x_{new} = \frac{x - x_{min}}{x_{max} - x_{min}}$$

Then, the standardised factors were summed in their respective clusters.



Afterwards, the cluster scores were calculated by standardising the sum of all the factor scores in their respective clusters on a scale of 0 - 10, to then be multiplied by their respective weighting fraction (e.g weight fraction for Air cluster = 40 % = 0.4) to obtain a weighted cluster score.

The final score was calculated by standardising the sum of all the weighted cluster scores on a scale of 0 - 10.

Finally, the cluster scores were ranked in descending order to obtain the best and worst cities for skin health.