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# Testing the Relationship between Air Temperature and Relative Humidity by Using T-Test for Some Selected Stations in Iraq

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## ABSTRACT

Temperature and relative humidity are the most important factors affecting on human comfort. This Research test the monthly average temperature and relative humidity for some selected stations in Iraq, three stations (Baghdad - Mosul - Basra) to find the pattern covariance of the annual average of temperatures and relative humidity for the period of time (2000-2014) By using the Welch T-test or paired T- test, We find that the calculated value is greater than the tabular value in both stations (Baghdad - Mosul) and (Baghdad - Basra) for both temperatures and relative humidity, and this indicates an increasing trend in the average of temperature and relative humidity in two stations (Baghdad - Mosul) and (Baghdad - Basra), and since the main hypothesis is that there is a relationship between the two racists and the calculations prove that, so we reject the null hypothesis, which proves the validity of the main hypothesis, i.e. there is a relationship between temperature and humidity in these selected stations.

**KEYWORDS**: Temperature; Relative Humidity; T-Test.

## الخلاصة

تعتبر درجة الحرارة والرطوبة النسبية من أهم العوامل التي تؤثر على راحة الإنسان. يختبر هذا البحث المتوسط الشهري لدرجة الحرارة والرطوبة النسبية لبعض المحطات المختارة في العراق ثلاث محطات (بغداد - الموصل - البصرة) لإيجاد نمط التباين المشترك لمتوسط درجات الحرارة السنوي والرطوبة النسبية للفترة الزمنية (2000-2014) وباستخدام اختبار (Welch T-test أو paired T- test) وجدنا أن القيمة المحسوبة أكبر من القيمة الجدولية في كل من المحطتين (بغداد - الموصل) و (بغداد - البصرة) لكل من درجات الحرارة والرطوبة النسبية وهذا يدل على اتجاه متزايد في متوسط درجة الحرارة والرطوبة النسبية في محطتين (بغداد - الموصل) و (بغداد - البصرة) ، وحيث أن الفرضية الرئيسية أن هناك علاقة بين العنصريين والحسابات تثبت ذلك ، لذلك نحن نرفض فرضية العدم ، مما يثبت صحة الفرضية الرئيسية أي أن هناك علاقة بين درجة الحرارة والرطوبة في هذه المحطات المختارة.

## INTRODUCTION

Living creatures are affected by the weather condition to varying degrees and in different ways. Animals and plants are directly and indirectly affected by the weather according to their species. Some of them respond to the change in the state of the sky, whether the sky is cloudy or sunny, and some respond to rain, snow, and changes in humidity air temperature, wind, and air pressure.

As for people, they affected by the weather in a way that differs from one person to another under the same circumstances because there are factors that affect the relationship between a person and his physiological performance and the weather, including his age, health status, food, and the weather that he used to in the past. As a person's health, movement, activity, and feeling of comfort or distress are all affected to a large extent by fluctuations in weather and climate conditions, as is the case with a specific weather or climate being linked to the spread of some diseases, the type of food we eat and the choice of our clothes is a reflection of weather conditions and the prevailing climate as well [1, 14].

The response of human beings to feeling of heat or cold depends on several factors, which are: temperature, relative humidity, wind speed. As high temperatures with high humidity increase the transfer of heat from the air to the body and at the same time hinder the evaporation, which makes the body does not cool quickly and its temperature becomes annoying. But during cold weather, high humidity increases the transfer of heat from the body to the surrounding atmosphere, which causes the body to lose part of its temperature at the time when it needs such heat. It is also noted that long periods of heat or long periods of cold greatly affect the vital signs of humans. We conclude that high temperature and extreme cold are harmful to human health because the human body will maintain its internal temperature, which is 37 ° C. As for high and low humidity, they are also harmful to human health, because the humid atmosphere helps the growth of bacteria and germs and causes laziness and lethargy, but the moderate-humid air is comfortable and healthy, which is better than wet or dry air [2, 15].

The relative humidity of a region differs greatly during the day, even though the amount of water vapor in the air remains the same, and in such cases the relative humidity changes when the temperature rises or falls, the relative humidity may be higher in the morning, when the temperature is low and the air is unable to carry more water vapor than it did at that time. But when the temperature rises during the day, the air becomes able to carry more water vapor, and thus the amount of relative humidity decreases. Therefore, since the air cools under a specific pressure and a constant amount of water vapor, it reaches a temperature that becomes saturated with it, and this temperature is called the dew point. However, if the temperature is lower than that, the water vapor begins to condense, and then clouds, fog or dew are formed. Hence, the lower the air temperature relative to the dew amount in it, the higher the relative humidity [3].

This pertinent relationship between temperature and humidity and their importance for living creatures, especially humans, has revealed the importance of studying the relationship between them.

One of the important things, whose results can be directed, in many aspects of scientific, service, economic and agricultural life, is to know the relationship between relative humidity and air temperature in the weather of Iraq, applied the hypothesis test (T-test) to these two factors for the stations of Basra, Baghdad, and Mosul and for the time period (2000-2014).

## Air Temperature

Surface air temperature in meteorology represents the temperature of free air at an altitude between (1.25-2 m) above the surface. It has been found that the temperature at this height represents almost the conditions that humans are exposed to on the surface. However, the surface air temperature measured in this way differs significantly from the surface temperature. On hot sunny days, the surface temperature of the Earth can be more than the surface air temperature. On the contrary, on cold frost nights it can be much lower than the surface air temperature, and until we get a reading from the thermometer that represents the air temperature, we must protect scales during the measurement from the radiation coming from the sun, sky, Earth and any surrounding objects, and there must be sufficient ventilation around it so that we can measure the temperature of the free air [1].

## Temperature Change

There are several changes that occur on temperature:

1. The daily change in temperature: It is the change that occurs on the temperatures during day and night, and this is the result of night and day due to the rotation of Earth around itself.
2. The seasonal change in temperature: This is a result of Earth's rotations around the sun, which causes the four seasons.
3. The change in temperature due to latitude: The temperature decreases as we move from the equator towards the poles due to the decrease in solar radiation.
4. The temperature changes according to the terrain: The average temperature of a desert differs from the average temperature of coastal areas. The change in temperatures in the desert is high, while the change in the coastal areas is low.
5. The temperature changes with the elevation: In the first layer of the troposphere, the layer in which different weather phenomena occur, in this layer the temperature decreases with the elevation at a rate of 6.5 °C/km [2].

## Temperature Scales

Most means of measuring temperature are designed using thermal scales (thermostats) by determination of two fixed points that represent a specific state of natural materials, given numerical values representing specific temperatures, and then divides the distance between two points into a specific number of equal parts, thereby creating a scale or a calibrator to measure temperature. It has been internationally agreed to set the freezing and boiling points of pure water under standard air pressure (1013.2 m bar) to be the basis for building thermal scales, which differ according to the conventional values given to each of the two fixed points, and the most famous temperature measures are shown in Table (1) below [3, 16]:

**Table 1.** Standard temperature measures.

| Scale | Freezing Point | Boiling Point | Number of Division |
|---|---|---|---|
| Celsius ºC | 0 | 100 | 100 |
| Fahrenheit ºF | 32 | 212 | 180 |
| Kelvin ºK | 273.2 | 373.2 | 100 |

## Atmospheric Humidity

Atmospheric humidity is a term that describes the amount of water vapor in the air, and the distinction between dry and wet air in the atmosphere is through the presence of water vapor or not. Water vapor is the invasive state of moisture in the atmosphere it is the most present condition in the atmosphere, where water is also present in a liquid form, such as cloud droplets or raindrops in a solid state such as snow and hail. The amount of moisture in the air varies with humidity, depending on the temperature and air pressure, as the air humidity is directly proportional to the temperature and inversely with air pressure. The warmer air, the more water vapor it carries because the high air pressure lowers the evaporation process by preventing the evaporated particles from escaping from the water surface to the atmosphere, and when the air contains the maximum amount of water vapor that can carry it under a certain temperature and pressure, then it is said that the air has been saturated with water vapor [4, 17].

1. Water vapor pressure: It is the partial pressure of water vapor as a gas component of the atmosphere.
2. Absolute humidity: The amount of weight of water vapor present in the air at a specific temperature.
3. Specific humidity: It is the ratio of the mass of water vapor to the mass of moist air that is associated with it.
4. Dew point: It is the temperature at which water vapor begins to condense
5. Mixing ratio: Is the ratio between the mass of water vapor to the mass of dry air with which water vapor is associated.
6. Relative humidity: The ratio of the real vapor pressure to the saturated vapor pressure at air temperature [4].

Relative humidity is the most common way of expressing air humidity, as it is a measure of the degree to which the air approaches the saturation of water vapor. If the air contains half of the amount of water vapor that it can carry only, then this humidity equals 50%, and the air is saturated with moisture that associated with shrouding in clouds and fog then the relative humidity in this case is 100%. In addition, the lower air layers over the oceans are saturated with humidity that reaches 100%. In the Sahara Desert and the subtropical desert regions, the relative humidity drops to only 10%.

There are several ways to measure them, including:

1- Hygrometer with dry and wet probes.
2- The capillary hygrometer [5].

## Temperature and Humidity and their Effect on Humans

The high temperature with high humidity increases the transform of heat from the air to the body and at the same time impedes evaporation, which makes the body does not cool quickly and its temperature becomes annoying. But during cold weather, high humidity increases the transfer of heat from the body to the surrounding atmosphere, which causes the body to lose a portion of its heat at the time when it needs such heat. Long periods of heat or long periods of cold have a significant impact on the vital signs of a person. Hence, we conclude that high temperature and extreme cold are harmful to human health because the human body will maintain its internal temperature, which is 37 ºC. Whereas, high and low humidity are also harmful to human health. The humid atmosphere helps the growth of bacteria, germs, and causes laziness and lethargy, but the moderate-humid air is comfortable and healthy and is better than wet or dry air [5].

The relative humidity of a region differs greatly during the day, even though the amount of water vapor in the air remains the same, and in such cases the relative humidity changes when the temperature increases or decreases, the relative humidity may be higher in the morning, when the temperature is low and the air is unable to carry more water vapor than it did at that time, but when the temperature increases during the day, the air becomes able to carry more water vapor, thus reducing the amount of relative humidity[6]. As the air cools under a specified pressure and a constant amount of water vapor, it reaches a temperature with which it becomes saturated. This temperature called the dew point, but if the temperature is lower than that, the water vapor begins to condense and clouds, fog, or Dew. Thus, the lower the air temperatures relative to the amount of dew in it, the higher the relative humidity [6, 18].

## The relationship between the Temperature and Atmospheric Humidity

Atmospheric humidity in the atmosphere increases directly with increasing temperature, that is, the higher the temperature, the higher the air humidity. For this reason, the humidity in the tropical regions increases, while in the Polar Regions decreases. It also increases in marine areas compared to land areas. The same can be said when comparing low areas (high humidity) and high areas (low humidity). The temperature is also affected by the humidity. Water vapor is a gas that absorbs thermal energy. The temperature of the gaseous envelope saturated with water vapor decreases by 1 km / 5 ° C, while decreases by 1 km / 10 ° C in case of non-saturated water vapor. In addition, the humidity decreases as the height increases because 90% of the water in the atmosphere is concentrated in the first five kilometers. This phenomenon is explained by moving away from water sources. The weight of water plays a fundamental role in the presence of this substance near the surface of the globe [6, 19].

II. Weather and Climate in Iraq

Iraq has a hot climate in most of spring, summer, and autumn months. Average temperatures in Iraq range from above 39 ° C in July and August to below zero in January. Figure (1) shows the annual average temperature in Iraq. Most of the rains occur from November and December until the end of April, and the most abundant ones are in the mountainous region in northern Iraq [7]. The summer months are accompanied by dry Southern and Southeastern winds, as well as dusty winds that occur from April to June and second from late September to November and Northern and Northwestern winds prevail from mid-June to mid-September, where dust storms accompany these winds [7]. The climate in the Western and Southern desert regions is characterized by hot Summers and cold Winters. This region also experiences short violent rainstorms in Winter. As for the Southeastern region, most of its rain is accompanied by thunderstorms in Winter and early Spring. The average annual average rainfall for this region is around 10-17 cm, and half of the Winter days are cloudy, and in Summer the weather is clear except for periods of dust storms [8] in Norther part of Iraq. The Kurdistan region, there is mountains that extend in the North and Northeast of Iraq, and the region's climate is characterized by mild Summers and cold Winters, and rain occurs mainly here in Winter and Spring, and is also accompanied by falling amounts of snow in many places. [8].

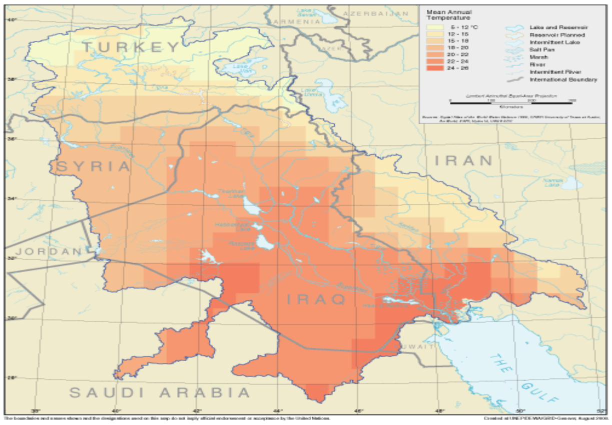


**Figure 1.** Annual average temperature in Iraq [9].

# METHODOLOGY

In the following section, Welch T-test or paired T-test is given and will be applied for detecting possible stochastic and deterministic trends for temperature at (Baghdad, Basra, and Mosul) stations. The T-test is a test to find out the significance of the differences between the two averages based on the statistic hypothesis test, as the statistical test follows the distribution of T if the alternative hypothesis is correct; in 1908 this test was presented by chemist William Sealy. They were previously using statistics as a trade secret in which he could derive an equation for the probability distribution of the Statistic-T and then some modifications of it were made by R.A. Fisher [10]:

$$T = \frac{\bar{y} - \mu}{\frac{s}{\sqrt{n}}} \quad (1)$$

Where:

$\bar{y}$ = Arithmetic mean

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n = size of the sample
s = standard deviation
μ = real arithmetic mean
It should be noted that the T-distribution has one coefficient called the degree of freedom df = n-1 and this distribution is similar to the usual symmetric distribution around zero and takes the form of a bell.

## Types of Test

There are three types of T-Test:

### *T-Test for One Sample*

This test is based on comparing one group to a hypothetical value, in which the sample is randomly chosen from the total of the population and the distribution of the mean that is tested is a normal distribution. This distribution is often used to compare the mean of the sample with a number that is most likely known [11]:

$$T = \frac{\bar{x} - \mu}{s/\sqrt{n}} \quad (2)$$

$$df = n\text{-}1 \quad (3)$$

Where: $\bar{x}$ The mean of the sample.

### *T-Test for Two Samples assuming Equal Variance*

It is also called unpaired T-test because it is used to compare two non-correlative samples, and the two samples are referred to independently if the observations in one of the samples are not related in any way to observations of the other sample, and is also used in cases where there are separate random subjects belonging to two groups, where it is given to the first group Coefficient A and for the second group coefficient B and comparison is made between the two groups [12].

$$T = \frac{\bar{x} - \bar{y}}{S_P\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \quad (4)$$

$$df = n_1 + n_2 - 2 \quad (5)$$

Where:
$\bar{x}$= the mean of the sample.
$\bar{y}$= the mean of the second set.
$S_p$ = the sum of the standard deviation of both samples.
The sum standard deviation gives a weighted average of the standard deviation of both groups, and between the standard deviation of both samples is closer to the standard deviation of the large sample and its equivalent:

$$S_P = \frac{\sqrt{(n_1 - 1)S_1^2} + \sqrt{(n_2 - 1)S_2^2}}{n1 + n2\ - 2} \quad (6)$$

Where: $S_1$ the standard deviation of the first set
$S_2$ the standard deviation of the second group

### *T-Test for Two Samples assuming non-Equal Variance*

This test is also called a Welch T-test or paired T-test as it compares two unrelated groups, in which the difference between the two groups is significantly different and is statistically expressed by the equations below [12]:

$$T = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{S_X^2}{n_1} + \frac{S_Y^2}{n_2}}} \quad (7)$$

$$df = \frac{\left[\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right]^2}{\frac{\left[\frac{S_1^2}{n_1}\right]}{n_1 - 1} + \frac{\left[\frac{S_2^2}{n_2}\right]}{n_2 - 2}^{2}} \quad (8)$$

Observed data from the same topic or from an identical subject that were withdrawn from the community with a normal distribution do not assume that the inequality is equal for both societies.

$$T = \frac{\bar{x} - \bar{y}}{S_d/\sqrt{n}} \quad (9)$$

$$df = n - 1 \quad (10)$$

## RESULTS AND DISCUSSION

For the purpose of applying the -T test on the relationship between relative humidity and temperature, monthly averages were obtained for the former racists and stations (Basra, Baghdad, Mosul) from the Iraqi Meteorological Organization and Seismology and for the period from (2000-2014) [9]. Some statistical characteristics (i.e., Annual average, Variance, Standard deviation, and Minimum and Maximum) for temperature and relative humidity are shown in Tables (2, 3, and 4).

**Table 2.** Some statistical characteristics of Baghdad station for temperature and relative humidity for the period (2000-2014).

| Baghdad | T°C | RH% |
|---|---|---|
| Average | 23.60 | 42.061 |
| Variance | 77.49 | 260.87 |
| *s* | 9.57 | 16.35 |
| Min. | 9.94 | 23.53 |
| Max. | 35. 94 | 67.33 |

**Table 3.** Some statistical characteristics of Mosul station for temperature and relative humidity for the period (2000-2014).

| Mosul | T°C | RH% |
|---|---|---|
| Average | 20.91 | 51.05 |
| Variance | 104.1 | 401.9 |
| *s* | 10.22 | 19.67 |
| Min. | 7.28 | 26.60 |
| Max. | 35.31 | 77.13 |

**Table 4.** Some statistical characteristics of Basra station for temperature and relative humidity for the period (2000-2014).

| Basra | T°C | RH% |
|---|---|---|
| Average | 26.54 | 60.30 |
| Variance | 94.49 | 10180.40 |
| *s* | 9.39 | 14.07 |
| Min. | 13.14 | 23.00 |
| Max. | 38.39 | 65.73 |

Figures (2, 3, and 4) show the monthly average of relative humidity and temperature for the period (2000-2014). By using the equations (7, 8) the following results can be obtained.

T-test average temperature for the selected stations: Table (5) for the stations (Baghdad, Basra, Mosul) at a 95% confidence level, which is equivalent to $\alpha = 0.05$ and when comparing their value with the degree of freedom in the T-Table [7] and for the stations the three, where we find that the calculated probability value is greater than the probability of the schedule at two stations (Baghdad and Mosul) and (Baghdad-Basra) for temperature.

T-test average relative humidity for the elected stations: Table (6) since the main hypothesis is the existence of a relationship between the two racists and the calculations are proven, therefore we reject the null hypothesis, which proves the validity of the main hypothesis, and there is a relationship between temperature and humidity in these two stations (Baghdad-Mosul) and (Baghdad-Basra).

**Table 5.** The values of T-test, Degrees of Freedom and tabular Probability for temperature in the selected stations.

| Stations | T-test value | Degrees of Freedom (*df*) | Probability % |
|---|---|---|---|
| Baghdad-Mosul (T) | 1.95 | 21 | 1.72 |
| Baghdad – Basra (T) | 2.05 | 27 | 1.70 |

**Table 6.** The values of T-test, Degrees of Freedom and tabular Probability for Relative Humidity in the selected stations.

| Stations | T-test value | Degrees of Freedom(*df*) | Probability % |
|---|---|---|---|
| Baghdad-Mosul (R.H) | 2.02 | 30 | 1.70 |
| Baghdad – Basra (R.H) | 1.82 | 40 | 1.68 |

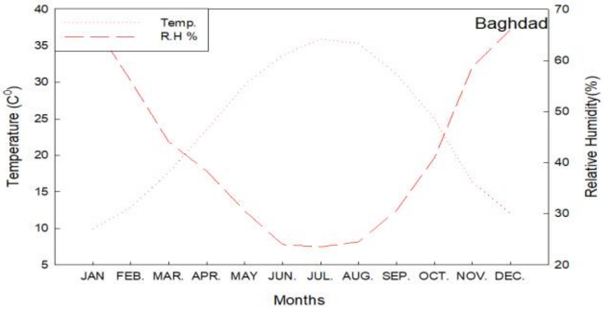


**Figure 2.** The Monthly Average of Temperature and Relative Humidity for Baghdad station (2000-2014).

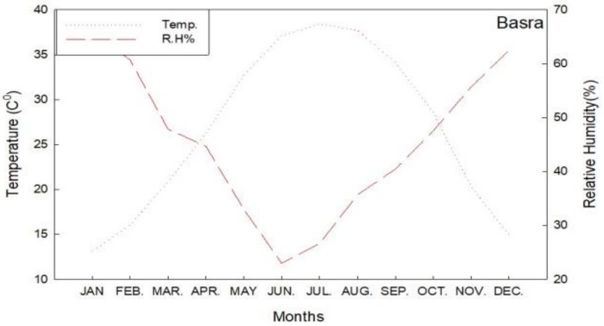


**Figure 3.** The Monthly Average of Temperature and Relative Humidity for Basra station (2000-2014).

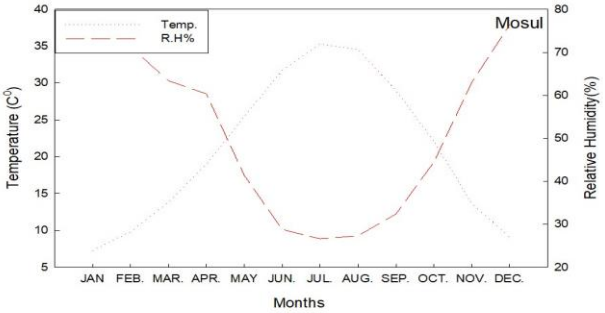


**Figure 4.** The Monthly Average of Temperature and Relative Humidity for Mosul station (2000-2014).

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**Table 7.** T –Test [13].

| Degrees of Freedom | Probability % | | | |
|---|---|---|---|---|
| | 0.1 | 0.05 | 0.01 | 0.001 |
| 1 | 6.31 | 12.71 | 63.66 | 636.62 |
| 2 | 2.92 | 4.30 | 9.93 | 31.60 |
| 3 | 2.35 | 3.18 | 5.84 | 12.92 |
| 4 | 2.13 | 2.78 | 4.60 | 8.61 |
| 5 | 2.02 | 2.57 | 4.03 | 6.87 |
| 6 | 1.94 | 2.45 | 3.71 | 5.96 |
| 7 | 1.89 | 2.37 | 3.50 | 5.41 |
| 8 | 1.86 | 2.31 | 3.36 | 5.04 |
| 9 | 1.83 | 2.26 | 3.25 | 4.78 |
| 10 | 1.81 | 2.23 | 3.17 | 4.59 |
| 11 | 1.80 | 2.20 | 3.11 | 4.44 |
| 12 | 1.78 | 2.18 | 3.06 | 4.32 |
| 13 | 1.77 | 2.16 | 3.01 | 4.22 |
| 14 | 1.76 | 2.14 | 2.98 | 4.14 |
| 15 | 1.75 | 2.13 | 2.95 | 4.07 |
| 16 | 1.75 | 2.12 | 2.92 | 4.02 |
| 17 | 1.74 | 2.11 | 2.90 | 3.97 |
| 18 | 1.73 | 2.10 | 2.88 | 3.92 |
| 19 | 1.73 | 2.09 | 2.86 | 3.88 |
| 20 | 1.72 | 2.09 | 2.85 | 3.85 |
| 21 | 1.72 | 2.08 | 2.83 | 3.82 |
| 22 | 1.72 | 2.07 | 2.82 | 3.79 |
| 23 | 1.71 | 2.07 | 2.82 | 3.77 |
| 24 | 1.71 | 2.06 | 2.80 | 3.75 |
| 25 | 1.71 | 2.06 | 2.79 | 3.73 |
| 26 | 1.71 | 2.06 | 2.78 | 3.71 |
| 27 | 1.70 | 2.05 | 2.77 | 3.69 |
| 28 | 1.70 | 2.05 | 2.76 | 3.67 |
| 29 | 1.70 | 2.05 | 2.76 | 3.66 |
| 30 | 1.70 | 2.04 | 2.75 | 3.65 |
| 40 | 1.68 | 2.02 | 2.70 | 3.55 |
| 60 | 1.67 | 2.00 | 2.66 | 3.46 |
| 120 | 1.66 | 1.98 | 2.62 | 3.37 |
| infinity | 1.65 | 1.96 | 2.58 | 3.29 |

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