What is the True Human Body Temperature?

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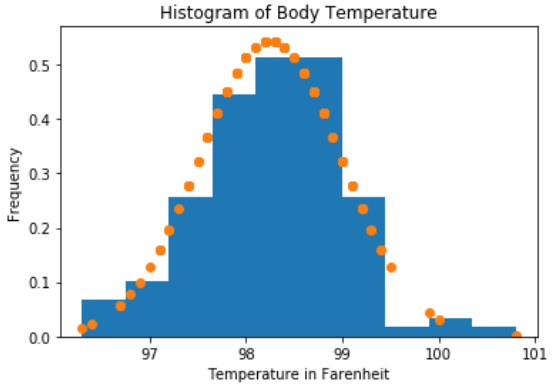
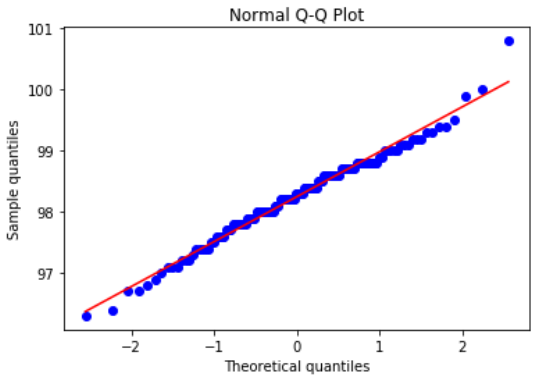
BACKGROUND

The mean normal body temperature was held to be 98.6 oF for more than 120 years since it was first conceptualized and reported by Carl Wunderlich in a famous 1868 book. But is this value statistically correct?

NORMALITY TEST

The data in this exercise is body temperature of 130 people composed of 65 male and 65 female participants. The distribution of body temperatures was tested for normality using Q-Q plot and by comparing theoretical normal distribution to the histogram of body temperature of the sample.





Inspecting graphically, the sample set follows a Normal Distribution.

Sample size of 130 is sufficiently large to apply the central limit theorem in the data analysis(CLT) which requires greater than 30 sample size. All samples are also independent on each other since it was taken from different people.

IS 98.6 ^{o}F the TRUE POPULATION MEAN?

Two hypotheses were tested to answer if 98. 6 ^{o}F is the true population mean.

Ho: True population mean is 98.6 ^{o}F

H1: True population mean is not 98.6 ^{o}F

One sample t- test was used to test these two hypotheses using the formula below.

$$t = \frac{sample\ mean - 98.6}{sample\ standard\ deviation/\sqrt[2]{sample\ size}} = -5.45$$

This calculated t value is then compared to the critical t value derived from the t-distribution table. If calculated t value > critical t value, Ho is rejected otherwise it is accepted.

Critical t value is 1.98 using p<0.05, degrees of freedom(n-1) =129 and 2-tail method.

Calculated t value < critical t value so the null hypothesis ***Ho: True population mean is 98.6 °F*** is accepted.

NORMAL TEMPERATURES

Both t statistic and z statistic using 95% confidence interval were for calculations. Results were summarized in the table below

This also mean that there is 95% confidence that the true population mean (98.6 °F) is 1.98 standard deviation away from the sample mean of 98.25 °F.

Comparison of t-statistic and z-statistic Table

	t-statistic	z statistic
A=(t or z)score	1.98	1.96
B=(t or z)score * sample standard deviation	1.45	1.44
Critical Temp1 (°F)	96.80	99.70
Critical Temp2 (°F)	96.81	99.69

Using the table above, for 130 samples t-statistic and z- statistic are very similar, almost the same.

Normal temperatures range from 96.8 °F to 99.7 °F. Any temperature outside this range is considered abnormal.

DIFFERENCE BETWEEN MALE & FEMALE TEMPERATURES

Two hypotheses were used to test if male and female temperatures are significantly different.

Ho: Female mean temperature is equal to male mean temperature

H1: Female mean temperature is NOT equal to male mean temperature

Two sample t- test with significance level of 0.05 was used to test these two hypotheses using the following formula.

$$t = \frac{(Tmean_{female} - Tmean_{male}) - d}{SE}$$ where d is difference of mean, d=0 for Ho

$$SE = \sqrt[2]{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$$ where SE is standard error, s_1 is female temperature standard deviation, s_2 is male temperature standard deviation and n_1 and n_2 are their respective sample sizes.

$$DF = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{s_2^2}{n_2}\right)^2}{n_2 - 1}}$$ where DF is degrees of freedom.

The calculated t-value and DF are used to calculate p value using t distribution table. Two tail distribution was used in solving p value.

P value = Probability (Mean temperature difference of male and female > 2.29)

Below is the summary of results.

$Tmean_{female} - Tmean_{male}$	0.29 °F
Assumed significance level	0.05
SE	0.13
t	2.29
DF	128
p value	0.024

The p value < assumed significance level which means the null hypothesis ***Ho: Female mean temperature is equal to male mean temperature*** will be rejected and accepting *H1*. So yes, there is a significant difference in temperature of male and female temperatures.

IPython NOTEBOOK SOLUTIONS

All solutions can be viewed in IPython Notebook in my github below.

https://github.com/DrAugustine1981/Springboard/blob/master/human_body_temp.ipynb