Statistics Research Project

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**Human Temperature**

Statement of the Problem

Is human temperature really 98.6? Can it be measured accurately with an infrared (IR) thermometer? I purchased an IR thermometer, which seemed to be very accurate. I wondered if the temperatures it was “seeing” were affected by the air between the meter and the object being measured. Since human temperatures are well-known to average 98.6° F, I decided to test the meter by taking measurements of the temperature of the human body at various locations.

Methods

The population for my research was all measurements of human temperature taken by an IR thermometer. Of course, I was not be able to access this population, and because of time, money and other limitations, I chose to use a convenience sample of the students in my MAT135 class at the Community College of Denver, Spring semester, 2017. Previous data collected in other statistics classes would be pooled with this new data. I had no reason to believe that the temperatures obtained by these groups would be different from each other, and that the pooled group would not be different from the population as a whole. So I believed that, while the sample was not random, it was still be representative of the population.

The measurements were taken by pairs of students, each measuring the other. Because the human body probably varies in temperature in different locations, and the IR thermometer might be better at measuring some locations than others, measurements were taken inside the mouth, on the forehead, on the back of the hand, on the palm of the hand and on the thumbnail. I believed the measurements taken would each be normally distributed about the true mean temperature of the body at that location thereby satisfying the Central Limit Theorem.

Because I had 18 previous samples and the new class had 17 students, the 35 total students sampled easily satisfied the Law of Large Numbers, especially since I had no reason to believe the data would be skewed.

Because I believed the air might be moving the temperatures measured toward the temperature of the room, I suspected the measured temperatures would be lower than 98.6° F, so my alternate hypothesis was: Ha: μ < 98.6. My null hypothesis for this research was: H0: μ ≥ 98.6. I set my alpha level at α = 0.05.

Results

For my data analysis, I calculated descriptive statistics using Excel followed by a confidence interval analysis plotted using the Excel high-low-close graph. The results of my descriptive data analysis are summarized in Table 1.

Table 1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *Inside Mouth* | *Forehead* | *BackHand* | *PalmHand* | *Thumbnail* |
| Mean | 91.9 | 92.2 | 88.4 | 89.6 | 82.5 |
| Median | 92.1 | 92.9 | 89.2 | 90.7 | 83.3 |
| Mode | 93.7 | 93.3 | 87.4 | 92.3 | 88.1 |
| Standard Deviation | 2.8 | 2.7 | 4.0 | 4.5 | 5.9 |
| Minimum | 86.9 | 84.2 | 79.3 | 77.1 | 67.2 |
| Maximum | 99.1 | 96.2 | 93.5 | 96 | 91.7 |
| Count | 34 | 34 | 34 | 34 | 34 |

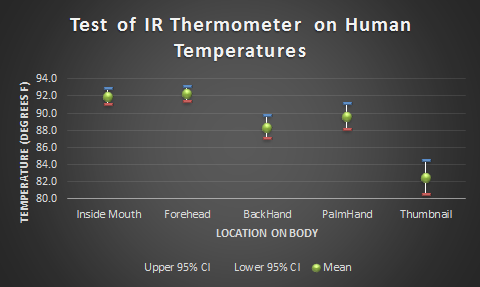
The results of the confidence interval analysis are summarized in Table 2.

Table 2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *Inside Mouth* | *Forehead* | *BackHand* | *PalmHand* | *Thumbnail* |
| Upper 95% CI | 92.9 | 93.2 | 89.7 | 91.1 | 84.5 |
| Lower 95% CI | 91.0 | 91.3 | 87.0 | 88.0 | 80.5 |
| Mean | 91.9 | 92.2 | 88.4 | 89.6 | 82.5 |

The high-low-close plot is shown on the next page as Graph 1.

Graph 3



My research confirmed my suspicion that the IR thermometer would not work well for measuring human temperatures accurately. None of the body locations included 98.6 degrees in their 95% confidence interval range. I was easily able to reject my null hypothesis and conclude that for all body locations the IR thermometer measured significantly lower than 98.6 degrees and would not be suitable for measuring human body temperature accurately.

Conclusions

The value 98.6 degrees is measured as the body’s “core” temperature. The IR thermometer cannot access this core temperature. It does provide useful information on the body’s surface temperature, for instance that the thumbnail measurement is significantly lower than the temperatures for any other body location. The back of the hand was significantly lower than inside the mouth and the forehead. The palm of the hand measurement was significantly lower that inside the mouth, but not the forehead.

Because the IR thermometer is very accurate, a further study could be done to determine whether increasing the inside mouth or forehead temperatures by a fixed amount might provide an accurate measure of “core” temperature, or whether the errors involved in this type of surface measurement cannot provide an accurate measure of “core” temperature.

References

“vf-tropi.com” (2017).

SULLIVAN, M. (2014). Fundamentals of Statistics Fourth Edition. Pearson Education,

Inc.

Appendix

Data used in this study

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Human Temperature** (measured in degrees Fahrenheit) | | | | |
| **Inside Mouth** | **Forehead** | **Back Hand** | **Palm Hand** | **Thumbnail** |
| 95.7 | 93.5 | 91.0 | 92.1 | 88.1 |
| 91.0 | 91.4 | 87.6 | 83.5 | 83.4 |
| 88.1 | 93.3 | 93.5 | 96.0 | 81.6 |
| 92.4 | 92.4 | 93.2 | 95.1 | 91.7 |
| 93.7 | 93.3 | 90.3 | 93.9 | 86.3 |
| 95.0 | 91.4 | 92.1 | 92.3 | 87.0 |
| 94.4 | 94.6 | 83.0 | 90.3 | 77.0 |
| 89.0 | 88.1 | 86.0 | 87.6 | 87.0 |
| 86.9 | 84.2 | 80.2 | 84.3 | 83.2 |
| 87.8 | 85.4 | 82.9 | 85.0 | 81.1 |
| 87.4 | 90.5 | 87.4 | 90.5 | 84.3 |
| 93.5 | 93.0 | 90.5 | 92.4 | 88.7 |
| 92.8 | 91.5 | 85.2 | 87.2 | 81.6 |
| 87.8 | 93.5 | 85.4 | 85.2 | 73.7 |
| 89.9 | 88.3 | 84.9 | 89.0 | 84.2 |
| 94.8 | 94.6 | 79.3 | 77.1 | 69.0 |
| 91.7 | 88.7 | 90.5 | 93.5 | 81.0 |
| 99.1 | 95.7 | 82.7 | 83.4 | 67.2 |
| 97.1 | 96.2 | 87.4 | 91.2 | 75.5 |
| 93.5 | 94.1 | 89.7 | 87.2 | 79.3 |
| 91.9 | 94.2 | 93.3 | 93.2 | 89.7 |
| 90.1 | 93.9 | 90.1 | 92.3 | 88.3 |
| 92.3 | 93.3 | 88.5 | 89.2 | 88.1 |
| 93.7 | 93.3 | 89.4 | 92.6 | 88.8 |
| 91.7 | 94.6 | 91.2 | 90.8 | 89.0 |
| 90.8 | 91.9 | 81.8 | 78.4 | 84.9 |
| 89.4 | 92.6 | 93.3 | 94.8 | 78.6 |
| 92.8 | 92.4 | 88.7 | 88.7 | 87.8 |
| 93.7 | 94.4 | 92.3 | 92.3 | 84.5 |
| 89.7 | 91.5 | 89.0 | 90.1 | 80.7 |
| 92.1 | 94.1 | 88.5 | 89.2 | 76.2 |
| 92.1 | 92.8 | 90.8 | 91.7 | 78.2 |
| 94.1 | 91.9 | 92.8 | 93.0 | 78.4 |
| 90.2 | 91.6 | 91.5 | 92.1 | 81.1 |