# Deacon's Challenge No. 50 Answer

You attempt to derive a reference range for TSH for an ethnic minority population. The first 10 samples give the following results:

| Result | n |
|---|---|
| Between 0.5 and 1.49 mU/L | 5 |
| Between 1.5 and 2.49 mU/L | 3 |
| Between 2.5 and 3.49 mU/L | 0 |
| Between 3.5 and 4.49 mU/L | 1 |
| Between 4.5 and 5.49 mU/L | 1 |

On the basis of these results, what range of TSH values would encompass 95% of the ethnic minority population?

*MRCPath, May 2000*

There are two problems with this set of data:

1 The individual results are not given, only the number of results falling into each class interval. The easiest way to deal with this is to assume that the results fall in the middle of the range i.e. there are 5 results within the range 0.5 to 1.49 so assume there are 5 results of the mid-point value (1.0 mU/L), similarly there are 3 samples with a value of 2 mU/L. Using this approach 10 individual results are produced which can be processed in the usual way.

2 The data are obviously skewed and do not form a Gaussian distribution. This can be overcome to some extent by taking logarithms (to the base 10) of the results then calculating the mean, SD and 95% confidence limits in the usual way. Taking antilogarithms of the confidence limits then gives the reference range.

A table can be completed in the following way:

| TSH result | $\chi = \log_{10}$ TSH result | $\chi^2$ |
|---|---|---|
| 1.0 | 0 | 0 |
| 1.0 | 0 | 0 |
| 1.0 | 0 | 0 |
| 1.0 | 0 | 0 |
| 1.0 | 0 | 0 |
| 2.0 | 0.301 | 0.0906 |
| 2.0 | 0.301 | 0.0906 |
| 2.0 | 0.301 | 0.0906 |
| 4.0 | 0.602 | 0.3625 |
| 5.0 | 0.699 | 0.4886 |

$n = 10$ $\quad \Sigma\chi = 2.204$ $\quad \Sigma\chi^2 = 1.123$





$$\text{Mean} = \frac{\Sigma\chi}{n} = \frac{2.204}{10} = 0.220$$

$$SD^2 = \frac{\Sigma\chi^2 - (\Sigma\chi)^2 / n}{n - 1} = \frac{1.123 - 2.204^2 / 10}{10 - 1} = 0.0708$$

$$SD = \sqrt{0.0708} = 0.266$$

Alternatively the mean and SD can be calculated directly on most modern pocket calculators. The 95% confidence are given by mean – 1.96 SD to mean + 1.96 SD.

$= 0.220 – (1.96 \times 0.266)$ to $0.220 + (1.96 \times 0.266)$

-0.301 to 0.741 (these values are logs and so do NOT have units)

Taking antilogs (to the base 10) gives the 95% confidence limits in mU TSH/L:

0.50 to 5.51 mU/L

Although the original data may have been expressed to one or two decimal places, this information has been lost by grouping the data into class intervals. Therefore it would be more correct to quote a reference range of less than 6 mU/L. ■

## Question 51

Two pure solutions of the same substance gave transmissions of 25.1% and 63.1% in the same spectrophotometer under identical conditions.

What is the ratio of their absorbances?

*MRCPath, May 1997*