Age-related changes of bicaudate ratio and maximal brainstem diameters: normative values on MRI.

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How to use supplementary percentiles and LMS tables

The Excel files contain tables with the L, M, and S parameters needed to generate exact percentiles and SD-scores (also called z-scores), as well as percentile values for the 1th, 3th, 10th, 25th, 50th, 75th, 90th, 97th and 99th percentiles. Age is listed as months and years points. To obtain L, M, and S values at finer age intervals interpolation could be used.

The LMS parameters are the median (M), the generalized coefficient of variation (S), and the power in the Box-Cox transformation (L).

Computing z-score and corresponding percentile for a given measurement:

The z-score (z) and corresponding percentile for a given measurement (x) at a certain age can be computed using the following equation:

\[ z = \frac{(xl/M)^L - 1}{LS} \text{ for } L \neq 0 \]

or

\[ z = \ln(xl/M)/S, \text{ for } L = 0 \]

where x is the physical measurement (e.g. BCR, pons etc.) and L, M and S are the values from the appropriate table corresponding to the age. The percentile corresponding to the computed z-score value can be determined by referring to the sheet “standard normal distribution”, where some z-scores and corresponding percentiles are listed. For example, the z-score -1.645 corresponds to the 5th, 0 to the 50th, 1.645 to the 95th and 1.881 to the 97th percentile. Alternatively, many spreadsheet programs have functions that convert z-scores to percentiles and vice versa.
Computing the value of a given measurement at a particular z-score or percentile:

The value \( x \) of a given physical measurement (e.g. BCR or pons) at a particular z-score (that corresponds to a percentile) can be computed using the following equation:

\[
x = M \cdot (1 + L \cdot S \cdot z)^{1/L} \quad \text{for } L \neq 0
\]

or

\[
x = M \exp(Sz) \quad \text{for } L = 0
\]

where the \( L, M, \) and \( S \) are the values from the appropriate table corresponding to the age. \( \exp(Sz) \) is the exponentiation function, e.g. \( e \) to the power \( (Sz) \).

The z-score corresponding to a certain percentile can be determined by referring to the sheet “standard normal distribution” in the Excel file. For example, the z-score -1.645 corresponds to the 5th, 0 to the 50th, 1.645 to the 95th and 1.881 to the 97th percentile.

Examples

1) A 30 year old patient has a BCR of 0.11. From figure 2 in the paper it can be assumed that this value is just below 97th percentile. The corresponding LMS values from Excel files (no sexual separation) gives \( L = 0.8500, M = 0.0857 \) and \( S = 0.1506 \). One can compute the z-score as:

\[
z = \frac{(x / M)^L - 1}{LS} = \frac{(0.11 / 0.0857)^{0.85} - 1}{0.85 \cdot 0.1505} = 1.85
\]

This z-score indicates an almost 2 standard scores higher BCR than the reference sample. According to a standard normal distribution table, this z-scores is slightly below the 97th percentile, a spreadsheet calculator or statistic software gives 0.9678432, that is 96.78th percentile.

2) One might be interested which BCR value of a 30 year old patient corresponds to the 50th percentile. According to a standard normal distribution table (or software), the 50th percentile has a z-score of 0. The BCR corresponding to the 50th centile in a 30 year old patient is obtained by the following equation (LMS-values see above, no sexual separation):

\[
x = M \cdot (1 + L \cdot S \cdot z)^{1/L} = 0.0857 \cdot (1 + 0.8500 \cdot 0.1505 \cdot 0)^{1/0.8500} = 0.0857
\]

The LMS-method is described in much more detail in several publications, e.g.:
