Recent Body Weight Studies

1) Burmaster, DE; Murray, DM. (1998) A trivariate distribution for the height, weight, and fat of adult men. Risk Anal 18(4):385-389.

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Burmaster and Murray (1998) fit a trivariate normal distribution to data for the height, the natural logarithm of body weight, and body fat for adult men for use in probabilistic physiologically-based pharmacokinetic (PBPK) models. Data from the U.S. Veterans Administration's (VA) "Normative Aging Study" in Boston, MA, were used. These data were collected in 1993 and included measurements of height, body weight, and body fat for 646 men, ages 50-80 years. Each man included in this data set had served in the U.S. Military. The subjects were randomly chosen for this study so that the results could be applied to the general (healthy) population.

The analysis was conducted in five basic steps. First, patterns in the data were evaluated in order to consider possible transformations of the data and to prepare summary statistics for the 646 measurements of height, body weight, and body fat. The authors believe that the Normative Aging Study data are well measured and reliable for men ages 50-80. Shown in the top section of Table 1 are the key summary statistics, including the arithmetic means and standard deviations; the second and third sections show the Pearson (product-moment) correlation coefficients and the Variance-Covariance matrix.

Second, scatter plots were examined for the three main variables as a function of age (Figure 1). Only weak downward trends were found for the three variables with increasing age, accounting for <5% change in the data across the ages.

Third, the three probability plots for the univariate marginal distribution of the data were examined (Figure 2). The authors concluded that a normal (Gaussian) distribution was an excellent fit ($adjR^2 \geq 0.994$) for each of the three univariate marginal distributions.

Fourth, the pairwise bivariate scatterplots for the data were studied (Figure 3). Based on the visual patterns observed in the scatterplots, the authors concluded that a correlated bivariate normal distribution was a good fit for each of the bivariate normal distributions.

Finally, the full trivariate structure of the data was analyzed (Figure 4). Since no anomalous voids or clusters were seen when the 3-D scatterplots were examined in continuous and stepped 3-D rotation, the authors concluded that a correlated trivariate normal distribution was a good fit to the height, weight, and body fat data.

Although the authors conclude that a trivariate normal distribution (parametric values shown in Table 1) adequately characterizes the Normative Aging Study data, they believe that it is not needed for routine PBPK modeling, since height is rarely included. Instead, they suggest that the results shown in Table 1 can be reduced to a bivariate normal distribution for body weight and body fat by using the corresponding 2 x 1 arithmetic mean vector and corresponding 2 x 2 variance-covariance matrix as parameters in the bivariate normal distribution.

A limitation of the study is that the data do not include measurements for children, women, or young men.

Table 1. Summary Statistics (n = 646)

Statistic	Ht[a] (cm)	ln[b] [Wt (kg)]	F[c] (pct)
Minimum	151.130	3.965	7.000
Amean	174.204	4.411	21.050
StdDev	6.509	0.145	4.999
Maximum	1985.580	5.002	34.000

Pearson Correlation Coefficients	Ht (cm)	ln [Wt (kg)]	F (pct)
Ht (cm)	1	0.486	0.074
ln [Wt (kg)]	0.486	1	0.613
F (pct)	0.074	0.613	1

Variance Covariance Matrix	Ht (cm)	ln [Wt (kg)]	F (pct)
Ht (cm)	42.364	0.458	2.401
ln [Wt (kg)]	0.458	0.021	0.444
F (pct)	2.401	0.444	24.990

[a] Height originally measured to nearest 0.1 inch; converted to centimeters by the authors.
[b] Body weight originally measured to nearest integer pound; converted to kilograms by the authors.
[c] Body fat to nearest integer percent of total body weight.

Source: Burmaster and Murray, 1998.