Recent Surface Area Studies


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Burmaster (1998) reanalyzed a data set published by the U.S. Environmental Protection Agency in the Exposure Factors Handbook, that contained measurements of skin area, height, and body weight. The original data set used in this analysis was based on observations of 401 individuals by Gehan and George (1970). Using multiple regression routines, the author refit an equation developed by Dubois and Dubois (1916) (log transformed) for predicting the total skin area as a function of height and weight of a person to the 401 observations:

\[
\ln[SA] = \ln[a] + b \ln[Ht] + c \ln[BW]
\]

where:

- \(SA\) = total skin area in m²
- \(Ht\) = height in cm
- \(BW\) = body weight in kg
- \(a, b, c\) = empirical constants

The author also fit this equation to the 161 observations for males and 140 observations for females.

Table 1 presents, in the top row, these results from the multiple regression for skin area as a function of height and/or body weight. All the fitted parameters in this row are statistically significant. Based on linear regressions of the log-transformations of Equations 2 and 3 (the center and bottom rows of Table 1) show the best-fit parameters. Equation 3 outperforms Equation 2 as a predictor of total skin area. Figures 1-3 show the data points and the best-fit for each group of people in both 3-D and 2-D plots as drawn by Mathematica®. Figures 4-6 show the best-fit straight line for Equation 3 (Table 1). Also, Equation 3 predicts total skin area, as well as Equation 1. “However, Equation 3 has the advantage of having only one explanatory variable.” The author concluded that for all practical purposes, the logtransformation of Equation 3 (Table 1) provides as good a fit to each of the three data sets (401 people, for 161 males, and for 140 females) as does the logtransformation of Equation 1 (Table 1). Various additional equations were presented that the author described as equally as reliable.

This study shows that using a univariate model for total skin area as a function of body weight produces useful and practical results with little or no loss of reliability as compared to a bivariate model. It was suggested that this new result leads to a new method to develop lognormal distributions for total skin area as a function of body weight alone.


Table 1. Results from the Regression for Skin Area as a Function of Height and/or Body Weight

<table>
<thead>
<tr>
<th>Eq. (1) SA = f(Ht, BW)</th>
<th>For 401 People</th>
<th>For 161 Males</th>
<th>For 140 Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(ahat) bhat chat adjR²</td>
<td>ln(ahat) bhat chat adjR²</td>
<td>ln(ahat) bhat chat adjR²</td>
<td></td>
</tr>
<tr>
<td>-3.7330 0.4170 0.5170 0.9921</td>
<td>-3.5933 0.3771 0.5371 0.9937</td>
<td>-3.3909 0.3209 0.5496 0.9961</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Eq. (2) SA = g1 (ht)</th>
<th>For 401 People</th>
<th>For 161 Males</th>
<th>For 140 Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(ahat) bhat chat adjR²</td>
<td>ln(ahat) bhat chat adjR²</td>
<td>ln(ahat) bhat chat adjR²</td>
<td></td>
</tr>
<tr>
<td>-8.1700 1.6963 zero 0.9806</td>
<td>-8.1784 1.6984 zero 0.9798</td>
<td>-8.2014 1.7019 zero 0.9860</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Eq. (3) SA = g2 (BW)</th>
<th>For 401 People</th>
<th>For 161 Males</th>
<th>For 140 Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(ahat) bhat chat adjR²</td>
<td>ln(ahat) bhat chat adjR²</td>
<td>ln(ahat) bhat chat adjR²</td>
<td></td>
</tr>
<tr>
<td>-2.2781 zero 0.6821 0.9909</td>
<td>-2.2752 zero 0.6868 0.9926</td>
<td>-2.2678 zero 0.6754 0.9956</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1 for 401 People


Figure 2 for 161 Males

Figure 3 for 140 Females


Figure 4 for 401 People

Figure 5 for 161 Males


Figure 6 for 140 Females