

## **Recent Surface Area Studies**

- 1) Burmaster, DE. (1998) Lognormal distributions for skin area as a function of body weight. Risk Anal 18(1):27-32.

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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 m <sup>2</sup>
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.

Reference: Dubois, D; Dubois, EF. (1916) A formula to estimate the approximate surface area if height and weight be known. Arch Int Med 17:863-871.

Reference: Gehan, EA; George, SL. (1970) Estimation of human body surface area from height and weight. Cancer Chemother Rep 1(4):225-235.

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

	For 401 People				For 161 Males				For 140 Females			
	ln(ahat)	bhat	chat	adjR <sup>2</sup>	ln(ahat)	bhat	chat	adjR <sup>2</sup>	ln(ahat)	bhat	chat	adjR <sup>2</sup>
Eq. (1) SA = f (Ht, BW)	-3.7330	0.4170	0.5170	0.9921	-3.5933	0.3771	0.5371	0.9937	-3.3909	0.3209	0.5496	0.9961
Eq. (2) SA = g1 (ht)	-8.1700	1.6963	zero	0.9806	-8.1784	1.6984	zero	0.9798	-8.2014	1.7019	zero	0.9860
Eq. (3) SA = g2 (BW)	-2.2781	zero	0.6821	0.9909	-2.2752	zero	0.6868	0.9926	-2.2678	zero	0.6754	0.9956

Source: Burmaster, 1998.

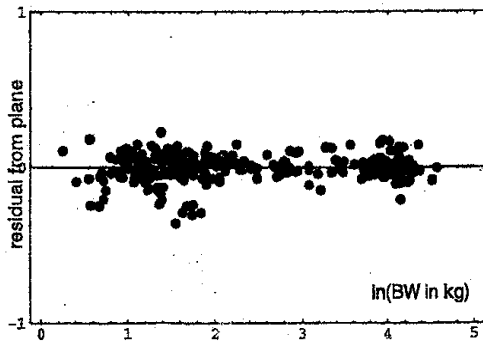
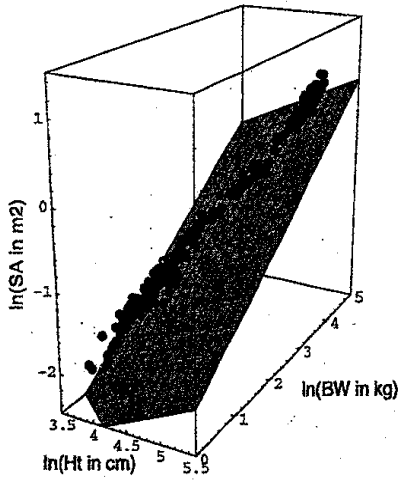


Figure 1 for 401 People

Source: Burmaster, 1998.

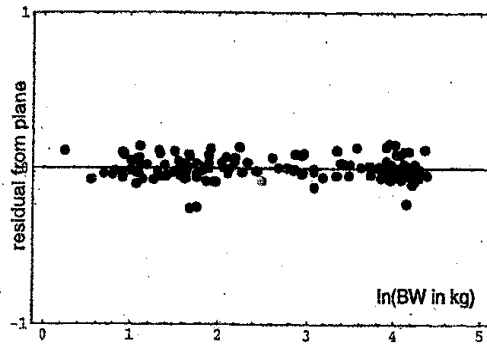
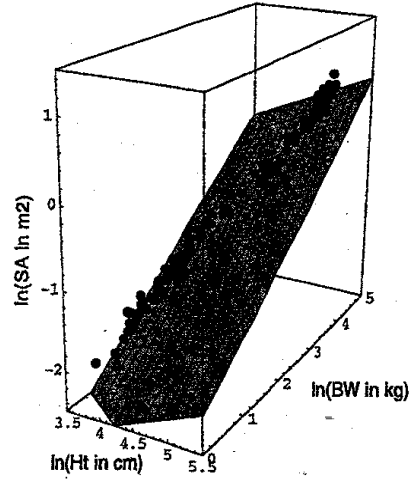


Figure 2 for 161 Males

Source: Burmaster, 1998.

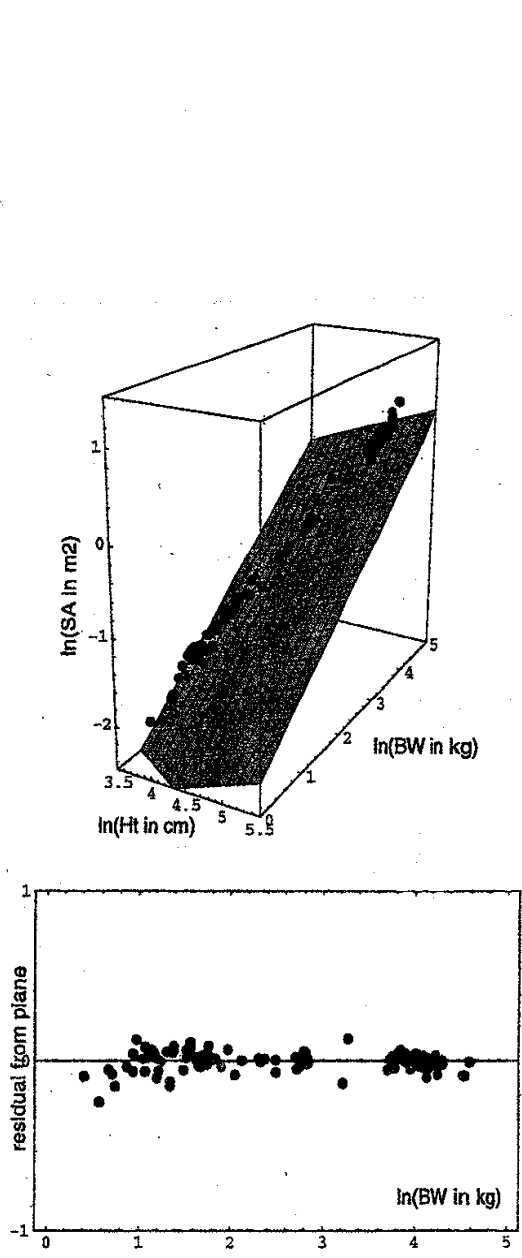


Figure 3 for 140 Females

Source: Burmaster, 1998.

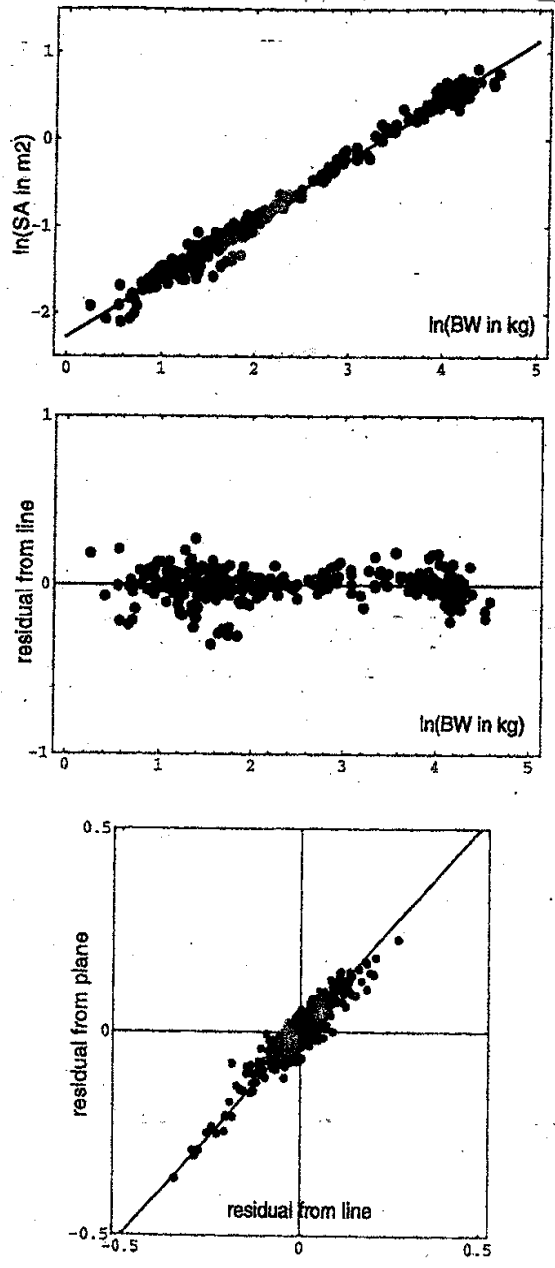


Figure 4 for 401 People

Source: Burmaster, 1998.

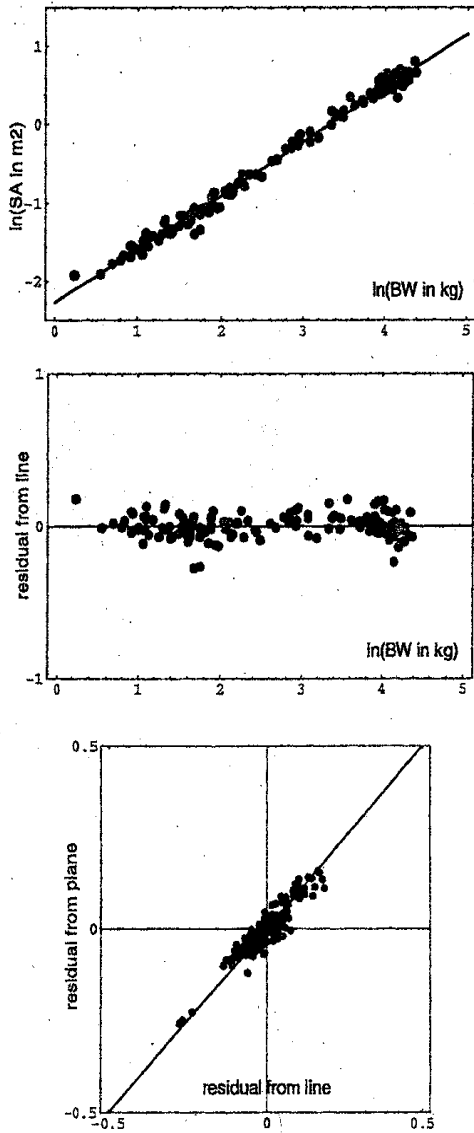


Figure 5 for 161 Males

Source: Burmaster, 1998.

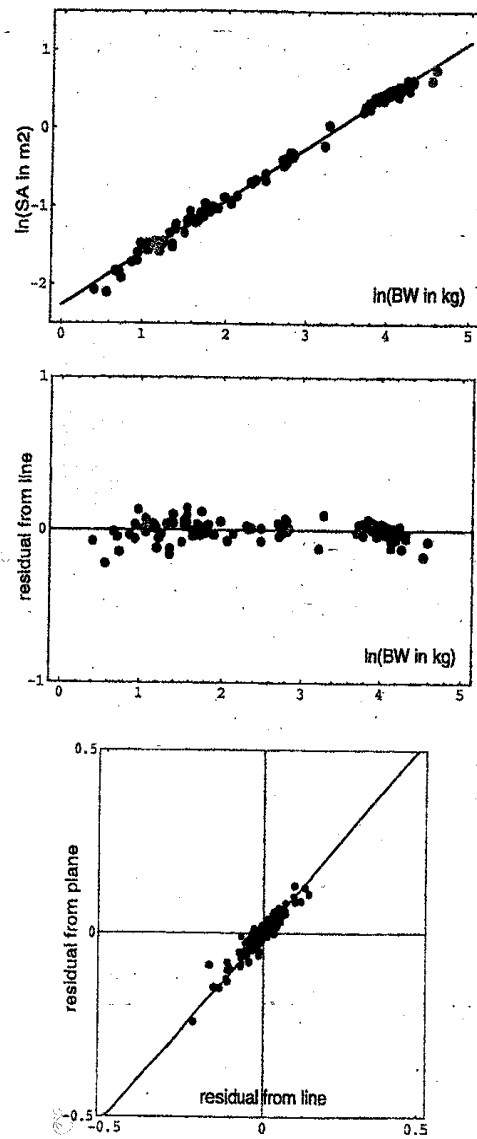


Figure 6 for 140 Females

Source: Burmaster, 1998.