Errata and Clarifications for *Biostatistics: The Bare Essentials* (2nd Ed)

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NOTE: In the most recent reprinting of the 2nd edition of *Bare Essentials*, many of the errors and typos listed herein may have been fixed. So if you do not find them in your copy, you obviously have one of the more recently printed books.

Chapter 2, Graphing Ordinal Data

The **Graphing Ordinal Data** section (top of page 8) begins as follows: "The use of histograms isn't limited to nominal data; it can be used with all four types" (emphasis added). But the previous section deals with the use of bar charts to display nominal variables. So, the sentence *should* read, "The use of bar charts isn't limited….".

Chapter 3, Variance and Standard Deviation

In statistics textbooks, it is conventional to use Greek letters to represent parameters and Roman letters to represent statistics.[1] Norman and Streiner acknowledge this on p. 43, where they show, for example, that σ is used to represent the population standard deviation (SD), and s to represent the sample SD. Nevertheless, the variance and SD are introduced in Chapter 3 (p. 21) as follows:

$$s^2 = \frac{\sum (X-\bar{X})^2}{N} = \frac{\sum x^2}{N} \qquad (3\text{-}7)$$

$$s = \sqrt{\frac{\sum (X-\bar{X})^2}{N}} = \sqrt{\frac{\sum x^2}{N}} \qquad (3\text{-}8)$$

The denominator is *N*, not *n*-1, so it is clear that these are formulae for the variance and SD of a population. Therefore, it would have been more appropriate to use Greek letters, as follows:

$$\sigma_X^2 = \frac{\sum (X-\mu_X)^2}{N} \qquad (3\text{-}7)$$

[1] Parameters are numbers calculated using population data, whereas statistics are calculated using sample data.

$$\sigma_X = \sqrt{\frac{\sum (X - \mu_X)^2}{N}} \qquad (3\text{-}8)$$

The variance of a sample, which can be used to estimate the population variance, is calculated as follows:

$$\text{Sample Variance} = s_X^2 = \frac{\sum (X - \bar{X})^2}{n-1}$$

And the sample standard deviation is just the square root of the sample variance:

$$\text{Sample SD} = s_X = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$

In some sections of *Bare Essentials*, s and s^2 are used to symbolize population SDs and variances.[2] This may cause confusion if you are expecting these symbols to represent sample statistics. Readers are advised to pay close attention to whether the denominator is N (for population SD or variance) or *n*-1 (for sample SD or variance).

Chapter 3, Table 3-3

Because of the way Table 3-3 is organized, it appears to suggest that if you use the *median* as your measure of central tendency (e.g., because your distribution is skewed), then you **ought** to use the *range* as your measure of dispersion. But this is not the case. In fact, it is far more common to report the *inter-quartile range* (IQR) in conjunction with the median.

Chapter 6, Exercise 6-b

The solution to Exercise 6-b in Chapter 6, which is shown on p. 278, is incorrect. It gives the probability of getting a sample mean of 56 or greater if the true population mean is 60. But the question asked for the *power* of the z-test, given that the true population mean was 60. The correct solution is given below.

Correct Solution to Chapter 6, Exercise 6-b. To answer this question, we must first compute a critical sample mean ($\bar{X}_{critical}$) that corresponds to z = 1.96, because 1.96 is the critical value of z

[2] For example, the *z*-score formula given on p. 29 shows *s* in the denominator. But the *z*-scores shown in Table 4-1 were obtained using the population SD, not the sample SD.

for a 2-tailed test with alpha = 0.05. We can obtain the critical sample mean by re-arranging the formula for z:

$$\bar{X}_{critical} = \mu_0 + 1.96(\sigma_{\bar{X}}) = 50 + 1.96\left(\frac{15}{\sqrt{16}}\right) = 57.35$$

This means we would need to have a sample mean of 57.35 or greater (or of 42.65 or lower, because it's a 2-tailed test) to reject H_0.

When $\mu_1 > \mu_0$, as in the present case, *power* is the area to the right of $\bar{X}_{critical}$, but under the sampling distribution of $\bar{X}$ that applies if H_1 is true. The sampling distribution of $\bar{X}$ under a true H_1 is normal with $\mu_1 = 60$ and $\sigma = 15$. The z-score that corresponds to $\bar{X}_{critical}$, using the H_1 distribution, is:

$$z = \frac{57.35 - 60}{\left(15 / \sqrt{16}\right)} = -0.7067$$

$$\text{Power} = p(z \geq -0.7067) = p(z \leq 0.7067) = 0.760$$

Chapter 7, Exercise 2

The SDs reported in Exercise 2 are incorrect. They were calculated with division by N, but should have been calculated with division by n-1. Because of that error, the SE of the difference and the t-value given in the back of book are both wrong. The correct values can be seen in the following output from SPSS.

Group Statistics

	GRP	N	Mean	Std. Deviation	Std. Error Mean
Y	1	5	15.80	**9.602**	4.294
	2	5	9.80	**6.943**	3.105

Independent Samples Test

		t-test for Equality of Means				
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Y	Equal variances assumed	**1.132**	8	.290	6.00	**5.299**

Chapter 8, Footnote 6

In footnote 6 (p. 69), the authors give $1.0-.95^k$ as the formula for working out the "overall probability of a significant result by chance alone when there are n comparisons". There are three points here:

1. That should be when there are *k* comparisons, not *n* comprisons. (Note that *n* doesn't appear in the formula.)
2. The .95 in that formula is actually 1 – alpha, with alpha assumed to be .05. A more general statement of the formula is: $1-(1-\alpha)^k$
3. Most importantly, that formula works only when all of the *k* comparisons are *mutually independent*. But that is not the case for all pair-wise comparisons in a set of means. Therefore, ***it is not the correct formula for this situation***. It is extremely difficult (if not impossible) to work out exactly the correct probability for this situation; and so the (Bonferroni) estimate of .30 is typically used instead.

Chapter 8, Equations 8-20 and 8-21

Equation **8-20** (p. 74) should read:

$$S=\sqrt{(k-1)F_{\alpha,df}}\sqrt{MS_{within}\times\sum\frac{C_j^2}{n_j}} \qquad (8\text{-}20)$$

That is, the first square root sign should only enclose the symbols to the right of the "=" sign.

Equation 8-21 should read:

$$S=\sqrt{3(2.88)}\sqrt{2.82\left(\frac{1+0+0+1}{10}\right)}=2.204 \qquad (8\text{-}21)$$

That is, the last term under the square root sign is divided by 10. And this changes the result. The following text should then read:

> So, any comparison greater than 2.204 would be significant at the .05 level. This value is a bit larger than .....

(i) change the value from 6.972 to 2.204
(ii) take "quite" out of the second sentence.

Chapter 8, Exercise 1-E

For question 1-E, the authors report (on p. 279) that the correct answer is *h only*, the probability of F (or the p-value) decreases. Clearly therefore, the wording of the question should be: *Decreases as the number of subjects per group* ***increases***.

Chapter 9, Figures 9-1 and 9-3

Figure 9-1 illustrates the partitioning of SS_{Total} for the ANOVA summary tables shown in Tables 8-2 (p. 70) and 9-3 (p. 82). SS_{Within} on the left side of Figure 9-1 should be 101.5, not 83.4.

Figure 9-3 shows the same data as the last two clusters in Figure 9-2 (Trojan and Unnamed). The line labels (Uncircumcised and Circumcised) need to be switched.

Chapter 9, error terms in mixed-model ANOVA (p. 86)

In the paragraph that starts with, "Who cares about the distinction?", you will find this sentence:

> In the present example, if brand is a **fixed** factor [emphasis added], then the denominator for brand is the within error term; for circumcised/uncircumcised it is the interaction term.

I believe the authors meant to say, "if brand is a **random** factor". In general, in a two-factor mixed-model ANOVA, "it is the *fixed* term that is tested against MS interaction and the *random* term that is tested against MS_{error}." (Howell, 2002, p. 445).

Chapter 11, Table 11-5 (p. 97)

The mean at the bottom of the 4th column should be **4.1**, not 3.9. So the numbers on the bottom row will now be:

4.8 3.9 3.0 **4.1** 3.8 3.4

Chapter 11, Table 11-6 (p. 97)

The Mean Square for Drug rounds to 7.82, not 7.80.

Also, the F-test for Subject is usually not reported in this design, and will probably not appear in the output from your stats package. If you analyze these data with GLM-Repeated Measures in SPSS, for example, the *SS*, *df* and *MS* for Subject will appear as the error term in the **Tests of Between-Subjects Effects** box (see below), but no F-test is reported.

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	881.667	1	881.667	103.952	.000
Error	**76.333**	**9**	**8.481**		

Chapter 13, Exercise 1

This exercise describes two regression analyses that examine the relationship between mathematical ability (X) and income (Y). Study 1 uses a sample of n=100 males aged 21-65, drawn from the local telephone book. Study 2 uses a sample of 800 from the same population.

The answer in the back of the book (page 281) indicates that the "significance of the correlation" is greater for Study 1 than for Study 2. This is incorrect.

The expression "significance of correlation" should be interpreted such that a lower p-value corresponds to a more significant correlation, and a higher p-value to a less significant correlation.

The p-value for a correlation comes from a t-test which has $\sqrt{(1-r^2)/(n-2)}$ as the denominator of the t-ratio. So as n increases, the denominator of the t-ratio decreases, and t increases. And as t increases, the p-value decreases.

Therefore, the p-value will be lower, and the significance of the correlation higher for the study with n=800 subjects (Study 2).

Chapter 17, Table 17-1: Incorrect SDs

The three standard deviations highlighted in the following table are incorrect in Table 17-1 (p. 156). The SDs for the two change scores were calculated with division by N rather than n-1. I have not been able to figure out the source of error in the SD reported for the Group 1 Post-test scores.

These same post-test data reappear in "1 month" columns of Tables 17-4 and 17-6. The SDs are reported correctly in Table 17-4; but in Table 17-6, the error from Table 17-1 is repeated (i.e., SD for Group 1 reported as 7.8 instead of 5.65).

Means & SDs for Table 17-1 (p. 156)

GRP		PRE	POST	CHANGE
1	Mean	26.7	21.9	-4.8
	N	10	10	10
	Std. Deviation	6.07	**5.65**	**1.87**
2	Mean	27.1	24.5	-2.6
	N	10	10	10
	Std. Deviation	7.82	7.47	**2.95**
Total	Mean	26.9	23.2	-3.7
	N	20	20	20
	Std. Deviation	6.8	6.6	2.7

Chapter 21, Table 21-4: Incorrect expected frequencies

Thanks to Ralph Brands for pointing out that the expected frequencies highlighed below are reported incorrectly in Table 21-4.

Observer 1 * Observer 2 Crosstabulation

Expected Count

		Observer 2				
		1 Saintly	2 Slightly crooked	3 Street thug	4 Serial killer	**Total**
Observer 1	1 Saintly	--	2.91	**7.50**	**3.35**	**15.0**
	2 Slightly crooked	4.28	--	26.00	11.62	**52.0**
	3 Street thug	**4.86**	11.45	--	**13.19**	**59.0**
	4 Serial killer	3.62	8.54	**22.00**	--	**44.0**
Total		**14.0**	**33.0**	**85.0**	**38.0**	**170.0**

When the correct expected frequencies are used, weighted kappa works out to 0.248, not 0.254 as shown in equation 21-16.

References

Howell, D.C. (2002). *Statistical Methods for Psychology* (5th Ed). Pacific Grove, CA: Duxbury.

Norman, G.R., & Streiner, D.L. (2002). *Biostatistics: The Bare Essentials* (2nd Ed). Hamilton, ON: B.C. Decker Inc.

Contact Information

If you are aware of any typos or other problems that I have not listed here, please let me know. You can reach me via e-mail at bweaver@lakeheadu.ca.