Suppose an industrial psychologist, striving to be economically practical, compared the coefficient alphas of three tests measuring the same construct given varying numbers of items. Second, suppose a test is translated into several languages. In this case, some items may be eliminated or modified based upon incomparable meanings across languages. Finally, suppose different types of participants (e.g., different classes of high school students) complete a particular test (e.g., self-esteem). In all three cases, a test of multiple independent coefficient alphas might be of interest.

Comparing multiple independent coefficient alphas has been addressed by Feldt et al. [1] among others. Kim and Feldt [2] simulated the Hakstian and Whalen TE [3] and the Fisher-Bonett statistics, which they modified from Bonett [4] to test the difference among more than two coefficient alphas, and found that both were similar in terms of Type I error, power, and their robustness to heteroscedasticity. Moreover, Feldt et al. [1] and Charter [5] explained that subsequent $F$ tests could be used to compare pairwise alphas. However, because these comparisons are not independent, a Bonferroni correction would be appropriate. Therefore, the purpose of the program was to compute the Fisher-Bonett statistic and subsequent $F$ tests for comparing multiple independent coefficient alphas.

The user is queried interactively for the number of coefficient alphas, the magnitude of each, sample size, and number of items. The output consists of a restatement of the input, the Fisher-Bonett value, its degrees of freedom, and probability using the algorithm by Dunlap and Duffy [6]. Next, the user provides the number of subsequent pairwise $F$ tests and is queried for the two coefficient alphas and sample sizes. The program responds with the values of the coefficient alphas, the degrees of freedom, $F$ ratio, and probability for each subsequent comparison as explained by Charter and Feldt [7]. Moreover, the Bonferroni correction is provided at the .05 and .01 levels for comparing probability levels. The program is written in FORTRAN 90 and runs on an IBM-PC or compatible. The output is contained in INDALOUT.

The Eating Attitudes Test [8] has gone through a couple of iterations. Initially, the scale consisted of 40 items (EAT40). However, a few years later, a shorter 26-item scale was developed [9]. Garner et al. [9] provided the coefficient alphas for EAT26 and EAT40 for both anorexia nervosa and female comparison participants. Because one is comparing independent coefficient alphas, only the EAT26 data will be used. Likewise, in a separate study, Lane et al. [10] computed the coefficient alpha of the
EAT26 with athletes. Finally, Mukai et al. [11] developed the Japanese version of the EAT26 and administered it to Japanese females along with the English version of the scale to American females [11]. The coefficient alphas and sample sizes for these studies are presented in Table 1.

Table 1: Coefficient alphas of the EAT26 and EAT40 From Selected Studies.

| Study                  | Participants          | Test | N   | Coefficient alpha |
|------------------------|-----------------------|------|-----|-------------------|
| Garner et al. [7]      | Anorexia Nervosa      | EAT26| 160 | .90               |
| Garner et al. [7]      | Female Comparison     | EAT26| 140 | .83               |
| Lane et al. [10]       | Athletes              | EAT26| 598 | .79               |
| Mukai et al. [12]      | American Females      | EAT26| 130 | .89               |
| Mukai et al. [12]      | Japanese Females      | EAT26| 171 | .84               |

Table 2: Sample Output From INDAL.

ALPHA 1 = 0.9000, SAMPLE SIZE = 160
AND THE NUMBER OF ITEMS = 26

ALPHA 2 = 0.8300, SAMPLE SIZE = 140
AND THE NUMBER OF ITEMS = 26

ALPHA 3 = 0.7900, SAMPLE SIZE = 598
AND THE NUMBER OF ITEMS = 26

ALPHA 4 = 0.8900, SAMPLE SIZE = 130
AND THE NUMBER OF ITEMS = 26

ALPHA 5 = 0.8400, SAMPLE SIZE = 171
AND THE NUMBER OF ITEMS = 26

THE FISHER-BONETT TEST FOR THE DIFFERENCE AMONG ALPHAS = 45.9125, WITH DEGREES OF FREEDOM = 4 AND IT HAS A PROBABILITY = 0.0000

************* FOR COMPARISON 1 *******

FOR THE DIFFERENCE BETWEEN 0.7900 AND 0.9000
WITH THE DEGREES OF FREEDOM = 159 AND 597
THE F RATIO = 2.1000 WITH A PROBABILITY = 0.0000
THE BONFERRONI PROBABILITY AT THE .05 LEVEL = 0.0167
THE BONFERRONI PROBABILITY AT THE .01 LEVEL = 0.0033

************* FOR COMPARISON 2 *******

FOR THE DIFFERENCE BETWEEN 0.8400 AND 0.8900
WITH THE DEGREES OF FREEDOM = 129 AND 170
THE F RATIO = 1.4545 WITH A PROBABILITY = 0.0223
THE BONFERRONI PROBABILITY AT THE .05 LEVEL = 0.0167
THE BONFERRONI PROBABILITY AT THE .01 LEVEL = 0.0033

************* FOR COMPARISON 3 *******

FOR THE DIFFERENCE BETWEEN 0.8300 AND 0.9000
WITH THE DEGREES OF FREEDOM = 159 AND 139
THE F RATIO = 1.7000 WITH A PROBABILITY = 0.0014
THE BONFERRONI PROBABILITY AT THE .05 LEVEL = 0.0167
THE BONFERRONI PROBABILITY AT THE .01 LEVEL = 0.0033
As shown in the output from Table 2, the Fisher-Bonett statistic (which distributes out as a chi-square on $k-1$ df) was 45.91 with a $p<.0001$ indicating that there was a statistically significant difference among the coefficient alphas. Suppose one is subsequently interested in determining if there was a statistically significant difference between the coefficient alphas of athletes and anorexia nervosa participants on the EAT26. Moreover, suppose a second question concerned testing the difference between the coefficient alphas of the Japanese and American females in the Mukai et al. [12] study. A third comparison examined the difference between the coefficient alphas of the anorexia nervosa and female comparison groups of the Garner et al. [9] study. Because these are non-independent comparisons, a Bonferroni approach would be more viable. As indicated from the output, there was a significantly higher coefficient alpha on the EAT26 for anorexia nervosa participants than for athletes and the female comparison group, $p < .01$. However, there was no statistically significantly significant difference between coefficient alphas on the EAT26 for the American and Japanese females, $p > .05$.

**Availability**

INDAL.FOR and the executable version (INDAL.EXE) may be obtained at no charge by sending an e-mail request to N. Clayton Silver, Department of Psychology, University of Nevada, Las Vegas, Las Vegas, NV 89154-5030 at fdnsilvr@unlv.nevada.edu.

**References**

1. Feldt LS, Woodruff DJ, Salih FA (1987) Statistical inference for coefficient alpha coefficients. Applied Psychological Measurement 11: 93-103.
2. Kim S, Feldt LS (2008) A comparison of tests for equality of two or more independent alpha coefficients. Journal of Educational Measurement 45(2): 179-193.
3. Hakstian RA, Whalen Tem (1976) A k-sample significance test for independent alpha coefficients. Psychometrika 41(2): 219-231.
4. Bonett DG (2003) Sample size requirements for comparing two alpha coefficients. Applied Psychological Measurement 27: 72-74.
5. Charter RS (1997) Testing the difference between two or more independent coefficients alpha: An example. Perceptual and Motor Skills 84: 464-466.
6. Dunlap WP, Duffy JA (1975) FORTRAN IV functions for calculating exact probabilities associated with $z$, $\chi^2$, $t$, and $F$ tables. Behavior Research Methods 7(1): 59-60.
7. Charter RS, Feldt LS (1996) Testing the equality of two coefficient alphas. Perceptual and Motor Skills 82: 763-768.
8. Garner DM, Garfinkel PE (1979) The eating attitudes test: An index of the symptoms of anorexia nervosa. Psychological Medicine 9(2): 273-279.
9. Garner DM, Olmsted MP, Bohr Y, Garfinkel PE (1982) The eating attitudes test: Psychometric features and clinical correlates. Psychological Med 12(4): 871-878.
10. Lane HW, Lane AM, Matheson H (2004) Validity of the eating attitude test among exercisers. Journal of Sports Science and Medicine 3: 244-253.
11. Mukai T, Crago M, Shisslak CA (1994) Eating attitudes and weight preoccupation among female high school students in Japan. J Child Psychol Psychiatry 35(4): 677-688.
12. Mukai T, Kambara A, Sasaki Y (1998) Body dissatisfaction, need for social approval, and eating disturbances among Japanese and American college women. Sex Roles 39(9): 751-763.