

Determine the Dimensionality of Polycystic Ovary Syndrome Health-Related Quality of Life Questionnaire (PCOSQ-50) Using Factor Procedure and Parallel Analysis

Abbas S. Tavakoli, DrPH, MPH, ME, Pamela J. Wright, PhD, MS, MEd, RN, CEN, Robin M. Dawson, PhD, APRN, CPNP-PC, FAAN

University of South Carolina, College of Nursing, Biobehavioral Health & Nursing Science

Abstract

Health-related quality-of-life (HRQoL) has been defined as the physical, psychological, and social domains of health. HRQoL is a multi-dimensional concept commonly used to examine the impact of the presence and treatment of chronic health conditions on an individual's physical, emotional, and social well-being. While HRQoL instruments can be used with most health conditions, they lack specificity for certain health conditions such as polycystic ovary syndrome (PCOS). This paper used parallel analysis to determine the dimensionality of Polycystic Ovary Syndrome Health-Related Quality of Life Questionnaire (PCOSQ-50). Parallel analysis, using a SAS macro and option parallel in Proc Factor, was used to determine the dimensionality of the Perspectives of Faculty Caring. Exploratory factor analysis was conducted using maximum likelihood, squared multiple correlations, and Promax rotation. Parallel analysis, using a SAS macro and option parallel in Proc Factor, was used to determine the dimensionality of the Perspectives of online Caring. Internal consistency reliability was assessed using Cronbach's alpha. Pearson's correlation assessed the association between factors and subscale items. Parallel analysis showed there were seven meaningful underlying factors. All loading from rotated factor pattern (standardized regression coefficient) were positive for 50 items, with factor loadings ranging from 0.30 to 0.99. There was positive correlation between seven factors ranging from .11 to .63. Scale reliability in this study was examined by estimating the Cronbach's alpha. The reliability coefficient for total scale was 0.93. The Cronbach's alpha for the subscales ranged from 0.81 to 0.97. Parallel analysis was a valuable method for determining the dimensionality of the PCOSQ-50 Scale.

Keywords: SAS, parallel analysis, exploratory factor analysis, psychometrics

Background

Health-related quality-of-life (HRQoL) has been defined as the physical, psychological, and social domains of health. HRQoL is a multi-dimensional concept commonly used to examine the impact of the presence and treatment of chronic health conditions on an individual's physical, emotional, and social well-being. While HRQoL instruments can be used with most health conditions, they lack specificity for certain health conditions such as polycystic ovary syndrome (PCOS). The original Polycystic Ovary Syndrome Questionnaire had 26 items placed in five domains: emotions (8 items), body hair (5 items), weight (5 items), infertility (4 items), and menstrual problems (4 items). Each item was answered using a 7-point Likert scale, with 7 representing optimal function and 1 representing the poorest function (Cronin et al., 2007). However, the original version had poor face and content validity indices, with low alpha coefficients for the domains of menstrual problems (0.56) and emotions (0.60) (Malik-Aslam et al., 2010). After several revisions, Nasiri-Amiri, and colleagues (2016) designed a new instrument, which includes 50 items in six domains: psychosocial/emotional, fertility, sexual function, obesity/menstrual disorders, hirsutism, and coping and is referred to as the PCOSQ-50. Items within each domain are answered using a 5-point Likert scale, with 1 representing the worst condition and 5 representing the best condition. Assessment of the psychometric properties of the PCOSQ-50 revealed a mean content validity index and ratio of 0.92 and 0.91, respectively, a Cronbach's alpha of 0.88, Spearman's correlation coefficients of test-retest of 0.75, and an intra-class correlation coefficient for the subscales ranging from 0.57 to 0.88 [9]. To date, further recommendations of all versions include additional application and measurement among different cultural populations of women with PCOS and psychometric testing based on use among larger samples of women with PCOS [10-13]. Additionally, the PCOSQ-50 was designed for women aged 18-42 years, and thus omits relevant HRQoL assessment for women with PCOS in the peri-post-menopausal years.

Purpose

This study used parallel analysis to determine the dimensionality of the current PCOS-specific health-related quality of life questionnaire (PCOSQ-50).

Methodology

This study used the data from a sample of women (n=935) with self-reported PCOS aged 18-42 years, recruited from two PCOS Facebook pages. The survey was set up in Research Electronic Data Capture (REDCap) software and was made available to eligible participants. Factor dimensionality was assessed through parallel analysis, which has been demonstrated to determine factor dimensionality more accurately than the traditional Kuder-Richardson. Parallel analysis produces correlation matrices from a randomly

chosen simulated dataset that has a similar number of observations as the original dataset.³ The observations in the simulated dataset have the same sampling error as observations in the original dataset.³ Eigenvalues were computed for both the simulated and original data and compared to determine the point at which the eigenvalue in the simulated dataset was higher than in the original dataset. The number of factors before this transition point denoted the number of factors that were retained. A scree plot was also created to compare eigenvalues from simulated and original datasets to corroborate our determination of the number of factors to retain.

Data Analysis

Exploratory factor analysis was conducted using squared multiple correlations and prior communality estimates. Maximum likelihood (ML) estimation was used to extract factors followed by Promax (oblique) rotation. First, parallel analysis, using a SAS macro and option parallel in Proc Factor, was used to determine the dimensionality of the PCOSQ-50 aged 18-42^{4,5}. Second, the Scree plot, eigenvalues, and proportion of eigenvalues were examined. An eigenvalue greater than one determined if a factor was retained in the factor structure. Third, a series of factor rotations were examined. Results of both varimax and promax rotation methods indicated an optimal factor structure of seven factors. When interpreting the rotated factor pattern, an item was determined to load on a given factor if the factor loading was 0.30 or greater for that factor and was less than 0.30 for other factors.⁴ Internal consistency reliability was assessed using Cronbach's alpha for the total scale and each of the seven subscales. Pearson's correlation assessed the associations between factors and subscale items. PROC MEAN and PROC FREQ were used to conduct descriptive statistics. PROC CORR and PROC FACTOR were used to conduct exploratory factor analysis, compute Cronbach's alpha, and estimate correlations. We used the SAS[®] macro, %parallel, and parallel option in Proc Factor to determine the dimensionality of the PCOSQ-50 among women ages 18- 42 years. All data analyses were performed using SAS/STAT[®] statistical software, version 9.4.⁶

Results

Table1 displays the frequency distribution of item 1 for the PCOSQ-50, which indicates that about 48% of participants suffered from bad mood sometimes to always. There were no missing values for any items.

Table 1. Frequency distribution of item 1 of the PCOSQ-50

In the past 4 weeks, how often have you suffered from bad mood due to PCOS?				
pcosq1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Never	89	9.52	89	9.52
Rarely	399	42.67	488	52.19
Sometimes	334	35.72	822	87.91
Often	99	10.59	921	98.50
Always	14	1.50	935	100.00

Table 2 reports frequency, means, and standard deviation of PCOSQ-50 items. The mean ranged from 1.17 (pcosqb7) to 3.52 (pcosqd1).

Table 2. Frequency, means, and standard deviations for PCOSQ-50 items (n=935).

Item	Label	mean	std	min	max
pcosq1	In the past 4 weeks, how often have you suffered from bad mood due to PCOS?	2.48	0.86	0.00	4.00
pcosq2	In the past 4 weeks, how often have you experienced impatience due to PCOS?	2.54	0.98	0.00	4.00
pcosq3	In the past 4 weeks, how often have you blamed yourself for having PCOS?	2.01	1.46	0.00	4.00
pcosq4	In the past 4 weeks, how often have you experienced trouble dealing with others?	2.15	0.90	0.00	4.00
pcosq5	In the past 4 weeks, how often have you suffered from low self-esteem due to PCOS?	3.02	1.03	0.00	4.00
pcosq6	In the past 4 weeks, how often have you experienced aggressiveness due to PCOS?	1.82	1.09	0.00	4.00

Table 2. Frequency, means, and standard deviations for PCOSQ-50 items (n=935).

Item	Label	mean	std	min	max
pcosq7	In the past 4 weeks, how often have you felt pessimistic about the treatment?	2.57	1.11	0.00	4.00
pcosq8	In the past 4 weeks, how often have you suffered from the embarrassment due to your appearance?	2.83	1.13	0.00	4.00
pcosq9	In the past 4 weeks, how often have you felt different to normal women?	3.01	1.13	0.00	4.00
pcosq10	In the past 4 weeks, how often have you experienced lack of control of emotions?	2.38	0.98	0.00	4.00
pcosq11	In the past 4 weeks, how often have you felt ugly or unattractive?	2.99	1.03	0.00	4.00
pcosq12	In the past 4 weeks, how often have you felt easily tired?	3.31	0.81	0.00	4.00
pcosqb1	In the past 4 weeks, how often have you felt sad seeing children?	1.64	1.43	0.00	4.00
pcosqb2	In the past 4 weeks, how often have you felt sad seeing pregnant women?	1.89	1.56	0.00	4.00
pcosqb3	In the past 4 weeks, how often have you experienced concern about infertility?	2.28	1.58	0.00	4.00
pcosqb4	In the past 4 weeks, how often have you felt you will accept all other PCOS manifestations if assured of pregnancy?	1.82	1.51	0.00	4.00
pcosqb5	In the past 4 weeks, how often have you felt fear of abortion?	1.74	1.57	0.00	4.00
pcosqb6	In the past 4 weeks, how often have you felt concerned about infertility in the future?	2.48	1.55	0.00	4.00
pcosqb7	In the past 4 weeks, how often have you experienced fear of divorce or separation?	1.17	1.31	0.00	4.00
pcosqb8	In the past 4 weeks, how often have you felt uselessness of sexual intercourse due to infertility	1.36	1.40	0.00	4.00
pcosqb9	In the past 4 weeks, how often have you experienced concern about the long-term effects of PCOS medication?	2.26	1.34	0.00	4.00
pcosqc1	In the past 4 weeks, how often have you felt unsatisfied with sex?	1.84	1.31	0.00	4.00
pcosqc2	In the past 4 weeks, how often have you experienced lack of sexual stimulation?	1.99	1.28	0.00	4.00
pcosqc3	In the past 4 weeks, how often have you experienced lack of sexual desire?	2.17	1.26	0.00	4.00
pcosqc4	In the past 4 weeks, how often have you experienced lack of lubrication during sexual intercourse?	1.51	1.32	0.00	4.00
pcosqc5	In the past 4 weeks, how often have you experienced lack of orgasm?	1.70	1.31	0.00	4.00
pcosqc6	In the past 4 weeks, how often have you felt ashamed of sexual coldness/unresponsiveness?	1.73	1.43	0.00	4.00
pcosqc7	In the past 4 weeks, how often have you experienced lack of libido because of PCOS?	1.96	1.36	0.00	4.00
pcosqd1	In the past 4 weeks, how often have you felt concerned about being overweight?	3.52	0.93	0.00	4.00
pcosqd2	In the past 4 weeks, how often have you felt the need to decrease your weight to control PCOS status?	3.49	0.94	0.00	4.00
pcosqd3	In the past 4 weeks, how often have you felt concerned about a fast return to your previous weight after any weight loss?	3.12	1.18	0.00	4.00
pcosqd4	In the past 4 weeks, how often have you felt concerned about the complete cessation of menstruation?	2.03	1.46	0.00	4.00
pcosqd5	In the past 4 weeks, how often have you felt concerned about menstruation at long intervals?	1.90	1.45	0.00	4.00
pcosqd6	In the past 4 weeks, how often have you felt willingness to reduce your weight to be more attractive for your spouse?	2.92	1.26	0.00	4.00
pcosqd7	In the past 4 weeks, how often have you experienced fear of diseases such as diabetes, hypertension, and heart disease?	2.73	1.27	0.00	4.00
pcosqd8	In the past 4 weeks, how often have you felt the urge to abandon treatments because of repetitive visits to doctors?	1.78	1.40	0.00	4.00
pcosqd9	In the past 4 weeks, how often have you experienced fear of cancer?	1.86	1.35	0.00	4.00

Table 2. Frequency, means, and standard deviations for PCOSQ-50 items (n=935).

Item	Label	mean	std	min	max
pcosqe1	In the past 4 weeks, how often have you felt embarrassed because of excess facial hair?	2.68	1.45	0.00	4.00
pcosqe2	In the past 4 weeks, how often have you felt concerned about the progression of excess body and facial hair?	2.71	1.40	0.00	4.00
pcosqe3	In the past 4 weeks, how often have you felt concerned about having excess facial hair?	2.68	1.45	0.00	4.00
pcosqe4	In the past 4 weeks, how often have you felt concerned about rapid regrowth of unwanted hair after its removal?	2.66	1.43	0.00	4.00
pcosqe5	In the past 4 weeks, how often have you felt embarrassed because of having excess body hair?	2.63	1.44	0.00	4.00
pcosqe6	In the past 4 weeks, how often have you experienced the need to cover your body and face because of excess hair?	2.26	1.56	0.00	4.00
pcosqf1	In the past 4 weeks, how often have you felt a lack of family support and acceptance of your disease?	1.86	1.39	0.00	4.00
pcosqf2	In the past 4 weeks, how often have you felt lack of satisfaction with being a woman?	2.10	1.34	0.00	4.00
pcosqf3	In the past 4 weeks, how often have you felt the desperate need for a cure?	3.13	1.08	0.00	4.00
pcosqf4	In the past 4 weeks, how often have you felt the need to complain with others about PCOS?	2.08	1.20	0.00	4.00
pcosqf5	In the past 4 weeks, how often have you felt difficulty communicating with others with PCOS?	1.91	1.36	0.00	4.00
pcosqf6	In the past 4 weeks, how often have you felt lack of satisfaction with your appearance (self-image)?	3.23	0.95	0.00	4.00
pcosqf7	In the past 4 weeks, how often have you felt lack of satisfaction with your role/future role as a spouse or partner?	2.24	1.36	0.00	4.00

Note. Items range from 1 to 4.

Figure 1 shows the plot of parallel analysis using macro which suggested five, six, or seven underlying dimensions.

Figure1. Parallel analysis plot of Eigenvalues using Macro.

Parallel Analysis -Median Simulated Eigenvalues
50 Variables, &niterIterations, 935 Observations

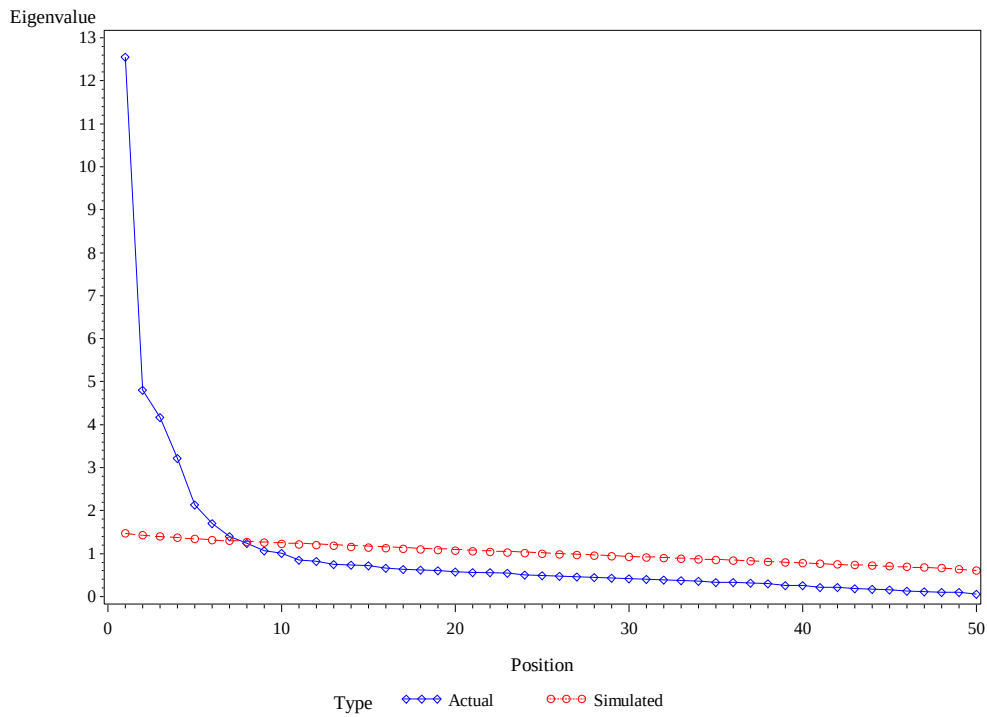


Figure 2 shows the plot of parallel analysis using parallel option in Proc Factor which suggested five, six, or seven underlying dimensions. The plot from Macro is a little different from Proc Factor.

Figure 2. Parallel analysis plot of Eigenvalues using parallel option in Proc Factor

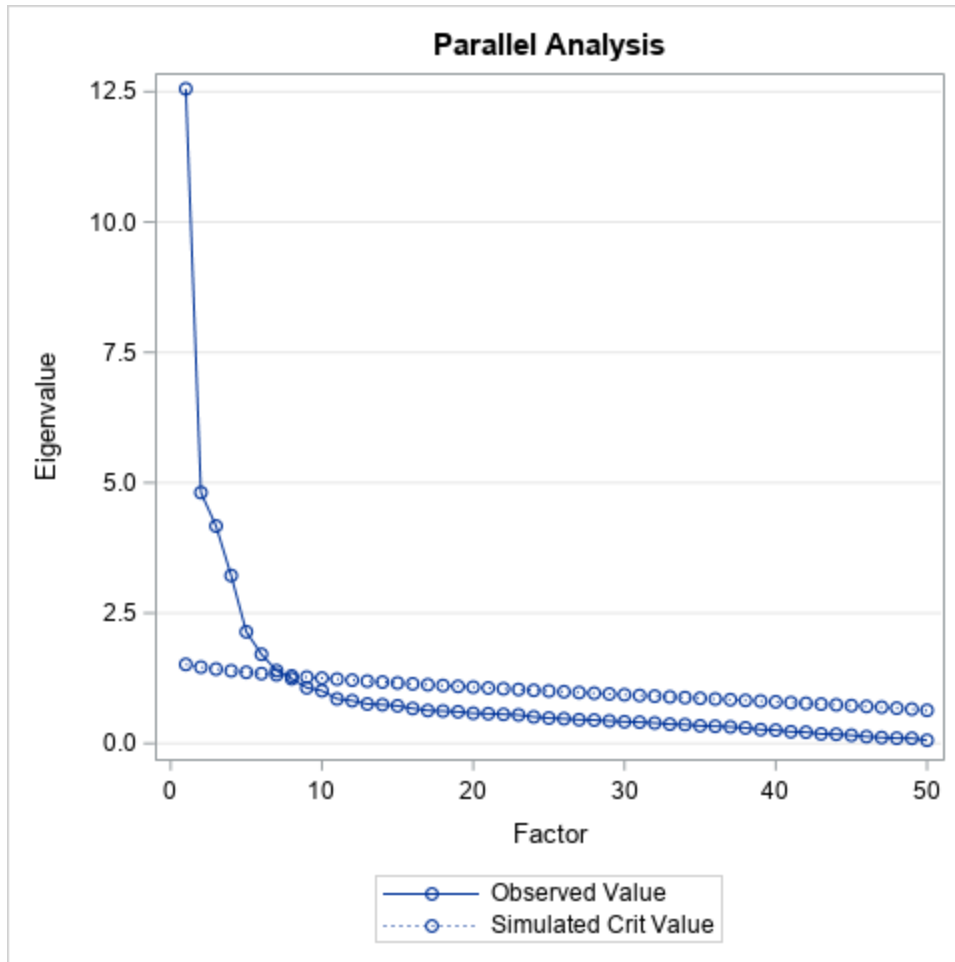


Table 3 reports eigenvalues for the PCOSQ-50 scale. Eight eigenvalues are above 1. Ninety-nine, 97, and 94 percent of the variance were explained by these for 7, 6, and 5 factors, respectively.

Table 3. Part of Eigenvalues for PCOSQ-50

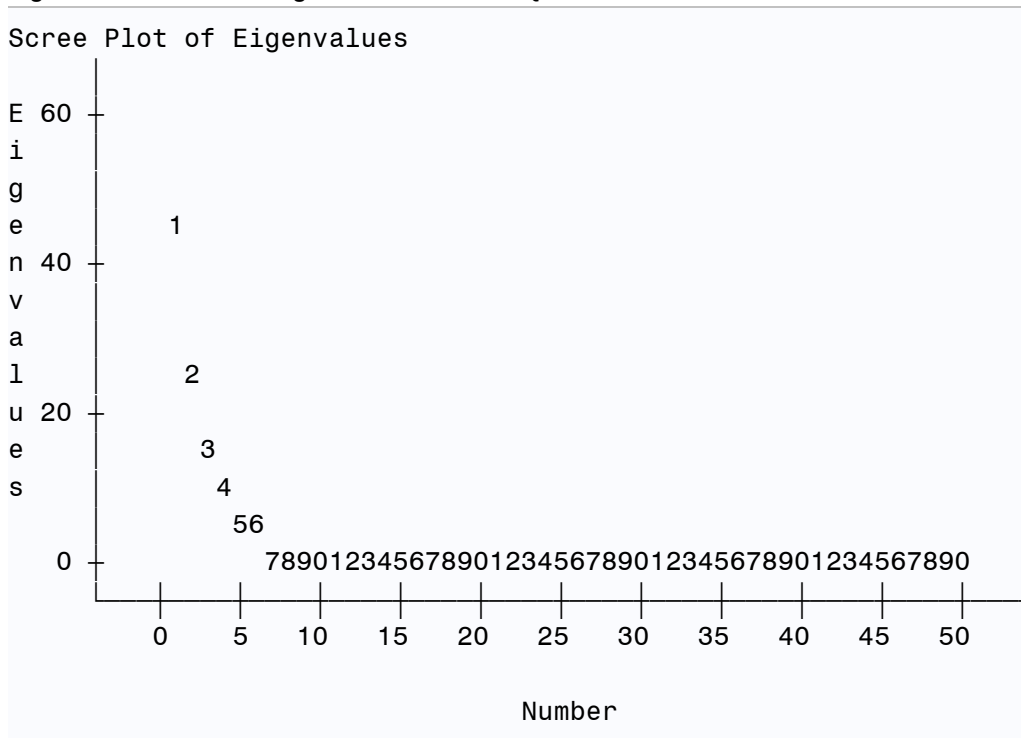
Preliminary Eigenvalues: Total = 101.270992 Average = 2.02541984				
	Eigenvalue	Difference	Proportion	Cumulative
1	45.3667732	21.6302146	0.4480	0.4480
2	23.7365586	10.0051696	0.2344	0.6824
3	13.7313890	5.0645925	0.1356	0.8180
4	8.6667965	4.5681581	0.0856	0.9035
5	4.0986384	1.5724102	0.0405	0.9440
6	2.5262282	0.5021785	0.0249	0.9689
7	2.0240497	0.6278659	0.0200	0.9889
8	1.3961838	0.0590839	0.0138	1.0027

Table 3. Part of Eigenvalues for PCOSQ-50

Preliminary Eigenvalues: Total = 101.270992 Average = 2.02541984				
	Eigenvalue	Difference	Proportion	Cumulative
9	1.3370999	0.5204328	0.0132	1.0159
10	0.8166671	0.0648034	0.0081	1.0240

Figure 2 displays the scree plot of eigenvalues for the PCOSQ-50 scale, which revealed that 5 or 6 factors are meaningful.

Figure 2: Scree Plot of Eigenvalues for PCOSQ-50 Scale



Tables 5 -7 report the Rotated Factor Pattern (Standardized Regression Coefficients) for the PCOSQ-50. Parallel analysis showed there were five, six, or seven meaningful underlying factors. Eigenvalues and the proportion of variance explained by each factor also suggested five to seven meaningful factors for the 50-item scale. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is 0.93, which is acceptable. The residuals are all small and the overall RMSR is 0.03, indicating that the factor structure explains most of the correlations.⁷

All 50 items loaded for seven factors. However, two items did not load for five and six factors (PCOSQD5 and PCOSQD7).

**Table 5. Rotated Factor Pattern (Standardized Regression Coefficients)
for the PCOSQ-50 Scale (five factors)**

	Factor1	Factor2	Factor3	Factor4	Factor5
pcosq1	78	-6	-4	-5	-5
pcosq10	75	-1	-1	-3	-17
pcosq2	71	-3	-5	-3	-10
pcosq6	70	-10	-3	-2	-11
pcosq4	68	-6	-3	-4	-7
pcosq5	60	-1	1	-5	23
pcosqf2	55	8	12	5	3
pcosqf1	50	-6	0	4	6
pcosq11	50	-8	1	-1	31
pcosq3	49	20	-1	-2	3
pcosqf4	46	12	-3	-4	7
pcosqf7	45	17	2	17	3
pcosqf3	44	14	7	-1	13
pcosqf5	44	8	-3	4	8
pcosqb7	43	11	-1	3	-8
pcosq7	43	2	2	6	8
pcosq8	41	-5	11	-1	30
pcosqd8	39	9	2	5	3
pcosq12	39	-2	-2	8	7
pcosq9	37	14	9	-1	13
pcosqd9	35	3	3	2	4
pcosqb9	30	14	2	9	11
pcosqd5	26	20	-5	-1	8
pcosqb3	-4	96	-1	-7	0
pcosqb6	-4	92	-1	-5	-1
pcosqb2	4	84	0	-1	2
pcosqb4	-3	81	-2	-2	-3
pcosqb1	13	77	2	0	-2
pcosqb5	-1	76	-1	0	-2
pcosqb8	15	54	1	31	-4
pcosqd4	22	35	1	1	5
pcosqe3	-8	-2	98	0	-1

**Table 5. Rotated Factor Pattern (Standardized Regression Coefficients)
for the PCOSQ-50 Scale (five factors)**

	Factor1	Factor2	Factor3	Factor4	Factor5
pcosqe1	-9	0	97	1	3
pcosqe2	2	-1	94	-3	-1
pcosqe5	5	-1	91	0	-3
pcosqe4	4	-2	91	-1	-5
pcosqe6	9	2	81	2	2
pcosqc3	-9	-5	-1	91	0
pcosqc7	-5	-6	-2	88	4
pcosqc2	0	-1	0	84	-2
pcosqc6	7	0	-2	77	5
pcosqc1	11	1	4	65	-2
pcosqc4	-3	3	0	56	-4
pcosqc5	9	3	0	54	-3
pcosqd1	-8	0	-2	0	92
pcosqd2	-9	3	-3	-3	91
pcosqd3	5	0	-2	3	59
pcosqd6	22	-6	-1	-5	53
pcosqf6	35	-7	2	-1	42
pcosqd7	18	6	6	5	29

Note: Root Mean Square Residual (RMSR) = 0.04.

Kaiser's Measure of Sampling Adequacy = 0.93.

PCOSQD5 and PCOSQD7 did not load any factors.

Table 6. Rotated Factor Pattern (Standardized Regression Coefficients) for the PCOSQ-50 Scale (six factors)

	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
pcosq6	79	-12	-1	-3	-12	-2
pcosq2	76	-5	-3	-4	-6	-3
pcosq1	73	-8	-4	-5	11	-5
pcosq10	69	-1	-1	-3	9	-15
pcosq4	67	-8	-2	-4	3	-3
pcosqf4	48	11	-2	-4	-4	11
pcosqf1	47	-6	1	4	5	8
pcosqf5	47	8	-1	4	-4	12
pcosqd8	42	8	3	5	-5	7
pcosqf3	40	14	8	-1	7	13
pcosqd9	39	3	4	2	-5	9
pcosqf2	38	9	12	6	25	-3
pcosqb9	35	13	3	8	-7	15
pcosqb7	35	11	0	3	10	-8
pcosqf7	34	18	2	17	16	-1
pcosq12	32	-3	-2	8	12	4
pcosqd5	32	19	-3	-1	-8	13
pcosq3	30	22	-1	-2	28	-4
pcosq7	29	3	2	6	22	2
pcosqb3	-6	97	-2	-7	0	-1
pcosqb6	-2	92	-1	-5	-5	0
pcosqb2	-3	86	-1	-1	10	-2
pcosqb4	0	81	-2	-3	-7	0
pcosqb1	5	78	1	0	9	-5
pcosqb5	2	76	-1	-1	-8	0
pcosqb8	13	54	1	31	0	-3
pcosqd4	27	34	2	1	-8	10
pcosqe3	-5	-2	98	-1	-4	1
pcosqe1	-9	0	96	1	2	2
pcosqe2	3	-1	94	-3	-1	1
pcosqe4	8	-2	91	-1	-7	-1
pcosqe5	3	-1	91	0	2	-3
pcosqe6	3	2	80	2	9	-1
pcosqc3	-9	-5	-1	91	0	-1
pcosqc7	-5	-7	-2	88	0	3

Table 6. Rotated Factor Pattern (Standardized Regression Coefficients) for the PCOSQ-50 Scale (six factors)

	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
pcosqc2	2	-1	0	85	-4	0
pcosqc6	3	0	-2	77	8	2
pcosqc1	12	0	4	65	-4	0
pcosqc4	-3	3	-1	56	-2	-3
pcosqc5	9	3	0	54	-1	-2
pcosq11	-1	-5	-5	0	93	-3
pcosq8	2	-2	8	0	70	5
pcosqf6	-2	-5	-1	0	69	17
pcosq5	24	0	-1	-5	63	1
pcosq9	18	16	8	0	31	3
pcosqd2	-1	1	-1	-4	4	88
pcosqd1	-4	-2	-1	0	12	83
pcosqd3	16	-2	0	2	-5	60
pcosqd6	7	-5	-1	-5	35	39
pcosqd7	21	5	7	5	0	29

Note: Root Mean Square Residual (RMSR) = 0.03.

Kaiser's Measure of Sampling Adequacy = 0.93.

PCOSQD5 and PCOSQD7 did not load any factors.

Table 7. Rotated Factor Pattern (Standardized Regression Coefficients) for the PCOSQ-50 Scale (seven factors)

	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7
pcosqe3	99	0	-6	0	-4	0	2
pcosqe1	97	2	-9	1	2	-2	4
pcosqe2	94	0	0	-3	-1	2	1
pcosqe4	91	-2	5	-1	-7	5	-1
pcosqe5	91	-1	3	0	2	1	-3
pcosqe6	80	1	9	2	9	-4	-2
pcosqb3	-1	97	-4	-6	-1	-3	2
pcosqb6	0	93	-3	-4	-5	0	2
pcosqb2	1	86	-6	0	10	0	1
pcosqb4	-2	80	1	-2	-7	-1	1
pcosqb1	2	78	-1	1	9	5	-3
pcosqb5	-1	74	11	-1	-8	-5	0
pcosqb8	2	53	11	31	0	4	-3
pcosqf3	4	5	61	-4	8	-3	4
pcosqd9	1	-6	59	-1	-5	-3	0
pcosqd8	0	0	58	2	-5	2	-1
pcosqf4	-4	4	56	-6	-3	8	4
pcosqf1	-1	-13	53	1	6	9	0
pcosqf5	-3	1	52	2	-2	9	5
pcosqb9	1	6	52	6	-7	0	8
pcosqf2	9	2	50	3	27	0	-10
pcosqd7	4	-3	48	2	0	-12	21
pcosqd5	-5	14	40	-3	-7	3	7
pcosqd4	0	29	38	0	-8	1	5
pcosqf7	1	13	35	16	17	7	-5
pcosqb7	-2	7	33	2	11	9	-12
pcosq7	1	0	30	5	24	6	-1
pcosqc3	0	-3	-11	92	-1	-1	1
pcosqc7	-1	-4	-9	88	0	2	5
pcosqc2	0	0	2	84	-4	0	0
pcosqc6	-2	0	4	77	8	-1	2
pcosqc1	4	1	6	65	-3	7	0

Table 7. Rotated Factor Pattern (Standardized Regression Coefficients) for the PCOSQ-50 Scale (seven factors)

	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7
pcosqc4	-1	3	2	56	-2	-4	-3
pcosqc5	-1	2	14	53	0	-2	-4
pcosq11	-4	-3	-10	0	95	1	-1
pcosq8	7	-3	7	0	72	-7	3
pcosqf6	-1	-5	0	0	72	-6	16
pcosq5	0	3	0	-4	66	20	3
pcosq9	7	13	20	-1	32	2	0
pcosq3	-2	19	26	-3	30	10	-7
pcosq1	0	0	-3	-2	11	76	2
pcosq2	0	2	2	0	-7	76	3
pcosq6	2	-6	9	0	-13	74	4
pcosq4	1	-1	1	-1	3	66	3
pcosq10	1	3	10	-1	10	59	-10
pcosq12	0	0	3	9	13	29	6
pcosqd2	1	5	0	-2	4	2	88
pcosqd1	1	2	-2	2	13	0	82
pcosqd3	0	-2	17	3	-5	5	56
pcosqd6	-1	-5	11	-5	36	-1	37

Note: Root Mean Square Residual (RMSR) = 0.03.

Kaiser's Measure of Sampling Adequacy = 0.93.

Table 8 reports means, standard deviations, minimums, and maximums of total scale and subscales of the PCOSQ-50 for five, six, and seven factors. The results showed the average of the total scale, and each subscale were 114.28, 15.25, 15.61, 12.89, and 19.01 or five factors respectively. The results indicated the average of the total scale, and each subscale were 103.28, 41.56, 15.25, 15.61, 12.89, 15.08, 15.08, and 15.78 for six factors respectively. The results indicated the average of the total scale, and each subscale were 99.08, 15.61, 13.22, 29.63, 12.89, 17.10, 14.68, and 13.05 for seven factors respectively.

Table 8: Frequency, Mean, and Standard Deviation for Total Scale and Subscales of the PCOSQ-50 (5, 6, and 7 factors; n=935)

Variable	Mean	Std Dev	Minimum	Maximum
tf5f1	51.52	15.01	6.00	88.00
tf5f2	15.25	9.64	0.00	32.00
tf5f3	15.61	8.14	0.00	24.00
tf5f4	12.89	7.26	0.00	28.00
tf5f5	19.01	4.67	1.00	24.00
tf5all	114.28	30.83	19.00	196.00
tf6f1	41.56	13.17	2.00	76.00
tf6f2	15.25	9.64	0.00	32.00
tf6f3	15.61	8.14	0.00	24.00
tf6f4	12.89	7.26	0.00	28.00
tf6f5	15.08	4.14	0.00	20.00
tf6f6	15.78	4.11	0.00	20.00
tf6all	103.28	28.51	12.00	172.00
tf7f1	15.61	8.14	0.00	24.00
tf7f2	13.22	8.93	0.00	28.00
tf7f3	29.63	10.87	1.00	56.00
tf7f4	12.89	7.26	0.00	28.00
tf7f5	17.10	5.01	0.00	24.00
tf7f6	14.68	4.17	1.00	24.00
tf7f7	13.05	3.49	0.00	16.00
tf7all	99.08	27.84	17.00	176.00

Table 9 reports Pearson correlations for the total scale and subscales of the PCOSQ-50 (seven factors). There was a weak positive correlation between seven factors range from .11 to .63 for seven factors. A positive correlation was found between factors and the total subscale ranging from .51 to .86 for four factors. Scale reliability in this study was examined by estimating the Cronbach's alpha. The reliability coefficient for total scale was 0.93. The Cronbach's alpha for the subscales ranged from 0.81 to 0.97. **Table 9: Pearson Correlation and Cronbach's Alpha for Total Scale and Subscales PCOSQ-50 (Seven Factors)**

Pearson Correlation Coefficients, N = 935 Prob > r under H0: Rho=0								
	tf7all	tf7f1	tf7f2	tf7f3	tf7f4	tf7f5	tf7f6	tf7f7
tf7all Total for seven factor	0.93	0.55971 <.0001	0.63513 <.0001	0.86576 <.0001	0.51772 <.0001	0.66789 <.0001	0.64473 <.0001	0.50507 <.0001
tf7f1 Seven factor / factor 1		0.97	0.11625 0.0004	0.33702 <.0001	0.10956 0.0008	0.36388 <.0001	0.26113 <.0001	0.24601 <.0001
tf7f2 Seven factor / factor 2			0.93	0.47485 <.0001	0.13382 <.0001	0.34270 <.0001	0.29338 <.0001	0.13072 <.0001
tf7f3 Seven factor / factor 3				0.85	0.32009 <.0001	0.62741 <.0001	0.56545 <.0001	0.45067 <.0001
tf7f4 Seven factor / factor 4					0.89	0.23529 <.0001	0.24574 <.0001	0.16282 <.0001
tf7f5 Seven factor / factor 5						0.83	0.52310 <.0001	0.53527 <.0001
tf7f6 Seven factor / factor 6							0.83	0.31806 <.0001
tf7f7 Seven factor / factor 7								0.81

Note: Cronbach's alphas are in the diagonal.

Conclusion

We used the SAS® macro, %parallel, and parallel option in Proc Factor to determine the dimensionality of the PCOSQ-50 among women with self-identified PCOS aged 18-42 years. Parallel analysis indicated four or five factors were the optimal solution for PCOSQ-50. All loading from rotated factor pattern (standardized regression coefficient) were positive for 50 items, with factor loadings ranging from 0.30 to 0.99. There was a positive correlation between seven factors, with a range from 0.11 to 0.63 for seven factors. A positive correlation was found between factors and the total subscale ranging from 0.51 to 0.86 for four factors. Scale reliability in this study was examined by estimating the Cronbach's alpha. The reliability coefficient for total scale was 0.93. The Cronbach's alpha for the subscales ranged from 0.81 to 0.97. Parallel analysis was a valuable method for determining the dimensionality of the PCOSQ-50 Scale.

REFERENCES

1. Testa, M. A., & Simonson, D. C. (1996). Assessment of quality-of-life outcomes. *New England Journal of Medicine*, 334(13), 835–840. <https://doi.org/10.1056/NEJM199603283341306>.
2. Centers for Disease Control and Prevention. (2021). HRQoL Concepts. CDC. Retrieved 10 December 2022, from <https://www.cdc.gov/hrqol/concept.htm>
3. Çokluk, Ö., & Koçak, D. (2016). Using Horn's Parallel Analysis Method in Exploratory Factor Analysis for Determining the Number of Factors. *Educational Sciences: Theory and Practice*, 16(2), 537-551.
4. Kabacoff, R. (2003). Determining the Dimensionality of Data: A SAS Macro for Parallel Analysis, *SUGI 28*, March 30 – April 2.

5. Horn, J. L. (1965). A rationale and test for the number of factors in factor analysis. *Psychometrika*, 30(2), 179-185.
6. SAS Institute Incorporated. (2013). *SAS for Windows 9.4*. Cary, NC: SAS Institute Inc.
7. Browne, M. W. & Cudeck, R. (1993), "Alternative Ways of Assessing Model Fit," in K. A. Bollen and S. Long, eds., *Testing Structural Equation Models*, Newbury Park, CA: Sage Publications.
8. Cronin, L., Guyatt, G., Griffith, L., Wong, E., Azziz, R., Futterweit, W., Cook, D., & Dunaif, A. (2007). Development of a health-related quality-of-life (PCOSQ) for women with polycystic ovary syndrome (PCOS). *Journal of Clinical Endocrinology and Metabolism*, 83(6), 1976-1983. <https://doi.org/10.1210/jcem.83.6.4990>
9. Malik-Aslam, A., Reaney, M. D., & Speight, J. (2010). The suitability of polycystic ovary syndrome-specific questionnaires for measuring the impact of PCOS on quality of life in clinical trials. *Value Health*, 13(4), 440-446. <https://doi.org/10.1111/j.1524-4733.2010.00696.x>.
10. Nasiri-Amiri, F., Tehrani, F.R., Simbar, M., Montazeri, A., & Mohammadpous, R.A. (2016). Health-related quality of life questionnaire for polycystic ovary syndrome (PCOSQ-50): Development and psychometric properties. *Quality of Life Research*, 25(7), 1791-1801. <https://doi.org/10.1007/s11136-016-1232-7>
11. Stevanovic, D., Bozic-Antic, I., Stanojlovic, D., Milutinovic, D. V., Bjekic-Macut, J., Jancic, J., & Macut, D. (2019). Health-related quality of life questionnaire for polycystic ovary syndrome (PCOSQ-50): A psychometric study with the Serbian version. *Women & Health*, 59(9), 1015-1025. <https://doi.org/10.1080/03630242.2019.1587664>
12. Nasiri-Amiri, F., Tehrani, F. R., Simbar, M., Montazeri, A., & Mohammadpour, R. A. (2018). The polycystic ovary syndrome health-related quality-of-life questionnaire: Confirmatory factor analysis. *International Journal of Endocrinology and Metabolism*, 16(2), e12400. <https://doi.org/10.5812/ijem.12400>
13. Jones, G. I., Hall, J. M., Balen, A. H., & Ledger, W. L. (2008). Health-related quality of life measurement in women with polycystic ovary syndrome: A systematic review. *Human Reproduction*, 14(1), 15-25. <https://doi.org/10.1093/humupd/dmm030>

TRADEMARK NOTICE

SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc. in the USA and other countries. ® indicates USA registration.

Other brand and product names are trademarks of their respective companies.

Contact Information

Abbas S. Tavakoli, DrPH, MPH, ME
 Professor
 College of Nursing
 University of South Carolina
 1601 Greene Street
 Columbia, SC 29208-4001
 Fax: (803) 777-5561
 E-mail: abbas.tavakoli@sc.edu

SAS Syntax

Part of Data steps:

```
data two; set one;
array items pcosq1 - pcosq12 pcosqb1 - pcosqb9 pcosqc1 - pcosqc7
      pcosqd1 - pcosqd9 pcosqe1 - pcosqe6 pcosqf1 - pcosqf7; ;
do over items; items= 5 - items; end;

tf5f1=sum (of pcosqd1 pcosqd2 pcosqf6 pcosqd3 pcosqd6 pcosq11 pcosq12 pcosq5 pcosqf3
pcosq8 pcosq9 pcosqd7 pcosq7 );

tf5f2=sum (of pcosqb3 pcosqb6 pcosqb2 pcosqb4 pcosqb1 pcosqb5 pcosqb8 pcosqd4);
tf5f3=sum (of pcosq6 pcosq10 pcosq4 pcosq1 pcosqf2 pcosqf1 pcosq2 pcosqb7 pcosq3
pcosqf5 pcosqf4 pcosqd8 pcosqf7 pcosqd9 pcosqd5 pcosqd5 );
tf5f4=sum (of pcosqe3 pcosqe1 pcosqe2 pcosqe5 pcosqe4 pcosqe6 );
tf5f5=sum (of pcosqc3 pcosqc7 pcosqc2 pcosqc6 pcosqc1 pcosqc5 );

tf5all= sum (of pcosqd1 pcosqd2 pcosqf6 pcosqd3 pcosqd6 pcosq11 pcosq12 pcosq5 pcosqf3
pcosq8 pcosq9 pcosqd7 pcosq7 pcosqb3 pcosqb6 pcosqb2 pcosqb4 pcosqb1 pcosqb5 pcosqb8 pcosqd4
pcosq6 pcosq10 pcosq4 pcosq1 pcosqf2 pcosqf1 pcosq2 pcosqb7 pcosq3
```

```
pcosqf5 pcosqf4 pcosqd8 pcosqf7 pcosqd9 pcosqd5 pcosqd5
pcosqe3 pcosqe1 pcosqe2 pcosqe5 pcosqe4 pcosqe6
pcosqc3 pcosqc7 pcosqc2 pcosqc6 pcosqc1 pcosqc5
);
```

```
tf6f1=sum (of pcosqd1 pcosqd2 pcosqf6 pcosqd3 pcosqd6 pcosq12 pcosq5 pcosqf3 pcosq8
pcosq9 pcosqd7 pcosq7 );
tf6f2=sum (of pcosq6 pcosqf1 pcosqf5 pcosqf4 pcosqd8 pcosq2 pcosq10 pcosq4 pcosq1
pcosqd9 pcosqb7 pcosqf2 pcosqd5 pcosqb9 pcosq3 pcosqf7);
tf6f3=sum (of pcosqe3 pcosqe1 pcosqe2 pcosqe4 pcosqe5 pcosqe6 );
tf6f4=sum (of pcosqb3 pcosqb6 pcosqb2 pcosqb4 pcosqb1 pcosqb5 pcosqb8 pcosqd4 );
tf6f5=sum (of pcosqc3 pcosqc7 pcosqc2 pcosqc6 pcosqc1 pcosqc5 pcosqc4);
tf6f6=sum (of pcosq11 pcosq5 pcosq8 );
tf6all = sum (of pcosqd1 pcosqd2 pcosqf6 pcosqd3 pcosqd6 pcosq12 pcosq5 pcosqf3 pcosq8
pcosq9 pcosqd7 pcosq7 pcosq6 pcosqf1 pcosqf5 pcosqf4 pcosqd8 pcosq2 pcosq10 pcosq4 pcosq1
pcosqd9 pcosqb7 pcosqf2 pcosqd5 pcosqb9 pcosq3 pcosqf7
pcosqe3 pcosqe1 pcosqe2 pcosqe4 pcosqe5 pcosqe6
pcosqb3 pcosqb6 pcosqb2 pcosqb4 pcosqb1 pcosqb5 pcosqb8 pcosqd4
pcosqc3 pcosqc7 pcosqc2 pcosqc6 pcosqc1 pcosqc5 pcosqc4 pcosq11);
```

```
tf7f1=sum (of pcosqd2 pcosqd1 pcosqd3 pcosqf6 pcosqd6 pcosqf3 pcosq12
pcosq5 pcosqd7 pcosq9 pcosq7 );
tf7f2=sum (of pcosqe3 pcosqe1 pcosqe2 pcosqe4 pcosqe5 pcosqe6);
tf7f3=sum (of pcosqb3 pcosqb6 pcosqb2 pcosqb4 pcosqb1 pcosqb5 pcosqb8 );
tf7f4=sum (of pcosqc3 pcosqc7 pcosqc2 pcosqc6 pcosqc1 pcosqc5 pcosqc4);
tf7f5=sum (of pcosqf1 pcosqd8 pcosqd9 pcosqf5 pcosqb7 pcosqf4 pcosqf2 pcosqd5
pcosqb9 pcosqd4 pcosqf7 );
tf7f6=sum (of pcosq1 pcosq2 pcosq6 pcosq10 pcosq4 );
tf7f7=sum (of pcosq11 pcosq8 );
```

```
label
tf4all =" Total for four factor"
tf5f1 ="Five factor / factor 1"
tf5f2 ="Five factor / factor 2"
tf5f3 ="Five factor / factor 3"
tf5f4 ="Five factor / factor 4"
tf5f5 ="Five factor / factor 5"
tf5all =" Total for five factor"
tf6f1 ="Six factor / factor 1"
tf6f2 ="Six factor / factor 2"
tf6f3 ="Six factor / factor 3"
tf6f4 ="Six factor / factor 4"
tf6f5 ="Six factor / factor 5"
tf6f6 ="Six factor / factor 6"
tf6all =" Total for six factor"
tf7f1 ="Seven factor / factor 1"
tf7f2 ="Seven factor / factor 2"
tf7f3 ="Seven factor / factor 3"
tf7f4 ="Seven factor / factor 4"
tf7f5 ="Seven factor / factor 5"
tf7f6 ="Seven factor / factor 6"
tf7f7 ="Seven factor / factor 7"
tf7all =" Total for seven factor";
```

Procedures:

Parallel analysis Macro⁹:

```
ods rtf; ods listing close;
```

```
%macro parallel(data=_LAST_, var=_NUMERIC_,
niter=1000, statistic=Median);%macro parallel(data=_LAST_, var=_NUMERIC_,
niter=1000, statistic=Median);
data _temp; set &data; keep &var; run;
```

```

/* obtain number of observations and variables in dataset */
ods output Attributes=Params;
ods listing close;
proc contents data=_temp ; run;
ods listing;

data _NULL_; set Params;
if Label2 eq 'Observations' then call
symput('Nobs',Trim(Left(nValue2)));
else if Label2 eq 'Variables' then call
symput('NVar',Trim(Left(nValue2))); run;

/* obtain eigenvalues for actual data */
proc factor data=_temp nfact=&nvar noprint
outstat=E1(where=(_TYPE_ = 'EIGENVAL'));
var &var; run; data E1; set E1; array A1{&nvar} &var;
array A2{&nvar} X1-X&nvar;
do J = 1 to &nvar; A2{J} = A1{J}; end;
keep X1-X&nvar; run;

/* generate simulated datasets and obtain eigenvalues */
%DO K = 1 %TO &niter;
data raw;
array X {&nvar} X1-X&nvar; keep X1-X&nvar;
do N = 1 to &nobs; do I = 1 to &nvar; X{I} = rannor(-1); end; output; end; run;
proc factor data=raw nfact=&nvar noprint
outstat=E(where=(_TYPE_ = 'EIGENVAL')); var X1-X&nvar;
proc append base=Eigen
data=E(keep=X1-X&nvar); run; %END;

/* summarize eigenvalues for simulated datasets */
proc means data=Eigen noprint;
var X1-X&nvar; output out=Simulated(keep=X1-X&nvar) &statistic=;
proc datasets nolist; delete Eigen;
proc transpose data=E1 out=E1; run;
proc transpose data=Simulated out=Simulated; run;

/* plot actual vs. simulated eigenvalues */
data plotdata; length Type $ 9; Position+1;
if Position eq (&nvar + 1) then Position = 1;
set E1(IN=A) Simulated(IN=B);
if A then Type = 'Actual'; if B then Type = 'Simulated';
rename Col1 = Eigenvalue; run;
title height=1.5 "Parallel Analysis - &statistic Simulated Eigenvalues";
title2 height=1 "&nvar Variables, &niter Iterations, &nobs Observations";
proc print data = plotdata ; run;
symbol1 interpol = join value=diamond height=1 line=1 color=blue;
symbol2 interpol = join value=circle height=1 line=3 color=red ;
proc gplot data = plotdata;
plot Eigenvalue * Position = Type; run;quit;
%mend parallel; run;
%parallel(data=two, var=pcosq1 - pcosq12 pcosqb1 - pcosqb9 pcosqc1 - pcosqc7
pcosqd1 - pcosqd9 pcosqe1 - pcosqe6 pcosqf1 - pcosqf7, niter=1000,
statistic=Median);
ods rtf close; ods listing; quit; run;

```

Other Procedures:

```
ods rtf; ods listing close;
```

```

%macro fact (q,n,t);
proc factor data=two rotate=promax scree reorder msa residual
parallel(alpha=0.01 nsims=10000 seed=20170229) map flag=.35 nfact=&n msa

```

```

plots=(parallel map);
var &q ;
title ' Parallel analysis ' &t;
%mend fact;
%fact (pcosq1 - pcosq12 pcosqb1 - pcosqb9 pcosqc1 - pcosqc7 pcosqd1 - pcosqd9
pcosqe1 - pcosqe6 pcosqf1 - pcosqf7,5,fivefactor score for perception );
%fact (pcosq1 - pcosq12 pcosqb1 - pcosqb9 pcosqc1 - pcosqc7 pcosqd1 - pcosqd9
pcosqe1 - pcosqe6 pcosqf1 - pcosqf7,6,six factor score for perception );
%fact (pcosq1 - pcosq12 pcosqb1 - pcosqb9 pcosqc1 - pcosqc7 pcosqd1 - pcosqd9
pcosqe1 - pcosqe6 pcosqf1 - pcosqf7,7,six factor score for perception );
run;
ods rtf close; ods listing; quit; run;

ods rtf; ods listing close;
%macro corr (q,t);

proc corr data=two pearson spearman ;
var &q;
TITLE1 'correlation'&t; run;
%mend corr;
%corr (two, tf7all tf7f1 tf7f2 tf7f3 tf7f4 tf7f5 tf7f6 tf7f7 , seven factor); run;
ods rtf close; ods listing; quit; run;

ods rtf; ods listing close;
%macro corr (d,q,t);

proc corr nocorr alpha nomiss data=&d;
var &q;
title ' Reliability coefficient'&t;
%mend corr;
%corr (two, pcosqd2 pcosqd1 pcosqd3 pcosqf6 pcosqd6 pcosqf3 pcosq12 pcosq5 pcosqd7 pcosq9 pcosq7 , all sample
fact1 for seven);
%corr (two, pcosqb3 pcosqb6 pcosqb2 pcosqb4 pcosqb1 pcosqb5 pcosqb8 pcosqd4 , all sample fact2 for seven);
%corr (two, pcosqb3 pcosqb6 pcosqb2 pcosqb4 pcosqb1 pcosqb5 pcosqb8 , all sample fact3 for seven);
%corr (two, pcosqc3 pcosqc7 pcosqc2 pcosqc6 pcosqc1 pcosqc5 pcosqc4 , all sample fact4 for seven);
%corr (two, pcosqf1 pcosqd8 pcosqd9 pcosqf5 pcosqb7 pcosqf4 pcosqf2 pcosqd5 pcosqb9 pcosqd4 pcosqf7 , all sample
fact5 for seven);
%corr (two, pcosq1 pcosq2 pcosq6 pcosq10 pcosq4 , all sample fact6 for seven);
%corr (two, pcosq11 pcosq8 , all sample fact7 for seven);
%corr (two, of pcosqd2 pcosqd1 pcosqd3 pcosqf6 pcosqd6 pcosqf3 pcosq12 pcosq5 pcosqd7 pcosq9 pcosq7 pcosqe3
pcosqe1 pcosqe2 pcosqe4 pcosqe5 pcosqe6 pcosqb3 pcosqb6 pcosqb2 pcosqb4 pcosqb1 pcosqb5 pcosqb8
pcosqc3 pcosqc7 pcosqc2 pcosqc6 pcosqc1 pcosqc5 pcosqc4 pcosqf1 pcosqd8 pcosqd9 pcosqf5 pcosqb7 pcosqf4
pcosqf2 pcosqd5 pcosqb9 pcosqd4 pcosqf7 pcosq1 pcosq2 pcosq6 pcosq10 pcosq4 pcosq11 pcosq8
, all sample total for seven);run;
ods rtf close; ods listing; quit; run;

```