

## **Online Supplement - Dyspnea-12 in asthma**

### **Methods for confirmatory factor analysis**

*Confirmatory factor analysis (CFA)*. CFA is used to examine the relationship hypothesized to exist between observed variables and their underlying latent constructs (i.e. factor structure). In this study, the latent constructs would be the physical and affective perceptions of dyspnea.<sup>1</sup> This is in contrast to exploratory factor analysis (EFA) which involves an “orderly simplification of interrelated measures” in which there is no preconceived or hypothesized structure of how the variables relate.<sup>1</sup> CFA requires an *a priori* specification of the model, and the analysis tests how well the data fit this model. It is recommended that 5-20 cases per variable (i.e., questionnaire item) be used to perform a CFA.

CFA involves a battery of tests to determine the adequacy of model fit to the data. Results may be discordant, but fit is considered acceptable if the majority of tests support adequate fit to the model. The statistics that are often used to determine model fit with CFA include the following: 1) chi-square—assesses the difference between observed and expected covariance matrices, and values close to zero indicate acceptable fit; 2) the Comparative Fit Index (CFI) is the same as the discrepancy function adjusted for sample size, and larger values (closer to one and  $\geq 0.90$ ) indicate acceptable fit; 3) Root Mean Square Error of Approximation (RMSEA) relates to the residual of the model, and smaller values (close to zero and  $< 0.06$ ) indicate acceptable fit; 4) Bentler and Bonnett’s Normed Fit Index (NFI)<sup>2</sup> tests the null hypothesis that the model is one in which all of the correlations or covariances are zero, and values  $\geq 0.90$  indicate acceptable fit; and 5) Bentler and Bonnett’s Non-normed index (NNI) touted to better reflect fit at all sample sizes, with values  $\geq 0.90$  indicating acceptable fit.<sup>2</sup> We used PROC CALIS in SAS version 9.1.3 (SAS Inc., Cary, NC) to test the hypothesized two-factor structure (items 1-7 would load on a factor describing the latent variable “physical perceptions of dyspnea,”; items 8-12 would load on a factor describing the latent variable “affective perceptions of dyspnea”).

## Results

i) *Manifest Variable Equations with Estimates.* Parameter estimates for the confirmatory factor model are significant at the 0.01 level if the t value exceeds 2.56.

Item1 = 0.7907 *F1	+ 1.0000 e1
Std Err 0.0828 p1,	t Value 9.5498
Item2 = 0.7740 *F1	+ 1.0000 e2
Std Err 0.0762 p2,	t Value 10.1513
Item3 = 0.8012 *F1	+ 1.0000 e3
Std Err 0.0750 p3,	t Value 10.6862
Item4 = 0.9333 *F1	+ 1.0000 e4
Std Err 0.0835 p4,	t Value 11.1745
Item5 = 0.8439 *F1	+ 1.0000 e5
Std Err 0.0799 p5,	t Value 10.5562
Item6 = 0.8439 *F1	+ 1.0000 e6
Std Err 0.0819 p6,	t Value 10.6422
Item7 = 0.9442 *F1	+ 1.0000 e7
Std Err 0.0898 p7,	t Value 10.5140
Item8 = 1.0473 *F2	+ 1.0000 e8
Std Err 0.0873 p8,	t Value 11.9996
Item9 = 1.0665 *F2	+ 1.0000 e9
Std Err 0.0877 p9,	t Value 12.1426
Item10 = 1.0406 *F2	+ 1.0000 e10
Std Err 0.0852 p10,	t Value 12.2118
Item11 = 1.0003 *F2	+ 1.0000 e11
Std Err 0.0815 p11,	t Value 12.2796
Item12 = 0.9061 *F2	+ 1.0000 e12
Std Err 0.0810 p12,	t Value 11.1919

**ii) Variances of Exogenous Variables**

Variable	Parameter	Standard Estimate	Error	t Value
F1		1.00000		
F2		1.00000		
F3		1.00000		
e1	vare1	0.35979	0.05531	6.505
e2	vare2	0.27185	0.04286	6.342
e3	vare3	0.23260	0.03784	6.148
e4	vare4	0.25265	0.04278	5.906
e5	vare5	0.27296	0.04402	6.200
e6	vare6	0.28040	0.04548	6.166
e7	vare7	0.34794	0.05597	6.217
e8	vare8	0.21079	0.03635	5.798
e9	vare9	0.20007	0.03523	5.678
e10	vare10	0.18267	0.03254	5.614
e11	vare11	0.16154	0.02913	5.546
e12	vare12	0.24125	0.03856	6.257

Variances are all significant at the 0.01 level.

**iii) Covariances Among Exogenous Variables**

Var1	Var2	Parameter	Standard Estimate	Error	t Value
F1	F2	covf1f2	0.86736	0.02962	29.28

Covariance between latent constructs is significant at the 0.01 level.

**iv. Correlations Among Exogenous Variables**

Var1	Var2	Parameter	Estimate
F1	F2	covf1f2	0.86759

**v. Fit Statistics**

Chi-Square = 84.8381

Chi-Square DF = 53

Pr > Chi-Square = 0.0036

RMSEA Estimate = 0.0771

Bentler Comparative Fit Index (CFI) = 0.9759

Bentler-Bonett NFI = 0.9387

Bentler-Bonett Non-normed Index (NNI) = 0.9699

**References**

1. Suhr D. Exploratory or Confirmatory Factor Analysis? *SAS Users Group International Conference* Vol 31. San Francisco: SAS User's Group; 2006:Paper #200
2. Bentler PM. Comparative fit indexes in structural models. *Psychol Bull.* Mar 1990;107(2):238-246.