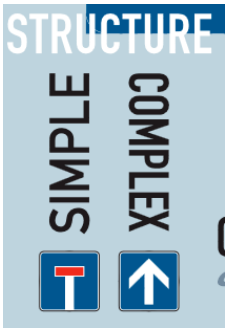

Study 6

Factorizing Anthropometric Measures of Women.

Source:

Vandenberg, S. G. (1968). A factor analysis of garment measures of Dutch women. *Human Biology, 40*, 295-313.

Aim of Vandenberg's study:

The author's main intention was to evaluate results of three rotation methods after centroid factorizing 15 anthropometric variables of women. The purpose of the selected rotation models is to achieve an optimal factorial simple structure.

Method:

Body features of 5001 Dutch women were measured for the garment industry. Eighteen specially trained students collected the data.		
1 Weight	6 Front length, from cervical to waist	11 Fist circumference with thumb inside
2 Stature	7 Length of back, cervical to waist	12 Length of middle finger
3 Maximum chest girth	8 Width of back, between armpits	13 Knee height
4 Minimum waist girth	9 Sleeve length across outside of bent arms	14 Foot length
5 Maximum hip girth	10 Hand circumference, across the four fingers	15 Foot width

Procedure of data analysis:

Centroid factors were rotated by Quartimax (Wrigley & Neuhaus, 1954), Varimax (Kaiser, 1958), and Oblimax (Saunders, 1961). An arbitrary criterion of loadings was used for each method to decide how many factors were rotated: Quartimax 4 factors, Varimax 5 factors, Oblimax 3 factors. Since the factors of different rotation methods showed much resemblance, the author‘s interpretation of the factors did not differ much from each other.

Table 1

Input for factor analysis:

```
 1
 .212   1
 .870 -.077   1
 .837 -.156  .906   1
 .913 -.011  .853  .881   1
 .001  .258  .567  .453 .458   1
 .220  .517  .064  .028 .097 .311   1
 .676  .058  .692  .647 .629 .436 .196   1
 .271  .714  .082  .031 .118 .271 .363 .135   1
 .495  .229  .401  .408 .411 .338 .171 .341 .311   1
 .467  .242  .362  .377 .374 .316 .200 .302 .310 .701   1
 .267  .506  .116  .098 .144 .229 .278 .172 .484 .458 .440   1
 .185  .732 -.012 -.042 .028 .241 .344 .052 .627 .202 .200 .409   1
 .360  .645  .154  .139 .227 .299 .339 .193 .567 .419 .391 .581 .573   1
 .395  .238  .284  .302 .339 .249 .173 .245 .238 .452 .412 .329 .257 .445  1
```

For names of variables, see Tables 2 and 3 (note: variables are renumbered).

Eigenvalues:

5.89 3.34 1.21 0.99 0.73 0.69 …

Varimax results

Table 2

Varimax-rotated loadings of PCA factors (original numbers):

No.	F1 Body Girth	F2 Body Height	F3 Extremi-ties	Variables
1	**.82**	.13	.34	Weight
3	**.96**	-.02	.10	Max. chest girth
4	**.96**	-.10	.16	Min. waist girth
5	**.92**	.02	.17	Max. hip girth
10	.36	.17	**.76**	Hand circumference
11	.32	.18	**.74**	Fist circumference
8	**.80**	.13	.03	Width of back
15	.26	.21	**.60**	Foot width,
12	.05	**.52**	**.56**	Middle finger length
6	**.53**	.41	-.06	Front length
14	.13	**.68**	**.44**	Foot length
9	.06	**.79**	.21	Sleeve length
13	-.03	**.81**	.12	Knee height
7	.16	**.66**	-.10	Length of back
2	-.07	**.91**	.14	Stature (height)
%	30.6	24.0	15.0	Sum: 69.6

Varimax factor interpretation:

F1 Body girth (circumference, width) seems to be the best interpretation even though a large F1 factor loading of variable 6 (front length) remains unintelligible . Vandenberg's Varimax F1 loadings are essentially the same. He termed F1 `weight' factor and claimed similarity with Kretschmer's pyknic body type and Sheldon's endomorphic type.

F2 loadings are restricted to variables denoting lengths of body parts without exception. Vandenberg's F2 'is one of linearity or length.' For this author, it resembles Kretschmer's "leptosome type and Sheldon's endomorphics."

We find large F3 loadings for hand, finger, fist, and foot; therefore, the `extension of extremities' appears to be an appropriate interpretation. However, F3 weight =.34 (body weight) does not fit. Vandenberg's interpretation of his F3 result is essentially the same: "We might call this a hand and foot factor".

Criticism:

The clustering of variables by Varimax and other simple structure factors is not unintelligible even though the loadings of some individual variables remain obscure. However, an all-inclusive unidimensional `volume' factor is lacking that is revealed by Varimin's rotation of these factors (see below). In addition, Varimax factors are unipolar without exception, while bipolarity would facilitate their interpretation as contributors to common variance.

Varimin results

Table 3

Varimin loadings (original numbers:

No.	F1 Body Volume	Body form: Slender vs. Corpulent	F3 Size of Trunk vs. Length of Extremities	Variables
1	.74	-.46	-.24	Weight
3	.65	-.46	-.55	Max. chest girth
4	.59	-.55	-.51	Min. waist girth
5	.67	-.47	-.46	Max. hip girth
10	.59	-.49	.36	Hand circumference
11	.57	-.46	.38	Fist circumference
8	.62	-.25	-.45	Width of back
15	.51	-.33	.32	Foot width
12	.57	-.01	.52	Middle finger length
6	.61	.10	-.27	Front length
14	.69	.14	.42	Foot length
9	.65	.38	.33	Sleeve length
13	.58	.49	.32	Knee height
7	.52	.44	.01	Length of back
2	.62	.56	.39	Stature (height)
%	36.0	17.7	16.4	Sum: 69.6

Interpretation of Varimin factors:

F1 is the result of variance of 'volume' (or mass, unspecified three-dimensionally). The best volume indicator is 'weight,' and the least appropriate one is 'foot width,' which is plausible. Volume is a most general factor. Its variance would increase by including non-adult boys and girls in the sample. The age of Vandenberg's youngest woman was 18, and the median age of his sample was roughly 45.

F2 is a bipolar factor indicating variance of human body forms whose polar designations tend to vary between 'slender' and 'corpulent' (or 'thin' vs. 'thick' or 'meager' vs. `fat'). With the addition of some length to a person's body, the person's `slenderness' would increase, while adding some 'girth' ('circumference') to it would increase the person's ' corpulence.'

F3 is another bipolar factor, apparently separating variables that represent measures of body trunk (chest, hip, back) and limbs (hand, fist, finger, foot, sleeve, knee (leg). This can be understood as a distinction of locations of body parts varying between `central' or 'middle' and `appended' parts whose growth seems to be independent to some extent.

Evaluation:

An interpretation of Varimin factors of body measurement is considerably more satisfactory than an interpretation of Varimax or other simple structure factors. The distinction between F1 and F2 is essentially a distinction between mass and form. **Varimax** etc. rotations do not uncover general and partitioning dimensions. Another deficit of simple structure factors is that actual bipolar structures of dimensions are forced to submit themselves to inadequate unipolar models.

Table 4

Minimal pairs:

	Bold numbers represent loadings of pairs of variables for a focal factor. Non-bold numbers are loadings of paired variables for non-focal factors			
Var. No.	F1 Body Volume	F2 Body Form: Slender vs. Corpulent	F3 Measures of Trunk vs. Extremities	
4	.59	-.55	-.51	Min. chest girth
2	.62	.56	.39	Stature (height)
10	.59	-.49	.36	Hand circumference
13	.58	.49	.32	Knee height
3	.65	-.46	-.24	Max. chest girth
12	.57	-.01	.52	Middle finger length
4	.59	-.55	-.51	Min. chest girth
14	.69	.14	.42	Foot length

Comment:

Interpretations of Varimin factors *may* be improved by forming contrastive minimal pairs among variables of one's sample.