Métodos Multivariados de Análise de Dados*

5ª Atividade

Alberson da Silva Miranda

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*Código disponível em https://github.com/albersonmiranda/analise_multivariada.

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1 CASE 1

```r
# importação do dataset
dados <- haven::read_dta("data-raw/pca/factor_whistleblowing.dta") |>
  subset(select = -id)
```

Com os dados carregados, primeiro verificamos a estrutura de correlação. Cada grupo de variáveis possui alta correlação entre si (LC, PSM e PI). Já entre elas, LC demonstra correlação negativa com PSM e PSM positiva com PI, mas nenhuma delas acima de 30%.

```r
# matriz de correlação
corrplot::corrplot(
  cor(dados),
  type = "upper",
  order = "hclust",
  tl.col = "black",
  tl.srt = 45
)
```

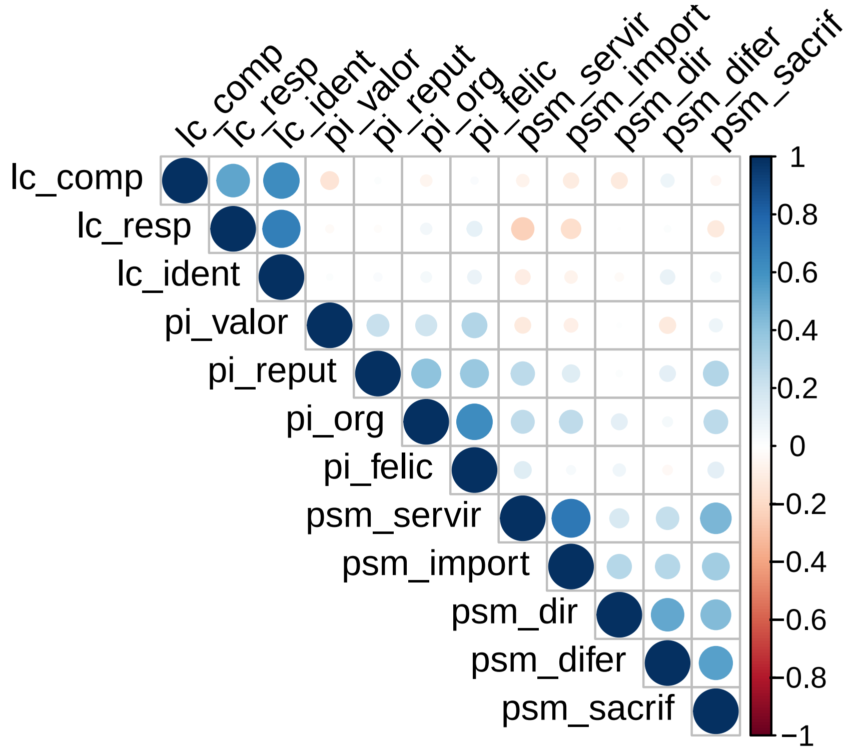

Figura 1.1: Matriz de correlação.

O segundo passo é verificar a adequação dos dados para a análise fatorial. Para isso, utilizamos o teste de esfericidade de Bartlett e o teste de Kaiser-Meyer-Olkin. O teste de Bartlett testa a hipótese nula de que a matriz de correlação é uma matriz identidade, ou seja, que não há covariância significativa entre as variáveis, enquanto o teste de KMO indica se os dados são adequados para a análise fatorial.

```r
# Teste de esfericidade de Bartlett
psych::cortest.bartlett(cor(dados), n = nrow(dados))
```

```
$chisq
[1] 505.5386

$p.value
[1] 5.613043e-69

$df
[1] 66
```

```r
# Teste de Kaiser-Meyer-Olkin
psych::KMO(dados)
```

```
Kaiser-Meyer-Olkin factor adequacy
Call: psych::KMO(r = dados)
Overall MSA =  0.65
MSA for each item = 
   lc_comp    lc_resp   lc_ident   pi_valor     pi_org   pi_felic   pi_reput 
      0.72       0.68       0.63       0.57       0.65       0.60       0.78 
psm_servir psm_import  psm_difer psm_sacrif    psm_dir 
      0.61       0.61       0.68       0.69       0.65 
```

Com p-valor de 0, podemos rejeitar a hipótese nula de que a matriz de correlação é uma matriz identidade. O teste de KMO, por sua vez, indica que os dados são adequados para a análise fatorial, com valor de 0,65, apesar de não muito promissores, segundo a escala dos autores do teste.

A seguir, vamos repetir o teste para cada grupo de variáveis. Para o primeiro grupo, LC, temos adequação para a análise fatorial. O Alpha de Cronbach de 0.69 indica uma consistência interna no limite do aceitável.

```r
# testes fator LC
lc <- dados[, 1:3]

# Teste de esfericidade de Bartlett
psych::cortest.bartlett(cor(lc), n = nrow(lc))
```

```
$chisq
[1] 139.2148

$p.value
[1] 5.581589e-30

$df
[1] 3
```

```r
# Teste de Kaiser-Meyer-Olkin
psych::KMO(lc)
```

```
Kaiser-Meyer-Olkin factor adequacy
Call: psych::KMO(r = lc)
```

```
Overall MSA =  0.69
MSA for each item =
 lc_comp  lc_resp lc_ident 
    0.76     0.70     0.64 
```

```r
# alpha de Cronbach
psych::alpha(lc)
```

```
Reliability analysis   
Call: psych::alpha(x = lc)

  raw_alpha std.alpha G6(smc) average_r S/N   ase mean  sd median_r
      0.82      0.82    0.77      0.61 4.7 0.028  2.8 1.3     0.62

    95% confidence boundaries 
         lower alpha upper
Feldt     0.76  0.82  0.87
Duhachek  0.77  0.82  0.88

 Reliability if an item is dropped:
         raw_alpha std.alpha G6(smc) average_r S/N alpha se var.r med.r
lc_comp       0.81      0.81    0.68      0.68 4.3    0.034    NA  0.68
lc_resp       0.76      0.77    0.62      0.62 3.3    0.042    NA  0.62
lc_ident      0.68      0.69    0.52      0.52 2.2    0.056    NA  0.52

 Item statistics 
           n raw.r std.r r.cor r.drop mean  sd
lc_comp  124  0.84  0.83  0.68   0.62  2.6 1.6
lc_resp  124  0.85  0.86  0.75   0.67  2.9 1.5
lc_ident 124  0.89  0.89  0.83   0.75  2.8 1.5

Non missing response frequency for each item
            0    1    2    3    4    5 miss
lc_comp  0.17 0.07 0.19 0.29 0.15 0.13    0
lc_resp  0.10 0.09 0.10 0.34 0.23 0.15    0
lc_ident 0.12 0.07 0.14 0.38 0.17 0.12    0
```

```r
# Análise fatorial
fa_lc <- psych::principal(lc, nfactors = 1, rotate = "none")
fa_lc
```

```
Principal Components Analysis
Call: psych::principal(r = lc, nfactors = 1, rotate = "none")
Standardized loadings (pattern matrix) based upon correlation matrix
          PC1   h2   u2 com
lc_comp  0.82 0.68 0.32   1
lc_resp  0.86 0.73 0.27   1
lc_ident 0.90 0.81 0.19   1

                PC1
SS loadings    2.22
Proportion Var 0.74

Mean item complexity =  1
Test of the hypothesis that 1 component is sufficient.

The root mean square of the residuals (RMSR) is  0.14
 with the empirical chi square  13.74  with prob <  NA

Fit based upon off diagonal values = 0.95
```

Para os demais grupos a interpretação segue bem semlhante ao primeiro. Para PI, temos:

```
# testes fator PI
dados_pi <- dados[, 4:7]

# Teste de esfericidade de Bartlett
psych::cortest.bartlett(cor(dados_pi), n = nrow(dados_pi))
```

```
$chisq
[1] 97.87511

$p.value
[1] 6.961261e-19

$df
[1] 6
```

```
# Teste de Kaiser-Meyer-Olkin
psych::KMO(dados_pi)
```

```
Kaiser-Meyer-Olkin factor adequacy
```

```
Call: psych::KMO(r = dados_pi)
Overall MSA =  0.67
MSA for each item =
pi_valor   pi_org pi_felic pi_reput
    0.77     0.63     0.64     0.79
```

```
# Alpha de Cronbach
psych::alpha(dados_pi)
```

```
Reliability analysis
Call: psych::alpha(x = dados_pi)

  raw_alpha std.alpha G6(smc) average_r S/N   ase mean  sd median_r
      0.69      0.69    0.66      0.36 2.2 0.045  4.4 0.6     0.34

    95% confidence boundaries
         lower alpha upper
Feldt     0.58  0.69  0.77
Duhachek  0.60  0.69  0.77

 Reliability if an item is dropped:
         raw_alpha std.alpha G6(smc) average_r S/N alpha se  var.r med.r
pi_valor      0.73      0.73    0.66      0.47 2.7    0.039 0.0176  0.41
pi_org        0.55      0.56    0.47      0.30 1.3    0.068 0.0057  0.29
pi_felic      0.52      0.54    0.45      0.28 1.2    0.074 0.0124  0.23
pi_reput      0.65      0.64    0.60      0.37 1.8    0.056 0.0477  0.29

 Item statistics
           n raw.r std.r r.cor r.drop mean   sd
pi_valor 124  0.62  0.60  0.36   0.30  4.3 0.88
pi_org   124  0.79  0.78  0.71   0.57  4.5 0.87
pi_felic 124  0.82  0.80  0.74   0.60  4.3 0.94
pi_reput 124  0.64  0.70  0.52   0.44  4.7 0.64

Non missing response frequency for each item
            1    2    3    4    5 miss
pi_valor 0.01 0.03 0.14 0.31 0.51    0
pi_org   0.01 0.03 0.10 0.16 0.69    0
pi_felic 0.01 0.05 0.14 0.23 0.57    0
pi_reput 0.00 0.02 0.05 0.16 0.77    0
```

```r
# Análise fatorial
fa_pi <- psych::principal(dados_pi, nfactors = 1, rotate = "none")
fa_pi
```

```
Principal Components Analysis
Call: psych::principal(r = dados_pi, nfactors = 1, rotate = "none")
Standardized loadings (pattern matrix) based upon correlation matrix
          PC1   h2   u2 com
pi_valor 0.52 0.27 0.73   1
pi_org   0.82 0.67 0.33   1
pi_felic 0.83 0.69 0.31   1
pi_reput 0.69 0.48 0.52   1

                PC1
SS loadings    2.11
Proportion Var 0.53

Mean item complexity =  1
Test of the hypothesis that 1 component is sufficient.

The root mean square of the residuals (RMSR) is  0.16
 with the empirical chi square  36.97  with prob <  9.4e-09

Fit based upon off diagonal values = 0.83
```

E, por fim, para o terceiro grupo, PSM, temos:

```r
# testes fator PSM
dados_psm <- dados[, 8:12]

# Teste de esfericidade de Bartlett
psych::cortest.bartlett(cor(dados_psm), n = nrow(dados_psm))
```

```
$chisq
[1] 206.6318

$p.value
[1] 6.666691e-39

$df
[1] 10
```

```r
# Teste de Kaiser-Meyer-Olkin
psych::KMO(dados_psm)
```

```
Kaiser-Meyer-Olkin factor adequacy
Call: psych::KMO(r = dados_psm)
Overall MSA =  0.65
MSA for each item =
psm_servir psm_import  psm_difer psm_sacrif    psm_dir
      0.57       0.60       0.72       0.71       0.71
```

```r
# Alpha de Cronbach
psych::alpha(dados_psm)
```

```
Reliability analysis
Call: psych::alpha(x = dados_psm)

  raw_alpha std.alpha G6(smc) average_r S/N   ase mean   sd median_r
      0.77      0.77    0.79       0.4 3.3 0.034  3.6 0.89     0.39

    95% confidence boundaries
         lower alpha upper
Feldt     0.69  0.77  0.83
Duhachek  0.70  0.77  0.83

 Reliability if an item is dropped:
           raw_alpha std.alpha G6(smc) average_r S/N alpha se var.r med.r
psm_servir      0.73      0.73    0.68      0.40 2.7    0.040 0.013  0.39
psm_import      0.72      0.72    0.69      0.39 2.6    0.041 0.023  0.44
psm_difer       0.73      0.73    0.74      0.40 2.7    0.041 0.034  0.39
psm_sacrif      0.70      0.70    0.72      0.37 2.3    0.046 0.042  0.28
psm_dir         0.75      0.75    0.76      0.43 3.0    0.039 0.032  0.40

 Item statistics
             n raw.r std.r r.cor r.drop mean  sd
psm_servir 124  0.71  0.72  0.67   0.52  4.1 1.2
psm_import 124  0.72  0.73  0.68   0.55  4.1 1.2
psm_difer  124  0.73  0.72  0.62   0.53  3.1 1.4
psm_sacrif 124  0.77  0.77  0.69   0.62  3.3 1.2
psm_dir    124  0.67  0.67  0.54   0.47  3.4 1.2
```

```
Non missing response frequency for each item
              0    1    2    3    4    5 miss
psm_servir 0.02 0.03 0.09 0.08 0.25 0.53    0
psm_import 0.01 0.03 0.10 0.10 0.21 0.55    0
psm_difer  0.06 0.08 0.10 0.39 0.20 0.18    0
psm_sacrif 0.02 0.04 0.14 0.38 0.25 0.17    0
psm_dir    0.02 0.06 0.10 0.35 0.27 0.21    0
```

```r
# Análise fatorial
fa_psm <- psych::principal(dados_psm, nfactors = 1, rotate = "none")
fa_psm
```

```
Principal Components Analysis
Call: psych::principal(r = dados_psm, nfactors = 1, rotate = "none")
Standardized loadings (pattern matrix) based upon correlation matrix
            PC1   h2   u2 com
psm_servir 0.73 0.53 0.47   1
psm_import 0.73 0.54 0.46   1
psm_difer  0.71 0.51 0.49   1
psm_sacrif 0.78 0.61 0.39   1
psm_dir    0.65 0.42 0.58   1

                PC1
SS loadings    2.60
Proportion Var 0.52

Mean item complexity =  1
Test of the hypothesis that 1 component is sufficient.

The root mean square of the residuals (RMSR) is  0.19
 with the empirical chi square  90.73  with prob <  4.7e-18

Fit based upon off diagonal values = 0.8
```

A partir daqui, ajustaríamos um modelo para a análise fatorial confirmatória (CFA) e testaríamos hipóteses (possivelmente utilizando o pacote {lavaan} e a função `lavaan::cfa()`). No entanto, não localizei instruções ou código nos exemplos fornecidos.

2 CASE 2

```r
# importação do dataset
dados <- haven::read_dta("data-raw/pca/FamilyWorkConflict.dta") |>
  subset(select = -ID)
```

Primeiramente, vamos reverter as respostas que estão invertidas.

```r
# reverter as respostas das colunas que terminam com "R"
dados <- dados |>
  dplyr::mutate(across(ends_with("R"), ~ 6 - .))
```

Com os dados corrigidos, vamos verificar a estrutura de correlação. O padrão que aparece no gráfico sugere *clusters* de variáveis correlacionadas, o que pode se rum indicativo para adequação da aálise fatorial.

```r
# matriz de correlação
corrplot::corrplot(
  cor(dados),
  type = "upper",
  order = "hclust",
  tl.col = "black",
  tl.srt = 45
)
```

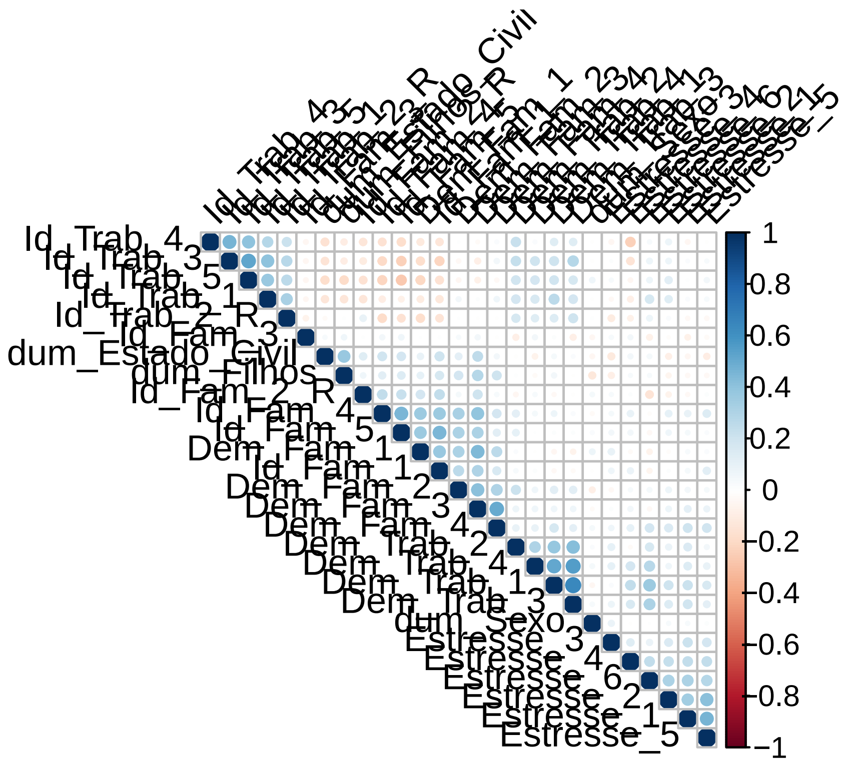

Figura 2.1: Matriz de correlação.

Em seguida, vamos verificar a adequação dos dados para a análise fatorial. O teste de Bartlett e o teste de KMO indicam que os dados são adequados para a análise fatorial.

```r
# Teste de esfericidade de Bartlett
psych::cortest.bartlett(cor(dados), n = nrow(dados))
```

```
$chisq
[1] 2623.652

$p.value
[1] 0

$df
[1] 351
```

```r
# Teste de Kaiser-Meyer-Olkin
psych::KMO(dados)
```

```
Kaiser-Meyer-Olkin factor adequacy
Call: psych::KMO(r = dados)
Overall MSA =  0.79
MSA for each item =
       Dem_Fam_1        Dem_Fam_2        Dem_Fam_3        Dem_Fam_4
            0.84             0.85             0.73             0.72
      Dem_Trab_1       Dem_Trab_2       Dem_Trab_3       Dem_Trab_4
            0.78             0.83             0.77             0.80
        Id_Fam_1       Id_Fam_2_R         Id_Fam_3         Id_Fam_4
            0.83             0.71             0.47             0.86
        Id_Fam_5        Id_Trab_1      Id_Trab_2_R        Id_Trab_3
            0.83             0.79             0.75             0.79
       Id_Trab_4        Id_Trab_5      Estresse_1       Estresse_2
            0.81             0.80             0.81             0.80
      Estresse_3       Estresse_4      Estresse_5       Estresse_6
            0.71             0.78             0.75             0.81
dum_Estado_Civil         dum_Sexo       dum_Filhos
            0.70             0.43             0.73
```

Com p-valor de 0, podemos rejeitar a hipótese nula de que a matriz de correlação é uma matriz identidade. O teste de KMO, por sua vez, indica que os dados são adequados para a análise fatorial, com valor de 0,79, segundo a escala dos autores do teste.

A seguir, vamos repetir o teste para cada grupo de variáveis. Para o primeiro grupo, demandas família, temos adequação para a análise fatorial. O Alpha de Cronbach de 0.7 indica uma consistência interna aceitável.

```r
# testes fator demandas família
dem_fam <- dados[, 1:4]

# Teste de esfericidade de Bartlett
psych::cortest.bartlett(cor(dem_fam), n = nrow(dem_fam))
```

```
$chisq
[1] 298.75

$p.value
[1] 1.515665e-61

$df
[1] 6
```

```r
# Teste de Kaiser-Meyer-Olkin
psych::KMO(dem_fam)
```

```
Kaiser-Meyer-Olkin factor adequacy
Call: psych::KMO(r = dem_fam)
Overall MSA =  0.71
MSA for each item = 
Dem_Fam_1 Dem_Fam_2 Dem_Fam_3 Dem_Fam_4 
     0.74      0.79      0.65      0.70 
```

```r
# Alpha de Cronbach
psych::alpha(dem_fam)
```

```
Reliability analysis   
Call: psych::alpha(x = dem_fam)

  raw_alpha std.alpha G6(smc) average_r S/N   ase mean   sd median_r
       0.7      0.71    0.66      0.37 2.4 0.024  3.5 0.86     0.36

    95% confidence boundaries 
         lower alpha upper
Feldt     0.65   0.7  0.75
Duhachek  0.66   0.7  0.75

 Reliability if an item is dropped:
          raw_alpha std.alpha G6(smc) average_r S/N alpha se   var.r med.r
Dem_Fam_1      0.67      0.68    0.60      0.41 2.1    0.029 0.01010  0.42
Dem_Fam_2      0.67      0.67    0.60      0.40 2.0    0.028 0.01678  0.44
Dem_Fam_3      0.55      0.55    0.45      0.29 1.2    0.038 0.00082  0.31
Dem_Fam_4      0.65      0.66    0.57      0.39 1.9    0.030 0.00500  0.42

 Item statistics 
            n raw.r std.r r.cor r.drop mean  sd
Dem_Fam_1 401  0.65  0.69  0.52   0.43  4.0 1.0
Dem_Fam_2 401  0.72  0.70  0.52   0.44  3.2 1.3
Dem_Fam_3 401  0.81  0.81  0.75   0.63  3.6 1.2
Dem_Fam_4 401  0.73  0.71  0.57   0.47  3.2 1.2

Non missing response frequency for each item
             1    2    3    4    5 miss
```

```
Dem_Fam_1 0.01 0.10 0.11 0.43 0.34    0
Dem_Fam_2 0.10 0.27 0.14 0.31 0.17    0
Dem_Fam_3 0.04 0.17 0.18 0.33 0.28    0
Dem_Fam_4 0.08 0.26 0.21 0.27 0.17    0
```

```r
# Análise fatorial
fa_dem_fam <- psych::principal(dem_fam, nfactors = 1, rotate = "none")
fa_dem_fam
```

```
Principal Components Analysis
Call: psych::principal(r = dem_fam, nfactors = 1, rotate = "none")
Standardized loadings (pattern matrix) based upon correlation matrix
           PC1   h2   u2 com
Dem_Fam_1 0.68 0.46 0.54   1
Dem_Fam_2 0.68 0.47 0.53   1
Dem_Fam_3 0.84 0.70 0.30   1
Dem_Fam_4 0.72 0.51 0.49   1

                PC1
SS loadings    2.14
Proportion Var 0.53

Mean item complexity =  1
Test of the hypothesis that 1 component is sufficient.

The root mean square of the residuals (RMSR) is  0.16
 with the empirical chi square  123.04  with prob <  1.9e-27

Fit based upon off diagonal values = 0.83
```

Para os demais grupos a interpretação segue bem semlhante ao primeiro. Para demandas trabalho, temos:

```r
# testes fator demandas trabalho
dem_trab <- dados[, 5:8]

# Teste de esfericidade de Bartlett
psych::cortest.bartlett(cor(dem_trab), n = nrow(dem_trab))
```

```
$chisq
[1] 475.8463
```

```
$p.value
[1] 1.338995e-99

$df
[1] 6
```

```r
# Teste de Kaiser-Meyer-Olkin
psych::KMO(dem_trab)
```

```
Kaiser-Meyer-Olkin factor adequacy
Call: psych::KMO(r = dem_trab)
Overall MSA =  0.76
MSA for each item =
Dem_Trab_1 Dem_Trab_2 Dem_Trab_3 Dem_Trab_4
      0.74       0.86       0.71       0.80
```

```r
# Alpha de Cronbach
psych::alpha(dem_trab)
```

```
Reliability analysis
Call: psych::alpha(x = dem_trab)

  raw_alpha std.alpha G6(smc) average_r S/N   ase mean   sd median_r
      0.78      0.78    0.74      0.47 3.5 0.018  3.8 0.87     0.47

    95% confidence boundaries
         lower alpha upper
Feldt     0.74  0.78  0.81
Duhachek  0.75  0.78  0.82

 Reliability if an item is dropped:
           raw_alpha std.alpha G6(smc) average_r S/N alpha se  var.r med.r
Dem_Trab_1      0.69      0.69    0.62      0.43 2.2    0.027 0.0164  0.42
Dem_Trab_2      0.80      0.80    0.73      0.57 4.0    0.017 0.0047  0.56
Dem_Trab_3      0.67      0.67    0.58      0.40 2.0    0.028 0.0112  0.38
Dem_Trab_4      0.74      0.74    0.68      0.48 2.8    0.023 0.0204  0.42

 Item statistics
             n raw.r std.r r.cor r.drop mean  sd
```

```
Dem_Trab_1 401  0.83  0.82  0.75   0.65  3.6 1.2
Dem_Trab_2 401  0.67  0.68  0.49   0.44  3.8 1.1
Dem_Trab_3 401  0.84  0.85  0.80   0.70  3.8 1.1
Dem_Trab_4 401  0.76  0.76  0.64   0.57  3.8 1.1

Non missing response frequency for each item
              1    2    3    4    5 miss
Dem_Trab_1 0.06 0.15 0.18 0.33 0.27    0
Dem_Trab_2 0.03 0.13 0.11 0.45 0.28    0
Dem_Trab_3 0.03 0.11 0.15 0.40 0.30    0
Dem_Trab_4 0.03 0.11 0.17 0.37 0.31    0
```

```r
# Análise fatorial
fa_dem_trab <- psych::principal(dem_trab, nfactors = 1, rotate = "none")
fa_dem_trab
```

```
Principal Components Analysis
Call: psych::principal(r = dem_trab, nfactors = 1, rotate = "none")
Standardized loadings (pattern matrix) based upon correlation matrix
            PC1   h2   u2 com
Dem_Trab_1 0.83 0.69 0.31   1
Dem_Trab_2 0.64 0.41 0.59   1
Dem_Trab_3 0.86 0.74 0.26   1
Dem_Trab_4 0.77 0.59 0.41   1

                PC1
SS loadings    2.43
Proportion Var 0.61

Mean item complexity =  1
Test of the hypothesis that 1 component is sufficient.

The root mean square of the residuals (RMSR) is  0.13
 with the empirical chi square  85.04  with prob <  3.4e-19

Fit based upon off diagonal values = 0.92
```

Para identificação com família, temos:

```r
# testes fator identificação com família
id_fam <- dados[, 9:13]
```

```r
# Teste de esfericidade de Bartlett
psych::cortest.bartlett(cor(id_fam), n = nrow(id_fam))
```

```
$chisq
[1] 243.2448

$p.value
[1] 1.42663e-46

$df
[1] 10
```

```r
# Teste de Kaiser-Meyer-Olkin
psych::KMO(id_fam)
```

```
Kaiser-Meyer-Olkin factor adequacy
Call: psych::KMO(r = id_fam)
Overall MSA =  0.7
MSA for each item = 
  Id_Fam_1 Id_Fam_2_R   Id_Fam_3   Id_Fam_4   Id_Fam_5 
      0.71       0.80       0.58       0.71       0.67 
```

```r
# Alpha de Cronbach
psych::alpha(id_fam)
```

```
Reliability analysis   
Call: psych::alpha(x = id_fam)

  raw_alpha std.alpha G6(smc) average_r S/N     ase mean   sd median_r
   7.1e-05      0.57    0.56      0.21 1.3 7.5e-05   54 999     0.23

    95% confidence boundaries 
         lower alpha upper
Feldt    -0.16     0  0.15
Duhachek  0.00     0  0.00

 Reliability if an item is dropped:
           raw_alpha std.alpha G6(smc) average_r  S/N alpha se var.r med.r
```

```
Id_Fam_1     7.3e-05      0.46    0.43      0.18 0.85  6.4e-05 0.028  0.14
Id_Fam_2_R   7.3e-05      0.55    0.53      0.23 1.23  6.4e-05 0.045  0.22
Id_Fam_3     6.6e-01      0.67    0.61      0.33 1.99  2.8e-02 0.012  0.31
Id_Fam_4     4.4e-05      0.45    0.42      0.17 0.80  6.3e-05 0.031  0.14
Id_Fam_5     3.8e-05      0.42    0.39      0.15 0.73  6.2e-05 0.023  0.15

 Item statistics
             n  raw.r std.r r.cor r.drop  mean      sd
Id_Fam_1   401 0.0065  0.68 0.585 0.0063   3.9    0.98
Id_Fam_2_R 401 0.0052  0.56 0.356 0.0050   3.9    1.20
Id_Fam_3   401 1.0000  0.37 0.063 0.0473 253.0 4993.58
Id_Fam_4   401 0.0592  0.70 0.606 0.0590   3.8    1.02
Id_Fam_5   401 0.0664  0.72 0.665 0.0662   3.6    1.07

Non missing response frequency for each item
              1    2    3    4    5 miss
Id_Fam_1   0.01 0.11 0.15 0.44 0.29    0
Id_Fam_2_R 0.03 0.18 0.07 0.32 0.40    0
Id_Fam_4   0.02 0.11 0.17 0.43 0.27    0
Id_Fam_5   0.03 0.17 0.17 0.43 0.19    0
```

```r
# Análise fatorial
fa_id_fam <- psych::principal(id_fam, nfactors = 1, rotate = "none")
fa_id_fam
```

```
Principal Components Analysis
Call: psych::principal(r = id_fam, nfactors = 1, rotate = "none")
Standardized loadings (pattern matrix) based upon correlation matrix
            PC1   h2   u2 com
Id_Fam_1   0.75 0.56 0.44   1
Id_Fam_2_R 0.53 0.28 0.72   1
Id_Fam_3   0.10 0.01 0.99   1
Id_Fam_4   0.75 0.56 0.44   1
Id_Fam_5   0.79 0.62 0.38   1

                PC1
SS loadings    2.02
Proportion Var 0.40

Mean item complexity =  1
Test of the hypothesis that 1 component is sufficient.
```

```
The root mean square of the residuals (RMSR) is  0.13
 with the empirical chi square  129.46  with prob <  3.1e-26

Fit based upon off diagonal values = 0.78
```

Para identificação com trabalho, temos:

```r
# testes fator identificação com trabalho
id_trab <- dados[, 14:18]

# Teste de esfericidade de Bartlett
psych::cortest.bartlett(cor(id_trab), n = nrow(id_trab))
```

```
$chisq
[1] 399.9121

$p.value
[1] 9.827553e-80

$df
[1] 10
```

```r
# Teste de Kaiser-Meyer-Olkin
psych::KMO(id_trab)
```

```
Kaiser-Meyer-Olkin factor adequacy
Call: psych::KMO(r = id_trab)
Overall MSA =  0.78
MSA for each item =
  Id_Trab_1 Id_Trab_2_R   Id_Trab_3   Id_Trab_4   Id_Trab_5
       0.80        0.82        0.75        0.80        0.78
```

```r
# Alpha de Cronbach
psych::alpha(id_trab)
```

```
Reliability analysis
Call: psych::alpha(x = id_trab)

  raw_alpha std.alpha G6(smc) average_r S/N   ase mean   sd median_r
```

```
      0.72      0.73      0.7      0.36 2.8 0.022  2.9 0.78     0.35

    95% confidence boundaries
         lower alpha upper
Feldt     0.68  0.72  0.76
Duhachek  0.68  0.72  0.77

 Reliability if an item is dropped:
            raw_alpha std.alpha G6(smc) average_r S/N alpha se  var.r med.r
Id_Trab_1        0.68      0.69    0.65      0.36 2.3    0.027 0.0156  0.34
Id_Trab_2_R      0.73      0.74    0.69      0.41 2.8    0.022 0.0068  0.41
Id_Trab_3        0.64      0.65    0.59      0.31 1.8    0.030 0.0053  0.30
Id_Trab_4        0.68      0.70    0.65      0.36 2.3    0.026 0.0093  0.35
Id_Trab_5        0.65      0.66    0.61      0.33 2.0    0.029 0.0087  0.30

 Item statistics
              n raw.r std.r r.cor r.drop mean  sd
Id_Trab_1   401  0.68  0.69  0.56   0.48  2.9 1.1
Id_Trab_2_R 401  0.64  0.60  0.42   0.36  2.8 1.3
Id_Trab_3   401  0.75  0.77  0.71   0.60  2.9 1.0
Id_Trab_4   401  0.68  0.68  0.56   0.46  3.1 1.2
Id_Trab_5   401  0.73  0.74  0.66   0.55  3.0 1.1

Non missing response frequency for each item
               1    2    3    4    5 miss
Id_Trab_1   0.10 0.31 0.23 0.32 0.04    0
Id_Trab_2_R 0.17 0.36 0.11 0.25 0.11    0
Id_Trab_3   0.07 0.30 0.28 0.33 0.03    0
Id_Trab_4   0.09 0.25 0.23 0.33 0.10    0
Id_Trab_5   0.07 0.33 0.20 0.35 0.05    0
```

```r
# Análise fatorial
fa_id_trab <- psych::principal(id_trab, nfactors = 1, rotate = "none")
fa_id_trab
```

```
Principal Components Analysis
Call: psych::principal(r = id_trab, nfactors = 1, rotate = "none")
Standardized loadings (pattern matrix) based upon correlation matrix
             PC1   h2   u2 com
Id_Trab_1   0.68 0.46 0.54   1
Id_Trab_2_R 0.55 0.30 0.70   1
Id_Trab_3   0.80 0.63 0.37   1
```

```
Id_Trab_4   0.69 0.47 0.53    1
Id_Trab_5   0.76 0.58 0.42    1

                PC1
SS loadings    2.45
Proportion Var 0.49

Mean item complexity =  1
Test of the hypothesis that 1 component is sufficient.

The root mean square of the residuals (RMSR) is  0.13
 with the empirical chi square  138.71  with prob <  3.4e-28

Fit based upon off diagonal values = 0.87
```

Para estresse, temos:

```r
# testes fator estresse
estresse <- dados[, 19:24]

# Teste de esfericidade de Bartlett
psych::cortest.bartlett(cor(estresse), n = nrow(estresse))
```

```
$chisq
[1] 329.1886

$p.value
[1] 4.672523e-61

$df
[1] 15
```

```r
# Teste de Kaiser-Meyer-Olkin
psych::KMO(estresse)
```

```
Kaiser-Meyer-Olkin factor adequacy
Call: psych::KMO(r = estresse)
Overall MSA =  0.78
MSA for each item =
Estresse_1 Estresse_2 Estresse_3 Estresse_4 Estresse_5 Estresse_6
      0.76       0.79       0.82       0.83       0.74       0.80
```

```r
# Alpha de Cronbach
psych::alpha(estresse)
```

```
Reliability analysis
Call: psych::alpha(x = estresse)

  raw_alpha std.alpha G6(smc) average_r S/N   ase mean   sd median_r
      0.68      0.68    0.65      0.26 2.1 0.024    3 0.81     0.24

    95% confidence boundaries
         lower alpha upper
Feldt     0.63  0.68  0.73
Duhachek  0.64  0.68  0.73

 Reliability if an item is dropped:
           raw_alpha std.alpha G6(smc) average_r S/N alpha se  var.r med.r
Estresse_1      0.61      0.60    0.56      0.23 1.5    0.030 0.0091  0.24
Estresse_2      0.62      0.62    0.58      0.24 1.6    0.029 0.0107  0.24
Estresse_3      0.69      0.69    0.65      0.31 2.3    0.024 0.0064  0.30
Estresse_4      0.67      0.66    0.63      0.28 1.9    0.025 0.0139  0.30
Estresse_5      0.60      0.60    0.55      0.23 1.5    0.031 0.0070  0.24
Estresse_6      0.65      0.64    0.61      0.26 1.8    0.027 0.0123  0.24

 Item statistics
             n raw.r std.r r.cor r.drop mean  sd
Estresse_1 401  0.70  0.70  0.62   0.51  2.9 1.3
Estresse_2 401  0.67  0.66  0.57   0.47  2.5 1.4
Estresse_3 401  0.44  0.48  0.28   0.23  4.2 1.1
Estresse_4 401  0.57  0.57  0.41   0.34  2.7 1.3
Estresse_5 401  0.71  0.70  0.64   0.52  2.8 1.4
Estresse_6 401  0.61  0.61  0.48   0.40  3.1 1.3

Non missing response frequency for each item
              1    2    3    4    5 miss
Estresse_1 0.21 0.20 0.19 0.28 0.11    0
Estresse_2 0.31 0.26 0.15 0.17 0.10    0
Estresse_3 0.03 0.05 0.12 0.23 0.56    0
Estresse_4 0.23 0.29 0.17 0.19 0.11    0
Estresse_5 0.25 0.19 0.17 0.27 0.12    0
Estresse_6 0.16 0.21 0.19 0.28 0.16    0
```

```r
# Análise fatorial
fa_estresse <- psych::principal(estresse, nfactors = 1, rotate = "none")
fa_estresse
```

```
Principal Components Analysis
Call: psych::principal(r = estresse, nfactors = 1, rotate = "none")
Standardized loadings (pattern matrix) based upon correlation matrix
            PC1   h2   u2 com
Estresse_1 0.73 0.53 0.47   1
Estresse_2 0.69 0.48 0.52   1
Estresse_3 0.39 0.15 0.85   1
Estresse_4 0.53 0.28 0.72   1
Estresse_5 0.74 0.55 0.45   1
Estresse_6 0.61 0.37 0.63   1

                PC1
SS loadings    2.36
Proportion Var 0.39

Mean item complexity =  1
Test of the hypothesis that 1 component is sufficient.

The root mean square of the residuals (RMSR) is  0.12
 with the empirical chi square  171.03  with prob <  3.8e-32

Fit based upon off diagonal values = 0.82
```

A partir daqui, ajustaríamos um modelo para a análise fatorial confirmatória (CFA) e testaríamos hipóteses (possivelmente utilizando o pacote {lavaan} e a função `lavaan::cfa()`). No entanto, não localizei instruções ou código nos exemplos fornecidos.