Survey data on perceptions of contraceptive measures as compositional tables

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Introduction. The perceived benefits of the male condom increase the likelihood of its use, while perceived harm reduces it, with a greater influence of the former on the latter [6]. In addition to the male and female condoms, there are different methods to avoid sexually transmitted infections/AIDS and unwanted pregnancies, such as the contraceptive pill and the morning-after pill (emergency contraception). Here we study the relative evaluation of young people of the possible benefits associated with the three most used methods (condoms (C), contraceptive pill (P), morning-after pill (M)), as a possible indicator of preferential use, i.e. if their evaluation supports the general believe.

Assumptions and principles.

The present approach is based on the assumptions and principles underlying compositional data analysis, as described in [1, 2, 4, 5], as well as on developments on contingency tables [3].

Survey data as samples of a compositional table.

A group of 145 students evaluated three protective measures in 10 different situations giving a value between 1 and 99 to each of them. The situations are summarised in Table 1. Each set of questions and answers is here considered a sample of a compositional table, leading to a sample of size $N = 145$.

item/	preventive measure	P	C	M
1	protect from sexually transmitted infections (STI)	P1	C1	M1
2	protect from pregnancy	P2	C2	M2
3	provide peace during and after intercourse	P3	C3	M3
4	economically accessible	P4	C4	M4
5	protect from the transmission of the AIDS virus	P5	C5	M5
6	evidence interest in protecting the health of the couple	P6	C6	M6
7	increase feelings of pleasure in man	P7	C7	M7
8	increase feelings of pleasure in woman	P8	C8	M8
9	are easy to use correctly	P9	C9	M9
10	do not cause side effects	P10	C10	M10

Table 1: Survey data as a compositional table. P = preservative; C = contraceptive pills; M = morning after pill.

The compositional mean or center, $\overline{T}$ of this sample of compositional tables, T_i, (Fig. 1, left) is computed as compositional average

$$\overline{T} = \frac{1}{N} \odot \bigoplus_{i=1}^{N} T_i = \mathcal{C} \exp\left(\frac{1}{N} \sum_{i=1}^{N} \operatorname{clr}(T) \right)$$

and it is proportional to a compositional contingency table.

A compositional contingency table can be orthogonally decomposed into an independent table, the closest independent table in the Aitchison sense, and the interaction table, reflecting the deviations from independence [3]:

$$\overline{T} = \underbrace{T_{\text{ind}}}_{\substack{\text{independent table}\\ \text{does not contain}\\ \text{interaction information}}} \oplus \underbrace{T_{\text{int}}}_{\substack{\text{interaction table}\\ \text{do not depend on marginals}}}$$

$$\begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \\ 8 \\ 9 \\ 10 \end{array} \begin{array}{c} \begin{array}{ccc} P & C & M \end{array} \\ \begin{pmatrix} 0.1047 & 0.0054 & 0.0032 \\ 0.0513 & 0.0420 & 0.0109 \\ 0.0487 & 0.0454 & 0.0066 \\ 0.0561 & 0.0277 & 0.0134 \\ 0.1105 & 0.0040 & 0.0024 \\ 0.0882 & 0.0107 & 0.0038 \\ 0.0077 & 0.0674 & 0.0192 \\ 0.0100 & 0.0663 & 0.0168 \\ 0.0405 & 0.0347 & 0.0151 \\ 0.0744 & 0.0077 & 0.0053 \end{pmatrix} \end{array} = \begin{pmatrix} 0.0366 & 0.0169 & 0.0063 \\ 0.0860 & 0.0396 & 0.0147 \\ 0.0732 & 0.0338 & 0.0126 \\ 0.0825 & 0.0380 & 0.0141 \\ 0.0304 & 0.0140 & 0.0052 \\ 0.0460 & 0.0212 & 0.0079 \\ 0.0645 & 0.0297 & 0.0111 \\ 0.0671 & 0.0309 & 0.0115 \\ 0.0830 & 0.0383 & 0.0142 \\ 0.0433 & 0.0199 & 0.0074 \end{pmatrix} \oplus \begin{pmatrix} 0.0910 & 0.0101 & 0.0164 \\ 0.0190 & 0.0338 & 0.0236 \\ 0.0212 & 0.0428 & 0.0167 \\ 0.0216 & 0.0232 & 0.0301 \\ 0.1156 & 0.0090 & 0.0146 \\ 0.0611 & 0.0161 & 0.0154 \\ 0.0038 & 0.0722 & 0.0553 \\ 0.0048 & 0.0683 & 0.0466 \\ 0.0155 & 0.0289 & 0.0338 \\ 0.0548 & 0.0123 & 0.0226 \end{pmatrix}$$

Figure 1: Center or mean table (left) and its decomposition in independent (centre) and interaction (right) tables.

Interaction table better interpreted as $\operatorname{clr}(T_{\text{int}})$ [3]

- Both rows and columns add to zero: positive interaction always accompanied by a negative one both in row and column.
- Sum of squares of entries add up to the square-norm of the interaction table (simplicial deviance) thus measuring the departure from independence.

Interactions between items and protective methods.

	P	C	M
1	1.3	−0.89	−0.41
2	−0.26	0.31	−0.05
3	−0.16	0.55	−0.39
4	−0.13	−0.06	0.2
5	1.54	−1.01	−0.53
6	0.9	−0.43	−0.48
7	−1.87	1.07	0.8
8	−1.65	1.02	0.63
9	−0.47	0.15	0.31
10	0.79	−0.7	−0.09

Figure 2: Interaction table (clr). Colors enhance importance of interaction (I). Red: strong positive I. Ocre: medium positive I. Grey: low positive I. White: no I. Pale blue: low negative I. Aquamarine: medium negative I. Dark blue: strong negative I.

The interaction table in Figure 1 is difficult to interpret in its raw form. Its clr (Fig. 2) gives a better insight. Entries show that condoms are positively valued as protection against sexually transmitted infections / AIDS, but at the same time considered an obstacle to pleasure during intercourse. The opposite happens with the two types of pill, which are poorly valued as protective against infections, but positively valued on pleasure. Less expected is the good evaluation of the condom in relation to "showing interest in protecting the health of the couple", highlighting an altruistic motivation, far from selfish motivations oriented toward one's own health, pleasure or economy. Surprising is the negative association of the morning-after pill with pregnancy protection, even though there is no interaction with the other methods.

Association of effectiveness of protective methods in different items.

Association is measured as inversely proportional to the variance of logratios, i.e. $\operatorname{Var}\left[\ln \frac{T_{ij}}{T_{k\ell}}\right] \approx 0\,, \Rightarrow$ cells T_{ij} and $T_{k\ell}$ can be strongly associated. The degree of association is visualised in Fig. 3.

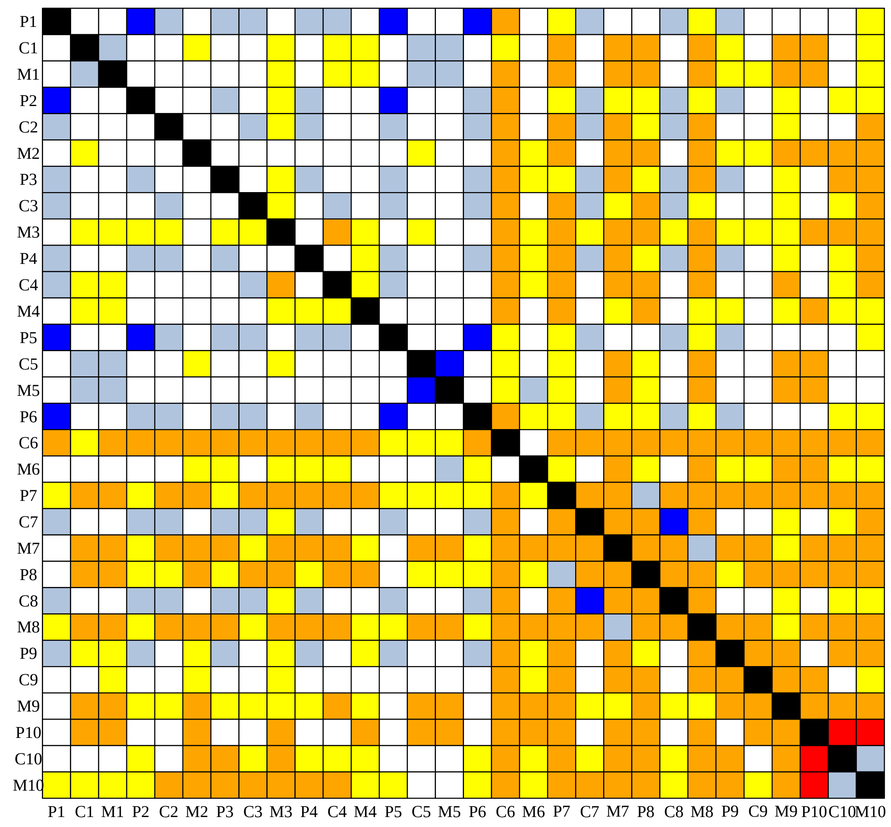

Figure 3: Heatmap of variation matrix. Colors enhance importance of association (A). Red: No A. Orange: very low A. Yellow: low A. White: weak A. Pale blue: medium A. Dark blue: strong A.

Figure 3 shows strong associations of P1 (protects against STI) with P5 (protects against AIDS) and P6 (evidence of interest in protecting the health of the partner). The same happens with C7 (increases man pleasure) and C8 (increases woman pleasure). There are also strong associations between P2 (protects against pregnancies) and P1 (protects against STI) on the one hand, and P2 and P5 on the other. This is not in contradiction with the results in Figure 2. The interaction points out that the protective value of preservatives against AIDS is better perceived than against pregnancy, and the association between P2 and P6 indicates that a good/weak perception of both protective measures is coupled. A possible interpretation is that the score assigned to P2 and P6 measures the perception of "protection", independently of protection against what.

Visualization: CoDa-biplot.

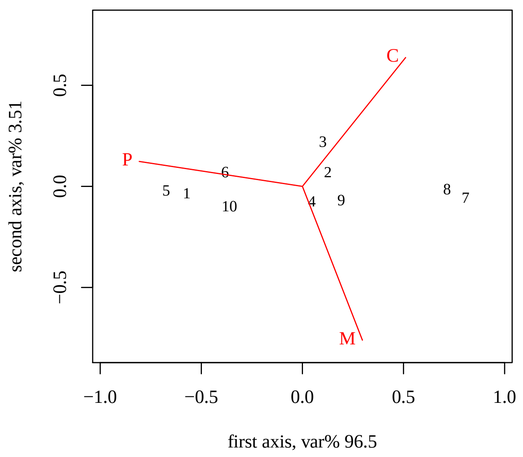

Figure 4: Form biplot of mean table.

In the biplot (Fig. 4) points correspond to items in the survey, arrows to protective measures. Comparing it with the clr-interactions (Fig. 2) and the associations (Fig. 3), following the arrow of P, observe that points 1 and 5 are close together, as well as points 7 and 8 at the other end, visualising the sign of the interaction and the degree of association. The biplot shows that there is essentially one dimensional axis that classifies the items, which is the balance $\sqrt{\frac{2}{3}} \ln \frac{P}{\sqrt{C \cdot M}}$.

Conclusions

- Hormonal methods clearly have a better acceptance than the condom regarding perceiving greater pleasure in intercourse, whereas the reverse occurs when it comes to feeling protected against STI. But the condom also counts in its favor with the good evaluation that it does not produce side effects and that its use shows interest in protecting the health of the couple, contrary to what is observed in the valuations of hormonal methods. The results suggest that, in general, the preferences of the participants in the study are inclined towards the condom against the contraceptive pill and the postcoital pill.
- Survey data can advantageously be treated as compositional tables, as the relevant information are the ratios between the different responses and items.
- Interactions between responses and items give insight into the importance respondents give to the different possibilities.
- Standard tools of Compositional Data Analysis are useful to detect and assess associations between items/responses. Main tools are: CoDa-variation array (bivariate associations); CoDa-biplot, visualization in reduced dimension; CoDa-dendrogram, describing balances coming from a sequential binary partition (SBP) and comparing means and variances of the chosen balances. Decomposition of the mean compositional table into independent and interaction tables.

References

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