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Spain Tenerife Canary Islands

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Relationship between repeated measures in clinical psychology studies: an empirical evaluation

José A López-López, Manuel J Albaladejo-Sánchez, Julio Sánchez-Meca, Fulgencio Marín-Martínez, María Rubio-Aparicio, and Juan J López-García
University of Murcia, Spain

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An initial example: weight before and after an intervention

Subjects	Pretest	Postest	D
1	80	78	-2
2	90	82	-8
3	72	73	$+1$
4	92	80	-12
…	…	…	…
	$\bar{Y}_{pre}$	$\bar{Y}_{post}$	$\bar{D}$
	S_{pre}	S_{post}	S_D

$$\bar{D} = \bar{Y}_{post} - \bar{Y}_{pre} = -9\ kg$$

Another example: anxiety symptoms before and after an intervention

Subjects	Pretest	Postest	D
1	8	3	−5
2	12	6	−6
3	9	6	−3
4	10	12	+2
…	…	…	…
	$\bar{Y}_{pre}$	$\bar{Y}_{post}$	$\bar{D}$
	S_{pre}	S_{post}	S_D

$$\bar{D} = \bar{Y}_{post} - \bar{Y}_{pre} = -4\ units$$

Estimators of the standardized mean change

$$d_1 = J_1 \frac{\bar{Y}_{post} - \bar{Y}_{pre}}{S_{pre}}$$

Becker

$$J_1 = J_{21} = J_4 = 1 - \frac{3}{4 \cdot df - 1}$$

$$df = \mathrm{n} - 1$$

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$$d_{21} = J_{21} \frac{\bar{Y}_{post} - \bar{Y}_{pre}}{\sqrt{S_D^2/2(1-r)}}$$

Borenstein (1)

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$$d_{22} = J_{22} \frac{\bar{Y}_{post} - \bar{Y}_{pre}}{\sqrt{S_D^2/2(1-r)}}$$

Borenstein (2)

$$J_1 = J_{21} = J_4 = 1 - \frac{3}{4 \cdot df - 1}$$

$$df = \mathrm{n} - 1$$

$$J_{22} = J_{32} = 1 - \frac{3}{4 \cdot df_2 - 1}$$

$$df_2 = \frac{2(\mathrm{n}-1)}{1 + r^2}$$

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Borenstein (2)

$$d_{31} = J_{31} \frac{\bar{Y}_{post} - \bar{Y}_{pre}}{\sqrt{(S_{pre}^2 + S_{post}^2)/2}}$$

Bonett (1)

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$$d_4 = J_4 \frac{\bar{Y}_{post} - \bar{Y}_{pre}}{S_D}$$

Gibbons

$$J_1 = J_{21} = J_4 = 1 - \frac{3}{4 \cdot df - 1}$$

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$$df_2 = \frac{2(\mathrm{n}-1)}{1 + r^2}$$

Simulated example 1

$N = 1000$ $\mu_{pre} = 4$ $\mu_{post} = 6$ $\Sigma = \begin{matrix} 1 & 0.5 \\ 0.5 & 1 \end{matrix}$

INDEX	RESULT
d_1	2.01
d_{21}	1.99
d_{22}	1.99
d_{31}	1.99
d_{32}	1.99
d_4	2.01

Simulated example 2

$N = 1000$ $\mu_{pre} = 4$ $\mu_{post} = 6$ $\Sigma = \begin{matrix} 1 & 1.05 \\ 1.05 & 2.25 \end{matrix}$

INDEX	RESULT
d_1	2.04
d_{21}	1.49
d_{22}	1.49
d_{31}	1.61
d_{32}	1.61
d_4	1.89

Simulated example 3

$N = 10$ $\mu_{pre} = 4$ $\mu_{post} = 6$ $\Sigma = \begin{matrix} 1 & 1.05 \\ 1.05 & 2.25 \end{matrix}$

INDEX	RESULT
d_1	1.94
d_{21}	0.95
d_{22}	0.97
d_{31}	1.27
d_{32}	1.25
d_4	1.41

Conclusion

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- They require different information and make different assumptions
- The choice can have a substantial impact on the results
- Also, several formulas have been proposed to calculate the sampling variance of each index
- The performance of each option for the estimator and its sampling variance should be examined taking a more comprehensive approach…
- … Ideally using Monte Carlo simulation

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