

Continuous outcomes

Trusted evidence.
Informed decisions.
Better health.



Steps of a Cochrane Review

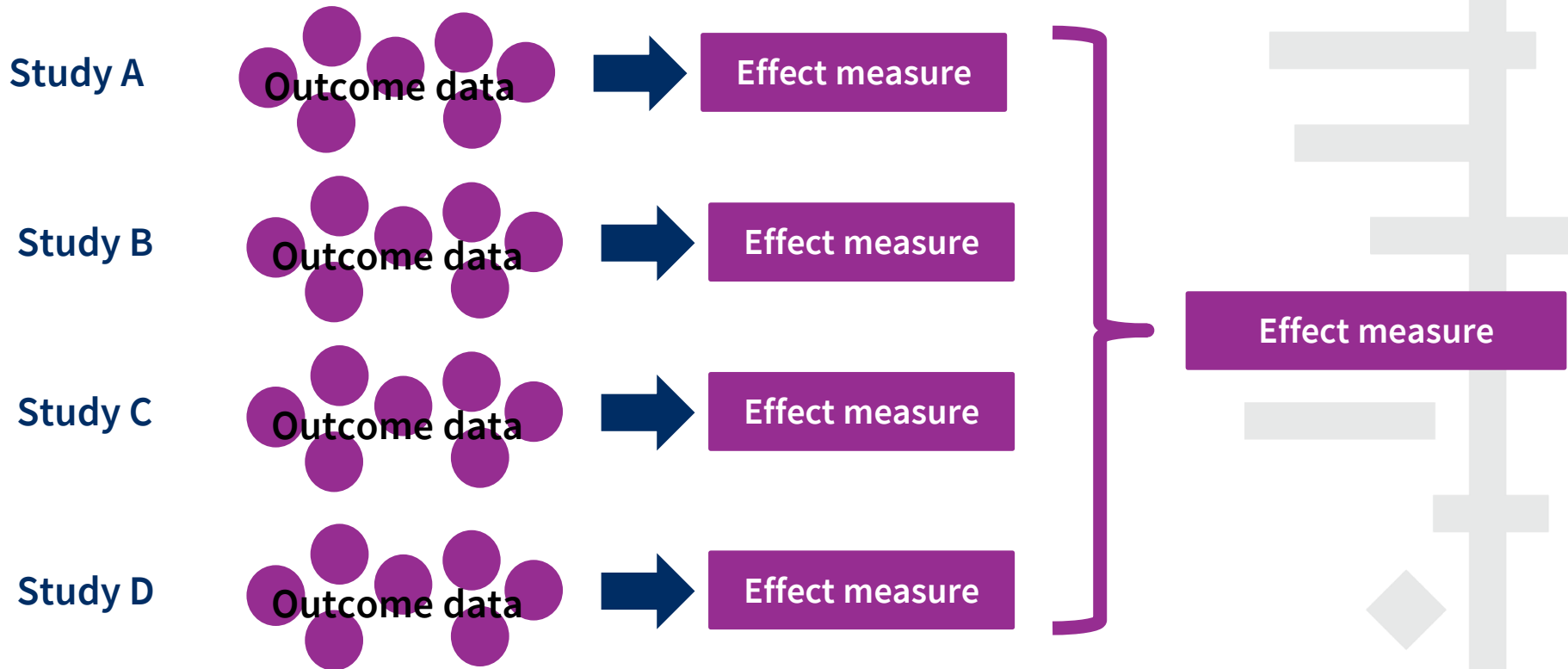
1. define the question
2. plan eligibility criteria
3. plan methods
4. search for studies
5. apply eligibility criteria
- 6. collect data**
7. assess studies for risk of bias
- 8. analyse and present results**
9. interpret results and draw conclusions
10. improve and update review



Study level

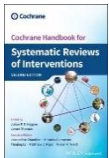


Review level



Session outline

- **effect measures for continuous outcomes**
- collecting data for continuous outcomes

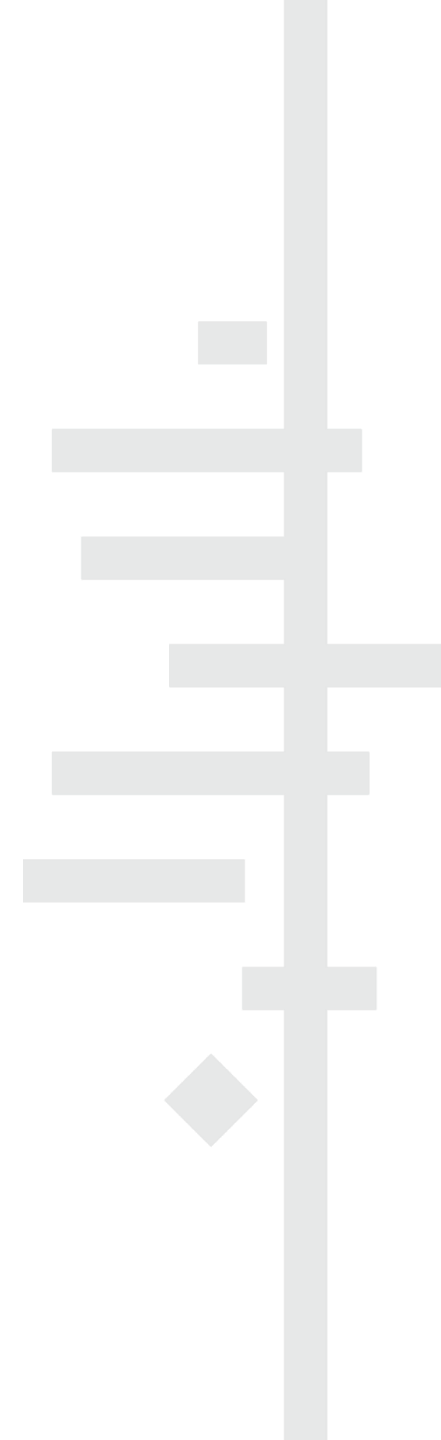


See Chapters 5, 6 & 10 of the Handbook



What are continuous outcomes?

- can take any value in a specified range
- intervals between values are equally spaced
- e.g. height, weight
 - a person can be 178.35627 cm tall
 - distance from 1 to 2 cm is the same as 171 to 172 cm
- other numerical scales commonly assessed as continuous
 - e.g. quality of life, pain, depression

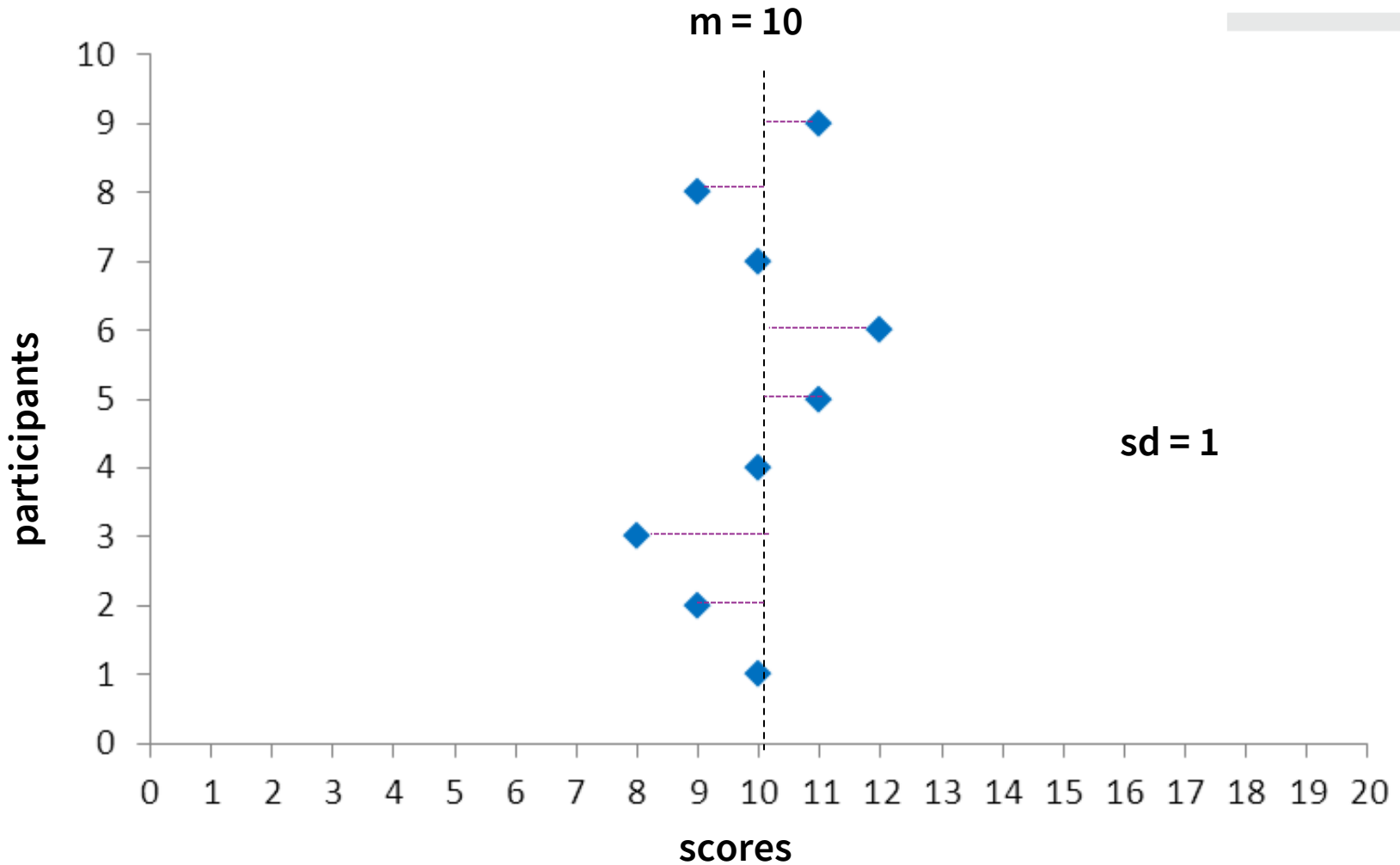


Expressing continuous outcomes

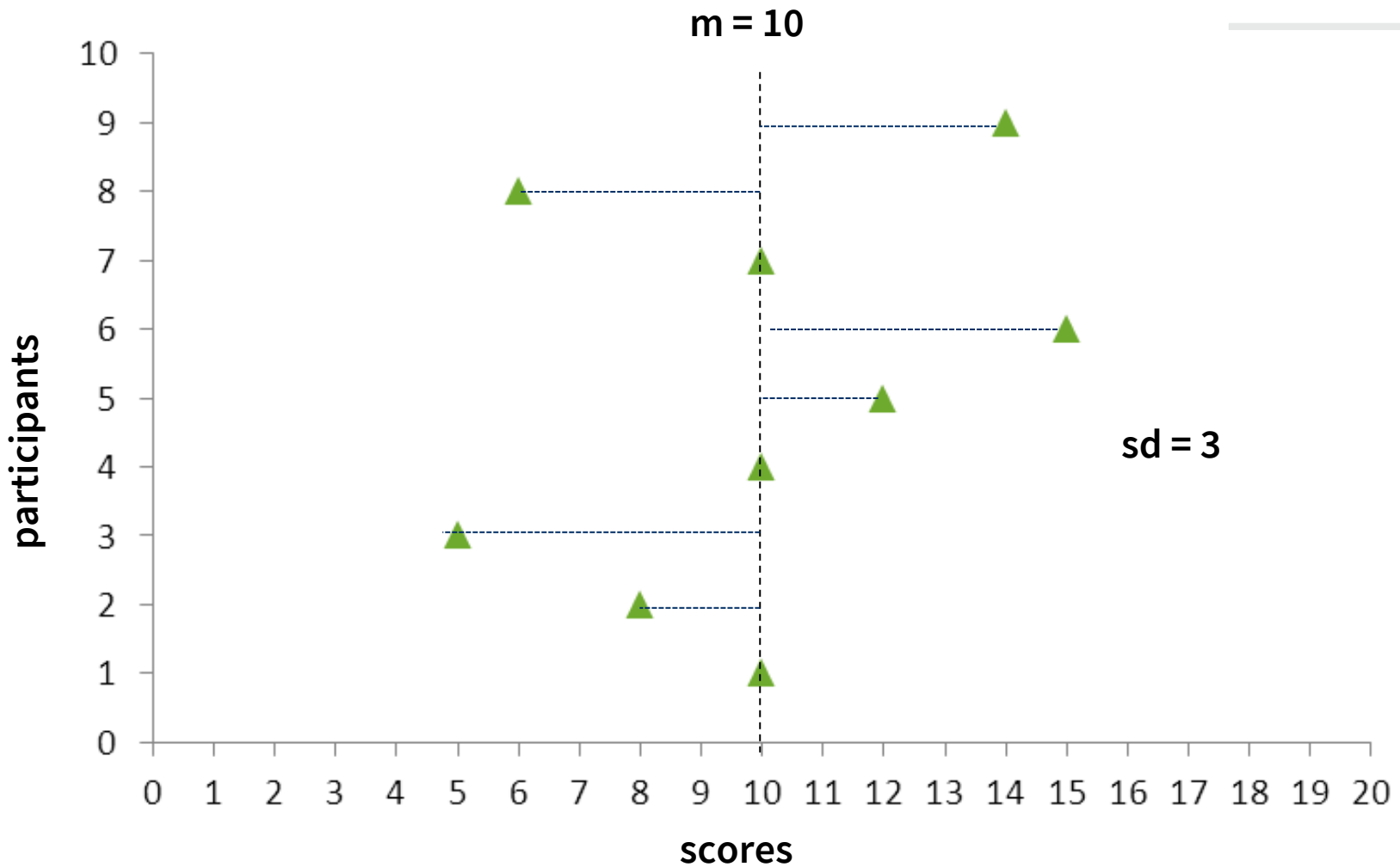
- two components
 - mean value
 - measure of variation

Irritability score	Mean	SD	N
Caffeine	20	9.1	65
Decaf	33	8.6	67

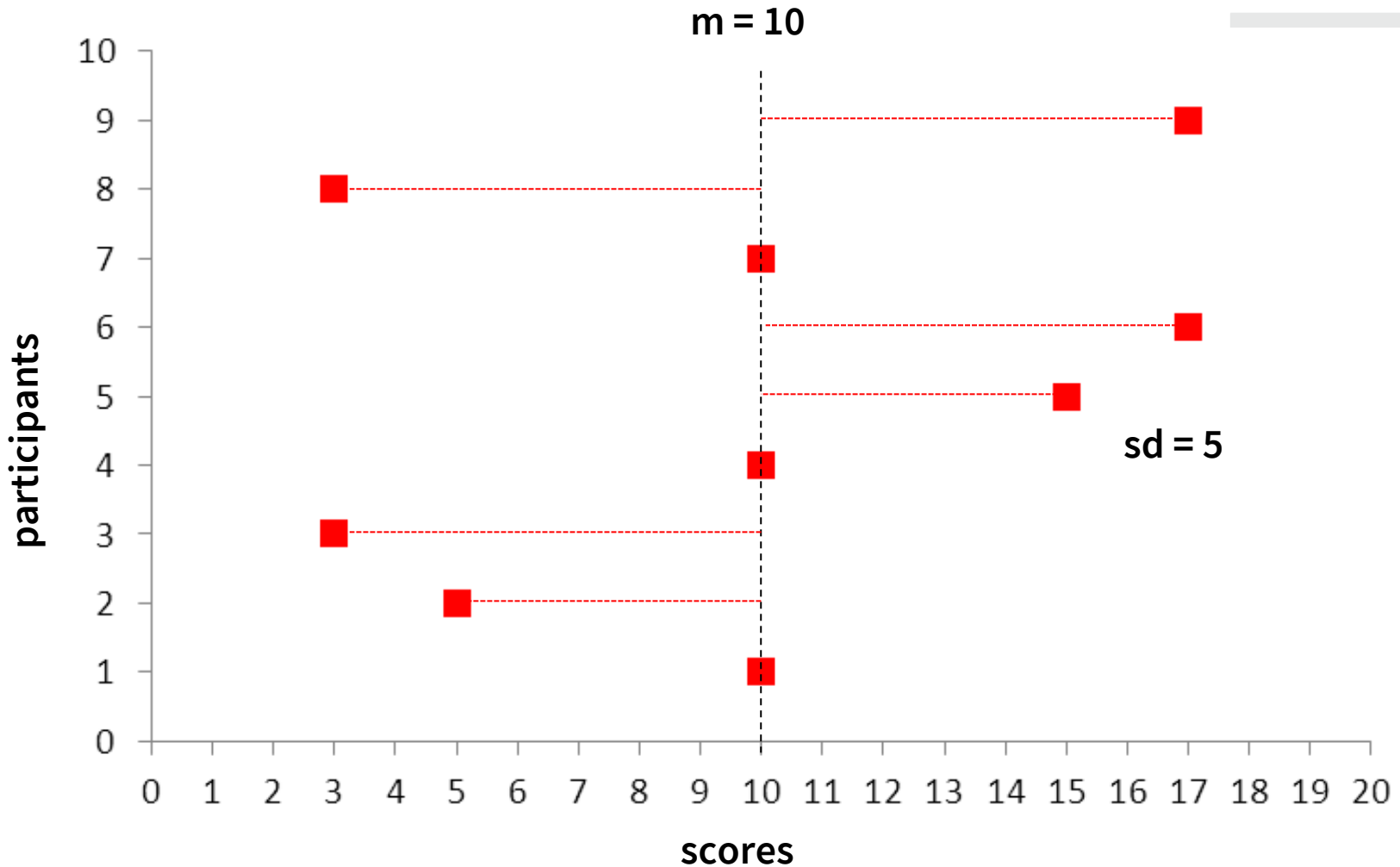
Standard deviations



Standard deviations



Standard deviations



Comparing two groups

- effect measures
 - mean difference (MD) (difference of means)
 - standardised mean difference (SMD) (effect size)
- **all** estimates are uncertain, and should be presented with a confidence interval



Mean difference

- when all studies use the same measurement scale

Irritability score	Mean	SD	N
Caffeine	20	9.1	65
Decaf	33	8.6	67

mean difference = mean of intervention – mean of control

= 20 – 33

= -13 points

When mean difference = 0, there is no difference between the groups

Interpreting mean difference

- how should we interpret a score of -13?
- depends on:
 - direction of the scale
 - length of the scale
 - minimally important difference
 - good or bad outcome

higher = more irritable

0-50

5

bad



Expressing it in words

- Mean difference **-13**
 - on average, participants with the intervention scored 13 points lower on the irritability scale
 - on average, the intervention reduced irritability by 13 points on the irritability scale

or for an increase:

- Mean difference **13**
 - on average, participants with the intervention scored 13 points higher on the irritability scale
 - on average, the intervention increased irritability by 13 points on the irritability scale

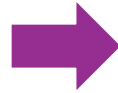
Study level



Review level



Study A



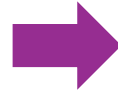
Study B



Study C



Study D



Standardised mean difference

- when different scales used to measure the same outcome
- SMD standardises the results
 - units of standard deviation
 - does not correct for direction – may need to multiply by -1

$$\text{SMD} = \frac{\text{mean of intervention group} - \text{mean of control group}}{\text{pooled standard deviation of both groups}}$$

When standardised mean difference = 0, there is no difference between the groups

Interpreting standardised mean difference

Irritability score	Mean	SD	N	MD	SMD
Caffeine	20	9.1	65	-13	-1.5
Decaf	33	8.6	67		




- how should we interpret a score of -1.5?
- compare to available SDs
 - was study likely to have high or low variation?
 - difficult for readers to interpret – convert results to a specific scale for reporting
- depends on same factors as mean difference

Example: converting SMD

Review: Manual therapy and exercise for adhesive capsulitis (frozen shoulder)

Comparison: 1 Manual therapy plus exercise plus electrotherapy plus placebo injection versus glucocorticoid injection

Outcome: 1 Overall pain

Study or subgroup	MT+Ex+Electro+Saline Inj N	Mean(SD)	Glucocorticoid injection N	Mean(SD)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
1 Change from baseline to 6 weeks							
Carette 2003	26	-21.8 (27.0248)	23	-39.1 (26.8567)		51.5 %	0.63 [0.06, 1.21]
Ryans 2005	20	-17.6 (39.1)	17	-9.7 (18.5)		48.5 %	-0.25 [-0.90, 0.40]
Subtotal (95% CI)	46		40			100.0 %	0.21 [-0.65, 1.07]
Heterogeneity: Tau ² = 0.29; Chi ² = 3.93, df = 1 (P = 0.05); I ² = 75%							
Test for overall effect: Z = 0.47 (P = 0.64)							

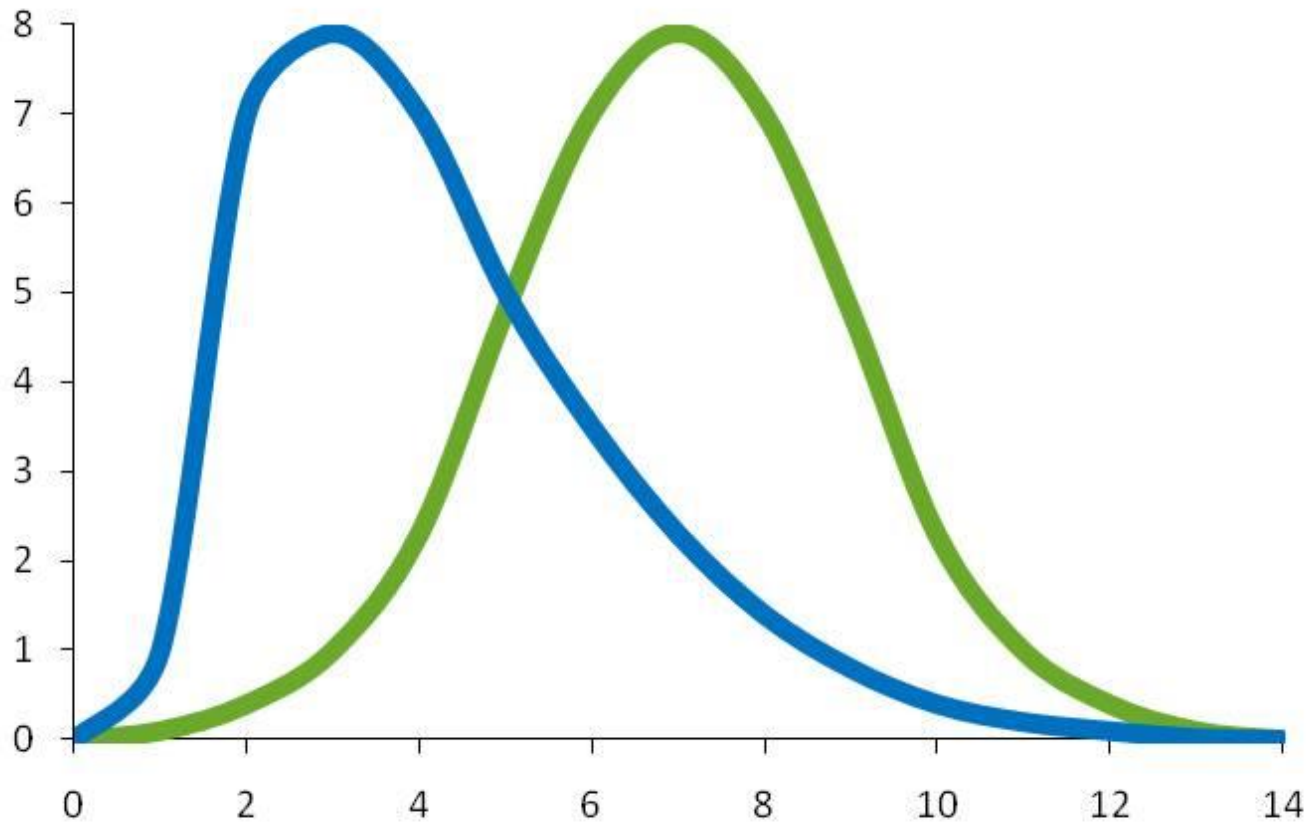
- pain measured using:
 - **SPADI pain scale** in Carette 2003 and **VAS rest pain** in Ryans 2005
- convert SMD to SPADI scale:
 - multiply SMD and 95% CI by pooled baseline SD from Carette 2003 = 18

$$MD = (SMD \times \text{pooled baseline SD}) = (0.21 \times 18) = 3.78$$

- report result:

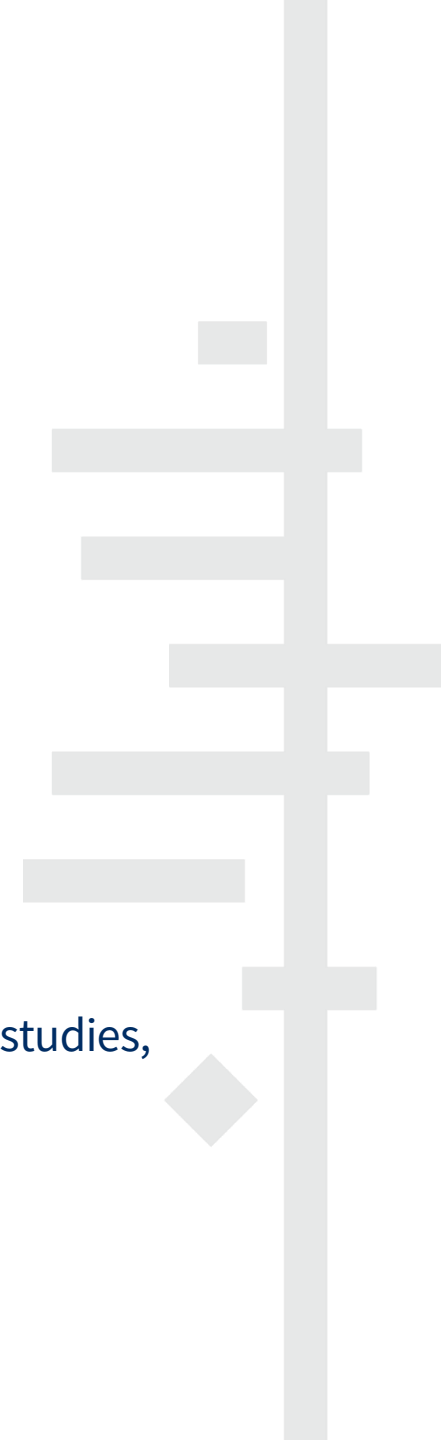
“SMD 0.21, 95% CI -0.65 to 1.07; this is equivalent to a MD of 3.78 points (-11.7 to 19.26) on a 100-point scale (SPADI)”

Normally distributed data



Skewed data

- indications of skew
 - reported as geometric mean or median, interquartile range
 - large SD in relation to the mean
 - $< 2 \times \text{SD}$ between mean and highest/lowest possible score
- addressing skew
 - get statistical advice before proceeding
 - may be no action required
 - possible actions may include sensitivity analysis without skewed studies, log transformation or other methods.



Session outline


- effect measures for continuous outcomes
- **collecting data for continuous outcomes**



Collecting data

- six numbers needed for meta-analysis

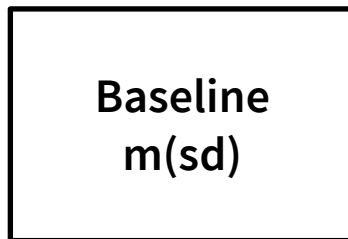
	Mean	SD	N
Intervention	20	9.1	65
Control	33	8.6	67



Try to collect the actual number measured for each outcome, at each time point

Post-intervention vs change from baseline

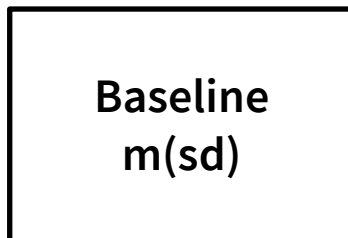
Control group



change $m(sd)$



Intervention group



change $m(sd)$



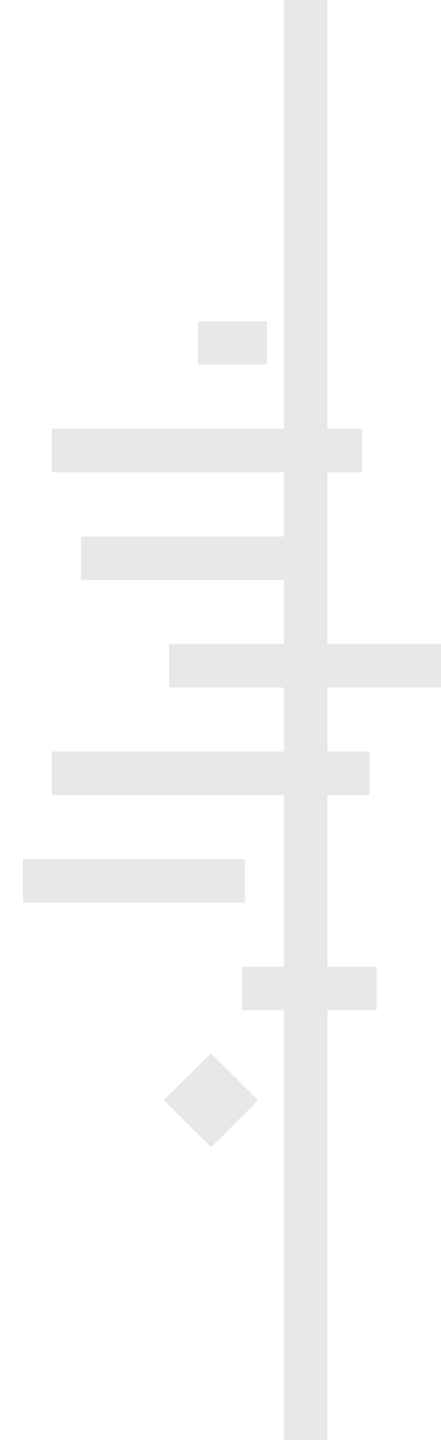
MD

MD



Change from baseline data

- can increase or decrease precision
 - reduce between-person variation
 - increase error for unstable or imprecise measures
- regression (ANCOVA) better to adjusting for baseline values
- work with what is reported in your included studies:
 - either post-intervention or change scores can be used
 - can use a mixture (only for MD, not SMD)
 - better to be consistent if possible
 - avoid selective outcome reporting
 - change scores require SD of the change



Other data formats can also be used

- statistics other than mean and SD
 - e.g. standard error, confidence interval, P value, t value, median, interquartile range
 - clarify with the author if unclear
 - can often calculate or estimate the mean and SD
- overall effect estimate
 - e.g. MD, ANCOVA, ratio of means, ratio of geometric means
 - can include in meta-analysis using generic inverse variance method
 - need a measure of variance (e.g. SE, 95% CI)

RevMan Calculator

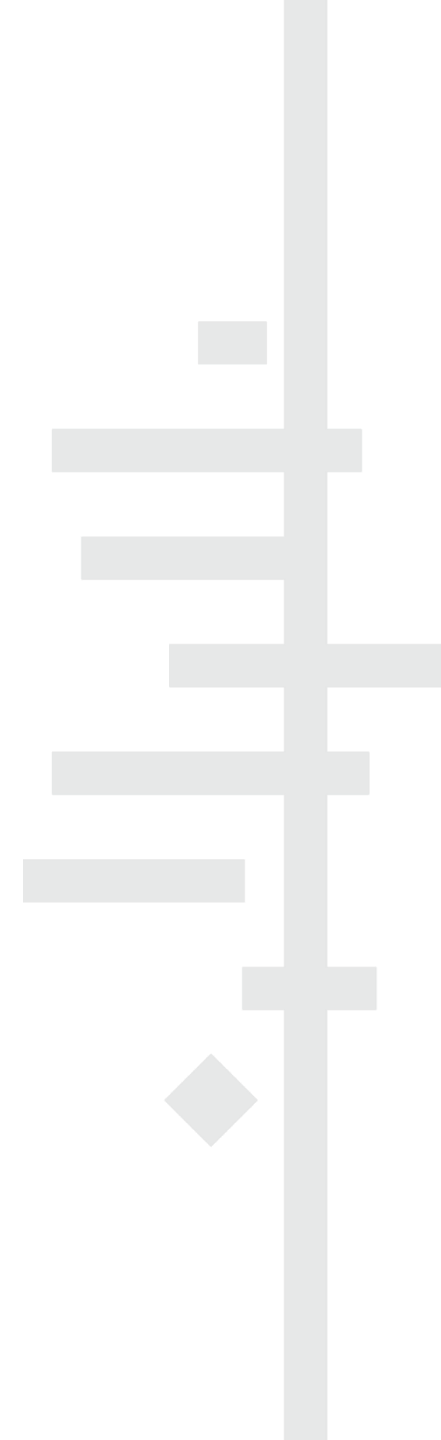
Calculator - [Irritability at 30 minutes (INAS scale)]

Caffeinated coffee	Mean1 22	N1 35	SD1 17.1566	SE1 2.9	CI Start1 16.1065	CI End1 27.8935	tTest1 <input checked="" type="radio"/> + 7.5862 <input type="radio"/> -	P value1 0.0000
Decaffeinated coffee	Mean2 32	N2 35	SD2 16.5650	SE2 2.8	CI Start2 26.3097	CI End2 37.6903	tTest2 <input checked="" type="radio"/> + 11.4286 <input type="radio"/> -	P value2 0.0000
N 70		MD -10.0000	SE 4.0311	CI Start -17.9009	CI End -2.0991	tTest <input type="radio"/> + <input checked="" type="radio"/> - 2.4807	P value 0.0156	

Confidence Interval: 90% 95% 99%

What to include in your protocol

- effect measure(s) to be used for continuous data



Take home message

- mean difference and standardised mean difference compare continuous measures between two groups
- for basic analysis of continuous data you need the mean and SD and the number of participants in each group
- both change and post-intervention data can be combined in your analysis
- the required statistics can often be calculated from the reported data



References

- Higgins JPT, Li T, Deeks JJ (editors). **Chapter 6: Choosing effect measures and computing estimates of effect.** In: Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (editors). Cochrane Handbook for Systematic Reviews of Interventions version 6.1 (updated September 2020). Cochrane, 2020. Available from www.training.cochrane.org/handbook.
- Deeks JJ, Higgins JPT, Altman DG (editors). **Chapter 10: Analysing data and undertaking meta-analyses.** In: Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (editors). Cochrane Handbook for Systematic Reviews of Interventions version 6.1 (updated September 2020). Cochrane, 2020. Available from www.training.cochrane.org/handbook.

Acknowledgements

- Compiled by Miranda Cumpston
- Based on materials by Cochrane Australia, Cochrane UK and the Cochrane Statistical Methods Group.
- Approved by the Convenors of Cochrane Methods Groups