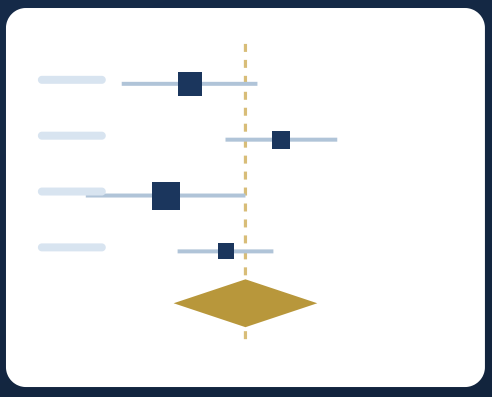
Research Gold

RESEARCH GOLD FIELD GUIDE

How to Read a Forest Plot

Every line, square, whisker, and diamond explained, so you can read a meta-analysis with confidence and spot the things a careful reviewer looks for. A reading guide from PhD methodologists.



Written by PhD methodologists researchgold.org

START HERE

A forest plot tells a whole meta-analysis in one picture

Once you can read it, a forest plot shows you what each study found, how much it is trusted, whether the studies agree, and what they say when combined. The trick is to read it in a fixed order, from the parts to the whole, rather than jumping straight to the diamond at the bottom.

PRINCIPLE

Read a forest plot from the outside in. First understand the axis and the line of no effect, then read each study, then judge whether the studies agree, and only then interpret the pooled diamond. Reading the diamond first, with no sense of the spread behind it, is how people are misled by a tidy summary.

The anatomy, part by part

1. **The vertical line of no effect**
   The reference line where the intervention and comparator are equal. For ratio measures this sits at one; for difference measures it sits at zero. Everything is read relative to this line.

2. **Each study as a square with whiskers**
   The square is the study estimate. The horizontal whiskers are its confidence interval, the range the true effect plausibly lies within. A wide interval is an uncertain study.

3. **The size of each square**
   Bigger squares carry more weight in the pooled result, usually because the study is larger or more precise. The size is information, not decoration.

4. **The diamond at the bottom**
   The pooled estimate across all studies. Its centre is the combined effect and its width is the combined confidence interval. If the diamond crosses the line of no effect, the pooled result is not statistically conclusive.

THE INTERPRETATION

What each feature is telling you

Work across this table as you look at a plot. Each visual feature maps to a specific piece of meaning.

FEATURE TO MEANING

What you see	What it means
A study whisker that crosses the line of no effect	That individual study is not statistically conclusive on its own
A very wide whisker	A small or imprecise study; it will carry little weight
A large square	A study with a strong influence on the pooled result
Squares scattered on both sides of the line	The studies disagree on direction; expect high heterogeneity
A narrow diamond clear of the line	A precise, statistically conclusive pooled effect
A diamond that straddles the line	The combined evidence does not rule out no effect

WATCH OUT FOR

A pooled diamond that sits clearly to one side can still rest on studies that wildly disagree. Always read the spread of the squares and the heterogeneity statistic before trusting the diamond. A confident summary over inconsistent studies is a finding to question, not to celebrate.

THE NUMBERS BESIDE THE PLOT

Reading the heterogeneity statistics

Most forest plots print a few summary numbers near the diamond. These tell you how much the studies vary beyond chance, which decides how much to trust a single pooled figure.

THE STATISTICS YOU WILL SEE, IN PLAIN TERMS

Statistic	What it captures	How to read it
I-squared	The share of variation due to real differences, not chance	Higher values mean the studies disagree more; interpret pooling cautiously
Tau-squared	The estimated variance of true effects across studies	Larger values mean a wider spread of underlying effects
The Q test	A test for whether variation exceeds chance	A small probability value points to real heterogeneity
Prediction interval	Where the effect of a future study would likely fall	Often much wider than the diamond, and more honest about spread

PRINCIPLE

When heterogeneity is high, the single pooled diamond matters less and the prediction interval matters more. A review that reports the prediction interval is telling you, honestly, how much the effect varies from setting to setting.

WHAT THE DIAMOND ASSUMES

The diamond means different things under different models

Before you read the pooled effect, find out which model produced it. A fixed-effect and a random-effects analysis of the same studies answer different questions, weight the studies differently, and can yield diamonds of very different widths.

THE TWO MODELS BEHIND A POOLED DIAMOND

Element	Fixed-effect (common-effect)	Random-effects
What it assumes	One true effect underlies every study	True effects vary; studies estimate a distribution of effects
What the diamond estimates	That single common effect	The mean of the distribution of true effects
How studies are weighted	By inverse variance alone, so large trials dominate	Inverse variance plus tau-squared, so small studies gain relative weight
When it is defensible	Few, similar studies with negligible heterogeneity	The default when clinical or methodological diversity is expected

WATCH OUT FOR

Three traps a careful reader checks. First, I-squared is *not* an absolute amount of heterogeneity: it is the share of total variation that is between-study, so it climbs simply because precise studies shrink the within-study part. Two reviews with identical tau-squared can report I-squared of 25 per cent and 90 per cent. Read tau-squared and the prediction interval, which are on the scale of the effect, before reacting to a high I-squared. Second, with few studies (under about ten) the random-effects standard error is itself badly estimated; a Hartung-Knapp-Sidik-Jonkman adjustment, which widens the interval and uses a t rather than z reference, is now the recommended default and you should expect to see it. Third, a random-effects model does not fix bias, it amplifies it: by up-weighting small studies it gives more influence to exactly the trials most prone to small-study effects.

WHAT THE PLOT CANNOT SHOW ALONE

Small-study effects and the studies that are not there

A forest plot shows the studies that were found. The threat to a meta-analysis is often the pattern among small studies, and the studies that were never published at all.

HOW TO INTERROGATE SMALL-STUDY EFFECTS

Tool	What it shows	How to read it
Funnel plot	Effect against precision (standard error)	A symmetric inverted funnel is reassuring; a gap in one bottom corner suggests missing small studies
Egger's regression test	Whether small-study effects are statistically detectable	Underpowered with fewer than ten studies; a non-significant result is not clearance
Contour-enhanced funnel	Whether asymmetry coincides with significance bands	Asymmetry into non-significant regions points to real heterogeneity, not just publication bias
Trim-and-fill	A sensitivity estimate if missing studies are imputed	Use as a what-if, never as a corrected truth; it assumes a specific mechanism

PRINCIPLE

Funnel asymmetry is not synonymous with publication bias. It can equally arise from genuine heterogeneity, poorer methods in smaller trials, or chance. Treat the funnel as a prompt to investigate, report a test only when there are enough studies to power it, and never present trim-and-fill as the real answer. The honest summary states the pooled effect, the prediction interval, and what the small-study analysis could and could not rule out.

WHEN YOU READ THE NEXT PLOT

The forest plot reading checklist

Run any forest plot through this order. It keeps you from being charmed by a tidy diamond before you have understood what is behind it.

- [ ] You located the line of no effect and know whether it sits at one or at zero.
- [ ] You read several individual studies, including their confidence intervals.
- [ ] You noticed which studies carry the most weight from their square size.
- [ ] You judged whether the studies broadly agree or scatter across the line.
- [ ] You read the heterogeneity statistics before interpreting the pooled effect.
- [ ] You identified whether the diamond came from a fixed-effect or random-effects model.
- [ ] You read tau-squared and the prediction interval rather than reacting to I-squared alone.
- [ ] You checked whether a Hartung-Knapp adjustment was used when the studies were few.
- [ ] You looked at the funnel plot and any small-study test for what the forest plot cannot show.
- [ ] You checked whether the diamond crosses the line of no effect.
- [ ] You looked for a prediction interval and read it when present.

WHEN THE POOLING HAS TO BE RIGHT

Have the meta-analysis behind the plot done properly

If you have the studies and need the effect sizes extracted, the right model fitted, heterogeneity explored, and journal-ready forest and funnel plots with a written results and methods section, our PhD methodologists deliver the complete meta-analysis to a standard that holds up in review. You make every judgement call; we do the analysis and the plots.

Get a quote for your meta-analysis

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