

Research Metrics

Impact Factor · h-index, g-index & i10-index · Altmetrics

Research metrics are quantitative indicators used to gauge the influence or reach of a publication, a researcher's body of work, or an entire journal. They fall into two broad families: **citation-based metrics**, which count how often published work is formally cited by later scholarly work (the Journal Impact Factor, h-index, g-index, and i10-index all belong here), and **altmetrics**, which track attention to research in venues outside the formal citation record, such as news coverage, social media, and policy documents. No single metric captures research quality on its own; each has a specific definition, a specific purpose, and specific, well-documented limitations.

1. The Journal Impact Factor (JIF)

1.1 Definition and calculation

The **Journal Impact Factor** is a journal-level metric, published annually by Clarivate in the Journal Citation Reports, that measures the average number of citations received in a given year by articles a journal published in the two preceding years. For Year X, the JIF is the number of citations recorded during Year X to "citable items" (research articles and reviews) published in Years X-2 and X-1, divided by the total number of such citable items published in those same two years. A JIF of 5.0 therefore means that, on average, each citable article the journal published in the prior two years was cited five times in the year being measured.

The Journal Impact Factor (JIF): a Two-Year Citation Window

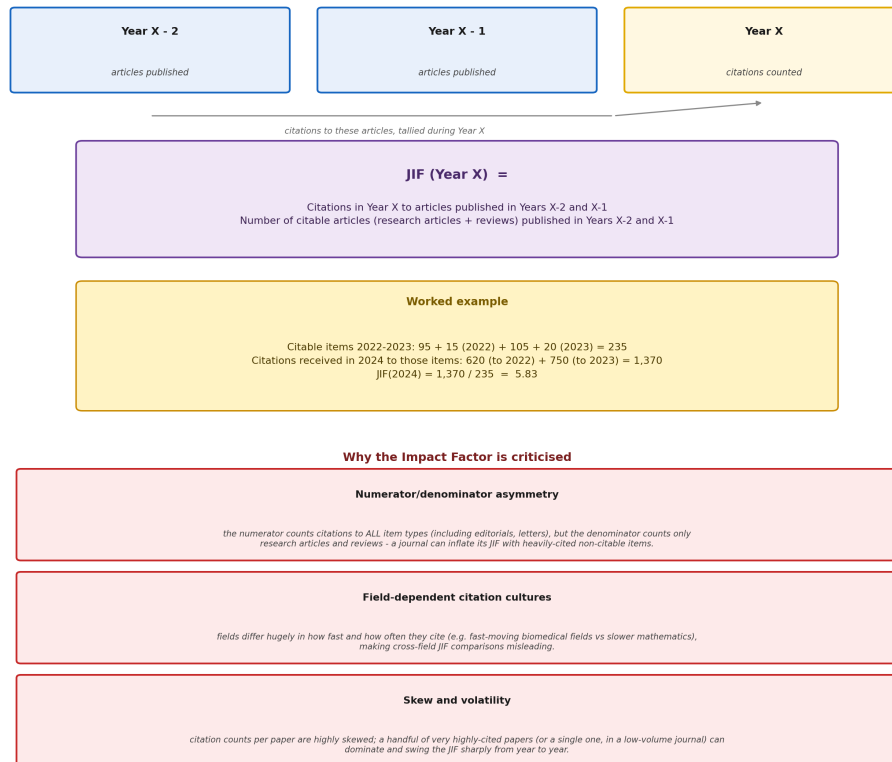


Fig. 1 - The two-year citation window behind the Journal Impact Factor, its formula, a worked numerical example, and the metric's principal criticisms.

1.2 Why the Impact Factor is criticised

Despite its wide use as a proxy for journal prestige, the JIF has well-established statistical weaknesses. Its numerator counts citations to all item types a journal publishes, including editorials, letters, and news pieces, while its denominator counts only research articles and reviews - a journal can inflate its JIF by publishing heavily-cited non-citable items. Citation practices also vary enormously by field: fast-moving biomedical fields cite far more, and far more quickly, than slower-moving fields such as mathematics, so comparing JIFs across disciplines is misleading. Citation counts per article within a journal are also highly skewed, so a single very highly-cited paper (or a small number of them) can dominate and swing a journal's JIF sharply from one year to the next, particularly for lower-volume journals.

Key points

- JIF is a **journal-level**, not an article- or author-level, metric - it says nothing about the citation count of any individual paper.
- It uses a fixed two-year citation window; variants such as the 5-Year Impact Factor use a longer window, useful in slower-citing fields.
- A high JIF reflects the average citation behaviour of a journal's articles, not the quality of any one article published in it.

2. Author-Level Metrics: h-index, g-index, i10-index

Unlike the JIF, the metrics in this section are calculated directly from one researcher's own publication and citation record, ranked from most-cited to least-cited. All three are illustrated below using the same hypothetical researcher's 20 papers, so the differences between them can be compared directly on identical data.

2.1 The h-index

Proposed by physicist Jorge Hirsch in 2005, the **h-index** is the largest number h such that the researcher has at least h papers each cited at least h times. It is found by ranking papers from most- to least-cited and finding the rank at which the citation count first drops below the rank number. The h-index rewards a sustained, consistent body of well-cited work: it is not inflated by one spectacular paper, but it is also not reduced by a long tail of rarely-cited papers, since only the h papers within the "h-core" matter to its value.

2.2 The g-index

Proposed by Leo Egghe in 2006 to address a specific weakness of the h-index - that a paper with far more than h citations contributes no additional value once it clears the h-index bar - the **g-index** is the largest number g such that the top g papers, taken together, have accumulated at least g^2 citations combined (equivalently, their average citation count is at least g). Because it is based on cumulative rather than per-paper citations, a small number of very highly-cited papers can raise the g-index well above the h-index for the same researcher, so g is always greater than or equal to h .

Same Researcher, Same 20 Papers: h-index vs g-index

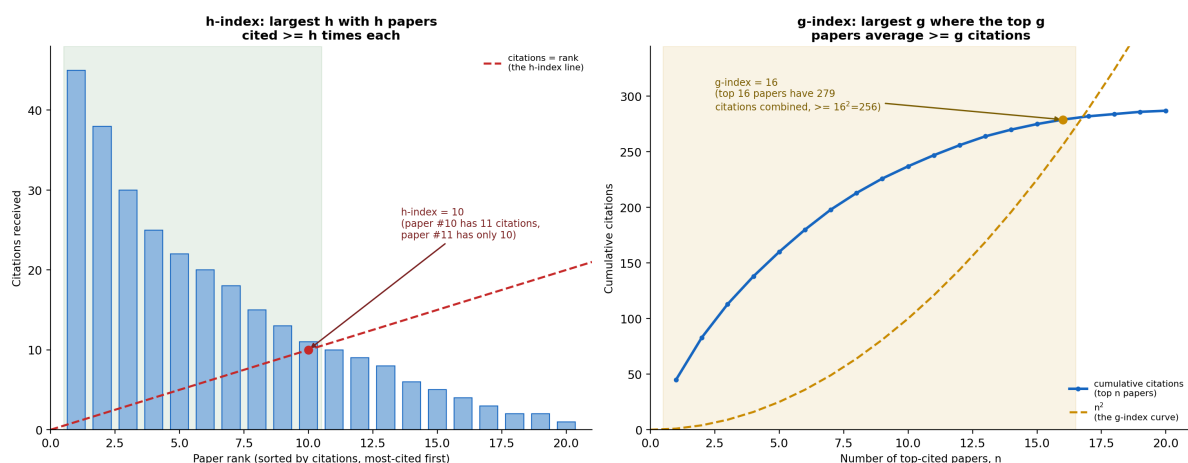
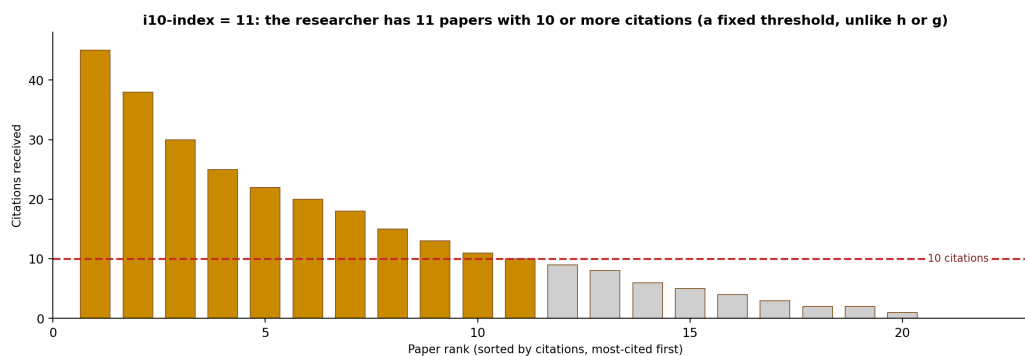


Fig. 2 - h-index and g-index computed from the same 20-paper citation record. The h-index (left) is a rank-vs-citations crossover point; the g-index (right) is a cumulative-citations crossover against n^2 , letting highly-cited papers compensate for weaker ones.

2.3 The i10-index

Introduced by Google Scholar in 2011, the **i10-index** is simply the number of a researcher's papers that have received at least 10 citations each. Unlike the h-index and g-index, which are both rank-based and adjust automatically to the size of a citation record, the i10-index applies a single fixed threshold - it is easy to compute and to explain, but it treats a paper with exactly 10 citations the same as one with 1,000, and its flat threshold makes it less discriminating for very senior researchers with many papers past that bar.



h-index = 10
*rank-based: needs h papers
 EACH individually cited $\geq h$ times*

g-index = 16
*rank-based, but lets highly-cited
 papers compensate for weaker ones*

i10-index = 11
*threshold-based: simply counts
 papers over a fixed 10-citation bar*

All three grow only with career length and rarely fall
 Because citations accumulate and are almost never retracted, all three indices can only increase (or stay flat) over a career - they reward sustained output as much as peak quality, and none of them adjusts for field, co-authorship size, or career stage.

Fig. 3 - The i10-index counts papers past a fixed 10-citation threshold. The three author-level indices are compared beneath: 10, 16, and 11 for the same researcher, reflecting each metric's different rule for what counts as "impact."

Key points

- h-index, g-index and i10-index are all **author-level** metrics computed from a ranked citation list, not journal-level metrics like the JIF.
- $g \geq h$ always, because the g-index lets a small number of very highly-cited papers compensate for weaker ones in a way the h-index cannot.
- All three indices can only stay flat or increase over a career, since citations accumulate and are almost never retracted - none of them falls even if a researcher stops publishing.
- None of the three adjusts for field-specific citation norms, co-authorship size, or career stage, so comparing raw values across disciplines or career lengths is misleading.

3. Altmetrics

3.1 What altmetrics measure

Altmetrics ("alternative metrics"), a term introduced in Jason Priem's 2010 altmetrics manifesto, track attention to research outputs in venues outside the traditional citation record - mentions in news media, discussion on social platforms such as X, citations in Wikipedia articles, coverage in policy documents, mentions on research blogs, saves in reference managers such as Mendeley, and commentary on post-publication peer-review platforms. Aggregators such as Altmetric.com and PlumX collect these signals and combine them into a single weighted score - Altmetric's "Attention Score" is the best-known example - that is displayed alongside an article as a quick indicator of its broader reach.

Because altmetric signals can appear within hours or days of publication, rather than the months or years citations take to accumulate, altmetrics are often described as an **early, complementary** indicator of an article's visibility and societal reach, sitting alongside - not instead of - the slower, more established signal of formal citation.

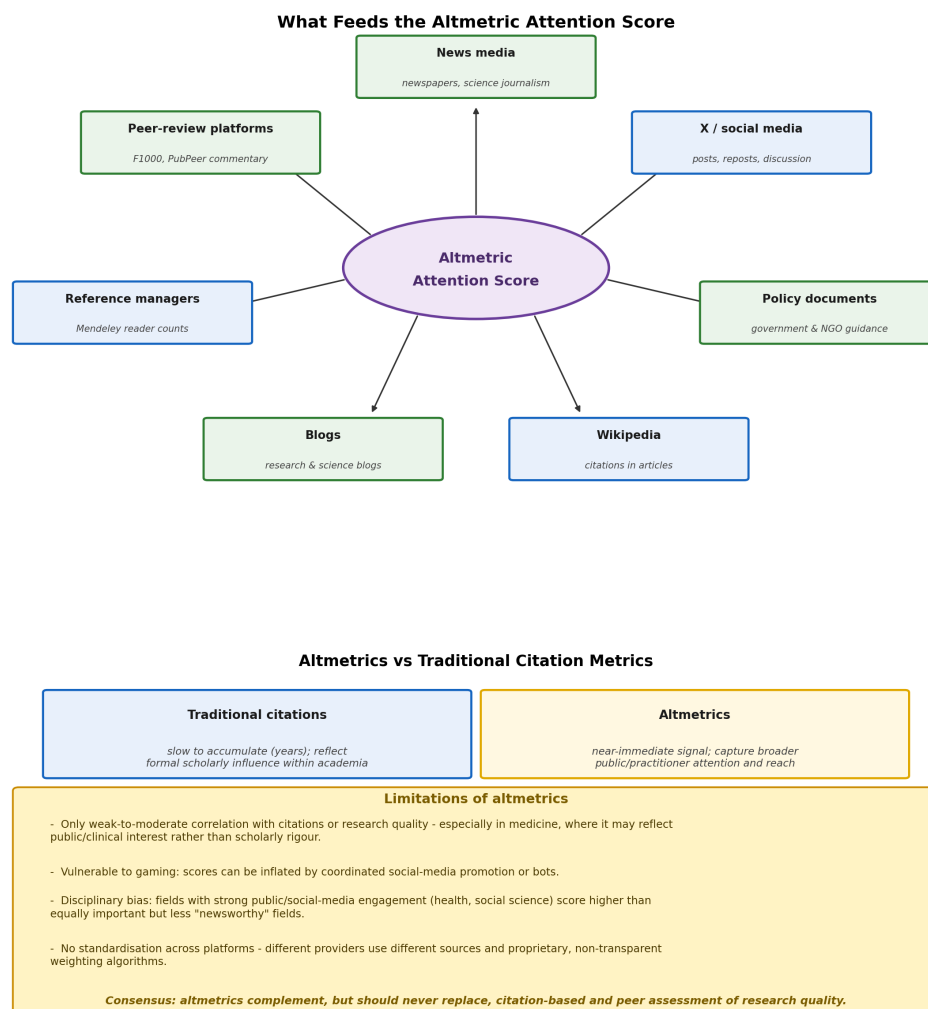


Fig. 4 - The sources that feed an aggregate altmetric attention score, how altmetrics compare with traditional citation-based metrics, and the main limitations of altmetrics.

3.2 Role and limitations in evaluating research impact

Altmetrics are most useful for surfacing the public, clinical, or policy reach of research that formal citation counts are slow to capture, and for giving early-career researchers or authors of non-traditional

outputs (datasets, software, policy briefs) some visible evidence of engagement well before citations could accrue. However, studies - particularly in biomedicine - have generally found only a weak-to-moderate correlation between altmetric attention and either citation counts or expert-judged research quality, meaning a high altmetric score reflects public or media interest more than scholarly rigour. Altmetric scores are also more vulnerable to gaming through coordinated social-media promotion, show disciplinary bias toward fields with strong public engagement (such as health and social science) over equally important but less "newsworthy" fields, and lack standardisation, since different aggregators use different source platforms and undisclosed, proprietary weighting algorithms.

Worth noting

- Major research funders and initiatives, including the Declaration on Research Assessment (DORA) and the San Francisco Declaration on Research Assessment more broadly, explicitly warn against using the Journal Impact Factor - or any single metric, including altmetrics - as a stand-in for the quality of an individual researcher's or article's contributions.
- Responsible research evaluation frameworks (e.g. the Leiden Manifesto) recommend combining several metrics with qualitative expert (peer) judgement, and always interpreting any metric in the context of its field's normal citation and attention patterns.

4. Comparing the Metrics

Metric	Level	What it captures	Main limitation
Impact Factor (JIF)	Journal	Average citations per citable item over a fixed two-year window	Says nothing about any one article; skewed by a few highly-cited items
h-index	Author	Largest h with h papers each cited $\geq h$ times	Ignores citations beyond the h-core; can never fall
g-index	Author	Largest g where the top g papers average $\geq g$ citations combined	Highly-cited papers dominate the score; g always $\geq h$
i10-index	Author	Count of papers with ≥ 10 citations (fixed threshold)	Threshold is arbitrary; does not distinguish 10 citations from 10,000
Altmetrics	Article	Attention in news, social media, policy, Wikipedia and similar venues	Weak correlation with quality; not standardised; gameable

Key points

- Metric level matters: the JIF describes a journal, h-index/g-index/i10-index describe an author, and altmetrics most naturally describe a single article.
- Every metric on this page is a proxy, not a direct measure, of research quality - each should be read alongside the others and alongside expert judgement, never in isolation.
- Citation-based metrics accumulate slowly and cannot fall; altmetric signals appear quickly but correlate only weakly with eventual scholarly influence.

5. Quick Revision Summary

Concept	Essence
Journal Impact Factor	Citations in Year X to items published in Years X-2, X-1, divided by citable items in those years
Citable items	Research articles and reviews only (the JIF denominator); numerator counts all citations
h-index (Hirsch, 2005)	Largest h: h papers each cited $\geq h$ times
g-index (Egghe, 2006)	Largest g: top g papers together cited $\geq g^2$ times; always $g \geq h$
i10-index (Google Scholar, 2011)	Count of papers with 10 or more citations; fixed threshold, not rank-based
Altmetrics	Attention signals outside formal citation: news, social media, policy, Wikipedia, blogs
Altmetric Attention Score	Weighted aggregate score (e.g. Altmetric.com) combining many altmetric sources
Shared weakness	None of these metrics adjusts for field, career stage, or co-authorship size
DORA / Leiden Manifesto	Responsible-assessment guidance: never rely on a single metric in place of expert judgement

Notes prepared for study purposes. Consult current primary literature for details required in formal citation or research use.