

RESEARCH STUDIES: Understanding Research Articles

This PIP Digest describes the parts of scientific publications and dissects key graph types to help you make your way through cancer research articles.

Key concepts

- How a scientific paper is structured
- Elements of commonly used graphs

Related PIP Digests

- Research Studies: Assessing Evidence
- Research Studies: Statistics 101
- Research Studies: More Statistics

The Structure of a Scientific Paper¹

Scientific papers can be quite complex, but they usually follow a common template. Understanding that template makes them easier to understand.

Most scientific journal articles contain:

- Abstract
- Introduction (also called Background)
- Methods
- Results (also called Findings)
- Discussion*
- References

**Sometimes the Results and Discussion sections can be presented in one combined section.*

The **abstract** is a summary of the article. Abstracts can help you quickly understand what a study is about and what the main findings are. A good abstract provides background information, describes the methods used, and summarizes the main results and conclusions. Abstracts should make sense on their own. They are almost always accessible for free, whereas the rest of the article may sit behind a paywall or subscription requirement. Abstracts can be "unstructured" (written in one long paragraph) or "structured" (broken down into individual section headings).

¹From: <http://www.understandinghealthresearch.org/useful-information/how-to-read-a-scientific-paper-4> (accessed on August 1, 2017)

The **introduction** presents the research question(s) or aim(s) and explains its significance. Introductions generally provide background about the paper's topic, including summaries of relevant research. Sometimes the introduction section does not have a title.

The **methods** section describes how the researchers carried out the research. It describes the general type of study (randomized controlled trial, case-control study, survey, etc.) and also gives more detailed descriptions of specific features (how many people were recruited, eligibility requirements, methodology for a questionnaire, etc.). Researchers must also describe how they measured their outcomes and analyzed their data. A good methods section gives sufficient detail for another researcher to repeat the study and test whether they can produce similar results.

The **results** (or **findings**) section reports the outcomes from the study. For example, if the research involved a large quantitative survey, the results section would include information about how many people completed the survey, basic information describing those people, and statistical analysis of their answers. If the method involved qualitative interviews, the findings would report on what interviewees said, using quotations from transcripts to illustrate important insights.

Where appropriate, results are shown in tables, graphs and other figures. If tables or figures are too large, complex, or numerous, they may be included on the journal website instead of in the published paper. If you are reading a study that might have extra material, look for a link to an 'Online Appendix,' 'Supplementary Data,' or 'Web-Only Data.'

The results section typically presents findings without commentary. Analysis and interpretation come in the discussion section.

If the study authors listed specific research questions in the introduction, the **discussion** section should either provide answers to those questions or explain why they are unable to answer them. Researchers also commonly discuss broader implications for their results, placing them in the context of related research studies. Researchers often make suggestions about how future research could build on their findings and how doctors or other relevant audiences might put their insights to use. Researchers also have a responsibility to discuss what, if anything, was unexpected about the findings, and disclose any limitations affecting the study. Conclusions often are incorporated into the discussion section, but they can also follow on as a short section on their own.

At the end of the paper is the **references** section, which lists details of the research papers, books, reports, and other sources that have been cited in the study, so that readers can find these sources to read for themselves.

A research paper might also include any or all of these other sections:

- Statement of funding sources crediting the people and/or organizations that supported the research. This section might be combined with the conflict-of-interest statement.
- Conflict-of-interest statement, in which researchers declare any relationships (financial or otherwise) that could add bias to the research.
- What is known: A list of previously established key insights.
- What this study adds: A summary of how this study builds on existing research.

- Highlights (or Key findings): Brief points highlighting the most important messages readers should take from the research.

Once you understand how research papers are structured, it is easier to find the information you seek. For example, if you see a headline about a new treatment and are curious about how similar the people in the study are to you, you can quickly locate the sampling strategy description in the methods section. Some experts suggest that the best way to determine if a scientific article is relevant is to read it in the following order:

1. Abstract
2. Discussion
3. Introduction
4. Results
5. Methods

Assessing a Scientific Paper

Assessing evidence can be a complex process. Even researchers do not always agree on the best ways to check the credibility of studies. Researchers commonly arrive at different conclusions about the same piece of research.

Understanding Health Research (<http://www.understandinghealthresearch.org/>) is a tool designed to help people review, understand, and decide how dependable and relevant a piece of research is. The tool guides users through the questions to ask about specific types of health research and helps them understand what the answers say about the quality of that research.

Understanding Graphs

Cancer research papers, scientific posters, and scientific presentations are often filled with different kinds of graphs. Some graphs are much more effective at conveying information than others! Well labelled graphs, with a descriptive title and clearly identified elements can be very helpful in making key results identifiable and understandable.

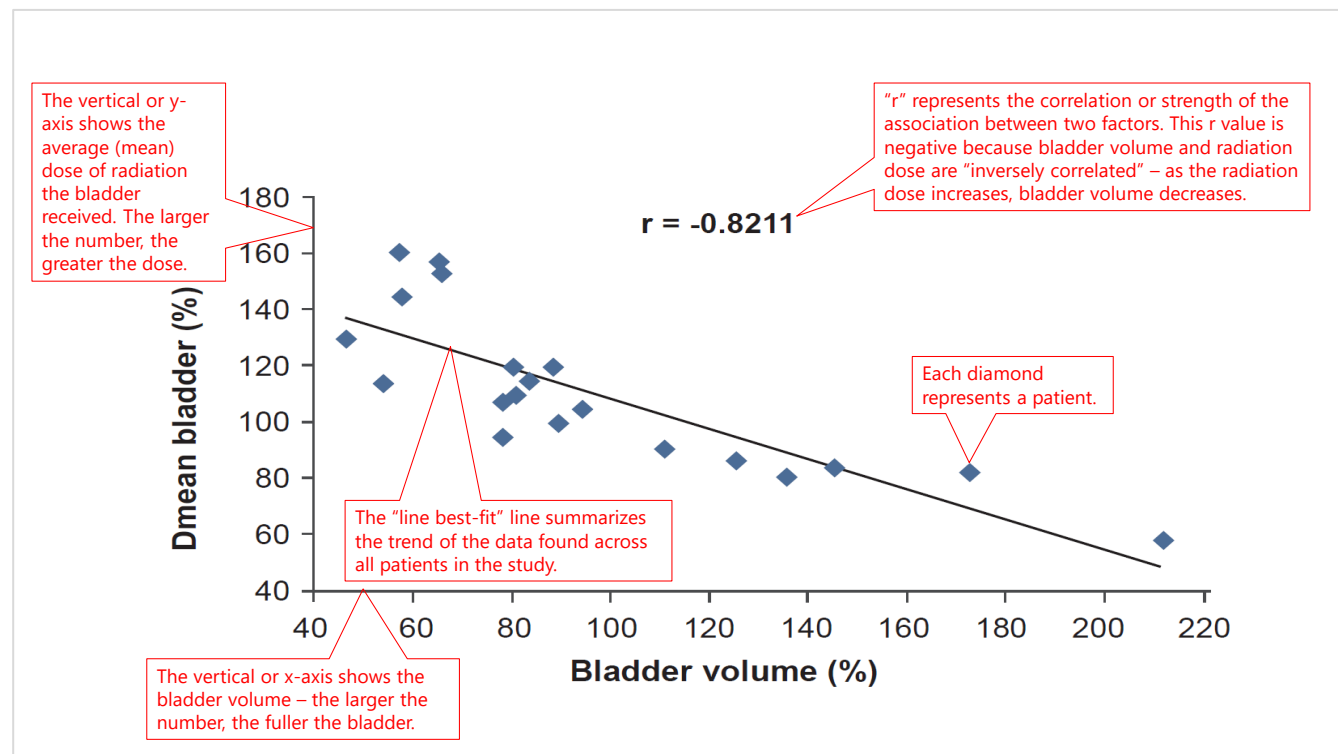
Four types of graphs commonly appear in clinical cancer research, research articles:

- Scatter plot
- Waterfall plot
- Survival curve
- Box plot

Here are annotated examples of each type:

Scatter Plot

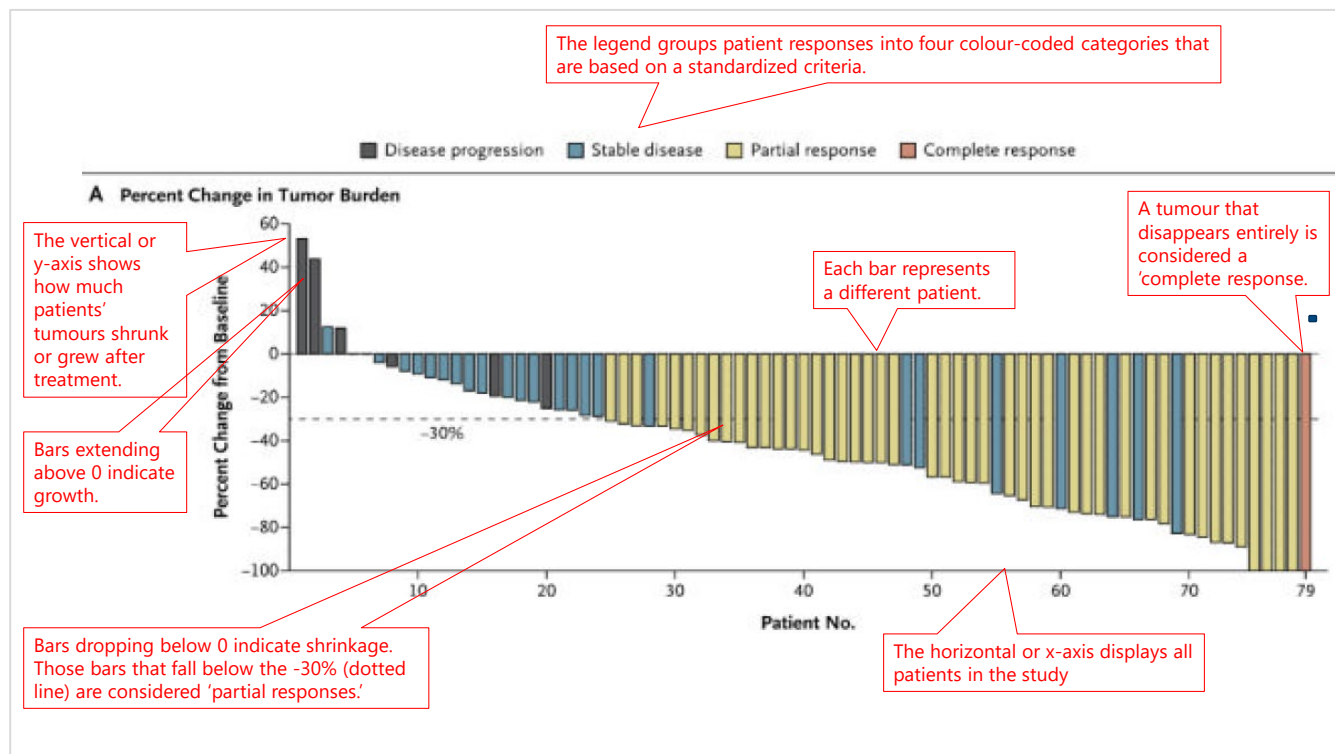
A scatter plot shows an association between two sets of data. This scatter plot compares bladder volume with the average dose of radiation the bladder receives during prostate radiotherapy for 20 patients. It shows that emptier bladders absorb more radiation.



Graph from: Fuchs F et al. (2019). Interfraction variation and dosimetric changes during image-guided radiation therapy in prostate cancer patients. *Radiation Oncology Journal*, 37(2):127–33.

Waterfall Plot

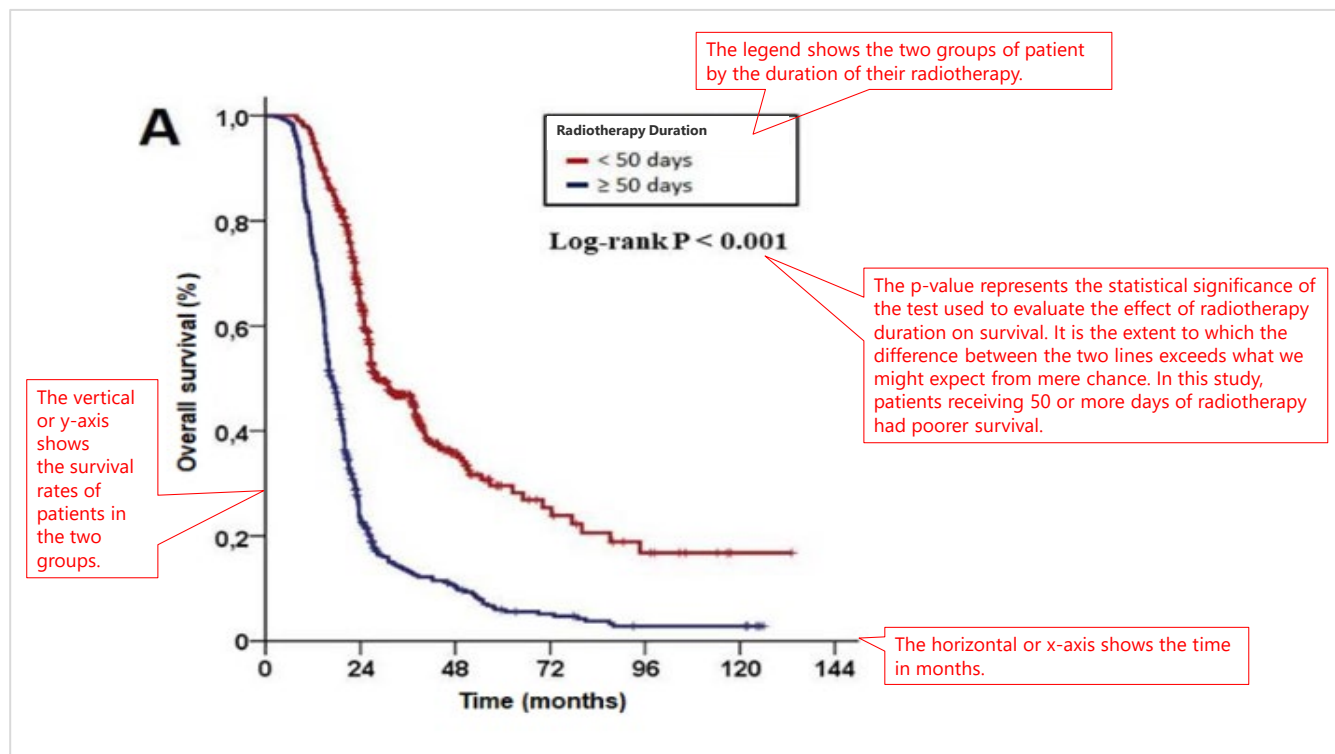
A waterfall plot shows the range of outcomes for all individuals in a study. This graph shows how 79 lung cancer patients responded to a new drug treatment. A waterfall plot typically displays worst to best outcomes from left to right.



Graph from: Kwak EL et al. (2010). Anaplastic lymphoma kinase inhibition in non-small-cell lung cancer. *New England Journal of Medicine*, 363(18):1693-703.

Survival Curve

A survival curve depicts the outcomes of a specific group of patients over time. This survival curve shows how patient survival differed for lung cancer patients who received 50 or more days of radiotherapy along with chemotherapy and those who had fewer than 50 days of treatment.

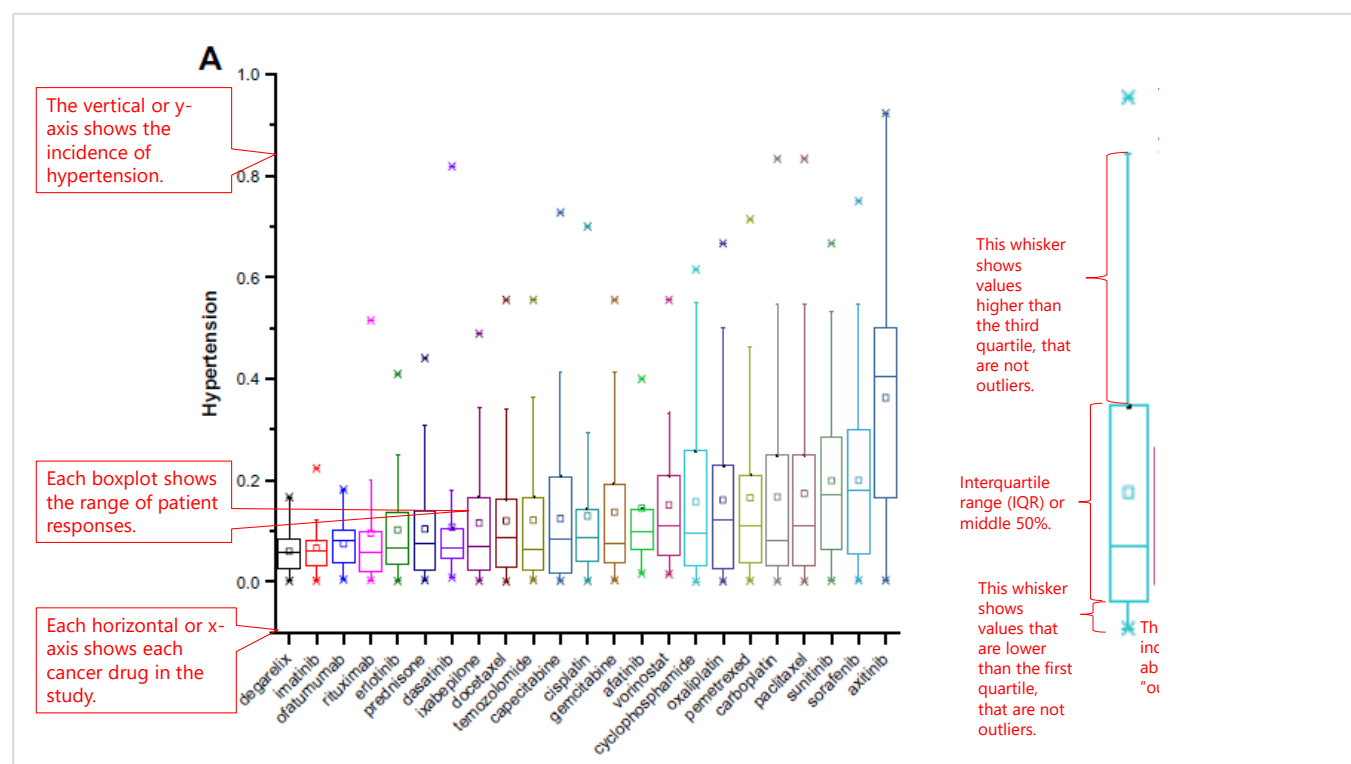


Graph from: Topkan E. et al. (2019). Significance of overall concurrent chemoradiotherapy duration on survival outcomes of stage IIIB/C non-small-cell lung carcinoma patients: Analysis of 956 patients. *PLoS One*, 14(7):e0218627.

Box Plot

A box plot shows how much results vary within a given test or experiment. This box plot compares the rate of hypertension experienced by patients on different cancer drugs. From left to right, it shows the drugs with the fewest to the most adverse effects.

The box plot system can illustrate patient responses that are typical, unusual, or outliers. On the right, we have expanded one element of the plot to illustrate these variations.



Graph from: Luo J & Cisler RA. (2016). Discovering outliers of potential drug toxicities using a large-scale data-driven approach. *Cancer Informatics*, 26(15):211-7.

Check out this video for more information:

- University of Minnesota Libraries. *How to Read and Comprehend Scientific Research Articles*. (YouTube) November 21, 2014 [5:03 minutes] <https://www.youtube.com/watch?v=t2K6mJkSWoA>