The Results Section

4

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4.1 Introduction

The Results section is the part of a research paper that answers the third of the four questions of Sir Austin Bradford Hill, namely, 'What did you find' [1]. It follows the Methods section, which has already answered the question 'What did you do?' [1]. It is therefore logical that results of all the steps enumerated in the Methods must be provided, preferably in the same sequence as their description in the Methods. Also, it is expected that all results would have corresponding methods described and that no new data would suddenly appear in the Results section.

A cardinal rule while writing this section is that it is better to err on the side of excess. It is better to provide your results in more detail than ending up with a Results section that leaves the reviewer or a reader feeling that he needs further data to fully understand your findings. This has become even more important in recent years, with meta-analyses becoming common—it is at times impossible to include in such analyses those papers whose Results sections provide inadequate details. Thus, the emphasis is on providing more data; the issue of consequent increase in the size of manuscripts has been resolved through the use of supplementary data section (*see below*).

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4.2 Three Components of Results

Results are usually provided in three components: text, tables and figures (or graphics). These three components should be used synergistically, taking care to avoid repetition of the same information in text and in accompanying tables and figures. However, this advice should not be used as a justification for statements in text such as: 'The results are presented in Tables I to V and Figures 1 to 3'. Such statements are a nightmare for editors and reviewers and hinder effective communication of the findings to the readers. Instead, important messages derived from data in tables and figures should be briefly spelt out in the text and possibly without actual numbers. Such text serves to complement the data shown in the tables and figures, which though should be understandable even without referring to the text.

In contrast to oral presentations, tables are preferred over figures in written presentations. This is because numerical data in a table are more accurate and detailed than those in the graphic format and because a journal reader has more time available to understand a complex table than an audience listening to a talk. Also, numerical data in tables are more amenable to use in subsequent meta-analyses. However, some data are more amenable to graphical representation (e.g. a scatter diagram showing relationship of two variables or a line showing temporal trend of a variable) since the latter conveys the message at a glance.

4.3 Contents

4.3.1 Study Subjects and Groups

The Results section generally begins with a description of the study subjects (patients in clinical studies, clusters in cluster-randomized community trials, animals in experimental studies, etc.) and study groups (e.g. placebo and treatment groups in a drug trial). It helps to provide full details as the readers can then assess whether all the study subjects fulfilled all the inclusion criteria, how they compared with those that the readers encounter in their practice, etc. This is particularly important when data have been generated at a tertiary referral centre, whereas the inference of the study will be applied at the primary or community care level, where the patients may differ from those seen in the referral setting. It helps to provide a table with the salient features of the study subjects; however, if this is done, the same information must not be repeated in the text.

In a study where the subjects are classified into two or more groups that are treated or followed-up differently (for instance, in a drug trial), information on the number and condition of subjects included in each group should be provided. This is often best done using a table containing a column for each study group. This allows the readers to compare the groups quickly. Whether p values for statistical comparison of various characteristics between study groups should be shown is a matter of debate; however, it is increasingly being considered inappropriate when a process of randomization has been used to assign subjects to two groups.

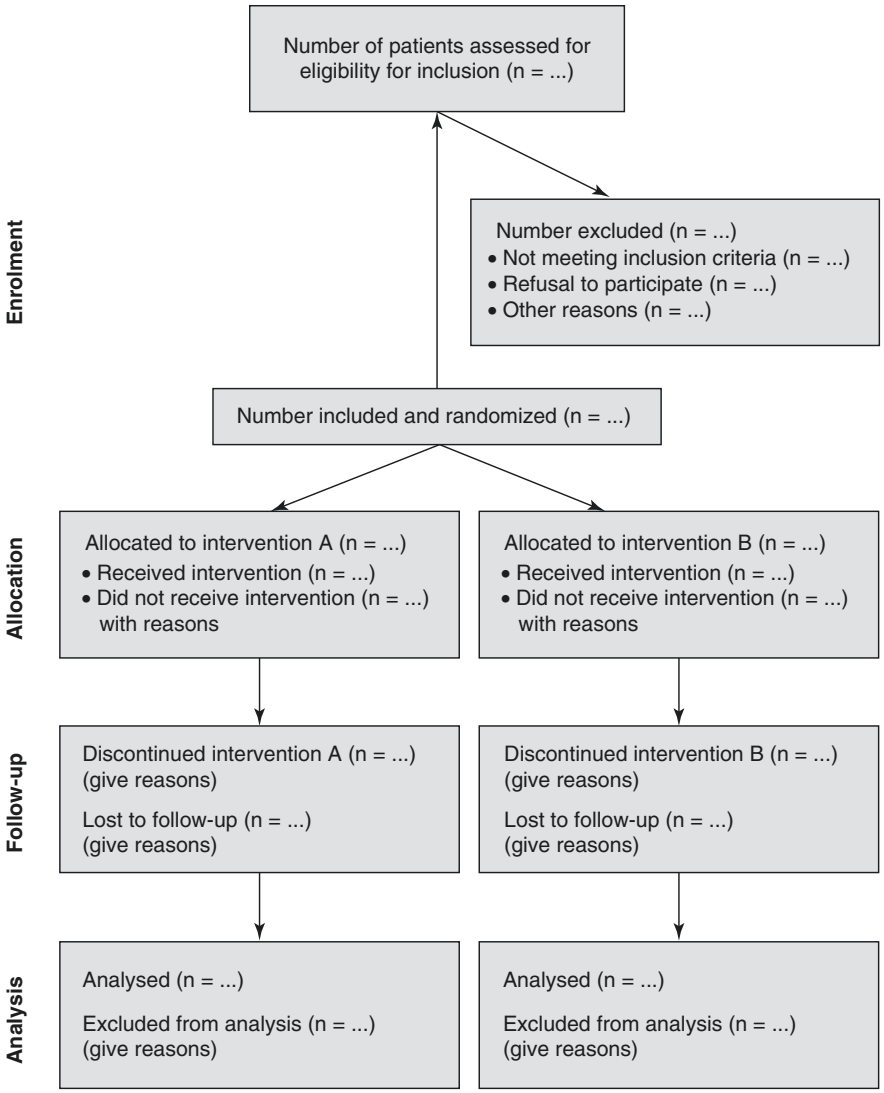

Fig. 4.1 Diagrammatic representation of the flow of patients in a drug trial

4.3.2 Flowchart for Study Subjects

For interventional studies, it is almost mandatory (*see* Chap. 18 on 'Reporting guidelines') to show the flow of patients through various phases (i.e. enrolment, intervention allocation, follow-up and data analysis) of the trial [2]. Such a graphic, known as the CONSORT flowchart (Fig. 4.1), helps the readers know the proportion of patients who fulfilled the eligibility criteria, agreed to participate in the study, completed the treatment, etc. It is also important to mention the proportion that dropped out and the reasons thereof, and the cause of death if any subject died

during the study period. Most good journals insist that the CONSORT statement, including providing a checklist and flowchart, is followed, because this helps improve the reporting of randomized controlled trials. This, in turn, enables readers to better understand a trial's conduct and to assess the validity of its results. In a graphic of this type, the numbers must add up correctly so that all subjects who were screened or included in the study are accounted for. Any discrepancies may be interpreted by reviewers (or readers) either as representing carelessness in data collection, organization or analysis on the part of authors or as an attempt to hide data; neither of these interpretations is charitable to the authors.

4.3.3 Results of Various Measurements

The section on description of study subjects is followed by the results of various experiments. It helps to present these in the form of a story; this is possible only if the results are presented in a chronological or a natural order. It does not necessarily mean the order in which the experiments were done; instead, it implies an order that makes for an easier understanding of results. For instance, if the study involves collection of several types of information in a group of subjects, the natural order may be to begin with clinical data and move sequentially through biochemical and serological data to genetic data. The aim is to progress from simple to more complex information. If the Methods were grouped and ordered in several subsections, the Results should follow the same order.

The Results section should have the information on all the variables that were evaluated, as outlined in the Methods section. No variable should be included in the Results if it was not included in the Methods. Similarly, if the assessment of a comparison or relationship was not mentioned in the statistical methods section, there is no place for it in the Results section.

If one is not sure of the sequence in which various results should be presented, a look at some similar papers may be useful. While doing this, one must avoid the temptation to use the text from such a paper as a template, lest one be guilty of plagiarism.

4.3.4 Numerical Data

For numerical data, actual values are preferred over percentages; the latter may be included in parenthesis after the actual numerical values. The only exception perhaps is large cohort studies with several thousand subjects, where percent values alone may be provided. Though frequently used, percent values are misleading if the number of observations is fewer than a hundred. Their use for observations sets of fewer than 50–70 should be discouraged.

Computer software programs automatically calculate means and ratios to several decimal points beyond that in individual observations. Authors often reproduce these as such in their results. The increased number of digits is misleading. One must remember that the values of mean and standard deviation cannot have a degree

of accuracy higher than those of the original observations, and hence the use of any additional digits must be avoided. However, others believe that one extra digit beyond that in the original data after the decimal point is acceptable.

Results must be specific and unambiguous. Adjectives such as 'most', 'some' and 'often' should be avoided, as these might convey different meanings to different people.

4.3.5 Statistical Aspects

Data should be summarized using appropriate measures of central tendency and dispersion (or variability). Mean and standard deviation (SD) are the most frequently used measures for this purpose; however, if the data are not normally distributed, median and interquartile range (or range) should be preferred. Authors often confuse SD with standard error (SE) and provide a measure of variability of data without specifying whether it is SD or SE; this must be avoided. Most journals today require authors to also provide confidence intervals around the estimate, since these provide additional useful information.

Probability values may be given as actual p values, or as being above or below a cut-off (e.g. $p < 0.05$ or p = ns, depending on whether or not the test result was statistically significant). However, when using the former option, any p values below 0.001 are usually rounded off to $p < 0.001$; also, one must know that p values can never be zero. One must avoid adding adjectives to the interpretation of the p value ('highly' significant, 'very highly' significant, etc.). Similarly, statistically speaking, differences that are non-significant do not exist. For instance, it is wrong to say 'Increase in weight of animals receiving the dietary supplement was higher than that of animals receiving the conventional diet, even though the difference did not reach statistical significance'. Similarly, it is better to avoid phrases such as 'trend towards significance', 'just short of significance', etc.

4.4 Tables

Tables are frequently used for presentation of data in the Results section. In fact, their use is often indispensable. They allow for a large amount of information to be presented in an organized manner within a small space. They also make for easy retrieval of the required information even though the entire table may appear quite intimidating. For instance, let us consider either the log tables that we used in school or the railway schedule. These are examples of large tables which are referred to only when required. We use these since there is a lot of information placed in a few pages.

A table is an appropriate method of presenting data in a research paper when the aim is to (1) summarize the research findings from a set of experiments done in several study subjects, (2) allow comparison of specific data from two or more groups, (3) relate one set of data to another making their relationship clear (e.g. the relation of weight of animals with their age) and (4) provide raw data to enable

readers to make calculations for themselves. When large amount of data are generated, as in epidemiological studies or hypothesis-free laboratory experiments (e.g. microarray or proteomics experiments), the number and size of tables may far exceed the space limit set by a given journal for a printed paper. Most journals today ask authors to submit even such raw data with their manuscripts as an addendum. Journals place such data in electronic format on their website (using labels such as supplementary data, web extra material, additional data, etc.) while printing only the most important tables. Interested readers can then download these supplementary data for viewing or reanalysis. However, such data are usually made available on an 'as-submitted-by-the-authors' basis—without a close examination or formatting. Hence, one must be particularly careful, as any errors in these data are unlikely to be picked up during the peer-review and publication process.

A good table must be compact and complete, i.e. it must be understandable without any detailed reference to the text of the paper. The data in a table must be accurate, important and related to each other; it is not a good idea to include several types of disparate (say clinical, biochemical and radiological) data in one table; in such cases, it may be preferable to create two or more tables, each dealing with data on one aspect. The format of the table must be clear and simple. This can be done by using logical groups for rows and columns and removing any unnecessary ones. A consistent style and terminology should be used throughout the table. The groups to be compared should be so placed that for comparison, the eyes move from left to right, and not from top to bottom.

A table consists of the following parts: (1) a title, (2) rows and columns, (3) row descriptors and column headings, (4) stub (heading for the first column that contains row descriptors), (5) the data in various cells (intersection of each row and column) and (6) footnotes and explanatory notes, if required (Fig. 4.2). Omission of any of these may render the table difficult to understand. Each table must have a short title, which should preferably be self-explanatory and not contain abbreviations. Explanations for all abbreviations and symbols used in a table should be included as footnotes. Symbols for footnotes vary from journal to journal, and the instructions for authors need to be consulted. Some journals use alphabets, others numerals and

Title: Parts of a table

Stub	Column A heading	Column B heading	Column C heading	
			Column C1 subheading	Column C2 subheading
Row 1 descriptor	Cell	Cell	Cell	Cell
Row 2 descriptor	Cell	Cell	Cell	Cell
Row 3 descriptor	Cell	Cell	Cell	Cell

Footnote and explanatory notes

Fig. 4.2 Various parts of a table. Each of these components must be present in a table, except footnote and explanatory notes which are optional

still others symbols, such as *, †, ‡, §, ¶, **, ††, etc. Units of measurement for each variable and the nature of the summary measures used (mean or median, SD or SE, confidence intervals) should be given; where statistical comparisons have been done, *p* values should be included in the table, either as a separate column or in a footnote.

Each table should be double spaced and placed on a separate page. Tables should be numbered consecutively in the order of their first citation in the text. Vertical rules should not be used within the table since these interfere with reading. Most journals use computer software to convert the electronic files submitted by authors into print files; complex formats and internal rules can interfere with this conversion process. Most journals thus prefer tables to be submitted as separate spreadsheet files or in a generic format (.txt or .csv files).

Some journals may limit the number of tables and figures for a particular type of article. Others may want authors to reduce the number of words in the text to accommodate an extra table or figure. It is therefore wise to check the 'instructions to authors' of the journal to which one plans to submit the manuscript and familiarize oneself with the type of tables and figures in recent issues.

4.5 Figures (Graphics)

The eyes and brain are better at picking up visual clues from pictures than from a set of numbers. Thus, it is easier to convey a message through illustrations than by using tables.

Graphics used in the Results section can be of several types [3], namely, (1) photographic pictures (including radiology images, nuclear scans, pathology images, etc.); (2) line diagrams of surgical findings, surgical technique or other data; (3) graphs or data charts (including pie diagrams, bar diagrams, line diagrams, scatter plots, etc.); and (4) graphics showing molecular data (nucleotide sequences for DNA or amino acid sequences for proteins) which consist primarily of text matter. Each of these types of graphics needs special attention (*see below*). All figures must be professionally drawn, using a computer program. Handwritten or typewritten labels on figures are not acceptable.

4.5.1 Photographic Images

Photographs are used to document observations. These include photographs of patients, radiological data (including CT scans, ultrasound, magnetic resonance imaging, nuclear scans), intraoperative findings, surgically resected specimens, histology slides, electrophoresis gel pictures, fluorescence microscopy images, etc. Such pictures often contain colours or a wide range of greys (known as continuous tone, grey-tone or half-tone pictures). Photographic prints are also frequently used for reporting of physiological data (e.g. electrocardiographic recording of an arrhythmia, electroencephalography recordings, pressure recordings in an animal

experiment, oesophageal manometry recordings, etc.) though in such settings, only two (black-and-white) or a few shades of grey may suffice.

A good photograph must be (1) true to the original, (2) clear and have good resolution, (3) of an appropriate size (appropriate reduction or enlargement), (4) of full tonal range for continuous-tone images and a sharp contrast for black-and-white images and (5) accompanied by a legend which explains the features included in the picture. To ensure good-quality reproduction, one needs to pay attention beginning with the initial data acquisition itself. Newer imaging devices allow images to be exported directly to a computer file in a digital format; the quality of such exported images is much better than that of photographs made from printouts or X-ray films. It is helpful to read the manual or consult the manufacturer in case of a specialized imaging device (e.g. radiology equipment) to obtain better-quality images. The images must be acquired at the highest resolution possible—one can always downgrade the resolution later if needed; the converse is not possible.

The area or object of interest must be placed near the centre of the picture. Unnecessary details should be trimmed. It helps to use as few intermediate steps as possible to go from the original picture to the final version because each step is associated with a loss in quality. The size of the final version submitted should be such that the journal does not need to either magnify or reduce its size; thus, it helps to make its width equal to either one column or two columns of the journal's printed page. It is helpful to look at a recent issue of the journal to which the paper is planned for submission to find out whether the journal prefers figures in column width or page width.

For photomicrographs, it is sometimes useful to combine more than one related photographs in one picture (e.g. showing different stages of a disease). The component images should be of similar brightness and contrast. The space between the components of such a composite figure should be just adequate to allow the components to be seen as separate. If images at two different magnifications are to be shown, it may be useful to include the more magnified image as a small inset (preferably in the right lower corner), taking care that important features of the larger picture are not obscured. It is also important to provide an internal scale within the picture or provide a measure of magnification in the figure legend; the former is preferable since the magnification factor may be altered by enlargement or reduction during the printing process.

Important features on the picture may need labelling. The labels should be short and unobtrusive, preferably in the form of single letters whose meaning can be explained in the figure legend. The labels should have an appropriate and uniform font size. Sans serif fonts, such as Helvetica or Arial (which lack thin horizontal extensions), are preferable. Labels should have a colour that contrasts with the background (black when the background is light coloured, and white when the background is dark); if a good contrast cannot be obtained, it may be useful to add a black or coloured square over the picture and place the letter over it in a contrasting colour or shade. Labels must not obscure important features of the underlying picture; use of arrows and lines may allow the labels to be placed away from the object being labelled. Also, arrows of different shapes and sizes can be used to mark different elements within an image and each arrow explained in the legend, to

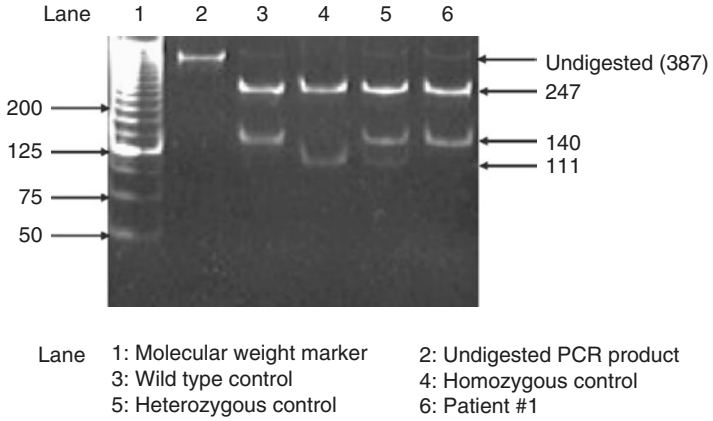

Fig. 4.3 An example of a well-labelled electrophoresis gei picture. The lanes have been numbered and description of each lane is included. Selected molecular weight marker bands are marked on the left and bands of interest in various specimens are marked on the right. Use of thin arrows helps accurate localization of the bands of interest. The labels used are unobtrusive and do not interface with the picture

eliminate the need to place text labels within the picture. One may try several possible methods of labelling and decide on the best one, possibly in consultation with one of the co-authors or another colleague. An alternative to labelling is to prepare an accompanying line diagram corresponding to the picture and label various structures in it.

Different areas of work and type of images may have their specific requirements. For instance, for gel images, it is important to label each lane and to label the bands of molecular weight markers (Fig. 4.3). It may be worth marking individual bands of interest.

It has become easier to modify/manipulate computer-based images by introducing changes in brightness and contrast, using colour filters or touching-up of details. It is unethical to change the image characteristics to such an extent that the message is altered.

For patient photographs, it is important to obtain the patient's written permission for publication and to use masking to maintain the patient's privacy and anonymity. Also, for radiographic images, care must be taken to remove patient identification information.

Photographs of physiological data (pressure tracings and graphs) can be either continuous tone or black-and-white, the latter being preferable. If these data have been recorded on a graph paper or a paper with grid lines, the background grid interferes with understanding. Therefore, for publication, it is better to record such tracings on a plain paper without a grid. Alternatively, if the grid and tracing are in different colours, it is possible to eliminate the grid by using a colour filter on the camera. Scales for both the variables (along the X- and Y-axes) must be included (Fig. 4.4).

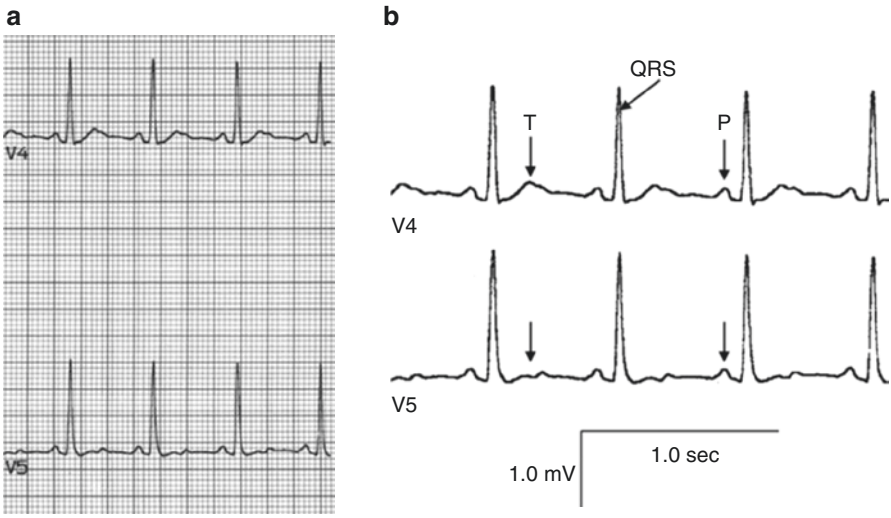

Fig. 4.4 A poor and a good picture for the same data. Section (**a**) shows a black and white picture of electrocardiography recording in which the background grid interfaces with the graph, the two graphs are widely separated leading to wastage of space. In (**b**) grid lines have been removed, the two tracings have been brought closer to each other to save space, and the relevant features have been marked using labels and arrows. Note that scale for both the X-axis and the Y-axis have been added

4.5.2 Line Diagrams

In biomedical science papers, line drawings are sometimes used for reporting data, depicting surgical findings, profiling family trees in inheritance studies, etc. These should be prepared using either a computer program or a drawing by a professional using a black ink pen to produce lines of uniform thickness. In the latter case, labelling should be done using a stencil to ensure a uniform font and letter size. Alternatively, the manual drawing can be scanned and typeset labels added. It should be made clear what each line represents. If the lines intersect, care must be taken to ensure that there is no ambiguity about how each line travels.

4.5.3 Graphs or Data Charts (Pie and Bar Charts, Line Graphs, Scatter Plots and Maps)

Graphs are a powerful medium to summarize and communicate numerical data. However, as discussed above, data tables are preferred over graphs for publication purposes. There are several forms of graphs, each with its specific uses.

Pie diagrams. A pie chart consists of a circle with several wedge-shaped pieces. It is used to indicate the components of a whole group. Each sector (or wedge)

stands for one component, and the area (and hence angle) of each sector is proportional to the size of the component it represents. Pie charts are easy to understand and have a strong visual impact. In a good pie chart, each sector is labelled and filled with a colour or pattern that is easily distinguishable from that of other sectors. The number of sectors should not exceed ten and no sector should be so small as to be virtually indistinguishable. Each sector should represent the number of observations or percentages. Many software programs allow for 3D pie charts, but one must avoid the temptation of using them as in these, the eye cannot easily make out the relative size of each sector (Fig. 4.5). Pie charts have limited use in research papers. These may be used when large amount of data are available, e.g. in an epidemiological study, for small data, a table or a text sentence may be preferred.

At times, two pie charts may be combined to illustrate the differences in distribution of various components between two groups.

Bar charts. These compare one or more sets of measurements using bars (usually vertical) whose heights represent the magnitude of measurement (Fig. 4.6a). Occasionally, horizontal bars are used; this allows long labels for each bar (Fig. 4.6b). Bar charts should be used to compare values of one variable across two or more groups (Fig. 4.6c), and at different time points. More complex bar charts compare the values of several variables. Stacked bars can show a comparison of the total value of a variable and that of its components across different groups (Fig. 4.6d).

Histograms. These are similar to bar charts, except that the bars are placed touching each other and only their tops are shown (Fig. 4.7a). They convey the time course of an outbreak of a disease or the age distribution of a group, etc. Sometimes, a line is used to connect the midpoints at the top of each 'bar' in a histogram to generate a 'frequency polygon' (Fig. 4.7b).

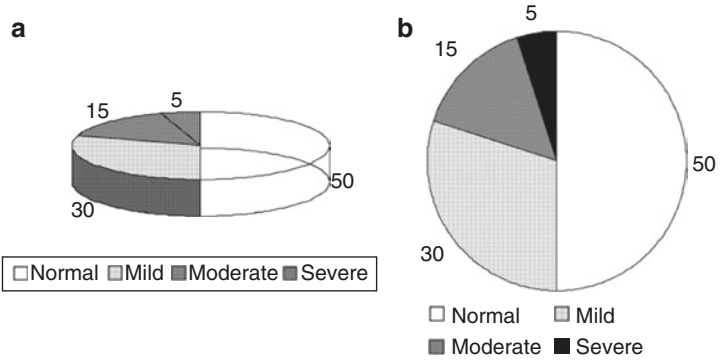

Fig. 4.5 A poor and a good pie chart; In (**a**), the 3-dimensional format interferes with understanding of the graph, the data labels are too small, the filling patterns of the two smallest sectors are indistinct from each other, and the legend has a small font and an unnecessary box around it. In the improved version (**b**), the 2-dimensional format makes for easy understanding, the data labels and legend are larger, and the box around the legend has been removed, and the legends and data labels now use the same font type and size

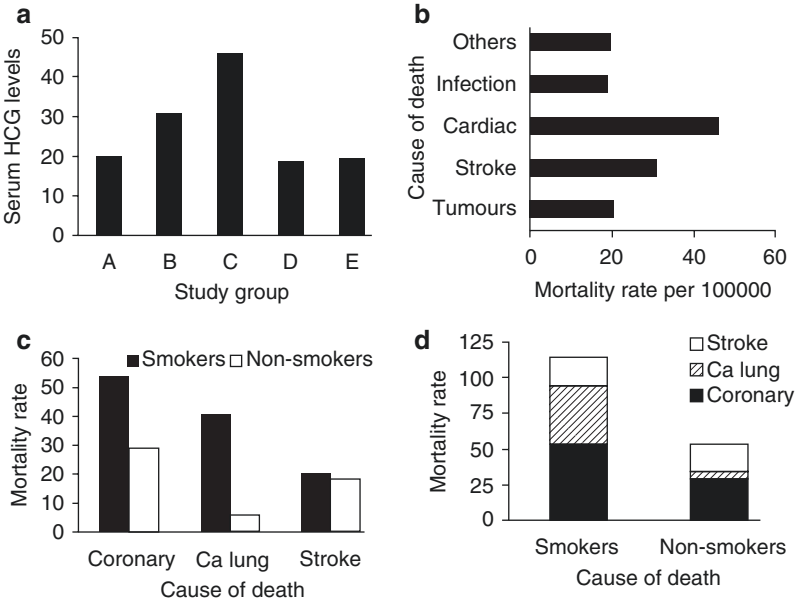

Fig. 4.6 Types of bar charts. Panel (**a**) shows a simple bar chart. Panel (**b**) shows a horizontal bar chart that is useful when the group names are long. Panel (**c**) shows a multiple bar chart; this format arrows comparison of several variables in two or more groups; in these charts, care must be taken to ensure that the bars to be compared with each other (smokers and non-smokers) are placed next to each other. Panel (**d**) shows a stacked bar chart; this format allows comparison of totals as well as various components (here, total mortality and mortality due to various causes)

Line graphs. A line graph can be thought of as a bar diagram where the midpoints of the tops of each bar have been joined by a line. These graphs emphasize the change in a variable rather than the absolute values. Thus, this form of data representation is used where change is important, for instance, to show the change in serum concentration of a drug over time or change in a measurement with age (Fig. 4.8).

Scattergrams. These charts show the relationship between two numerical variables. The value of one variable (usually an independent variable) is shown along the X-axis and that of the other (usually a dependent variable) is shown along the Y-axis (Fig. 4.9). Each study unit (e.g. each patient) is represented by a dot (or a data point). Thus, the chart has as many data points as the number of study units. These charts provide a strong visual impression of the relationship of change in one variable with that in the other. Thus, placement of data points along a line from the left lower corner to the right upper corner indicates an increase in the value of the dependent variable with an increase in the value of the independent variable. Also, data points placed closely together suggest a strong relationship, whereas widely scattered data points indicate a weak relationship. Computer programs allow a trend line to be drawn across the scatter diagram along with the statistical calculation showing any correlation between the two variables; however, the use of such a line should be a deliberate decision, with no scope for misinterpretation.

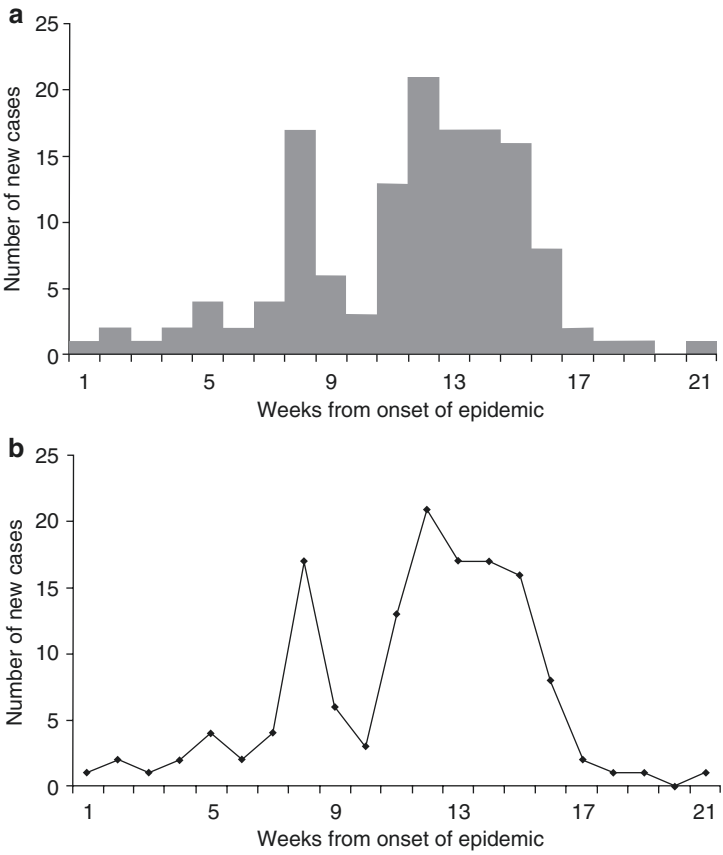

Fig. 4.7 (**a**) An example of a histogram. Such charts are useful for showing age distribution of a population, time course of an outbreak, etc. (**b**) Frequency polygon. This figure shows exactly the same data as shown in (**a**) but in a different format

Fig. 4.8 Line diagrams. These show change with time or time trends much batter then bar graphs. Different lines must be drawn in different styles and a legend describing each line must be included

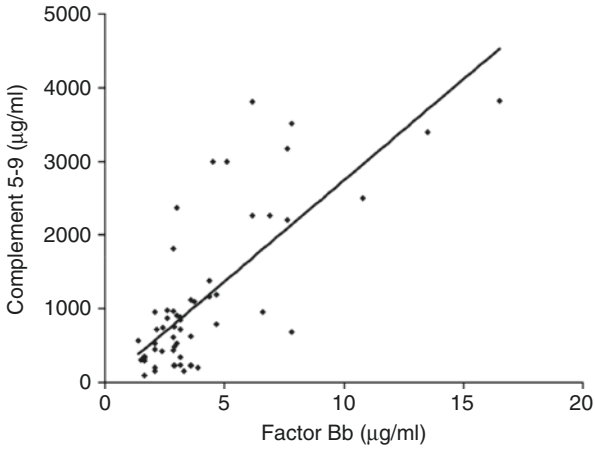

Fig. 4.9 A scatter diagram with a regression line

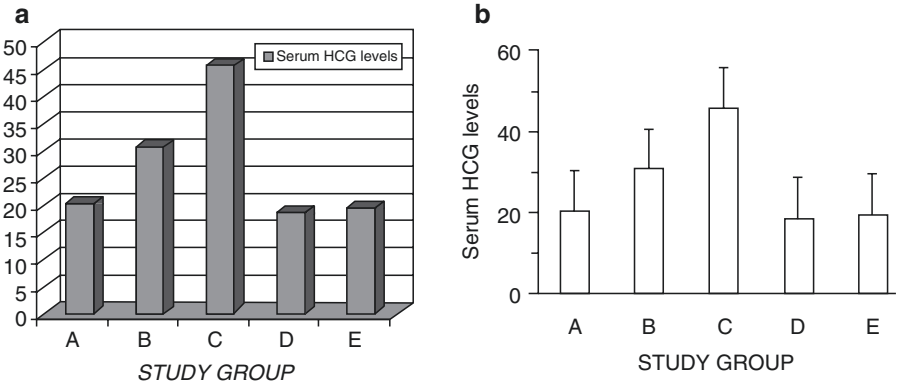

Fig. 4.10 A poor bar diagram (**a**) and its improved version (**b**). The poor diagram has 3-dimensional bars (the third dimension adds to clutter and makes it difficult to read the value corresponding to each bar on the Y-axis), grid lines (add to clutter), has too many labels on the Y-axis (add to clutter) in a small font (unreadable), and has no label to indicate what it represents (serum HCG levels). The X-axis has a thick line where none is necessary (there is no continuum along X-axis). The X-axis legend is in all capitals (difficult to read) and uses italics font (reduces readability). A legend box included in the right upper corner is not needed (necessary only if the chart has bars of two or more types which need to be distinguished from each other). The improved version (**b**) is much less cluttered, has few unnecessary lines and provides some additional information (error bars added)

4.5.4 Preparation of Graphs

All graphs should be drawn professionally. Use of computer programs has made their preparation easy. However, automatic settings of these programs often produce cluttered graphs. To prepare a good-quality graph, one needs to pay attention to each component by using as little 'non-data' ink as possible (Fig. 4.10). The axis lines

must not be too heavy or should not extend far beyond the last group or observation. The two axes should intersect at zero. Starting one or both axes at a non-zero value can be misleading and falsely exaggerate differences; if this is done, then it should be clearly indicated. The nature of scale—whether arithmetic or logarithmic—must be clear. If any of the axes has a discontinuous scale, the change must be indicated by a scale break. Each axis must carry a label indicating the variable it represents. The labels should be large enough to be legible but should not be too large and must not be in capital letters; sans serif fonts are usually preferred. The label for the Y-axis can be placed either vertically along the axis line or horizontally above the Y-axis line. The number of tick marks and labels indicating their values on each axis should generally be limited to 4–6.

The symbols used for different groups (say circles, triangles, diamonds, squares—each filled or unfilled) should be distinct and of appropriate size. Similarly, the patterns used in various bars should be well defined. If a paper has several figures, the pattern used for each group must be consistent for all. In bar and pie charts, a legend should clearly indicate what each pattern (filled, hatched, not filled, etc.) stands for. Variability in data can be shown using vertical lines equal in length to the SD extending above or below (or both) from the mean (i.e. from tops of bars in bar graph or the markers in a line graph). Use of three-dimensional bars, bold fonts and shadowing for text character and grid lines should be avoided.

4.5.5 Use of Geographical Maps

Geographical maps portray selected information and knowledge derived from scientific observation. They occasionally accompany papers on epidemiological studies and show the areas affected by a disease.

Maps may contain several different types of information, such as the distribution of a disease-causing agent (such as a vector or animal), or a timeline if a disease is spreading outward from a smaller area. If directed at health agencies planning a response, health centres and transport links might be shown.

Maps should be uncluttered. Do not name too many towns or physical features but try and show a few locations that are necessary to convey the key message. It is useful to show physical features close to the margins of the map so that a reader can quickly locate the area that he is looking for.

Maps should have a clear title, a clear legend, and an internal line scale. Do not use a scale expressed as a ratio (e.g. 1 cm = 5 km) unless the journal editors request you to do so; this is because the image may be enlarged or reduced during the printing process.

Symbols and gradations of tint should be legible after printing and not just look nice on-screen. Tints above 50% can often be difficult for the eye to separate. Most people can easily identify printed tints below 50% at 15% intervals (e.g. 5, 20, 35 and 50%) (*see* the pie chart on page 41).

A number of cartographic drawing packages are marketed, but advice from a colleague or cartographer can be sought for those who are less acquainted with maps.

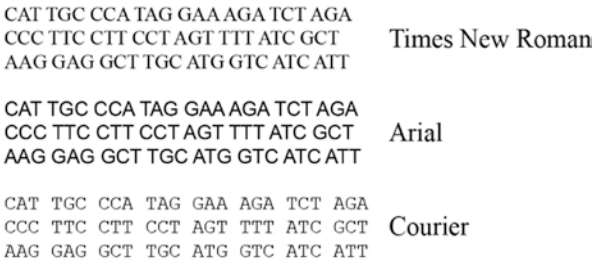

Fig. 4.11 DNA sequence data written using three different fonts. The letters align well when written in a non-proportional font (Courier) but not when written in proportional fonts (Times Roman or Arial). Hence, for such figures, a non-proportional font should be used

4.5.6 Graphics Containing Molecular Data

Figures are often used to provide sequences of nucleotides in DNA or RNA and of amino acids in proteins. In addition to providing information on the primary structure of a molecule, such figures try to (1) find homology between different sequences; (2) provide a consensus sequence by aligning various related sequences; (3) locate particular patterns (motifs); (4) display information on folding of protein or mRNA, etc.; and (5) show sites at which these sequences can be cut using specific enzymes. Such graphics have their own particular set of rules to make these simpler to understand.

The first point to consider is whether the entire sequence needs to be included in the manuscript. It is usually adequate to deposit the full sequence data with a central database (say GenBank) and provide the database accession number in the manuscript. Using this information, a reader can access the entire sequence easily on the internet. Thus, the figures to be printed with the paper can then include only the region(s) of particular interest.

Sequence data must be shown using fixed-width or non-proportional fonts (e.g. Courier) in which each letter takes up the same amount of space, allowing proper alignment of letters one above the other (Fig. 4.11); alignment of sequence data is impossible to maintain with the use of proportional or variable-width fonts such as Times New Roman, Helvetica or Arial. Nucleotides usually need to be numbered—this can be done either at the beginning and the end of lines, or above the line showing the sequence. One may need to try various combinations to find the arrangement with the most aesthetic and uncluttered look. It helps to provide a space after every ten nucleotides (or three, if the aim is to indicate different 3-nucleotide long codons) to allow for easier reading of sequences. The regions needing particular emphasis (e.g. regions of homology or non-identity) and specific nucleotides or amino acids (representing sites of action of restriction enzymes, crucial mutations, etc.) can be underlined (using single or multiple lines of varying thickness, if required), overlining, boxes, arrows, bold letters or a stippled background (Fig. 4.12). If several sequences have been aligned, the first sequence can be shown in full and only variations shown for the others; this makes viewing easier. It is helpful to see how data are represented in similar papers.

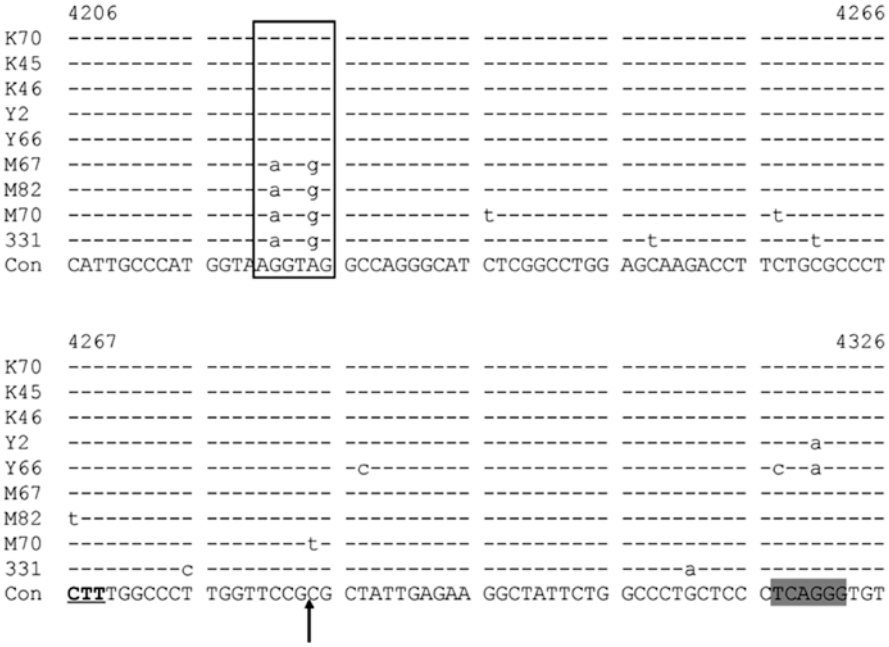

Fig. 4.12 Different methods used to represent various features in figures containing molecular data. The aim is to reduce clutter as much as possible. Only a selected region (nucleotide 4206–4326) of a long DNA molecule is shown. The full DNA sequence is not shown for each of the nine specimens studied (K70, K45, K46, Y2, Y66, M67, M82, M70, 331); instead, only differences from a consensus sequence (Con) are shown. This emphasizes the differences between different sequences, which is the point of interest in the paper. Use of a non-proportional font and spaces after each set of 10 nucleotides give a neat appearance. Nucleotide numbers are indicated at the top of each set of 60 nucleotides and not in each row. Regions or nucleotides of interest can be shown using box, boldface letters, underlining, or a grey background for selected nucleotides, and arrows, etc.

4.5.7 Figure Legends

Each figure must be accompanied by a legend that describes its salient features. The legend should explain any labels used on photographs and define the abbreviation and symbols used. These should also have the explanation for the measure of dispersion used (SD or SE) and any marks that indicate statistical significance. For photomicrographs, the stain used and magnification must be mentioned. In the case of graphs (e.g. pie, bar and line diagrams), the legend should explain the axes, various patterns used for bars or pies and results of any statistical comparisons (*p* values). The figure along with its legend must be fully and independently comprehensible. Legends for all the figures can be printed on a separate sheet.

4.5.8 Precautions While Submitting Figures

These days, most figures are submitted as computer files. The manuscript handling systems in different journals vary in the types of files they can process. Hence, it is important to look up the specifications for a particular journal. These could relate to file format, resolution, file size, depth of colour, permitted compression techniques, etc.

If you plan to submit illustrations in colour, you should ascertain whether or not the journal prints colour images. Some journals publish illustrations in colour only if the author pays the additional cost; this is often difficult if your research is not funded. However, if the authors request, the journals would often agree to include colour images in the online PDF version, even though the print version includes only a greyscale or black-and-white image.

4.6 Pitfalls to Avoid

Common mistakes in the Results section include (1) mismatch of numbers in text and tables; (2) failure to account for all study subjects; (3) inclusion of results for variables that were not mentioned in the Methods section; (4) omission of results for one or more variables (for one or more groups); (5) repetition of data in text, tables and figures; and (6) inclusion of some interpretation, conclusions and speculations. One must make an effort to avoid these common pitfalls. As for the rest of the manuscript, it helps to ask your co-authors and one of your colleagues to read through your results and review your figures and tables. The latter, not being too familiar with the data, are more likely to point out ambiguities and discrepancies. Their feedback should go a long way towards improving this section of your paper.

References

1. Bradford Hill A. The reasons for writing. Br Med J. 1965;2:870–1.
2. CONSORT. http://www.consort-statement.org. Accessed 24 Apr 2015.
3. Briscoe MH. Preparing scientific illustrations: a guide to better posters, presentations and publications. 2nd ed. San Francisco: Springer; 1995.

Suggested Reading

Moher D, Schulz KF, Altman DG. The CONSORT statement: revised recommendations for improving the quality of reports of parallel-group randomised trials. Lancet. 2001;357:1191–4.