Peer reviewed article

When should you use statistics?

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In this edition of the Swiss Medical Weekly, Battisti and colleagues [1] report on the use of non-invasive ventilation in the recovery ward for patients who have had general surgery. During the review process, the authors made a fair point: they felt that a complicated statistical analysis is not really appropriate in a feasibility study. On the other hand I felt that their simple statistical analysis of observational data could be misleading. I suggested that the authors provide only descriptive statistics and remove all statistical inference – that is, all confidence intervals and p-values – and they agreed.

This exchange of views raises an important practical question: when should you use statistics? I do not see there is any point in providing statistics for "cultural reasons" – that is, simply because editors, reviewers and readers expect them. If they do not add value, leave them out. I will try to provide some common sense rules of thumb on the use of statistics, avoiding controversy as much as possible. Because unfortunately any discussion quickly leads to difficult philosophical questions such as whether randomisation is important and whether probability is a long run frequency in repeated sampling or a statement of personal opinion. And there is no getting around it – statisticians do not agree on the answers to these fundamental questions.

A statistic is a summary of numerical information. If you don't have much information, then it makes sense to report all your data. Then your reader knows all you know and you can get on with discussing what is essentially a case series.

Pilot studies, feasibility studies, exploratory studies: typically statistical inference is not warranted in studies of this sort. What these studies have in common is that they are all a prelude to a larger and more detailed confirmatory study; one in which inference would then be appropriate. You might use a pilot study to collect data for a sample size calculation or to see if your survey questions collect useful data; a feasibility study to see if a novel idea can be put into practice; an exploratory study to generate hypotheses for further investigation. Typically such studies involve a convenience sample; that is, a small amount of observational data. The best strategy is usually to present your data using graphics (boxplots, scatterplots) and to summarise using descriptive statistics, especially those that are robust to outliers (such as the median and interquartile range). However when discussing your data, it is still wise to weigh up what these data might or might not imply in order to guide the informal inference that is inevitable. Informal inference will be made by the reader because interest lies not so much in this (non-random) sample, but in the population it came from.

Randomisation provides justification for conventional statistical inference. In a random sample survey, one of many possible samples is taken from some population – and hence inference is a sampling-based inference. In a randomised controlled trial, the allocation of treatment and control is one of many possible randomisations – and hence inference is a randomisation-based inference [2]. Confidence intervals should be given wherever possible – even if there has been a formal sample size calculation [3, 4] – because confidence intervals show the power of your study to detect clinically relevant differences [5]. The founding editor of Epidemiology went so far as to practically ban all p-values [6].

Observational studies have no randomisation. Conventional statistical inference then relies on judgements of exchangeability within strata defined by covariates [7, 8]. This means that you feel that having adjusted for certain covariates, whether a patient receives treatment or not is essentially a random event. Obviously you can never hope to measure all covariates that might influence treatment uptake, but a sensible choice of a reasonable number of covariates should be sufficient because many covariates will be correlated. This is model-based inference and it is only a good as your model – all models are wrong but some are useful [8]. Multivariate adjustment will be needed to convince others that under your model exchangeability is a reasonable assumption. Obviously what is an appropriate model is a matter of opinion, and for this reason statistical inference using Bayesian or subjectivist methods would seem at least as valid if not more so. With observational data, any of these approaches would seem preferable to some sort of simple statistical inference such as a chi-square or t test.

Therefore I offer the following four rules of thumb on the use of statistics. (1) Give all the data if there are few. (2) For a preliminary study based on a convenience sample, summarise data with descriptive statistics. (3) For a random survey or randomised controlled trial, calculate confidence intervals. (4) For an observational study, calculate confidence intervals using multivariate models.

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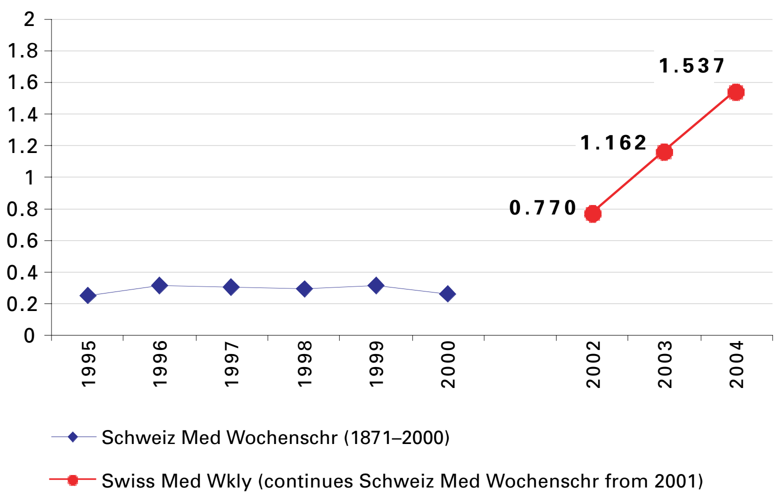

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