

### It was my understanding that there would be no math

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The choice of title for this commentary needs a word or two of explanation. For those of you who do not recognize the reference, it is a quote by Chevy Chase from a 1976 *Saturday Night Live* sketch in which he portrayed

then U.S. President Gerald Ford fielding a question related to budgetary figures during a presidential debate. Since its sentiment is also how some clinicians feel when presented with statistical figures in a research paper, it seemed an appropriate choice considering the topics that will follow. There was a time when the p value was the be all and end all of statistical reporting. Thankfully, there has been a gradual trend towards the use of statistical methods that present research findings in a more clinically-relevant manner. A requirement of this evolution, however, is that clinicians are able to understand and interpret such methods in order to appropriately apply the current evidence base to their patients. Inspired by an excellent series of articles<sup>1-4</sup> written by Professor Jennifer Bolton, a former mentor of mine at the Anglo-European College of Chiropractic, the purpose of this commentary is to discuss several important statistical concepts as a refresher for clinicians. Specifically, we will consider the use and interpretation of risk statistics.

#### Risk Statistics

Although commonly used in statistical reporting, p values are of limited use when attempting to apply research findings to individual patients in a clinical setting. To overcome this, the use of risk statistics (e.g. relative risk, odds ratios) in reporting results has become relatively common. These statistical methods require the use of categorical data (e.g. yes/no, present/absent) and are used to compare the “risk” of an outcome occurring when an exposure is present relative to when it is not present (see Figure 1).

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		Outcome	
		Present	Absent
Exposure	Present	a	b
	Absent	c	d

Figure 1 An example of a  $2 \times 2$  contingency table constructed to evaluate the relative risk or odds ratio of an outcome of interest.

		Improvement	
		Improved	Not Improved
Treatment Group	Treatment	a	b
	Control	c	d

Figure 2 An example of a  $2 \times 2$  contingency table constructed to evaluate the “risk” of a person improving with treatment compared to no treatment.

To put this in clinically-relevant terms, let’s use an example of a study designed to assess the effectiveness of a particular treatment in improving pain levels compared to a sham treatment. In such a study, the treatment group (e.g. treatment/control) would represent the “exposure”, whilst the degree of improvement (e.g. improved/not improved) would represent the “outcome” (see Figure 2). Some of the people who receive the treatment will improve, whilst others will not. The same is true for the people who do not receive the treatment. Risk statistics could then be used to essentially compare the “risk” of a person improving with the treatment relative to the “risk” of him/her improving without the treatment.

It is important to note that the interpretation of an increased or decreased “risk” depends on the nature of the outcome of interest. If the outcome is positive (e.g. improvement with treatment – see Figure 2), then an increased “risk” is desirable. Conversely, if the outcome is negative (e.g. the presence of a disease – see Figure 3), then an increased “risk” is undesirable.

Two statistics are generally used to calculate the magnitude of this “risk”: relative risk (RR) and an odds ratio (OR). Although often used interchangeably, these two measures are not the same:

- RR is the more appropriate statistic to use for

		Presence of Disease	
		Yes	No
Risk Factor	Present	a	b
	Absent	c	d

Figure 3 An example of a  $2 \times 2$  contingency table constructed to evaluate the “risk” of a person developing a disease following exposure to a risk factor compared to no exposure.

prospective studies (e.g. randomized controlled trials, cohort studies) when participant selection is based on the exposure (e.g. treatment vs. no treatment). In such cases, the RR is the proportion of people with the exposure who develop the outcome relative to the proportion of people without the exposure who develop the outcome.

- An OR is the more appropriate statistic to use for retrospective studies (e.g. case-control studies) when participant selection is based on the outcome (e.g. disease vs. no disease). In such cases, the OR is the odds of the outcome in the people with the exposure relative to the odds of the outcome in the people without the exposure.

Using the table presented in Figure 1, these definitions would be represented mathematically by the following equations:

$$RR = \frac{a/(a+b)}{c/(c+d)}$$

$$OR = \frac{a/b}{c/d}$$

To be honest, an understanding of the mathematical nuts and bolts of how to calculate these statistics is probably not as important to clinicians as how to interpret them:

- If the RR or OR *equals one*, there is no increased (or decreased) risk of the outcome with the exposure.
- If the RR or OR is *greater than one*, there is an increased risk of the outcome with the exposure.
- If the RR or OR is *less than one*, there is a decreased risk of the outcome with the exposure.

	Overweight		Obese	
	Males	Females	Males	Females
Hypertension	1.3	1.6	1.8	2.4
Coronary Artery Disease	1.3	1.8	1.7	3.1
Type II Diabetes	2.4	3.9	6.7	12.4

Figure 4 *The relative risk of co-morbidity incidence comparing overweight to normal weight and obese to normal weight.*<sup>5</sup>

To better illustrate the interpretation of these statistics, Figure 4 provides an adaptation of data regarding the relative risk of certain co-morbidities (outcomes) associated with being overweight or obese (exposure).<sup>5</sup> Below are examples of how to interpret these figures.

- Overweight males have a 30% increased risk (RR = 1.3) of developing hypertension compared to normal weight males.
- Obese females are 12.4 times more likely (RR = 12.4) to develop type II diabetes compared to normal weight females.

### Putting it into Perspective

The following examples are adapted from those presented elsewhere<sup>3</sup> and serve to illustrate the advantages of risk statistics over p values from a clinical point of view.

Example 1 (Figure 5)

Treatment Group	Mean VAS (Pre-Treatment)	Mean VAS (Post-Treatment)	Mean Difference
SMT	50	25	25
Control	50	35	15

Between-group difference = 10  
95% CI of the difference = 6.8 to 13.2  
p < 0.001

Figure 5 *Data collected for a hypothetical randomized controlled trial assessing the effect of spinal manipulative therapy (SMT) on pain levels as measured by Visual Analogue Scale (VAS) compared to no treatment in a sample of low back pain patients.*<sup>3</sup>

Although the p value in isolation indicates that a “significant difference” exists in the change in pain levels between the two groups, it gives no indication as to the magnitude or direction of the difference (i.e. how much

“better” or “worse” the treatment was). The 95% confidence interval (CI) does admittedly provide some indication of the expected mean effect of the treatment in the low back pain population as a whole. However, the direct application of these results to an individual patient sitting in your office is somewhat limited (e.g. how likely he/she is to improve, how much improvement he/she can expect with the treatment).

Example 2 (Figure 6)

Treatment Group		Improvement	
		Improved	Not Improved
	SMT	10	10
	Control	4	16

% Improved = 50% (SMT), 20% (control)  
RR = 2.5

Figure 6 *Data collected for a hypothetical randomized controlled trial assessing the effect of spinal manipulative therapy (SMT) on the improvement of pain levels compared to no treatment in a sample of low back pain patients.*<sup>3</sup>

Converting the data presented in Example 1 into categorical data using a predetermined definition of “improvement” or “no improvement” in pain levels allows for the calculation of the RR of improvement with treatment. Doing so yields a RR of 2.5. You could therefore say to a patient that he/she is 2.5 times more likely to improve (as defined in the study) with treatment than if he/she does not receive treatment. This is far more meaningful to both you and the patient than an interpretation of either the p value or 95% CI reported in Example 1.

### Conclusion

The purpose of this commentary is *not* to suggest that p values do not have a place in statistical reporting. To the contrary, the p value is a very useful statistic that provides important information regarding a data set. However, for certain research questions, the use of complementary measures such as risk statistics can be highly advantageous in assisting clinicians to apply research findings more directly to individual patients. Henceforth, it is not only crucial that clinicians are able to understand and interpret such figures, but that researchers also consider the advantages of incorporating the use of these statistical

measures (when appropriate) into their study designs in order to allow clinicians to use their results more efficiently in their clinical practices.

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