number of times that we had to learn statistics before we understood it.

5 6 7 9 10 11 15 16 17 17 17 19 20 23 25 30

In this series of numbers, the mean is 13.58, the median is 17 and the mode is also 17. This illustrates one way of deciding whether information is normally distributed or not: in a bell shaped curve, the mean, mode and median are all the same. Take this one more step: when describing normally distributed data, the mean is conventionally used to describe the average value (with the confidence intervals), whereas the median is used (with its range or, preferably, interquartile range) in non-parametric data. This means that if you are reading a paper, and the authors describe the data as non-parametric but use the mean and confidence intervals, then they do not know what they are talking about. (How impressive would it be to point that error out in front of your lecturer or consultant?). More usually, when a paper uses a mean and confidence interval then they are saying indirectly that the data are normally distributed.

What’s the difference between a t-test and Mann-Whitney U test (and why is it important anyway?)

Once you have decided what the data are (qualitative versus quantitative, normally distributed versus non-parametric) you can decide what test to use (or when reading a paper whether they should have used that test in the first place). The simplest example is quantitative data. Often statistical tests try to compare two groups. If these groups are normally distributed a t-test is used, whereas if they are non-parametric a Mann-Whitney U test is used. If more than two groups are being compared another test is introduced, while for normally distributed data analysis of variance (ANOVA) is used. Another test that is often used in papers is the chi-squared (χ^2) test, which compares proportions (hence its full name: the χ^2 test of proportions). Essentially this compares the proportions in two groups: are there more asthmatics in group A or B? Or more women in the cases or controls?

What’s the difference between an odds ratio and a relative risk?

This is another two terms that are often confused or considered to be synonymous. Let us explain these mathematically first, with reference to Table 1.

<table>
<thead>
<tr>
<th>Table 1: Outcome One vs Outcome Two</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome One</strong></td>
</tr>
<tr>
<td>Cases</td>
</tr>
<tr>
<td>Controls</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

The relative risk is also known as the risk ratio, and represents the ratio of risk in the exposed group (Cases) to the risk in the unexposed group (Controls). In Table 1, the relative risk of Outcome One is (A/E) / (C/F) or (5/19)/(12/17) = 0.37. This result means that the relative risk of Outcome One is 17% less in the exposed group to the controls, or in other words, the exposure is protective (if Outcome One is beneficial). This is usually easier to understand than an odds ratio; when the latest health scare is reported by the media (butter makes you 17% more fat!) they are usually referring to the relative risk. Results of cohort studies are most often quoted as relative risks.

The odds ratio is the ratio of odds of an outcome in the exposed group to the odds of an outcome in the unexposed group. In Table 1, the odds ratio is (A/B) / (C/D) or (5/14)/(12/5) = 0.14. Odds ratios are most often provided when reporting the results of case-control studies where the prevalence of the underlying outcome cannot be estimated. Odds ratios are slightly more difficult to understand, unless you get a kick out of maths (so why are you doing medicine?). Think of odds ratios as the odds of a greyhound winning a race (Santa’s little helper at 5/1) and you’ve got the idea. So even though odds ratio and relative risk are often seen as being synonymous, they actually represent completely different values. (It’s only when outcomes are rare that the OR and RR will be similar).

This article is really an introduction to the basics of relevant statistical tests. We have tried to show the differences between commonly used tests and terms. Most importantly, we hope that this short tutorial helps you as you tackle and critically appraise the statistics section of the next paper you read.

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Further reading
5. BMJ “Statistics Notes” or “Statistics for the non-statistician”

What is the Difference Between Sensitivity and Specificity? Or Positive Predictive Value and Negative Predictive Value? And What’s a ROC if It’s Not a Type of Bird?

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Let’s start honestly: sensitivity and specificity are two terms that confuse nearly everyone. As a medical student, they are something that you learn for an exam and then forget, until you meet them again at a journal club and the consultant starts talking about the sensitivity of the test and you frantically try to remind yourself where the false positives went and are the denominator false negatives or positives. Worse yet, when you are the consultant and are faced with a group of bright eyed trainees who...
studied the new curriculum in medicine and who have excellent
statistics skills… It’s even worse again when you are doing
research, or trying to decide whether to use a new test. Hopefully,
if we understand the first principles, we will remember the more
complicated concepts. So, let’s start at the very beginning.

Here are some important abbreviations used in this tutorial:

- **TP** True Positive
- **TN** True Negative
- **FP** False Positive
- **FN** False Negative
- **PPV** Positive Predictive Value
- **NPV** Negative Predictive Value
- **ROC** Receiver Operator Curve

A concept that most medical students realise at some stage in
their medical training is that tests could be wrong. For example,
we all would have thought at one stage in our training that once a
CT pelvis suggested someone had an ovarian tumour then that
woman had to have an ovarian tumour. In university, you suddenly
realise that every result is based on numerous factors. In the case
of the potential ovarian tumour on CT, these factors will include
the presence or absence of scar tissue in the area, the quality of
the films and the experience of the person interpreting the results,
amongst others. So, one of the fundamentals of evaluating the
usefulness of a test is to factor in that fact that some tests may
be wrong: either the test says someone has the disease when
they don’t (false positive [FP]) or the test says that someone does
not have the disease when they actually do (false negative [FN]).
A test is useful only if it has very few FP or FN: otherwise, why do
it? There are four different ways of describing a test, each giving
different pieces of information. Let’s go through them one by one.
We will start with sensitivity and specificity, which focus on
the patients, and move on to predictive values, both positive and
negative, which focus on the tests themselves.

**Sensitivity**
The textbooks will tell you that “sensitivity = TP / TP + FN” or, in
other words, the number of people correctly identified with the
disease (true positives [TP]) divided by the total number of people
with the disease (TP and FN). Sensitivity gives an idea of how
good a test is at correctly identifying those with the disease
(alternatively, sensitivity is the risk of sending a guilty man to jail).
Another way of remembering this is to use the mnemonic
“SnNout”: a test with high sensitivity (Sn+) with a negative result (−
N-) will rule “out” the diagnosis.\(^3\)

**Specificity**
Again, the textbooks will tell you that “specificity = TN / TN + FP”; or in other words the number of people correctly identified
as being disease free (true negatives [TN]) divided by the total
number of people who are truly disease free (TN and FP). Another
way of looking at this is that specificity gives an idea of how good
a test is at correctly identifying those who are well (in the context
of the disease under investigation), or, the risk of setting an
innocent man free. If you think of the mnemonic “SpPin”; a test with high specificity (Sp-) with a positive result (+P-) will rule the
diagnosis “in”.

Clinical examples of sensitivity and specificity would be the
diagnosis of ventricular fibrillation (VF) using a defibrillator.
Obviously if a patient is in cardiac arrest due to VF, one needs to
be pretty certain that the patient definitely has a VF before
shocking them (high specificity) and not something else (high
sensitivity). In such life threatening emergencies, when we say
“pretty certain” we mean REALLY certain. Therefore the sensitivity
and specificity of a defibrillator in diagnosing VF are 98.6% and
97.77% respectively.\(^4\)

**Positive Predictive Value**
Positive predictive value refers to the likelihood that a positive test
result is correct. The textbooks will tell you that “PPV = TP / TP +
FP”, thus using only the positive results. A clinical example of a
high positive predictive value would be in the diagnosis of liver
fibrosis associated with Hepatitis C, which traditionally is
diagnosed by a liver biopsy: An alternative test, the FIB-4 index,
which combines aspartate aminotransferase (AST), alanine
aminotransferase (ALT), platelets and age, has a positive
predictive value of 82% (at a FIB4 index level greater than 3.25)
in the prediction of liver fibrosis\(^5\) compared with liver biopsy and
fibrotest. The researchers in this study conclude that FIB-4 is a
simple, accurate and non-invasive test for the assessment of liver
fibrosis in Hepatitis C.

**Negative Predictive Value**
Negative predictive value (NPV) tells you the likelihood that a
negative result is correct and, again, the textbooks will tell you that
“NPV = TN / TN + FN”. An example of this is the use of fetal
fibronectin in the detection of preterm labour. When a woman
presents with symptoms suggestive of preterm labour, but is not
obviously in labour, a vaginal swab for fetal fibronectin has a high
negative predictive value—98%—for prediction of preterm labour
within the next seven days.\(^6\) What this means clinically is that
women with a negative test are sometimes discharged home with
advice, whereas those with a positive result may be retained in
hospital for observation.\(^7\)

**ROC (Receiver Operator Characteristic) Curve**
Unless you go to a very research-orientated medical school, you
might not learn about a ROC until you come to write your first
paper and your supervisor suggests it. Rather than looking blankly
at them, learn the basics of it now. ROC says a lot about the
usefulness of a test in a graphic visual form.\(^8\) Most of us are
primarily visual, so while a sensitivity of 80% may sound great on
paper, the ROC allows us to see it on a graph and also to
calculate it to other tests. The “gold standard” test is represented
in Figure 1, which also shows two other tests that we shall deal
with in a moment. If the x axis represents the FP fraction (FP/
total or [1-specificity]), and the y axis represents the TP fraction
(TP / total or sensitivity), then the perfect test is shown as a line
which slopes steeply, reaches the maximum y value quickly and
then stays there. If this represents the “gold standard” test, then
all other new tests can be compared to it on the same graph.
Referring back to Figure 1, the first new test is good, but not as
good as the gold standard test, and the second one is not
reasonable at all. The best cut-off point for any test can be found
by picking the point nearest the left-hand corner of the graph as
long as the sensitivity scale goes to 1 or 100% and both axes
start at 0. Several tests can be compared by calculating the area
under the curve (AUC) for each test. This is only an introduction
to ROC curves, but if you are interested in knowing more then we
recommend a website (http://www.rad.jhmi.edu/eng/javarrad/roc/JROCFITi.html) which allows you to change data and watch the resulting effects on the ROC.8

Like the other tutorials in this series, we aim to give you a working knowledge of sensitivity and specificity in order to use it clinically. For further reading, refer to any of the books or articles in the reference list.

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References
1. Diagnosis and Screening, Chapter 4 in Evidence-Based Medicine.

Research Confuses Me: What is Qualitative Research & What is the Difference Between Grounded Theory and Phenomenology?

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What is qualitative research? Are there different types of qualitative research? Is qualitative research important in medicine? Is it not enough for me to understand quantitative research and its methodology? It is unsurprising that medical students might feel overwhelmed studying many different research study designs.

Some might even do as some of us initially did: we “skim-read” the chapters on qualitative analyses. We reasoned that so much medical teaching and medical literature relies on numbers (p-values, confidence intervals, odds ratios, relative risks, etc.), the ‘hard data’. By comparison, qualitative research has more words and fewer numbers. The outcomes can sometimes appear “obvious”, and we wondered if so much effort was needed or justified. However, the benefit of qualitative methodology in medicine are widely recognised and accepted. This extends especially to the Cochrane Database of Systematic Reviews, where systematic reviews of qualitative studies are conducted.

So what is qualitative research? In this tutorial, we will explain the methodologies and terminologies of common types of qualitative studies, using two research questions for illustration: firstly, what are the attitudes of pregnant women with breech presentation to performing ECV?5 less than 70% would recommend ECV, and only 78% would have an ECV themselves.6 What do women want? This is an ideal area for qualitative research – a complex, emotive issue, with cultural and personal factors that involve not only the woman but her partner, her family, her perceptions of pregnancy and delivery. As medical professionals, we are aware of some factors - concerns regarding safety and pain - but what else is hidden, unexplored? It has been shown that ECV is more successful if a woman undergoes either clinical hypnosis or neurolinguistic programming prior to the procedure5,8...but why is that? Qualitative studies empower us to explore these hidden issues and concerns.

Coeliac Disease research question
The dietary limitations of having both coeliac disease and type 1 (insulin dependent) diabetes mellitus (T1DM) are significant. In children with coeliac disease, with or without T1DM, the introduction of a gluten-free diet has been shown to improve their qualitative sense of well-being and vitality,6,7 as well as quantitative growth,5,6 haemoglobin8 and small intestinal mucosal histology.9 The impact on the child with diabetes of a co-diagnosis of coeliac disease is an ideal question for a qualitative study. So is the impact of recommending a gluten-free diet to a child who is already trying to adhere to a dietary plan for their T1DM. Children may be asymptomatic prior to diagnosis8,9 and this may lead to suboptimal dietary adherence.11 Qualitative studies could highlight how health professionals can help to encourage dietary adherence.

Grounded Theory Approach
The grounded theory approach was developed in the 1960s12, when sociologists studied the communication of health professionals with dying patients. Their results changed this communication forever from a culture of subterfuge to open discussion. Grounded theory is defined as “a way of thinking and conceptualizing the data”13 (in other words, forming new theories).

Let us re-phrase our diabetes-coeliac research question: “What theory might explain the feelings and perceptions of adolescents...