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Chudleigh, Jane and Smith, Joanna

Research essentials: introduction to quantitative research

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Title

What are the key features of quantitative research?

Aim

This article aims to demystify quantitative research, and outline common approaches to undertaking quantitative research and the statistical tests employed.

The essentials

What is quantitative research?

Quantitative research is ‘the study of research questions and/or hypotheses that test relationships, assess differences, seek to explain cause and effect relationships between variables and test for intervention effectiveness’ (LoBiondo-Wood and Haber (2014, 8). Quantitative research is a deductive approach that test theories and hypotheses. In general quantitative approaches can be grouped into descriptive, correlation, quasi-experimental research and experimental research. Figure 1 presents different research questions and designs using the example of cystic fibrosis (CF).

Figure 1: Linking research questions to quantitative studies designs

Question	Possible research design	Possible statistical approaches
What is the feasibility of recruiting and retaining both newborn screened infants with CF and healthy control infants to a longitudinal, observational study?	Descriptive: collect data on recruitment and retention rates of study participants.	Data could be presented as means/medians and percentages
Is there an association between duration of physical activity and lung function in children with CF?	Correlational: record weekly length of physical activity (minutes) and lung function in children with CF.	Linear regression could be used to graphically demonstrate associations between length of physical activity against lung function; correlation coefficients could be calculated using Spearman’ rho (non-parametric) and Pearson’s product moment (parametric) tests.
Does a new exercise regime have any impact on lung function in children with CF?	Quasi experimental: a new exercise regime implemented for children with cystic fibrosis with lung function measured monthly. Healthy controls could be compared to with children with CF not undertaking the new exercise regime.	The independent t-test (parametric) might be a suitable statistical test to compare mean lung function results of both groups to determine any statistically significant differences.
Which nutritional supplement is more effective for children with CF diagnosed with moderate malnutrition?	Experimental: children with CF with moderate malnutrition randomised to receive one of two nutritional supplements. Neither the researcher nor the child/parent would be aware of which supplement the child had been randomised to receive (double blind RCT).	The independent t-test (parametric) might be a suitable statistical test to compare BMI in both sets of children as well as other measures such as lung function.

Descriptive research

Descriptive studies aim to explore and describe a phenomena without any manipulation. Data collected methods such as observation, interviews and questionnaires are used but unlike qualitative studies the data collected is numerical often using standardised tools and measures. This type of study allows for possible relationships to be sought and the development of hypotheses that can be tested in future quantitative studies (Burns and Grove 2011). Often, simple descriptive statistics such as frequency, mean, mode or median are used to report data from descriptive studies.

Correlational research

Correlational research aims to explore relationships / associations between given variables; the correlation or extent of an association is reported numerically known as a correlation coefficient. A positive correlation describes findings when both variable; a negative correlation exists when one variable increases and the other decreases. In statistical reporting, a perfect positive correlation is represented by the value 1, while 0 indicates no correlation and -1 indicates a perfect negative correlation (Burns and Grove 2011). Various tools are used to collect data in correlational research including validated questionnaire or scales.

Quasi-experimental research

The aim of quasi-experimental research is to examine causal relationships between variables (Burns and Grove 2011). These types of studies are considered quasi-experimental since they lack the element randomisation seen in experimental studies.

Experimental Research

This type of research, often considered to be the gold standard, is objective, systematic and highly controlled; the double blind, randomised controlled trial (RCT) being a perfect example. This type of research allows causality between independent and dependent variables to be examined under highly controlled conditions (Burns and Grove 2011). A range of statistical tests might be used in these types of studies depending on the data collected.

How is the sample size determined in quantitative research?

Sample size is extremely important in quantitative studies, and are typically large compared to qualitative studies because the larger the sample the more likely the findings can be generalised to the population of interest. In order to determine the sample size required to detect a statistically significant difference between those who receive an intervention a power calculation is often undertaken (LoBiondo-Wood and Haber 2014).

How is quantitative research data collected and analysed?

Normally, research protocols for quantitative studies are designed prior to the study commencing, are rigid and have to be followed closely to allow the hypothesis to be tested effectively (Burns and Grove 2011). A range of methods are used to collect data in quantitative research including questionnaires or validated surveys but can also include the collection of measures such as weight, height, BMI or elements of lung function as suggested in Figure 1. The data collected is numerical and analysed using statistical methods to test these hypotheses or answer a research question.

How is reliability and validity achieved in quantitative research achieved?

Reliability is closely related to consistency and repeatability, and makes a judgement about whether the test or measurement used if repeated with the same subjects under the same conditions would the same results. Validity refers to the degree to which the concept purported to be being measured is actually being measured. In quantitative research the validity and reliability are assessed using

statistical tests that estimate the size of error in samples and calculating the significance of findings (typically p-values or confidence intervals).

Key messages

Quantitative research involves many different approaches some of which can be complex and difficult for children and parents to fully comprehend.

Quantitative research can be very useful for providing evidence about the effectiveness of therapeutic interventions and therefore can provide children and parents with robust information to help them make decisions about treatment interventions.

Geek speak

Null Hypothesis (H_0)

Assumes there is no statistical relationship between two variables.

Parametric Tests

Statistical tests used with being ratio or interval data that are normally distributed and homogenous.

Non-parametric tests

Statistical tests used with ordinal or nominal data that does not need to be normally distributed or homogenous.

P value

Estimates the probability of rejecting the null hypothesis (H_0) and is conventionally accepted to be 5% or 0.05 (less than 1 in 20 chance of being wrong). For example, if the null hypothesis states there is no difference in lung function between children with CF and those without, if the P value is found to be ≤ 0.05 , the null hypothesis may be rejected. That is, there is a statistically significant difference between the lung function of children with cystic fibrosis compared with children without cystic fibrosis.

Confidence intervals

Data gathered during studies normally only represents a sample of the whole population and is therefore never a perfect representation of the whole population. Therefore, while the mean is a useful measure, confidence intervals can be more useful as they tell us the range within which the parameter we are investigating (the true mean in this instance) is likely to lie.

Resources

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