

Prifysgol Cymru
University of Wales
Trinity Saint David

Quantitative Research Methods

Place, Purpose & Uses

CHICKENS PREFER BEAUTIFUL HUMANS

Stefano Ghirlanda, Liselotte Jansson, and Magnus Enquist
Stockholm University

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Transforming Education; Transforming Lives

Learning outcomes

- By the end of this lecture students should be able to
 - Describe the quantitative research process
 - Develop a research question
 - Develop one or more hypotheses
 - Understand the principles of data analysis using statistical tools
 - Interpret the results of data analysis and draw appropriate conclusions

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Introduction to Quantitative Research

(in Kinesiology & Health Sciences)

- Quantity is the unit of analysis
 - Amounts
 - Frequencies
 - Degrees
 - Values
 - Intensity
- Uses statistics for greater precision and objectivity
- Based on the deductive model
- Careful, systematic and structured process for problem solving

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Deductive v Inductive Reasoning

- Deductive reasoning
 - Theory Driven
 - Testing a general assumption to arrive at a specific answer/solution
- Inductive reasoning
 - Information driven
 - Logical argument in which specific premises lead to a general conclusion

E.g.

- Premise 1: All students are clever
- Premise 2: Kate is a student
- Conclusion: Kate is clever
- This assumption can be tested



- E.g.
- Premise: My dog wears a jumper
- Conclusion: All dogs wear jumpers
- All we know is that there is at least one dog in Wales and that he wears a jumper

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The Scientific Method

Highly structured, sequential series of steps for conducting a scientific research study

1. Understand the problem area
2. Identify the research question
3. Formulate one or more hypotheses
4. Plan the research methodology
5. Collect the data
6. Analyse the data with statistical tools
7. Interpret the results & discuss
8. Derive conclusions from the results



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Step 1: Understand the problem area

- Literature search
- Even if the topic is handed to you by a supervisor
- Consider the *quality* of your literature
 - Be critical
 - Peer reviewed?
 - Robust methodology?
 - How would I know?



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Literature Searching & Organising your Literature

Dr Kate Williams



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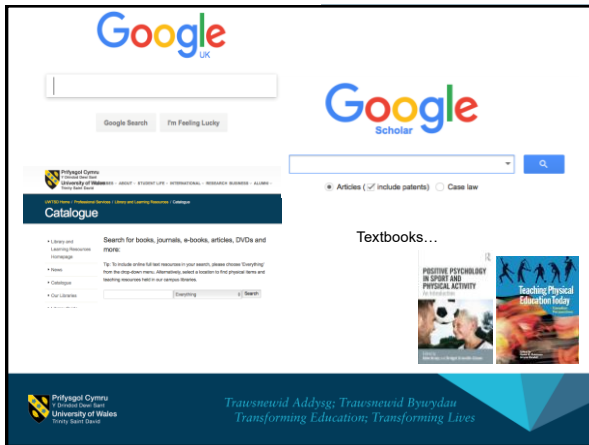


Where do you search for information?

- You have been given an assignment on physical activity levels and student achievement
- Where do you start?



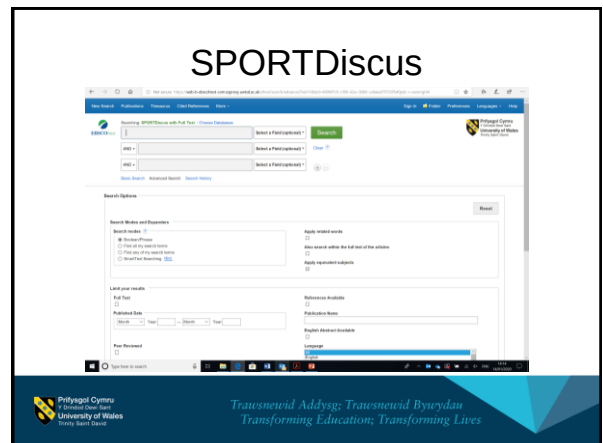
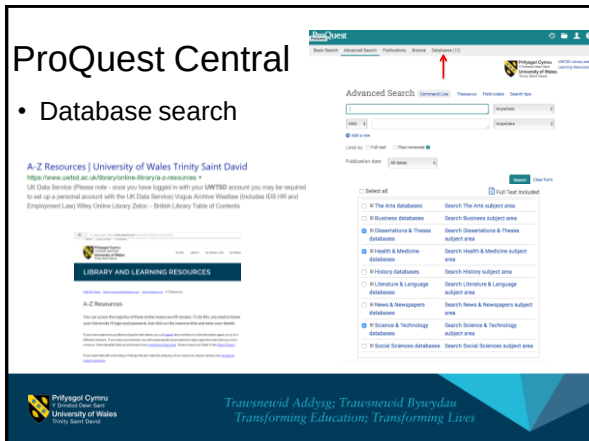
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At level 7 you should

- Consult relevant academic resources
 - NO GOOGLE
 - NO college textbooks (E.g. UG level)
 - Unreferenced, non-peer reviewed information

**YOUR RESEARCH SKILLS (or lack thereof)
WILL AFFECT ASSIGNMENTS & THUS YOUR
DEGREE**



Click on 'Choose Databases'

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How to Search

BOOLEAN operators

- AND
- OR
- NOT
- "physical activity" AND "student" AND "achievement"

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How to Search

- Physical Activity OR student OR achievement

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Consider terminology

- Physical Activity
 - Exercise, physical fitness, physical education, sport
- Student
 - Pupil, child, adolescent, schoolboy/schoolgirl
- Achievement
 - Attainment, success, grades, academic

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MESH Thesaurus

The screenshot shows the ProQuest Central MESH Thesaurus interface. At the top, there's a navigation bar with 'ProQuest Central', 'Advanced Search', 'Browse', 'Thesaurus', and 'Help/Info'. Below this is a search bar with the placeholder text 'Enter a keyword or MESH Thesaurus term'. To the right of the search bar are buttons for 'Advanced' and 'Simple'. Below the search bar is a 'Thesaurus List' section. A red arrow points to the 'MESH 2018 Thesaurus' link in this list. The bottom of the slide features the University of Wales Trinity Saint David logo and the motto 'Trafnusneid Addysg; Trafnusneid Bywydau Transforming Education; Transforming Lives'.

MESH Thesaurus

The screenshot shows the MESH 2018 Thesaurus interface. At the top, there's a navigation bar with 'MESH 2018 Thesaurus', 'Advanced Search', 'Browse', 'Thesaurus', and 'Help/Info'. Below this is a search bar with the placeholder text 'Enter a keyword or MESH Thesaurus term'. To the right of the search bar are buttons for 'Advanced' and 'Simple'. Below the search bar is a 'Thesaurus List' section. A red arrow points to the 'MESH 2018 Thesaurus' link in this list. The bottom of the slide features the University of Wales Trinity Saint David logo and the motto 'Trafnusneid Addysg; Trafnusneid Bywydau Transforming Education; Transforming Lives'.

How to Search

- Truncations
 - Achievement
 - Achieve
 - Achieves

Achiev*

- Studies
- Student
- Students
- Study

Stud*

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How to Search

- Wildcards
 - Women
 - Woman

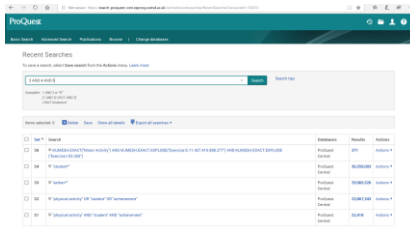
Wom?n

- Analyse
- Analyze

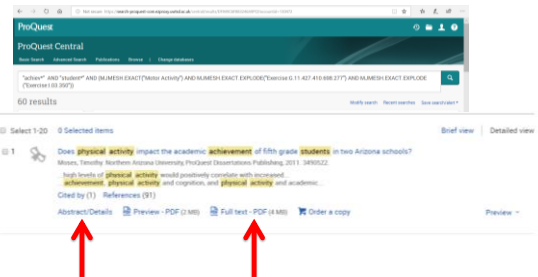
Analy?e

The bottom of the slide features the University of Wales Trinity Saint David logo and the motto 'Trafnusneid Addysg; Trafnusneid Bywydau Transforming Education; Transforming Lives'.

Narrowing the search...



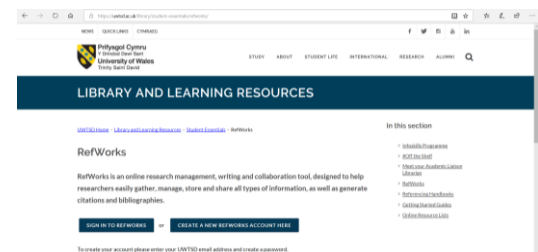
What next?



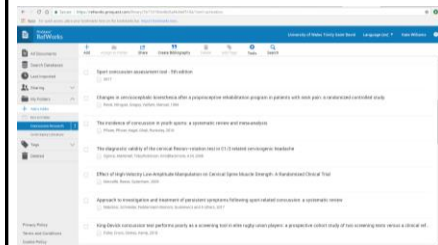
Export these references using REFWORKS



UWTSD Refworks



REFWORKS



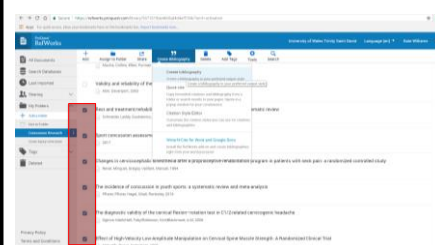
You can organise your references in to files e.g. for each assessment point

You can also select the articles you have used in your assignment and create a reference list



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REFWORKS



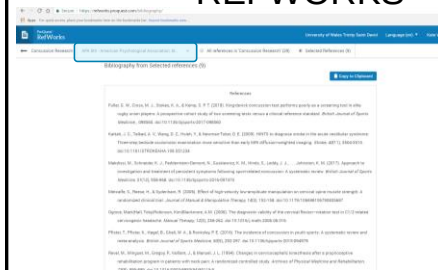
Select the articles you wish to present in your reference list

Click on "Create Bibliography"



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REFWORKS



You can select the reference style you need ...
e.g. APA 6th edition
Or Harvard British

And then copy to clipboard and paste to your assignment!



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Quality of Evidence

Table 2: NHMRC Hierarchy of Evidence

Level of evidence	Type of study design
I	A systematic review of level II studies
II	A randomised controlled trial
III-I	A pseudorandomised controlled trial (i.e. Alternate location or some other method)
III-2	A comparative study with concurrent controls: • Non-randomised, experimental trial • Cohort study • Case-control study
III-3	An interrupted time series with a control group
IV	A comparative study without concurrent controls: • Historical control study • Two or more single arm study • Interrupted time series without a parallel control group • Case series with either post-test or pre-test/post-test outcomes



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Summary

- Try to avoid GOOGLE (Scholar) unless you know the specific paper you want!
- Use library database searches such as ProQuest or EBSCO (Medline/SportDiscus)
- Use Boolean operators (OR, AND, NOT)
- Use Truncations (*) and Wildcards (?)
- Export to REFWORKS to manage your references and create reference list.



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Any questions ?



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Step 2: Identify the research question

- In order to develop a research question you MUST identify your variables
 - Independent
 - Variable under study that the researcher manipulates
 - Manipulation or variation of this variable is the cause of change in other variables
 - Dependent
 - The variable of primary interest
 - The variable being measured in order to determine the effects of the independent variable
- The number and type of variables dictates which statistical test will be used

The effect of **caffeine consumption** on **performance** in elite cyclists
The effect of **(independent variable)** on **(dependent variable)**



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Step 2: Identify the research question

- 3 types of Research Question
 - Descriptive
 - To describe phenomena or characteristics of a particular group of subjects being studied
 - Survey research
 - Qualitative research



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Determinants of college students' health-promoting lifestyles.

Larouche R.

Weight management behaviors of African American female college students.

July F, Hawthorne D, Elliot J, Robinson W.

Department of Nursing, Fayetteville State University, USA.

School-based HIV-prevention education--United States, 1994.

MMWR Morb Mortal Wkly Rep. 1996 Sep 6;45(35):760-5.



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Step 2: Identify the research question

- 3 types of Research Question
 - Difference
 - Is there a difference?
 - Experimental research
 - » Treatment vs. control
 - Pre- vs. post-test comparisons
 - Non-experimental research
 - » Compare one group to another based on existing characteristics



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Example of non-experimental comparison research

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Study habits and academic achievement among medical students: A comparison between male and female subjects.

Adkins DS¹, Sosa-Park J², Jaiswal R³

¹ Author information

Abstract

PURPOSE: Study habits of medical students contribute to better understanding learner achievement and success. This study examines the relationship between study habits, including gender and nonacademic factors that affect learning, to investigate their relationship with performance outcomes.

METHODS: This study was conducted in March 2015 at the College of Medicine and Applied Medical Science at TCU University. A survey was administered, measuring study habits such as study time, study partners, source of study breaks, study interruptions, difficulty concentrating, study activity, and delayed study. Comparisons were examined by high and low grade point average (GPA) and by gender.

RESULTS: A total of 257 students completed the questionnaire (50% high GPA and 41% low GPA, 50% males and 50% females). Results indicated significant differences for time of study, study materials, study interruptions, study engagement between students of high and low GPAs. Gender differences were found for study time, study materials, study breaks, student activity, and delayed study time.

CONCLUSIONS: This study found that study habits differ by gender and also have significant impact on performance outcomes of learners. Given that students' academic success is an important outcome for medical schools, these findings call for implementing these results to enhance curricular changes and promote better learning outcomes.

PMID: 28080178 DOI: 10.1101/147000



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Example of Experimental comparison/difference research

International Journal of Sport Nutrition and Exercise Metabolism, 2006, 16, 412-420
© 2006 Human Kinetics, Inc.

The Effect of Caffeine as an Ergogenic Aid in Anaerobic Exercise

Kathleen Woolf, Wendy K. Bidwell, and Amanda G. Carlson

The study examined caffeine (0 mg/kg body weight vs. placebo) during maximal exercise. Eighteen male athletes (24.1 ± 5.8 yr, BMI 24.4 ± 2.3 kg/m²) completed a 10 s sprint, 10 s rest, and 10 s sprint test. During the caffeine trial, mean total weight was lifted with the chest press, and a greater peak power was obtained during the 10 s sprint. No differences were observed between treatments for the leg press and average power, maximum power, and power drop (Wagon test). There was a significant treatment main effect found for pre-exercise glucose and muscle concentrations. Higher concentrations were noted in the caffeine trial. A significant interaction effect treatment and time was found for chest and glucose concentrations. Post-exercise chest glucose and forearm and glucose concentrations (sprint blood pressure) were significantly higher during the caffeine trial. The differences were found between treatments for serum lactate and concentrations, plasma lactate concentrations, serum creatinine concentrations, heart rate, and rating of perceived exertion. There was no main effect of caffeine on total or mean total weight lifted for the chest press and a greater peak power obtained during the 10 s sprint in the caffeine trial.

Keywords: hormonal responses, exercise metabolism, physiological responses, RPE.



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Step 2: Identify the research question

• 3 types of Research Question

– Relationship

- To investigate the degree to which two or more variables covary or are associated with each other
 - Rather than analysing the differences between groups, researchers characterise the relationships among them.
 - Extent to which variables are related
 - Not to establish cause-and-effect



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Relation of cardiovascular fitness and physical activity to cardiovascular disease risk factors in children and adults.

Sallis JF, Patterson TL, Buono MJ, Nader PR.
Department of Pediatrics, University of California, San Diego, La Jolla.

The associations of physical activity and cardiovascular fitness with cardiovascular disease risk factors were studied in 88 male adults, 180 female adults, 148 male children, and 142 female children. Subjects were families recruited from elementary schools in San Diego, California. Fitness (VO₂ max) was measured by a submaximal cycle ergometer test. Physical activity was assessed by seven-day recall interview, yielding caloric expenditure, and by a simple self-rating of activity level. Risk factors included blood pressure, high density lipoprotein (HDL) cholesterol, the ratio of high density lipoproteins to low density lipoproteins (LDL), and body mass index. For all subgroups, fitness was strongly and significantly correlated with virtually all risk factors. After adjustment for body mass index, most fitness-risk factor associations were no longer significant. *Seven-day caloric expenditure was significantly correlated with HDL/LDL only in female adults and children. The activity rating was significantly correlated with body mass index in all subgroups and with HDL/LDL in female adults and male adults. The simple activity rating tended to be correlated with fitness.* The pattern of association was similar for adults and children.

Am J Epidemiol. 1988 May;127(5):933-41.



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Step 2: Identify the research question

- Make sure it's worthwhile...

BMJ

BMJ 2011;342:d7008 doi: 10.1136/bmj.d7008 Published 10 December 2011

Orthopaedic surgeons: as strong as an ox and almost twice as clever? Multicentre prospective comparative study

Conclusions Male orthopaedic surgeons have greater intelligence and grip strength than their male anaesthetic colleagues, who should find new ways to make fun of their orthopaedic friends.



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Step 2: Identify the research question

- Make sure it's worthwhile...

Can apparent superluminal neutrino speeds be explained as a quantum weak measurement?

M V Berry¹, N Brunner², S Popescu¹ & P Shukla²

¹H H Wills Physics Laboratory, Tyndall Avenue, Bristol BS8 1TL, UK

²Department of Physics, Indian Institute of Technology, Kharagpur, India

Bulletin of the Seismological Society of America

Vol. 64 October 1974 No. 5

IS THE SEQUENCE OF EARTHQUAKES IN SOUTHERN CALIFORNIA, WITH AFTERSHOCKS REMOVED, POSSESSING?

By J. K. GARDNER and L. KNOPF

ABSTRACT
Yes.

Abstract
Probably not.



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Step 3: Formulate one or more hypothesis

Research hypothesis (H_1)

- Educated guess
- Intelligent expectation based on understanding of the problem area
- Should be justifiable
- Simply stated in a single sentence?
- At least two variables that are clearly stated?
- Is the relationship/difference precisely stated?
- Testable?



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Null Hypotheses (H_0)

- Implicit complementary statement to the research hypothesis
- States no relationship/difference exists between variables
- Statistical test performed on the null
- Assumed to be true until support for the research hypothesis is demonstrated



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Step 4: Planning a Methodology

- Organisational aspects of the study
 - Sampling Method
 - Research design
 - Criteria used for the selection of study participants
 - Number of participants needed
 - Research protocol (what is each subject expected to do)
 - Apparatus/equipment or instruments used in data collection
 - Statistical tests used to analyse the data



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Sampling Method

- Where will my participants come from?
- Random Selection
 - Procedure for selection of participants that provides equal chance of selection from all members of a population
 - Uses software – random number generator
- Stratified Random Selection
 - Population is divided (stratified) on some characteristics before random selection of the sample
 - Ability, performance, attitude, age, geography etc



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Sampling Method

- Systematic Sampling
 - Sample every 10th, 100th, or 1000th person from a list e.g. electoral role or phone book
 - Should be comparable to random sample if sample is large enough
- Convenience Sampling
 - Group of participants for a study selected because of readiness of opportunity
- Random Assignment to groups
 - Often confused with random selection
 - Participants already selected but randomly assigned to groups



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Inclusion and Exclusion Criteria

- Inclusion criteria
 - Characteristics individuals must possess in order to qualify for participation in a study
- Exclusion criteria
 - Characteristics individuals cannot possess in order to qualify for participation in a study
- Consider medical grounds, previous exposure to dependent or independent variable, years experience



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Participant numbers required

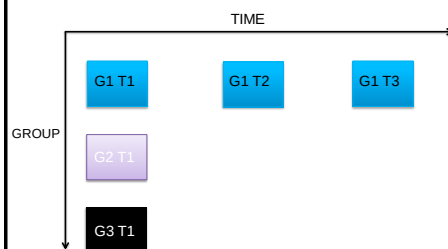
- How many participants do I need?
- POWER of the study
 - Probability of correctly rejecting or accepting the null hypothesis
- Greater the power of the study, the greater the odds of arriving at statistically significant findings that accurately reflect the population
- Generally calculate the number of participants needed to arrive at a power level of 0.8
- Need the following information to calculate sample size
 - Acceptable level of significant (0.05)
 - Power of study (80%)
 - Expected effect size (0.15) ESTIMATED
 - Standard Deviation in population (0.5) FROM LITERATURE

Free online tool for calculating sample size G^*Power^2



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What is my Research Design?



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Research Design

- One-Shot Study Design



E.g. teacher collects data from end of term exam (D) and draws conclusions about the quality of instruction received (T)

- One Group Pretest-Posttest Design



E.g. Phys Ed teacher measures 'fitness' at the start of term (D_1) and end of school year (D_2) as a test of effectiveness of Phys Ed programme (T)



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Research Design

- Control Groups are important but not always possible....

Parachute use to prevent death and major trauma related to gravitational challenge: systematic review of randomised controlled trials

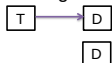
Conclusions As with many interventions intended to prevent ill health, the effectiveness of parachutes has not been subjected to rigorous evaluation by using randomised controlled trials. Advocates of evidence based medicine have criticised the adoption of interventions evaluated by using only observational data. We think that everyone might benefit if the most radical protagonists of evidence based medicine organised and participated in a double blind, randomised, placebo controlled, crossover trial of the parachute.



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Research Design

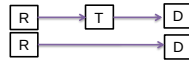
- Static Group Comparison Design



- Control Group
- No pre-test

E.g. Comparison of performance on soccer test of students who received instruction and those who did not

- Post test-Only Design



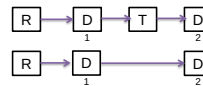
- Random assignment of groups



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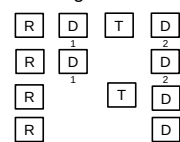
Research Design

- Pretest-Posttest Design



- Demonstrate that the groups were equivalent at the beginning
- Any change as a result of intervention?

- Solomon Four-Group Design



- Often used in studies where there is concern the pretest will influence posttest measures (e.g. tests of skill)



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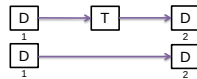
Research Design

• Time Series Designs



Interrupted by treatment
Ensure a stable baseline
Examines lasting effect of treatment
Can use more than one T phase

• Non-equivalent Control Group Design



No random assignment
Often use voluntary participation rather than random assignment

Research Protocol

- Should detail exactly what you have DONE (Past Tense)
- Section on
 - Participants
 - Study Design
 - Method
 - Statistical Analysis
- Reader should be able to reproduce your study from the detail here

Equipment or instruments

- Validity
 - The accuracy of a test, instrument or measure
 - Does it measure what it is supposed to measure
 - Tools used to measure dependent variable are accurate
- Reliability
 - The repeatability of a test or measure
 - Consistent yield
 - Stability
 - Test-retest reliability
 - Useful if one person is completing repeated measures or team of people collecting measures

Statistical Tests: Levels of Data

- Nominal Data
 - Non-numerical measures labelled by name (e.g. gender, ethnicity.)
 - Frequency count
- Ordinal Data
 - Ranked measures
 - Sit on a scale (0-5, likert scales)
- Interval Data
 - Numerical measures of quantities where zero does not indicate complete absence of the measure (e.g. temperature)
- Ratio Data
 - Highest order of data
 - Numerical measures of quantities for which zero indicates absence of the measure
 - (e.g. height, weight, distance, time, age)

Statistical Tests: Parametric & Non-Parametric Statistics

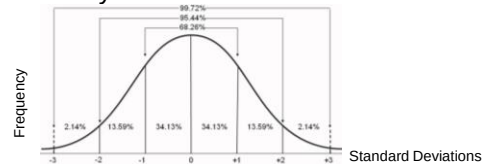
- All statistical tests fall in to two broad categories
- Parametric
 - Category of statistical test used for sets of Interval & Ratio data
- Non-Parametric
 - Category of statistical tests used for Nominal and Ordinal Data
 - As well as Interval and Ratio data that does not meet the assumptions required



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Statistical Tests: Normal Distribution

- Bell shaped frequency plot for which the mean, median and mode are coincident and centrally located



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Statistical Tests: Normal Distribution

- Skewness
 - Horizontal shift in a normal curve
- Kurtosis
 - Vertical shift in a normal curve

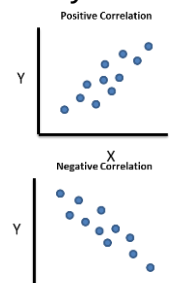


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Statistical Tests: Types of Analysis

Finding relationships among variables

- **Correlation**
 - A measure of the relationship among two or more variables
 - Do they change together in a predictable fashion
 - Strength of correlation
 - -1.0 to +1.0
 - The further away from 0.0 the stronger the correlation
 - Use Pearson's Product Moment Correlation Coefficient
 - **BUT** no cause & effect

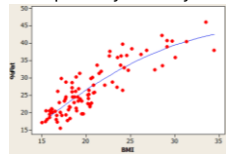


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Statistical Tests: Types of Analysis

Finding relationships among variables

- Regression
 - A statistical method for predicting one variable based on the value of another variable
 - Used when there is a significant, strong correlation
 - E.g. skinfold calliper scores predict your body fat %



Statistical Tests: Types of Analysis

Finding Differences among Groups

- Testing a hypothesis
- Setting an appropriate alpha level
 - Level of significance
 - Usually <0.05 or 0.01 in human participants
 - P value

Statistical Tests: Types of Analysis

Finding Differences among Groups

- T-Tests
 - Compares two groups on one dependent measure
 - Two groups and two sets of data
 - Paired T Test (repeated measure)
 - Same subjects tested twice
 - Independent T Test
 - Two groups of people and you want to compare their scores



Statistical Tests: Types of Analysis

Finding Differences among groups

- Between Groups One Way Analysis of Variance (ANOVA)
 - More than two groups
 - Test that allows evaluation of the null hypothesis between two or more group means
 - Avoids repeated T-Tests



Statistical Tests: Types of Analysis

Finding Differences among groups

- Repeated Measures One Way Analysis of Variance (ANOVA)
 - Same group testing on more than two occasions



Statistical Tests: Types of Analysis

Finding Differences among groups

- Multivariate Analysis of Variance (MANOVA)
 - Compares groups on a number of different but related dependent variables
 - ANOVA with several dependent variables
 - E.g. comparing the effect of an intervention on a number of outcome measures (such as anxiety, depression, sleep, mood)
 - E.g. teacher wanted to compare pupils from 3 primary schools results in Maths and English tests

	Math	English
School A	D	D
School B	D	D
School C	D	D

Statistical Tests: Types of Analysis

Finding Differences among groups

- ANOVA & MANOVA
- Significant results indicate that differences exist, but do not show which groups differ from each other
- Post Hoc Tests are used as a follow up for an ANOVA/MANOVA to show where significant differences occur



Statistical Tests: Types of Analysis

Finding Differences among Groups

- A difference exists
 - Perhaps I have completed a post-hoc to find the difference
- Then what?
- Examine Effect Size
 - Simple way of quantifying the difference between two groups

EDITORIAL	
Using Effect Size—or Why the P Value Is Not Enough	GAEL M. SULLIVAN, MEd, MPH RICHARD FENNA, PhD

Step 5: Collecting the data

- Easy part!



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Step 6: Analysing your data with statistical tools

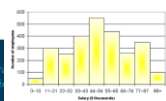
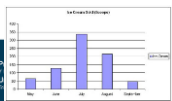
- You should never collect data without identifying HOW you will analyse it!



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Step 7: Interpret & Discuss the Results

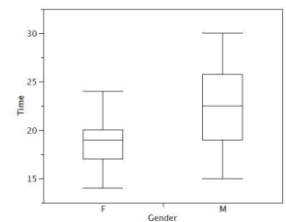
- Tables & Graphs (Figures)
- Bar Graphs
 - Data in categories on X-Axis
 - Categories presented in any order
 - Bars do not touch – data is discrete and numerical
- Histograms
 - Data in ranges on x-axis
 - Ranges placed in numerical order
 - Data is continuous
 - Bars can touch



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Step 7: Interpret & Discuss the Results

- Box Plots
 - Descriptive statistic
 - Separates data in to quartiles
 - 1st and 3rd quartiles
 - Median (middle value)
 - Whiskers
 - Minimum
 - Maximum

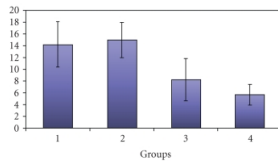


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Step 7: Interpret & Discuss the Results

The importance of Standard Deviation

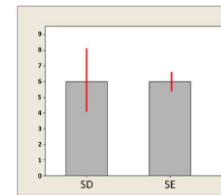
- Measure of variability
- Dispersion of data away from the mean
- Represented as error bars on a graph
 - Small SD Bar = low spread
 - Large SD Bar = larger spread



Look for overlap:
Overlap – less likely to be statistically different
No overlap – maybe a significance

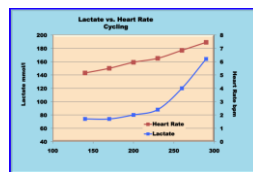
Step 7: Interpret & Discuss the Results

- Standard Error of the Mean (SEM)
 - Estimator of population characteristic
 - Inferential statistic rather than descriptive statistic
 - Often used in reporting as it is usually smaller than SD
 - Makes data look tighter – less overlap



Step 7: Interpret & Discuss the Results

- Line Graph
 - Data on x-axis is numbered
 - X-axis data is specific – not ranges
 - Points are placed in numerical order
 - A line can be drawn through the points



Step 7: Interpret & Discuss the Results

- Tables
 - Units of measurement should be clear
 - Horizontal lines ONLY no vertical
 - Table title should be **above** with capital letter only for first word.

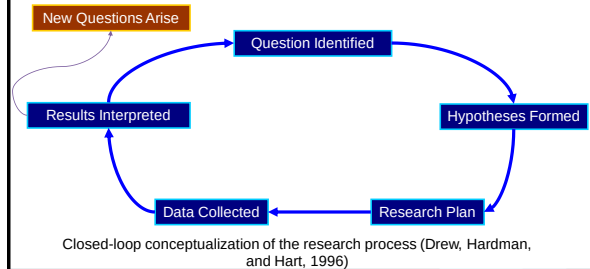
	Group 1 n = 21 (52.5 %)	Group 2 n = 19 (47.5 %)	p value
Age (years)			
Mean ± SD	26.0 ± 8.49	25.7 ± 8.12	n.s.
Gender % (n)			
Male	81.0 (17)	94.7 (18)	n.s.
Female	19.0 (4)	5.3 (1)	
Dominant extremity % (n)			
Right	81.0 (17)	89.5 (17)	n.s.
Left	19.0 (4)	10.5 (2)	
Injured knee % (n)			
Right	38.1 (8)	15.8 (3)	n.s.
Left	47.6 (10)	68.4 (13)	
Bilateral	14.3 (3)	15.8 (3)	
Baseline VISA-P			
Mean ± SD	32.5 ± 12	69.5 ± 10.05	<0.001

Values expressed as mean ± SD or frequencies and percentages

Step 8: Derive Conclusions from Results

- Be careful not to over reach the results when making conclusions
- Can you accept or reject the H_0 and H_1 ?
- Do not
 - Over generalise the results
 - To a larger population
 - Overstate the impact of the research
- Acknowledge the limitations of the study
- Suggestions for future research

Cyclical Nature of Scientific Method



Summary

- Quantitative methods of enquiry have the ability to be objective
- Consider the use of quantitative methods as part of mixed-method approach to research
- **“Beware of the man of one method”**

Mixed Methods Research: A Research Paradigm Whose Time Has Come

R. Burke Johnson, Professor and

Mixed Methods Research in the Movement Sciences

Case studies in sport, physical education and dance

For next session...

- Consider
 - Your research questions (descriptive, difference, relationship)
 - Qual or Quant?
 - Hypothesis
 - Draw a diagram of your research design

