Summer Training Report

By

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Firstly, I would like to express my sincere gratitude to my mentor, **Ms. Shweta Aggarwal** for her continuous support and guidance during my summer training study and research, her patience, motivation, enthusiasm, and immense knowledge. Her instructions helped during my research and report writing.

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Lastly, I would like to thank my parents and my brother for supporting and caring for me in the time of this pandemic. Without their support, I would not have been able to complete this project.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

ARI	Acute respiratory infections
NFHS	National family health survey
SDG	Sustainable developmental goals
EBF	Exclusive breast feeding

Part 1

Research Report

ABSTRACT

Acute Respiratory Infections (ARIs) are one of India's leading causes of disease-related deaths in under-five aged children. Although various steps are taken by the government to reduce the under-five mortality, a more targeted approach would help in achieving the low mortality sooner. Various risk factors are said to be associated with ARI's including exclusive breastfeeding, indoor pollution, immunization coverage, and malnutrition.

Aim: This paper aims to find out the predictors of acute respiratory infection in children under the age of five in Madhya Pradesh.

Methods and Material: It is a community based cross-sectional descriptive study using secondary data from NFHS-IV.

Statistical analysis used: Multiple linear regression using enter and stepwise method is done in SPSS version 22.

Results: Breastfeeding within one hour of birth; vaccination for measles; stunting; underweight; and households using clean fuel for cooking were found to be the significant predictors of ARI.

Conclusions: The study shows that the focus on the predictors of ARI will help in the reduction of overall disease burden. It will guide researchers and policymakers to try a different approach for reducing the burden.

Keywords: ARI-burden, under-five mortality, exclusive breastfeeding, indoor pollution, malnutrition.

INTRODUCTION

ARIs (Acute Respiratory Infection) are one of India's leading causes of disease-related deaths in children under five. ARI's signs and symptoms consist of cough followed by short rapid breathing, fever, and chills that can lead to death, especially when other co-morbidities are present. India accounts for one-third of the overall WHO mortality burden in Southeast Asia (Mathew et al., 2011). “In India, more than 4 lakh deaths every year are due to pneumonia accounting for 13%-16% of all deaths in the paediatric hospital admissions (Jain et al., 2001). According to Million’s death study, “369,000 deaths occur due to pneumonia among children 1-59 months at the rate of 13.5/1000 live births. More number of deaths due to pneumonia was reported from central India.” (Kumar et al., 2010)

According to NFHS-4, the prevalence of ARI in Madhya Pradesh is 2.1 %. An overall rise in social and economic development can help in reducing the incidence of these infections. Every decrease in ARI deaths would provide an incremental advantage in achieving the Sustainable Development Goals (SDGs 3), whose objective is to stop preventable deaths of children below five by 2030. In Madhya Pradesh, there is a lack of detailed studies on ARI risk factors that impede the development of prevention and control strategies. Therefore by this paper we tried to find out the predictors of ARIs in children under the age of five in Madhya Pradesh, using secondary data from the NFHS-4 survey from known risk factors present in the literature review, and to use these results as guidelines for policymakers and advisors.

LITERATURE REVIEW

For the literature review, PubMed and Google Scholar were used to retrieve literature data between 10/04/2020 and 28/04/2020. The search was confined to the last 20 years referring to the Indian and South Asian contexts. Keywords used for the search were the burden of ARIs, ARIs in children, exclusive breastfeeding and ARI, malnutrition, underweight, indoor pollution, etc. the terms ARI and pneumonia were used interchangeably among the papers. The papers with the highest citations were selected.

A meta-analysis of studies revealed that “protection provided by breast milk declined steadily with age during infancy.” Protection is provided for infectious diseases like diarrhoea, respiratory infections, thus reducing mortality.(WHO Collaborative Study Team, 2000)

A study was done in southern Nepal to study the effect of breastfeeding pattern, time of initiation on the mortality of new-borns. It showed that there was a “trend toward higher mortality with increasing delay in breastfeeding initiation.” The study concluded that “approximately 7.7 and 19.1% of all neonatal deaths maybe avoided with universal initiation of breastfeeding within the first day or hour of life, respectively.”(Mullany et al., 2008)

Results of another study showed that suboptimal breastfeeding increases the risk of pneumonia morbidity and mortality. The results stated that “deaths due to pneumonia were higher among infants which were not breastfed compared to exclusively breastfed infants”.(Lamberti et al., 2013)

A study identified the causal factors related to environment and host factors for pneumonia and classified them into definite, likely, and possible risk factors. In this, the definite risk factor included Malnutrition, Low birth weight, Non-exclusive breastfeeding, Lack of measles immunization (within the first 12 months of life), and Indoor air pollution.(Rudan et al., 2008)

A community-based longitudinal study done in south India concluded that children of poor housing with smoke-producing conditions suffered more frequently from ARIs than others.(Acharya et al., 2003)

A study conducted in two districts of Maharashtra in 16 clusters revealed the incidence of ARI of 0.49 per child per month and the incidence of pneumonia was 0.075 per child per year. It was not associated with any of the housing environment factors ($p > 0.05$) but was found to be associated with partial immunization ($p < 0.05$) (Gothankar et al., 2018).

Based on the literature review following variables were selected as predictors for the current study:

- Breastfeeding pattern

- Malnutrition
- Indoor pollution- in terms of usage of clean fuel
- Immunization status

OBJECTIVES

Research question

What are the predictors of ARIs in under five aged children of Madhya Pradesh?

Study objective

- To know the current prevalence rates of ARIs
- To know how breastfeeding patterns; immunization status; malnutrition and indoor pollution can predict the prevalence of ARIs.

METHODOLOGY

The study uses a quantitative method and it was a community based descriptive cross-sectional study. The study consists of children living in Madhya Pradesh under the age of five years. Secondary data was used for the analysis. NFHS-IV(National family health survey) data for Madhya Pradesh was downloaded from www.data.gov.in. The NFHS-4 gathered data on all children born within 5 years from the survey year in each household selected to participate. A two staged sampling design was adopted by the NFHS in both rural and urban areas. It had four survey questionnaires (Household Questionnaire, Woman's Questionnaire, Man's Questionnaire, and Biomarker Questionnaire). (*National Family Health Survey (NFHS-4)*, 2017) For the current study data from the household questionnaire and woman's questionnaire was selected.

Data analysis

Before the analysis, the collected data was prepared. The dataset was checked for missing data and outliers. The original data file was in .csv format, a new file was made from the same containing all the selected variables. The total values for each district were selected instead of separating rural and urban areas then it was converted to .sav file to use in

SPSS version 22. A multiple regression analysis was done using the enter method (*model x*) and stepwise method (*model y*) to find out the predictors of ARI in Madhya Pradesh.

RESULTS

Demographic profile of under-five children with symptoms of ARI

Among 23,109 under-five children surveyed in NFHS-4 of Madhya Pradesh, 495(2.1%) children showed symptoms of ARI, out of which 252 were males and 244 were females and 79 children (15.9%) resided in urban areas whereas 416 children (83.88%) resided in the rural area. The prevalence of symptoms of ARI was "highest in the Sagar (6.2) district and lowest in Sheopur and Bhopal". (*National Family Health Survey (NFHS-4), India, 2015-16: Madhya Pradesh*, 2017)

Predictive model

The results of the regression analysis indicated that the *model x* explained 58.7% (adjusted r^2= 0.587) of the variance and that the model was a significant predictor of the prevalence of ARI, F (10,36) = 7.540, p<0.00, whereas *model y* explained 53.4%(adjusted r^2= 0.534) of the variance and the model was a significant predictor of the prevalence of ARI, F (4,42) = 14.182, p<0.00. The regression summary is shown in table 1

Breastfeeding pattern as a predictor

Two variables were taken in breastfeeding pattern i.e.

i. Percentage of children under age six months exclusively breastfed
ii. Percentage of children under age three years breastfed within one hour of birth.

In both the models used, it was seen that percentage of children breastfed within one hour of birth was a significant predictor of the prevalence of ARI whereas the exclusive breastfeeding was not a significant predictor.

Malnutrition as a predictor of ARI

For malnutrition, three variables were considered, the percentage of children who are stunted, the percentage of children who are wasted, and the percentage of underweight children. In the *model, x* wasting was found to be a significant predictor with a negative beta value, whereas in *model y* underweight children were found to be a significant

predictor of ARI, with negative beta values. Stunting was not a significant predictor of ARI in either of the models.

Table 1- Regression Summary

Variables	Beta coefficients (*model x*)	Beta coefficients (*model y*)
Children under age 6 months exclusively breastfed	.005 (0.629)	0.106 (0.336)
Children under age 3 years breastfed within one hour of birth	-.059 (0.002) *	-0.44 (0.015) *
Children under 5 years who are stunted	-.083 (0.178)	0.059 (0.683)
Children under 5 years who are wasted	-.153 (0.028) *	-0.204 (0.113)
Children under 5 years who are under weight	-.012 (0.855)	-0.135 (0.000) *
Households using clean fuel for cooking	-.057 (0.000) *	-0.044 (0.001) *
Children age 12-23 months who have received measles vaccine	-.090 (0.005) *	-0.039 (0.012) *
Children age12-23 months who have received BCG	.024 (0.560)	0.210 (0.284)
Children age12-23 months who have received polio	.002 (0.942)	0.263 (0.052)
Children age12-23 months who have received DPT	.046 (0.113)	0.321 (0.093)
	R^2 = 0.677	R^2= 0.575
p-value is indicated in parenthesis **shows statistically significant variable*		

Household pollution as a predictor of ARI

For household pollution, percentages of household using clean fuel for cooking were found to be a significant predictor of ARI in both the models with negative beta values.

Immunization status as a predictor of ARI

In both, the models, the percentage of children who have received measles vaccination was found to be a significant predictor of ARI, whereas DPT, polio, and BCG were not found to be a significant predictor of ARI.

DISCUSSION

ARIs in children is one of the major public health concerns related to developing countries such as India. It is one of the leading causes of childhood mortality. The current study aims to find the predictors of the prevalence of ARI in under-five children. Mainly four variables were considered for the same, which were selected from the literature review.

ARI and Breastfeeding pattern

It has been well established that breast milk acts as a protective barrier in young infants and its benefits include prevention of developing allergies and asthma in children as well as a lower risk of respiratory illness, diarrhoea, and ear infections. The study results suggested that the early initiation of breastfeeding after birth was a significant predictor of ARI, and it had a negative effect on the dependent variable which means as the percentage of children breastfed within one hour of birth will increase the prevalence of ARI will decrease. This is in line with one of the studies showing a delayed initiation of breastfeeding, which increases the mortality risk among new-borns. (Mullany et al., 2008). Thus, the study emphasizes the importance of early initiation of breastfeeding. Early initiation of breastfeeding ensures that the child receives the first milk of mothers which contains colostrum that is rich protective factors. The NFHS-IV data of Madhya Pradesh showed that only 34.4% of the children received breastmilk within one hour of birth. This number is very low. Increasing the knowledge of mothers along with other interventions regarding the importance of breastmilk is very crucial to increase this low percentage, which will further aid in decreasing the burden of ARI.

Exclusive breastfeeding(EBF) did not show any significant effect on the prediction of ARI, which is one of the definitive risk factors of childhood pneumonia(Rudan et al., 2008). This result is in line with another recent study which shows “no association of EBF with reported pneumonia”(Gothankar et al., 2018) but in contrast with a study which shows compared to exclusively breastfed infants 0-5 months of age, “the relative risk of

incident pneumonia was highest among those not breastfed and lowest among those predominantly breastfed".(Lamberti et al., 2013)

So furthermore, specific studies are required to see how breastfeeding can impact the ARIs, but EBF should not be ruled out as a predictor as it increases the overall immunity of the infant, thus decreasing the susceptibility towards infections.

ARI and Malnutrition

For malnutrition three variables were considered i.e., children with stunting (height-for-age), wasting(weight-for-height) and underweight (weight-for-age). Wasting and underweight children were found to be statistically significant in predicting the prevalence of ARIs. A malnourished child has a deficit of necessary nutrients required for growth and proper functioning of bodily functions thus creating a state of susceptibility towards infections, hence malnutrition combined with infancy may be a predictor of ARI. Malnutrition is also considered a definitive risk factor of childhood pneumonia. (Rudan et al., 2008)

ARI and Indoor household pollution

Percentages of households using clean fuel for cooking were taken as an indicator of lack of indoor pollution which occurs due to cooking fuels other than LPG, like wood, natural gas, coal, etc. The results showed that this variable is a significant predictor of the prevalence of ARI in both models. It also showed that the predictor variable has a negative relationship with the outcome variable i.e., as the percentage of households using cleaner fuels increases the prevalence of ARI will decrease. "Exposure to indoor air pollution from biomass fuels leads to increased risk of respiratory infection, especially lower infections in the respiratory tract."(Selvaraj et al., 2014) This result is also in line with the study which showed that "children of poor housing with smoke-producing conditions suffered more frequently from ARIs than others".(Acharya et al., 2003).

ARI and Immunization status

Based on the findings of the study percentages of children of 12-23 months old have received the measles vaccine were a significant predictor of ARI, this is following the literature. As deaths due to measles are mostly because of complications related to pneumonia and diarrhoea. According to one study, "pneumonia cases due to bacterial and viral agents are not preventable, but an immunization against measles, influenza, and

possibly the use of bacilli Calmette–Guérin (BCG) will contribute to decreasing the pneumonia burden".(Rudan et al., 2008) The significance of this predictor may be contributed to these reasons. Additionally, vaccines provide immunity against various bacterial as well as viral microorganisms that attack the body and cause various diseases. A child's immunity is comparatively lesser as compared to an adult and vaccines provide an additional layer of protection against infection. Infections from certain viruses and bacteria cannot be prevented but vaccines can reduce the severity of infections as well as provide herd immunity for the population. The new multistage measles vaccine policy will further aid in measles vaccine coverage as the second dose of vaccine is provided at the state level after the national implementation schedule. "The second dose of vaccine provides immunity to measles infection that makes children more vulnerable to secondary pneumonia."(Verma et al., 2011)

CONCLUSION AND RECOMMENDATIONS

Our study showed that the breastfeeding pattern, measles vaccination, malnutrition, and indoor pollution can be the predictors for the prevalence of ARI in Madhya Pradesh. The following recommendations can be drawn from the findings:

- Promotion of early initiation of breastfeeding in rural and urban areas with the support from Anganwadi workers using various IEC materials.
- Promotion of benefits of EBF for up to six months of age, by showing how exclusive breastfeeding can be a cheaper alternative to prevent various bacterial and viral infections
- Promotion of smokeless chulhas in villages. Setting up of biogas plants in villages by the government which will supply the households with methane gas via pipelines and work as to how normal stoves work.
- Implementation of schemes to reduce malnutrition such as providing dietary supplements to pregnant mothers, new-borns, and infants. Additional to this, regular checking of nutritional status of the child via local PHC's and if deficit found, providing the necessary supplement.

- Additionally, providing nutritious food to new mothers and infants via food packets supplied via the government.
- Promotion of importance of vaccinations for the child. Conducting various programs in various rural as well as urban areas to show how timely vaccination can help prevent various diseases.
- Programs can be in the form of nukkad natak, skits, etc that piques the interest of the community and yet deliver a strong message.

These findings may have significance in helping policymakers and researchers form strategic plans of actions that will address areas of weakness identified in this research paper and help in further research opportunities regarding the same. The last step to decrease the burden of ARIs would be to use evidence-based interventions for a more directed approach in specific areas that are lacking.

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Part 2

Course report

"Understanding Clinical Research: Behind the Statistics"

by University of Cape Town

COURSE DESCRIPTION

Being familiar with the basics of healthcare research analysis and results is a very important skill. This course aims to improve your statistical skills by enabling you to fully understand the papers that you read. This course is not about complicated mathematical operations and equations rather it is about the development of an understanding of the principles underlying those equations and operations. This knowledge would help us in critically evaluating the research around us. The course is designed to be finished over six weeks, building our knowledge in a structured way. It is not an exhaustive course in statistics - rather it offers a practical approach to medical research and commonly used statistical analysis. By the end of the course, we should have moved away from merely reading the introduction and findings of the abstracts to be able to take a closer look at the paper's methodology and results.

COURSE OBJECTIVES

- To identify what are the various study types and why the researcher chooses a specific type of study.
- To define data variations that decide the type of statistical test that we should apply to make our findings meaningful.
- To understand the concept of p-value.
- To learn about hypothesis testing and confidence intervals.
- To know the most common statistical tests and their assumptions.

- To learn how good are these tests are at picking up the presence or absence of disease
- To learn how to choose appropriate tests for a given study
- To learn how to interpret positive and negative results

COURSE CONTENTS

Weeks	Content
Week 1 ***Types of studies*** Time: approx. 4 hours	1. Observational & experimental studies 2. Case series studies 3. Case-control studies 4. Cross-sectional studies 5. Cohort studies 6. Experimental studies 7. Meta-analysis and Systematic Review
Week 2 ***Data types and description*** Time: approx. 7 hours	1. Some key concepts: Definitions 2. Data types 3. Introduction to central tendency 4. Measures of central tendency 5. Measures of dispersion 6. Sampling
Week 3 ***Key concepts related to statistical analysis*** Time: approx. 5 hours	1. P-values 2. Central limit theorem 3. Skewness and Kurtosis 4. Data Distributions 5. Types of distribution Normal distribution 6. Sampling distribution- types

Week 4 ***Hypothesis testing and confidence levels*** Time: approx. 4 hours	1. Introduction to Hypothesis Testing 2. Testing assumptions: Null and alternative hypothesis 3. Type I and II: Hypothesis testing errors 4. Confidence intervals 5. Confidence levels
Week 5 ***Types of tests*** Time: approx. 4 hours	1. Introduction to parametric tests 2. Student's t-test 3. ANOVA 4. Linear Regression 5. Introduction to nonparametric tests 6. Checking for normality 7. Comparing paired observations: Signs 8. Ordering values: Ranking 9. Paired comparisons: Sign ranks 10. Summation of ranks: Rank sums 11. Comparing two populations: Mann-Whitney-U test
Week 6 ***Tests for categorical data*** Time: approx. 3 hours	1. Introduction to comparing categorical data 2. Observed frequencies: Contingency tables 3. Chi-square test 4. Association between two variables: Fisher's exact test 5. Introduction to sensitivity and specificity 6. Measuring performance: Sensitivity and specificity 7. Proportions of results: Positive and negative predictive values

Course methodology

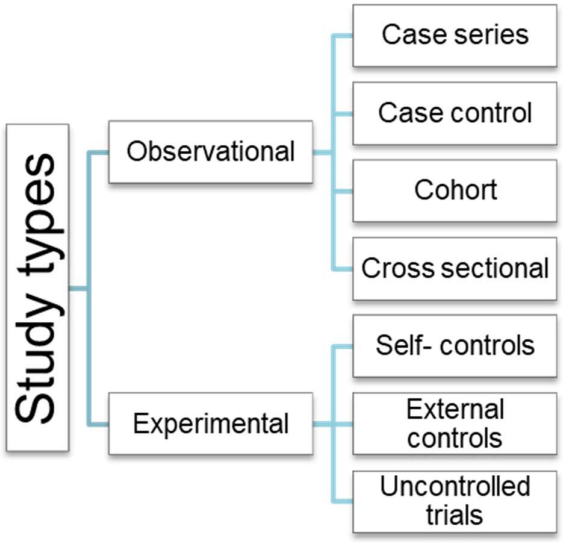
The course uses the following methods:

1. Lecture videos
2. Reading materials
3. Case presentation
4. Quizzes

Key learnings

Week 1

- Types of studies:

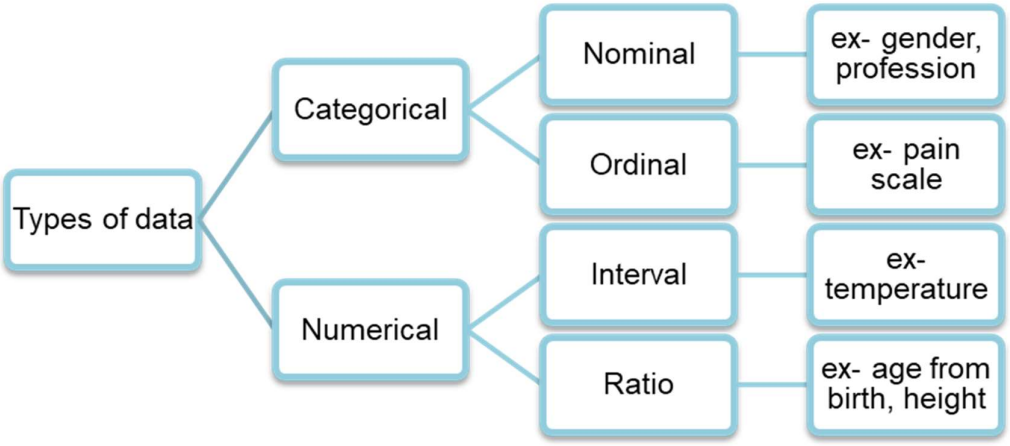


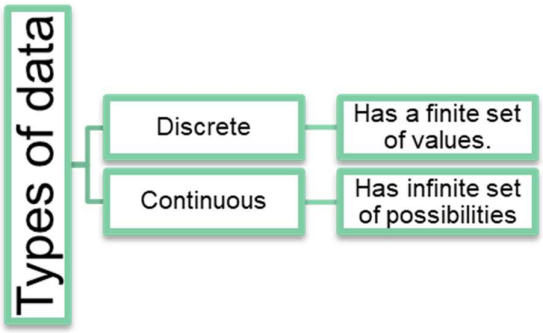
- Difference between Meta-analysis and systemic review

  Meta-analysis is often seen as a quantitative look at previously published data. Systematic review takes a more qualitative look and is usually much more involved than a meta-analysis.

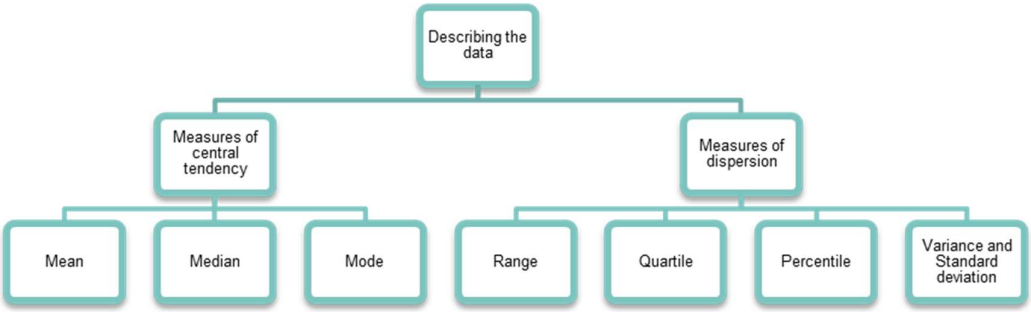
Week 2

- Types of data



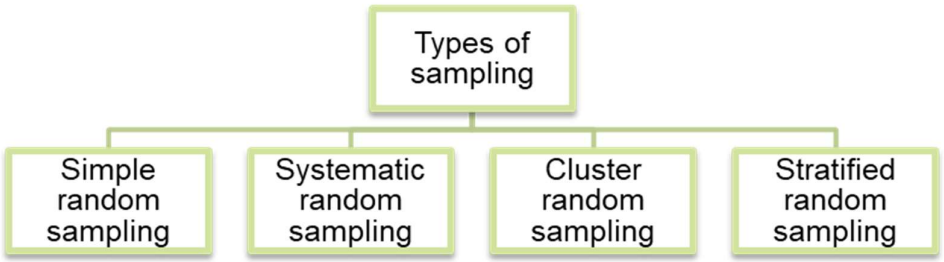


- Describing the data



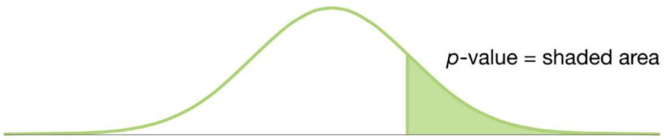
- Visual representation of data- bar graphs, pie charts, histograms, distribution plots, scatter plots, violin plots, and scatter plots.
- Sampling:

  We only take a small fraction of subjects from a large population with the characteristic that we want to examine while performing a study. That small faction is called a sample and this process is called sampling.

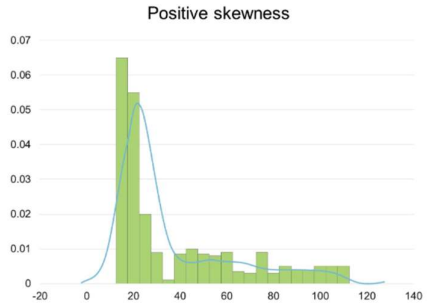


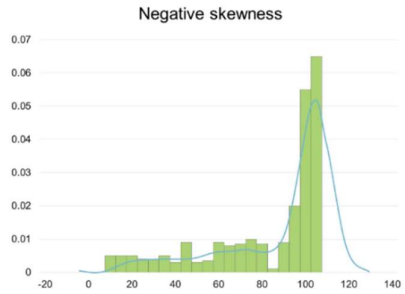
Week 3

- ***p-value***



- ***Central limit theorem***: It states that "if we plot all the possible differences of averages between two groups, the resulting graph will form a smooth and symmetrical bell-shaped curve."

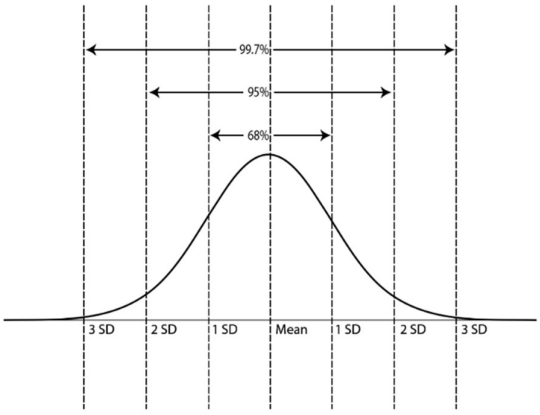




Kurtosis:

- ***The shape of data:***

  i. The normal distribution: It is symmetrical in nature with a bell-shaped curve, most values are centred around the mean.



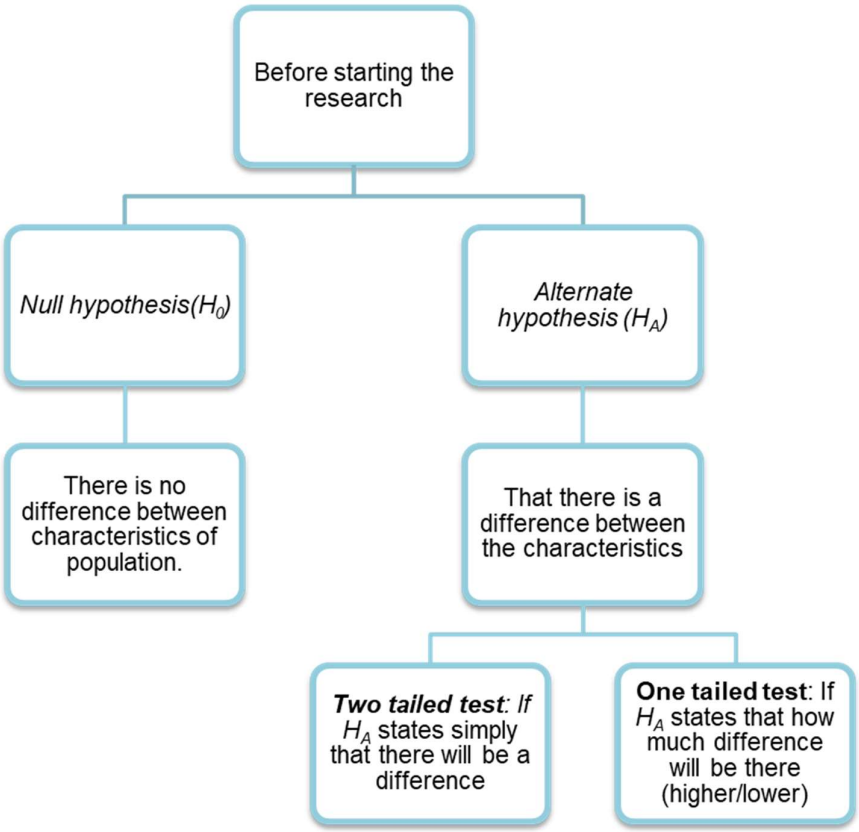
ii. Sampling distribution: It is the probability of occurrence of the characteristic in a given sample.

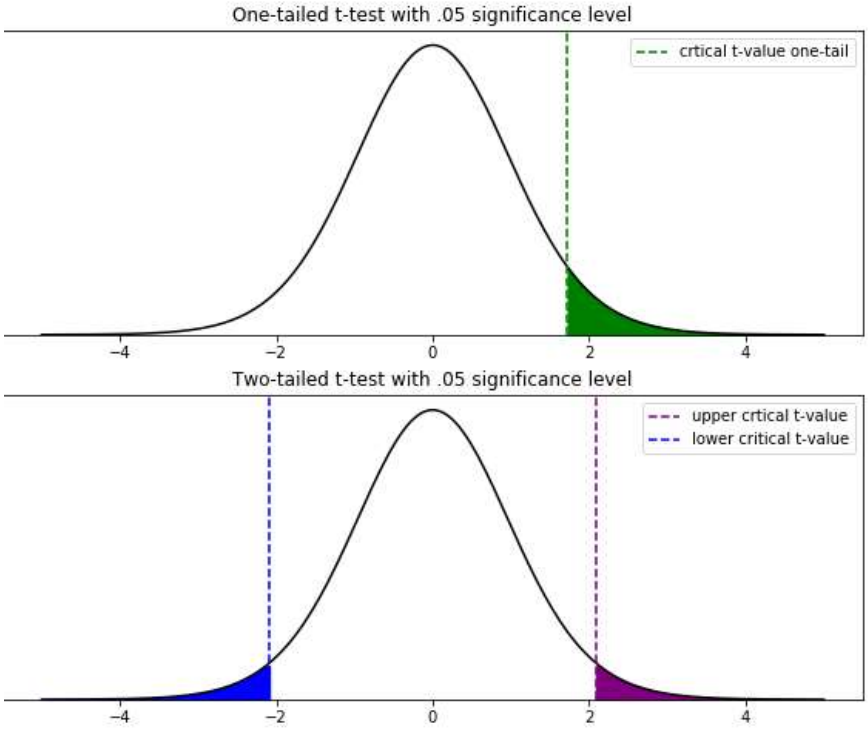
z-distribution: This distribution takes values from parameters present in population

t-distribution: It takes values from parameters present in the sample data set. It is the probability of distribution of a statistic that is obtained from the larger population from which the samples were taken.

Week 4

- ***Hypothesis testing***

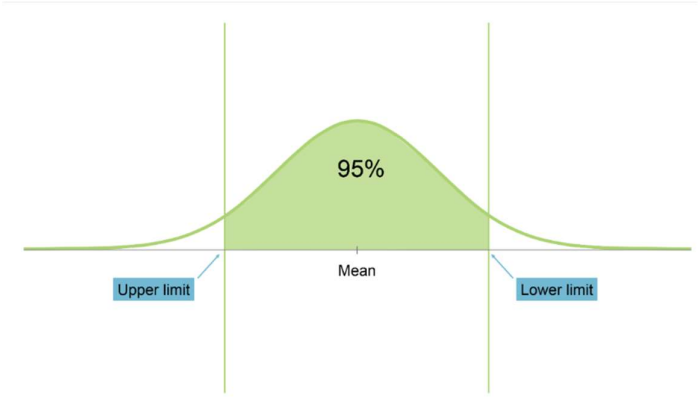




- *Hypothesis error*

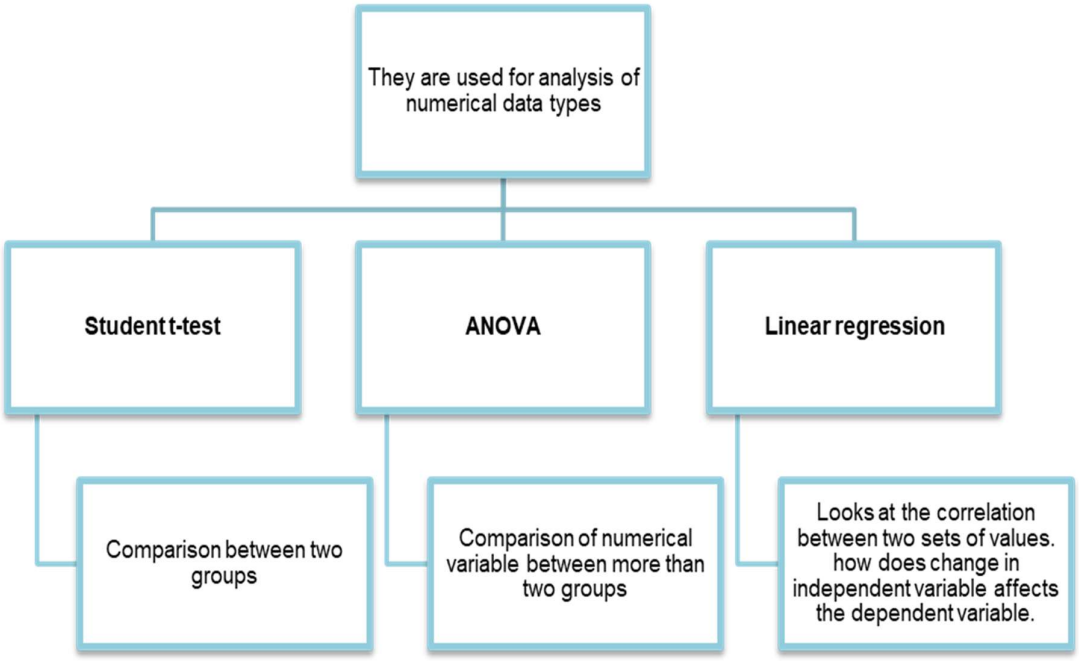
	The null hypothesis is valid	The null hypothesis is invalid
Reject the null hypothesis	Type I error	✓
Fail to reject the null hypothesis	✓	Type II error

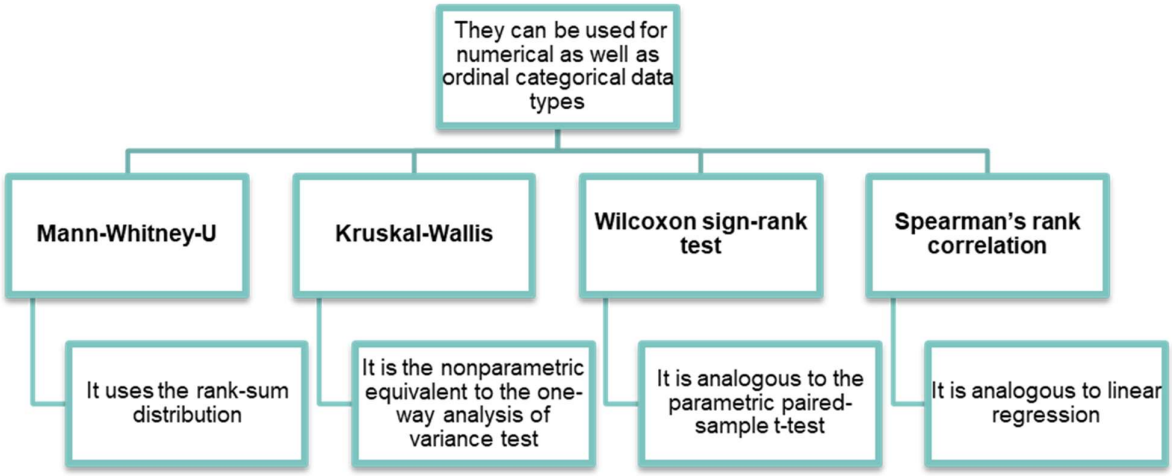
- ***Confidence intervals:*** A confidence interval is a range of values that possibly include an unknown population parameter**.**
- ***Confidence level:*** It refers to the percentage of probability, or certainty, that the confidence interval would contain the true population parameter when you draw a random sample many times.



Week 5

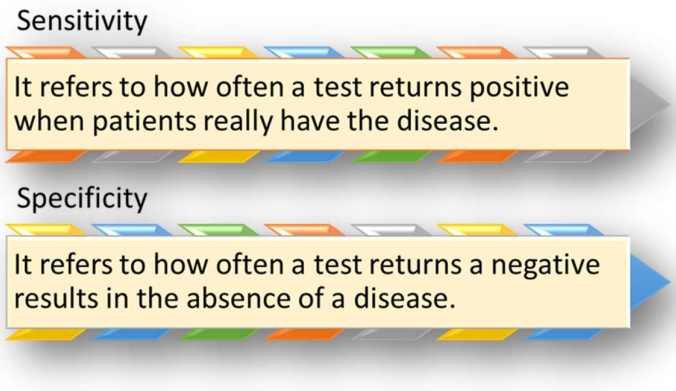
- ***Parametric and non-parametric tests***





Week 6

- **Comparing categorical data**
  1. Chi-square($\chi 2$) tests are the most common tests used in statistical tests for nominal and ordinal categorical data types.
     - ✓ $\chi 2$ *goodness of fit test*- This test allows us to see whether the distribution pattern of our data fits a predicted distribution.
     - ✓ $\chi 2$ *test for independence*- This is also called the $\chi 2$-test for the association.
     - ✓ ***Cochrane's rule*** states that to use the $\chi 2$ test, "more than 80% of the values in the expected table must be larger than 5. If not, Fisher's exact test should be used."
  2. Fisher's test only uses a 2×2 table. It uses factorials for calculation.
- **Specificity and sensitivity**



	With disease	Without disease	
Test positive	90 (True positive)	90 (False positive)	180
Test negative	10 (False negative)	810 (True negative)	820
	100	900	1000

$$\text{Sensitivity} = \frac{\text{True positive (TP)}}{\text{With disease}} = \frac{90}{100} = 90\%$$

$$\text{Specificity} = \frac{\text{True negative (TN)}}{\text{Without disease}} = \frac{810}{900} = 90\%$$

- **Predictive Values**