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AN OVERVIEW OF STATISTICS: COMPREHENDING HYPOTHESIS TESTING AND STATISTICALIMPERFECTIONS (ERRORS AND BIAS)

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ABSTRACT

Hypothesis testing is a fundamental process in statistical analyses for research projects. It involves determining the likelihood of an event occurring by chance. In experimental studies, subjects are divided into two groups - a treatment group and a control group. The results from these groups are compared to ascertain if any observed differences can be attributed to the treatment effect or are merely due to random sampling error. The null hypothesis, which posits that there is no difference between the groups, is conventionally tested. For instance, in a study examining treatment effects on mortality rates, the null hypothesis would state that the treatment has no effect. This methodology forms the core of most statistical analyses in individual research projects.

KEYWORDS: Biostatistics, Statistical bias, Hypothesis testing, Statistical Error.

INTRODUCTION

A clinical trial begins with an assumption or belief, and then proceeds to either prove or disprove this assumption. In statistical terms, this belief or assumption is known as a hypothesis. Hypothesis testing is a statistical method that is used in making statistical decisions using experimental data. Hypothesis testing is a technique for calculating the likelihood of an observed event occurring purely by chance. Most statistical studies for particular research initiatives are based on this process of evaluating hypotheses. In the field of research, errors and bias can significantly impact the validity and reliability of study findings. Understanding these elements is crucial for interpreting the results accurately and making informed decisions.

Methods

In hypothesis testing, the research topic of interest is divided into two types of hypotheses: the null hypothesis (H0) and the research hypothesis (H1), also known as the alternative hypothesis. These hypotheses include contradictory opinions.

H0: The null hypothesis: It is a statement about the population that either is believed to betrue or is used to put forth an argument unless it can be shown to be incorrect beyond a reasonable doubt.

H1: The alternative hypothesis: It is a claim about the population that is contradictory to H0 and what we conclude when we reject H0.

In most circumstances, it is easier to reject a false assertion (null hypothesis); hence, we usually assume the opposite of our study topic of interest. We then test to see whether we can reject the null hypothesis, providing support for our research hypothesis. Hypothesis testing does not establish that the research hypothesis is correct; rather, it implies that the hypothesis is reasonable.

Steps for Hypothesis Testing

In general, regardless of the research question, there are four hypothesis testing steps:

1. Formulate the null and research hypotheses.
2. Select a significance level.
3. Calculate the test statistics.
4. Analyze and state conclusion based on H_0 (null hypothesis).

Step 1: Formulate the Null and Research Hypotheses

Although we initially assume the null hypothesis to be true, the investigator seeks to answer his or her research question. For example, in a clinical trial of a new drug, our research question might ask, "Is the new drug more effective (i.e., decrease mortality)

than a placebo (sugar pill)?"We would define our null and research hypotheses as.

H_0: The average mortality rate does not differ between the treatment and control groups H_1: The average mortality rate does differ between the treatment and control groups Research hypotheses refer to relationships suspected in the entire population of interest.In this example, the researcher would hypothesize that the new drug is more effective in all transported patients meeting the inclusion criteria (population of interest). However, when an investigator actually tests a hypothesis, they are running the statistical analysis in only a small sample and then inferring these findings to the population of interest.

Step 2: Select a Significance Level

The significance or alpha level (α) establishes the probability that the investigator is willing to accept that he or she has incorrectly rejected the null hypothesis. In other words, given α=.05, the investigator is willing to accept that his or her decision to rejectthe null hypothesis will be wrong 5% of the time (i.e., say that the treatment significantly decreases mortality when actually it does not). The most common alpha levels are 0.05 and 0.01. The significance level is also the criterion level used to define the cutoff probability (of seeing a sample mean, for example) that is so extreme that we consider it very unlikely that we would see a sample mean associated with that probability bychance. This cutoff probability or critical value is used to determine whether the null hypothesis should be rejected and is discussed in detail in step 4. In essence, the alpha level is used to establish statistical significance of the findings and should thus be established a priori (before you actually run the statistical test).

Step3: Calculate the Test Statistic

Having established the significance level to test the hypothesis, the investigator can now collect data and con-duct the statistical test that has been selected. The process for calculating a test statistic is beyond the scope of this paper. The reader is advised to consult with a statistician for further detail and may wish to consult other statistical references,[3] on the topic.

Step4: Analyze and State Conclusion based on H_0

The test statistic calculated in step 3 is then compared with the critical value established, in part, by the significance level selected in step 2. The critical value defines the set of values of the test statistic (the critical region) for which the null hypothesis should be rejected.In other words, values of the obtained test statistic that equal or exceed the critical value and therefore fall within the critical region are considered unlikely to occur as a result of chance or sampling error alone. The investigator can then conclude, with some confidence, that there is a "statistically significant difference" or that the extreme value of the test statistic was attributable to the treatment.

We use the probability value (*p*-value) of a hypothesis test to determine the probability of obtaining an equal or more extreme value of the test statistic than that calculated instep 3 because of chance alone, given a true null hypothesis. We compare the significance level defined in Step 2 ($\alpha = 0.05$) with the *p*-value obtained with our test statistic in step 3. If the *p*-value obtained is smaller than 0.05 ($p < 0.05$), we reject H_0. If the *p*-value is larger than 0.05($p > 0.05$), we fail to reject H_0. Thus, the probability that a sample drawn from a specified population (ALL trans-ported patients meeting your inclusion criteria) will produce a test statistic value greater than or equal to the critical value is less than 5%. Only 5% of samples drawn from a population produce test statistic values as extreme or more extreme than your obtained test statistic. Smaller *p*-values provide evidence that the null hypothesis is unlikely to be true, providing support for the research hypothesis.

Potential Errors

When doing hypothesis testing, you can make one of two types of errors. You can concludethat there is a difference between the two groups, when there actually is no difference, oryou can conclude that there is no difference between the two groups when actually there is a difference (fail to measure a difference). The first error is called a type I (or alpha) error, and the second is called a type II (or beta) error. Type I and II errors are important to theinvestigator because he or she can make decisions in the study design and data analysis that will decrease one or the other of these errors. This is particularly important because the investigator cannot know whether they have made either of these errors when interpreting the data. An additional difficulty is that, as the chance of a type I error decreases, the chance of a type II error increases and vice versa. Given our decision to either reject or not reject the null hypothesis, there are two alternatives for reality or truth. The following table gives the four possible results for any hypothesis test.

Table 1:

Statistical decision	True state of the Null Hypothesis	
	H0 True	H0 False
Reject H0	Type 1 Error	Correct
Do not Reject H0	Correct	Type 2 Error

Some research books consider Type 3 error that is solving the wrong problem -results from- Failing to acknowledge that researcher asked the wrong question to the wrong people while trying to solve the wrong problem. Researcherfail to adequately define mere problematic background assumptions.

Errors in research methodology can be classified into two types: random errors and systematic errors. 1. Random errors are unpredictable and caused by chance. They can be reduced by increasing the sample size.

2. Systematic errors, on the other hand, are consistent and repeatable errors that can introduce bias into the study.

Bias refers to any tendency which prevents unprejudiced consideration of a question. Inresearch, bias can occur at various stages, including data collection, analysis, interpretation, publication, and review.

Bias in Research

Bias-(Unknown or un-acknowledged error)

In research, bias is described as a systematic error or deviation from true results It occurswhen there is an underlying factor that consistently distorts the results. Bias is important in research because it can affect the findings of the study and how they are reported. If 'bias exists, health decisions may be made on incorrect information. Researchers and clinicians try to identify possible sources of bias or systematic error so they can eliminate or compensatefor possible.

Types of bias[1]

A number of types of bias that could affect the conduct, findings and use of studies have been identified Possible sources of bias include

1. **Selection bias-** This relates to who is included in a study. For example running a survey only on the internet automatically prevents anyone without internet access from participating Studies on volunteers always have this kind of bias.
2. **Attrition bias-**When there is non-response to intervention, it may lead to dropouts Understanding the effect of dropouts is important. If participants involved in a weight loss trial are not losing weight, they may become disillusioned and dropout. The weight loss program may seem more effective because those dropping out were not counted in the results.
3. **Measurement bias-**Various types of measurement errors can lead to bias such as Ifan instrument is not calibrated properly it will consistently measure inaccurately. Study participants may not remember and record events that occurred. Using a scale that is not suitable for the group e.g. a pain scale in English being used f recently arrived immigrants who don't know English.
4. **Researcher bias-** This occurs when a researcher's personal beliefs influence the choice of methodology or the research question.
5. **Confounding bias-** Sometimes a third effect can be associated with both caused the effect. For example an anesthetic agent seems to result in a higher risk of death. However t was found that this anesthetic was only used in riskier operations that had a higher death rate.
6. **Publication bias-** Research with positive results is more likely to be published than research that shows no effect. This can make interventions seem more effective than they actually are.
7. **Procedural bias-** Procedural bias exists most often when we administer the re- search interview or questionnaire under adverse conditions. For example using psyche students for course credit.
8. **Design bias-** The bias occurs when the case group and the control group are not properly matched, and the confounding factors are not properly accounted for at the time of analysis.
9. Research design bias is introduced when the study fails to identify the validity problems or when publicity about the research fails to incorporate the researcher's caution.
10. **Length bias-** In case of prevalence studies (case-control study) if the sample includes disproportionately more of those who are healthier and survive longer, and the conclusion can't be generalized to those who have less survival time. Cross sectional studies also suffer from this bias for conditions that are rapidly fatal.
11. **'Lead-time' bias-** While conducting a research on a particular disease, the problem occurs that all the cases are not detected at the same stage, this may lead to a bias called 'Lead- time' bias For example in case of cancers, some may be detected at thetime of screening such as by Pap smear and some may be detected clinically But the time of follow-up is generally from the time of detection. This difference in Lead-time can cause systematic error in the results.
12. **Berkson's bias-**Hospital cases when compared to hospital controls can have bias if the exposure increases the chances of admission. Thus cases in hospital will have disproportionately higher number of subjects with that exposure. For example, casesof injury in motor vehicle accidents have this kind of bias.
13. **Hawthrone effect-** The change in behavior and response of a person when he/she comes to know that he/she is being observed or being investigated.
14. **Response bias-** When bias occurs due to the difference in responses of the subjects in study and control groups. For example, severe cases may are likely to give more correct responses regarding history and current illness as compared to controls. Some patients may not be comfortable with their sexual history and other information because of stigma attached to these diseases. This bias comes under Information bias.

RESULTS

The results of a hypothesis test are interpreted in terms of a pre-specified level of significance. It refers to the degree of evidence we require to accept an alternative hypothesis. This is best determined before looking at the data, so as not to influence our judgments. We therefore reject the null hypothesis if our sample data lies in the critical region; otherwise, we do not reject the null hypothesis. The presence of errors and bias in research can lead to skewed results, affecting the study's validity and reliability. For instance, selection bias, where certain groups are over or underrepresented, can lead to misleading conclusions about the population. Similarly, measurement errors can distort the actual relationship between variables.

DISCUSSION

The p-value is used in hypothesis testing to help you support your null hypothesis. The p-value is a number between 0 and 1 and interpreted in the following way: A small p-value (typically ≤ 0.05) indicates strong evidence against the null hypothesis, so you reject the null hypothesis. A large p-value (> 0.05) indicates weak evidence against the null hypothesis, so you fail to reject the null hypothesis.

Mitigating errors and bias is a critical aspect of research methodology. This can be achieved through careful study design, rigorous data collection and analysis procedures, and transparent reporting of methods and findings.

Statistical significance

The statistical significant means that the 'statistic' is reliable, and it doesn't mean the finding is important. A researcher's finding may be true without being important When the results are highly significant, they mean it is very probably true.

Statistical significance is attained when a 'p' value is less than the significance level 'a' (probability of rejecting the null hypothesis given that it is true). Significance levels show us how likely a result is due to chance? The most common level used to mean something are good enough to be believed is 95 out of 100 This means that the finding has a 95% chance of being true ($p<0.05$) Other significance levels are $p<0.01$ and $p<0.001$.

Only random representative samples should be used in significance testing. Testing statistical significance is all about the chance of findings that will not hold up in the future replications

Clinical significance

Clinical significance is a decision based on the practical value or relevance of a particular treatment, this may or may not involve statistical significance as criteria Clinical significance has little to do with statistics and is a matter of judgments.

Clinical significance often depends on the magnitude of the effect being studied Studies can be statistically significant yet clinically in-significant For example, A large study might find a new drug lowered blood pressure on average 1mm Hg of drop in blood pressure wouldn't justify the action of new drug significantly.

CONCLUSION

Hypothesis testing is used in statistics to test the validity of a claim or hypothesis about a population parameter, based on sample data. By using a pre-determined level of significance and sample data, we can make determinations about the population. While it is challenging to completely eliminate errors and bias in research, understanding their sources and potential impact can help in designing more robust studies and interpreting the results more accurately.

REFERENCES

1. Basics of Reaserch methodology and medical statistics, Dr. Bilal Ahmad Wani and Dr. Shaheen Ahmad Wani. Edition, 2021; 12: 211.
2. Statics for the Behavioral Science 10e., Frederick J Gravetter, Larry B. Wallnau, print year, 2015; 8: 223.
3. Research Methodology Methods and Techniques (Second revised edition), C.R.Kothari, Chapter-9, page np.184.
4. Fundamentals of RESEARCH METHODOLOGY and STATISTICS, Yogesh Kumar Singh (New Age International Publisher) Chapter-4, page no.54.
5. RESEARCH METHODOLOGY: TOOLS AND TECHNIQUES, Dr. Prabhat Pandey Dr. Meenu Mishra Pandey, Bridge Center 2015 Chapter-6, page no. 32.
6. RESEARCH METHODOLOGY, ALAGAPPA UNIVERSITY, Dr Deepak Chawla, Dr Neena Sondhi, VIKAS® PUBLISHING HOUSE PVT. LTD., Unit-10 page 172.