

# Hypothesis Testing

Pages with reference to book, From 98 To 100

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In conducting any research the first step is to define what is the research question or, in other words, what interests the researchers. For example, birthweights in a hospital is a broad area and in order to be specific we need to state the precise feature of birthweights which is of interest. This question is the research question and is formulated into a hypothesis that you wish to test. In a scientific study, the fundamental research question is framed in the form of a hypothesis. Hypotheses are generated prior to conducting a scientific study and depend on the research question.

## **What is a hypothesis?**

A hypothesis is defined simply as a statement about one or more populations. The hypothesis is concerned with the characteristics of interest in the population such as birthweight, blood pressure level, arising from the research question. For example, if the research question is comparing the mean birthweights of babies born in a hospital to the mean birthweight of Pakistan babies then the hypothesis can be stated as: "Is the mean birthweight of babies born at a public hospital in Karachi similar to the mean birthweight in Pakistan".

## **Why is it necessary to test a hypothesis?**

Hypothesis testing is extremely important for research opinions by looking at data, but a hypothesis test provides uniform decision-making criteria that will be consistent and replicable when used by different researchers. After formulating the hypothesis the next step, i.e., hypothesis testing, determines whether or not such statements are consistent with available data.

## **How do I frame a hypothesis?**

There are two statistical hypotheses involved in hypothesis testing. The first is the hypothesis to be tested, usually referred to as the "null" hypothesis or  $H_0$ . The null hypothesis states that the results observed in a study, experiment, or test are no different than what might have occurred as a result of chance alone, or that the observed difference is not large enough to rule out the element of chance which may occur as a result of the sampling process. The "alternate" hypothesis,  $H_A$ , states that the results observed are different from what might have occurred by chance. Generally, the null hypothesis is set up for the express purpose of being rejected. The hypothesis process whereby you accept or reject the null hypothesis is called "the test of significance" and the statistical measure used is called the test statistic".

## **How do I accept or reject the null hypothesis ( $H_0$ )?**

The "test statistic" serves as a decision maker. The decision to reject or not to reject the null hypothesis depends on the magnitude of the test statistic. The test statistic used depends on the type of data. If we are conducting a test of significance for the difference between two means then the appropriate test statistic is the "Z test" (normal distribution with sample size greater than 25) or the "t test" (normal distribution with sample less than 25) and the test statistics are "Z" and "t" respectively. However, if we are conducting a test of significance for categorical data (such as sex, education level, type of water supply) then the test of significance is the "chi-square test" and the test statistic is the "chisquared  $QC$ ". The decision, to accept or reject the null hypothesis, is made on the basis of the desired level of significance and designated by alpha ( $\alpha$ ).

## **What is $\alpha$ ?**

The significance level of a test is denoted by  $\alpha$ .  $\alpha$  is described as the probability of rejecting the null hypothesis, given that the null hypothesis is, in fact, true. This reflects the role that chance can play in accepting or rejecting the null hypothesis. For example, a level of 0.05 reflects the probability that the

rejection of the null hypothesis can be false 5% of the time. The more frequently encountered values of alpha are 0.05 and 0.01.

### **What are the steps in hypothesis testing?**

There are five basic steps in hypothesis testing. These are:

- Step one: Definition of  $H_0$  and  $H_A$ .
- Step two: The appropriate test statistic.
- Step Three: The decision rule.
- Step Four: Calculation of the test statistic
- Step Five: The statistical decision.

The following example illustrates these steps:

In this example the research question is:

Is the mean diastolic blood pressure among adult men attending an outpatients clinic at a small hospital different from the mean diastolic blood pressure of the general adult male population living in that community?

The data available tells us that the mean diastolic blood pressure among 83 adult males aged 25-55 years is 73 mmHg with a standard deviation of 11.6 mmHg. The mean diastolic blood pressure among the general population is 70mmHg.

### **Step One: What is the null ( $H_0$ ) and alternate ( $H_A$ ) hypothesis?**

$H_0$ : There is no difference in the mean diastolic blood pressure readings between the adult males attending the outpatients clinic and the general population.

$H_A$ : There is a difference in the mean diastolic blood pressure readings between the adult males attending the outpatients clinic and the general population.

### **Step Two: What is the test of significance and the test statistic?**

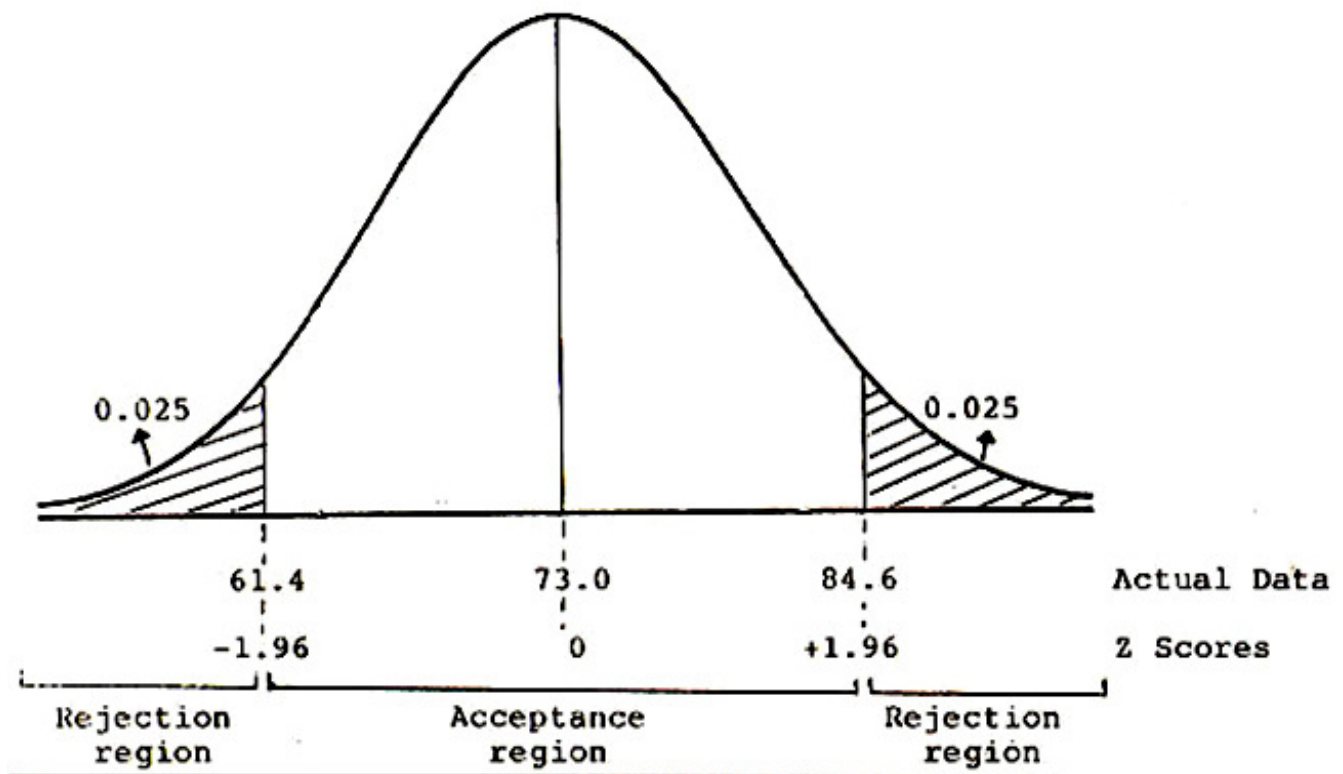
As the data is continuous (measurement values for which means can be calculated) the test of significance can be either the Z test or the t test. However, as the sample size is greater than 25, the Z test is more appropriate. The test statistic is therefore Z (generally referred to as 'Z score').

Step Three: What is the decision rule?

The decision rule specifies that we choose a level of significance, i.e., a level. In this situation we will choose an a level of 0.05 which is most commonly used.

### **Step Four: Calculate the test statistic.**

Prior to calculating the test statistic, we should draw the distribution curve and highlight the acceptance and rejection regions for the null hypothesis (as shown in Figure).



**Figure. Critical region for the test of significance.**

Accepting or rejecting the null hypothesis depends on whether the test statistic fall in the acceptance or rejection regions depicted in Figure. The formula to be used is:

Mean [Sample - Population]

Standard Deviation/ $\sqrt{n}$

where  $n$  is the sample size. In our example

$73-70$

$11.6/83$

$= 2.50$

#### **Step Five: What is the statistical decision?**

We will use a two tailed Z test as our null hypothesis is testing no difference in either direction. In other words, we are interested in testing whether the mean diastolic blood pressure readings in the out patients clinic is greater or lesser than that in the general population. If we were testing a difference in only one direction, i.e., the mean diastolic blood pressure is either greater than or lesser than that in the general population, we would use a one-tailed Z test. Since, in our example, the computed test statistic  $Z = 2.36$  falls in the rejection region shown in Figure, we reject the null hypothesis. We can, therefore, state that the mean diastolic blood pressure reading from the outpatients department is statistically significantly different from that of the general population. As the level of significance ( $\alpha$ ) was set at 0.05, the  $p$ -value is 0.025. We can also look up the Z tables and compute the exact probability of rejecting the null hypothesis. In this situation, the exact probability is  $<0.025$ .

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