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Introduction

A t-test determines whether there are significant differences in the means of the groups when certain characteristics of the groups are taken into consideration. In general, this method is used when the data has a wide variance and follows a normal distribution, for example when 100 coins are flipped. An assumption that applies to an entire population can be tested with the t-test as a hypothesis testing tool. For t-tests, a number of factors contribute to their significance, including t-statistics, t-distributions, and degrees of freedom. When three or more means are involved in a test, a variance analysis must be performed. The interpretation of observations in science is called hypotheses. It is important to distinguish between different types of definitions. The importance of hypotheses in scientific research cannot be overstated. Experimentally validated predictions or explanations are based on data which have been supported by analysis. Science is not a mere collection of observations and experiments and therefore cannot be proven or disproven solely based on observation and experimentation. In a similar manner, a hypothesis can be expressed as "If X, then Y.". In science, hypotheses are explanations or predictions that provide an explanation or prediction.

In order for a null hypothesis to qualify for rejection, the results must be strong and unlikely to be due to chance alone. Many tests, such as the t-test, can be used to determine whether a factor is present. The testing of a larger sample size will extend the scope of statistical analyses beyond the t-test. Statistical experts often use a z-test when they have a large sample size. Further tests can be conducted such as the chi-square and the F-test.

The null hypothesis and the alternative hypothesis

Hypothesis justifies a set of facts that are based on some approximation and are testable via certain further investigations. Basic hypotheses can be divided into two categories: *null hypothesis and alternative hypotheses*. A problem is usually the starting point for research. Following this, these hypotheses elaborate upon and clarify the research problem in a more specific and detailed manner. It is advisable to express the criteria of the research problem as the relationship between two or more variables using the null hypothesis and alternative hypothesis. As the criterion, a statement should express both or more of the measurable variables in a way that is comprehensible. Statistical tests and relational statements must be clearly informed by the null hypothesis and alternative hypothesis.

It is important to note that the research problems differ from null hypothesis and alternative hypothesis in that they do not encompass complex questions that can be tested. It is still possible to test these two hypotheses. Before the data collection and interpretation phases in a research project can be conducted, the null hypothesis and alternative hypothesis must be clearly and appropriately formulated. If the null hypothesis and alternative hypothesis do not describe the expected relationship between the variables or do not contradict previous research, then they are unreliable. In order to ensure their simplicity and conciseness, they should be stated simply and concisely. A null hypothesis and an alternative hypothesis cover the purpose and importance of trying to describe a phenomenon as accurately as possible. Research studies directly test a relationship statement to obtain results for the researcher or investigator.

Generally, **H₀** is considered to be the null hypothesis. The null hypothesis states that there is no statistical significance between the two variables in the hypothesis. Alternative hypothesis simply is the inverse, or opposite, of the null hypothesis, it is generally denoted as **H₁**.

For the current objective of the analysis, the relevant hypothesis are:

H₀ (null): There is no statistically significant difference between the mean of the ages of the white patients, compared to BAME patients.

H₁ (alternative): There is a statistically significant difference between the mean age of the white patient group, compared to the BAME patient group.

Putting the hypotheses to the test

Regarding the data analysis, the Microsoft Excel program was used to fulfill the objective of this analysis. In order to start, it is important to find the Critical Value, and if the t-test is lower than the critical value, we are not rejecting H_0 (the null hypothesis), but if the value is higher, we would. For the white patients group, the mean age was 36.58, and for the BAME patients group, it was 60.04. Statistically, the computed difference was 23.46; computed ratio was 0.61 (on average, those in the BAME group were 1.64 times older than white patients); and p-value was equal to 1.96×10^{-8} . After that, it is necessary to find the value of confidence level for the t-test. As we already know, we need to test the probability values of 0.01, 0.02, and 0.10. Therefore, 100 times, there will be 99%, 98%, and 90% chance to reject the null hypothesis, 1%, 2%, and 10%. Since we have two sets of data, we simply add the number data from column 1 and the number data from column 2, minus 2.

Using the rule of three, we can determine the degrees of freedom for the 98. As a result, we will be able to determine the following degrees of freedom.

For 1% is 2,137, 2% is 1,899, 10% is 1,343.

t-Test: Paired Two Sample for Means		
	<i>Variable 1</i>	<i>Variable 2</i>
Mean	36,58	60,04
Variance	143,5138776	547,1820408
Observations	50	50
Pearson Correlation	-0,04487294	
Hypothesized Mean Difference	0	
df	49	
t Stat	-6,20016745	
P(T<=t) one-tail	5,74692E-08	T_{obt}
t Critical one-tail	2,40489176	T_{crt}
P(T<=t) two-tail	1,14938E-07	
t Critical two-tail	2,679951974	

T_{obt} is greater than T_{crt} for 1%. In this case, we can reject the null hypothesis and accept the alternative hypothesis.

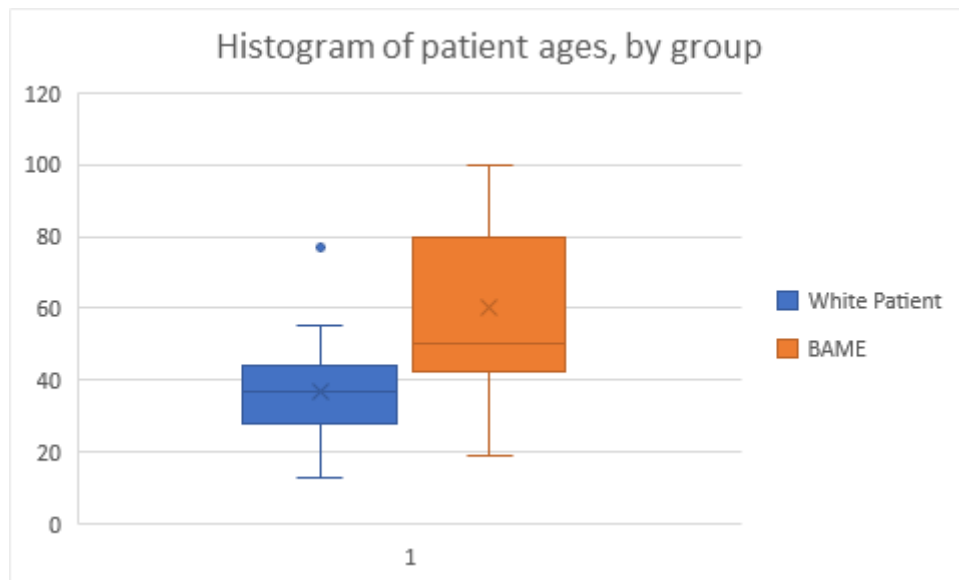
t-Test: Paired Two Sample for Means		
	<i>Variable 1</i>	<i>Variable 2</i>
Mean	36,58	60,04
Variance	143,5138776	547,1820408
Observations	50	50
Pearson Correlation	-0,04487294	
Hypothesized Mean Difference	0	
df	49	
t Stat	-6,20016745	T_{obt}
P(T<=t) one-tail	5,74692E-08	
t Critical one-tail	2,109872718	T_{crt}
P(T<=t) two-tail	1,14938E-07	
t Critical two-tail	2,40489176	

With 2%, we can see that T_{obt} exceeds T_{crt} , so the null hypothesis can be rejected and the alternative hypothesis embraced.

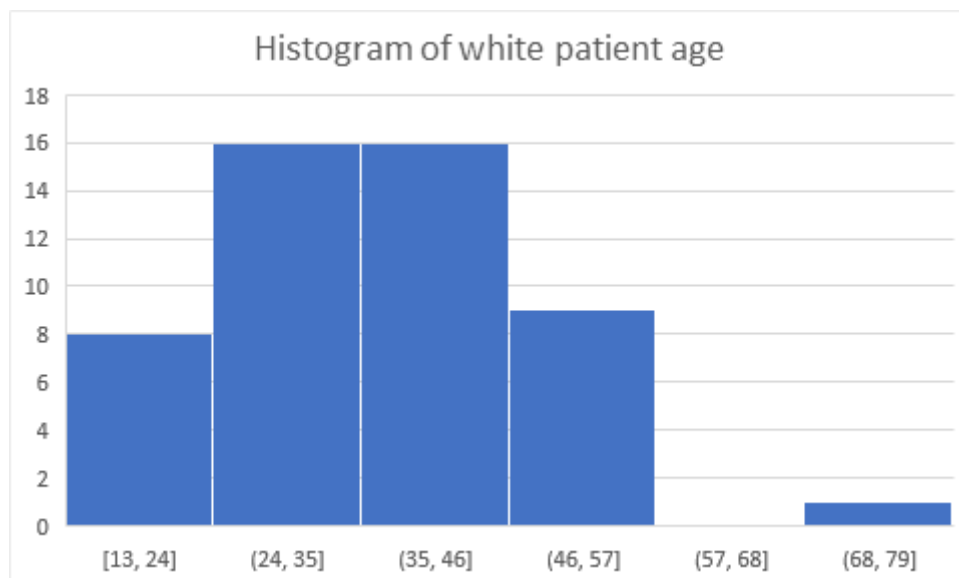
t-Test: Paired Two Sample for Means		
	<i>Variable 1</i>	<i>Variable 2</i>
Mean	36,58	60,04
Variance	143,5138776	547,1820408
Observations	50	50
Pearson Correlation	-0,04487294	
Hypothesized Mean Difference	0	
df	49	
t Stat	-6,20016745	T_{obt}
P(T<=t) one-tail	5,74692E-08	
t Critical one-tail	1,299068785	T_{crt}
P(T<=t) two-tail	1,14938E-07	
t Critical two-tail	1,676550893	

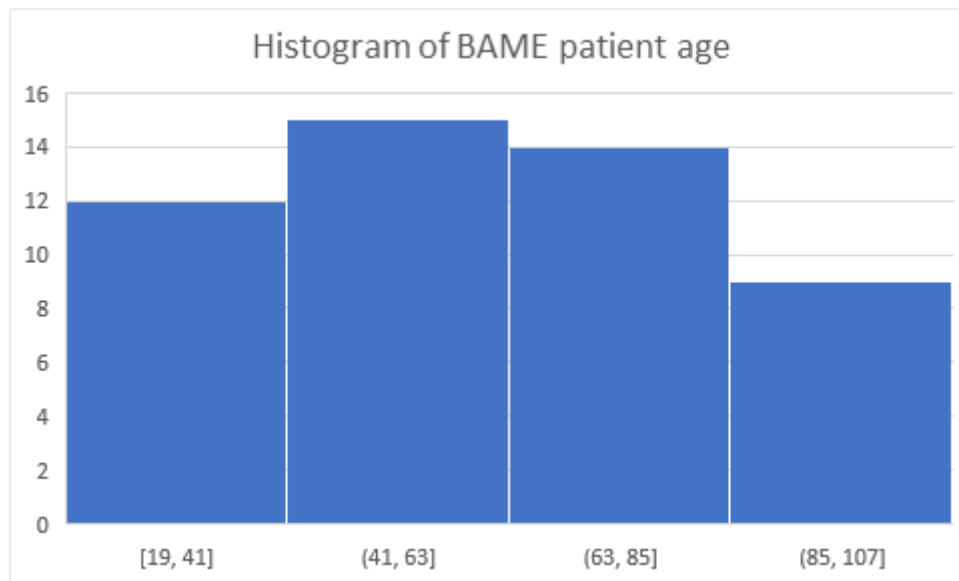
In the case of 10%, we can see that T_{obt} is greater than T_{crt} , so the null hypothesis is rejected while the alternative hypothesis is accepted.

A look at outliers and normality



For the white group, most patients tend to be under the age of 51, with only two outliers (55, respectively 77).





Shapiro-Wilk normality ($p=0.008$) rejects the idea of a Gaussian distribution in the BAME group due to the distribution of ages having a higher tail to the right (older patients).

Since the non-paired Student t-test averages down extreme values and considers multiple data points rather than only comparing one point to another (like the paired Student t-test would), outliers shouldn't have a significant influence on results.

Controlling biases and other factors

A total of 100 COVID-19 patients from 100 separate observations have been examined, 50 from BAME groups and 50 from white groups. Because individual participants are already diagnosed, this appears to be more of a case-control study as opposed to an exposure-dependent or cohort study.

An author chooses precisely who will participate in the study, and is therefore able to influence the results (unconsciously), bringing them towards the desired result. Consequently, the author cannot gain information about the incidence of disease or risky behavior through a case-control study. The data collected in the majority of case-control studies are retrospective (i.e. collected after the events being studied have already happened) and could therefore be invalid, incomplete, unstructured or have no standardization.

It is clear that one of the challenges for our analysis is a shortage of healthy individuals' data. Our available data only pertains to patients who are already ill, so we cannot estimate a prevalence.

Possible measures: it is imperative to collect data pertaining to incidence and prevalence of such diseases from cohort studies, and to follow the evolution of such indicators.

It appears that the socio-economic context of the two groups is a second problem which cannot be controlled. There is evidence that financial and income inequality negatively impacts members of the BAME population more than whites, which may cause BAME members to buy less personal care items or postpone their medications, thus using public medical services more (and being discovered as carriers or sick patients more often). The disparities between incidence and mean ages between BAME and white societies could also be influenced by overwork and stress-related immunosuppression.

Possible measures: it would be ideal if patients were matched based on their basic information (age, gender), their job conditions, and their socioeconomic background.

Another challenge is standardizing the data collected. As we don't know about the methods used by institutions collecting, processing, and providing the data, and whether the same methods are used for COVID-19 infections, we cannot make a determination here. An institution located in a neighborhood where white people dominate might use a more sensitive test than one in a neighborhood where BAME people determine the majority. We would then be faced with the issue of overestimation when it comes to white people compared to BAME people.

Possible measures: despite being considered better than single-center studies, multicenter studies still require a great deal of preparation and effort to complete.

In order to ensure compatibility between data points, all healthcare institutions participating in the program must standardize their patient selection, interaction, and data gathering procedures. Due to the available multiple diagnostic tests, each with a different sensitivity and specificity, it is possible that some institutions may overestimate the incidence, whereas others may underestimate it during the COVID-19 pandemic.

The same test has to be used by all the institutions to ensure compatibility or reproducibility, or a complex statistical analysis must be performed (all data points from each type of diagnostic test are compared among themselves, and then a corresponding value is computed for comparison among different types of tests). A single-center study, if such a thorough and complex preparation is not possible, might provide a more comprehensive

picture of incidence and prevalence of the disease. Vaccinations, handwashing practices, mask usage, and social distancing are also crucial for preventing COVID-19.

Bibliography

FAQ: What are the differences between one-tailed and two-tailed tests? (n.d.).

Retrieved July 27, 2021, from Ucla.edu website:
<https://stats.idre.ucla.edu/other/mult-pkg/faq/general/faq-what-are-the-differences-between-one-tailed-and-two-tailed-tests/>

Hayes, A. (2021, May 19). T-Test. Retrieved July 27, 2021, from Investopedia.com website:
<https://www.investopedia.com/terms/t/t-test.asp>

Illowsky, B., & Dean, S. (2013). *Introductory statistics*. Retrieved from <https://opentextbc.ca/introstatopenstax/chapter/null-and-alternative-hypotheses/>

Inequality - Income inequality - OECD Data. (n.d.). Retrieved July 27, 2021, from Oecd.org website:
<https://data.oecd.org/inequality/income-inequality.htm>

Null hypothesis and alternative hypothesis. (2009, November 9). Retrieved July 28, 2021, from Statisticssolutions.com website:
<https://www.statisticssolutions.com/null-hypothesis-and-alternative-hypothesis/>

Otu, A., Ahinkorah, B. O., Ameyaw, E. K., Seidu, A.-A., & Yaya, S. (2020). One country, two crises: what Covid-19 reveals about health inequalities among BAME communities in the United Kingdom and the

sustainability of its health system? *International Journal for Equity in Health*, 19(1), 189.

Rungta, K. (2020, January 1). What is Data Analysis? Research. Retrieved July 28, 2021, from Guru99.com website:
<https://www.guru99.com/what-is-data-analysis.html>

T test (Student's T-test): Definition and examples - statistics how to. (2017, August 7). Retrieved July 29, 2021, from Statisticshowto.com website:
<https://www.statisticshowto.com/probability-and-statistics/t-test/>

The impact of COVID-19 on BAME communities. (n.d.). Retrieved July 29, 2021, from Gov.uk website:
<https://www.local.gov.uk/lga-libdem-group/our-press-releases/impact-covid-19-bame-communities>

(N.d.-a). Retrieved July 29, 2021, from Mdx.ac.uk website:
https://unihub.mdx.ac.uk/__data/assets/pdf_file/0038/187499/How-To-Write-A-Report.pdf

(N.d.-b). Retrieved July 29, 2021, from Gov.uk website:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/908434/Disparities_in_the_risk_and_outcomes_of_COVID_August_2020_update.pdf