

Project Report on

**A STATISTICAL ANALYSIS ON MEDICAL NEGLIGENCES IN INDIA
(2017-2022)**

SUBMITTED TO
DEPARTMENT OF STATISTICS
IN PARTIAL FULFILMENT OF
THE AWARD OF THE PG DIPLOMA IN DATA ANALYTICS
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DECLARATION

I hereby declare that the project entitled “**A STATISTICAL ANALYSIS ON MEDICAL NEGLIGENCES IN INDIA**” which is being submitted for the partial fulfillment of the PG DIPLOMA IN DATA ANALYTICS (Statistics) to the Department of Statistics, Maharshi Dayanand University, Rohtak, is based on the theoretical work carried out by me under the supervision of **Prof. S.C. Malik**, Department of Statistics, Rohtak. The results embodied in the report have not been submitted to any university or institution for the award of any degree or diploma.

Place: Rohtak

VISHAKHA

Date:

CERTIFICATE

This is to certify that the project entitled “A STATISTICAL ANALYSIS ON MEDICAL NEGLIGENCES IN INDIA” is submitted by Vishakha, Department of Statistics in fulfilment of the requirement for pg diploma in data analytics. This project was an authentic work done by her under my supervision and guidance. This project has not been submitted to any other institution for the award of any degree.

Date.

PROF. SC. MALIK

DEPARTMENT OF STATISTICS

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CHAPTER 1

INTRODUCTION

Medical negligence refers to the breach of duty by a medical professional that results in harm or injury to a patient. In India, medical negligence theories combine legal principles and healthcare ethics, providing a framework for analyzing liability. Here's a brief guide to the relevant theories for your project:

1. Legal Framework for Medical Negligence in India

- **Tort Law:** Medical negligence is primarily governed under tort law, which holds individuals accountable for causing harm due to a breach of duty.
- **Contract Law:** Patients and doctors share an implied contractual relationship where the doctor owes a duty of care.
- **Criminal Law:** Under **Section 304A** of the Indian Penal Code, criminal negligence applies if gross negligence results in death.
- **Consumer Protection Act, 2019:** Patients can claim compensation for medical negligence as "deficiency in service."

2. Essential Elements of Medical Negligence

To establish negligence, the following elements must be proven:

- **Duty of Care:** The medical professional owed a duty of care to the patient.
- **Breach of Duty:** The doctor failed to provide the standard level of care expected.
- **Causation:** The breach directly caused injury or harm to the patient.
- **Damage:** The harm caused resulted in measurable losses (physical, emotional, or financial).

MEDICAL NEGLIGENCE:

The statement from the Department of Health in 1999 emphasizes the importance of adhering to clinical guidelines in providing appropriate treatment. It suggests that doctors who fail to meet these standards may face repercussions when their performance in that clinical area is evaluated. This underscores the significance of maintaining high standards of care to ensure patient safety and well-being.

Medical errors can have devastating consequences for patients, despite doctors' best intentions. Patients often place great trust in their healthcare providers, viewing them as authorities who can heal them. However, doctors, like everyone else, are fallible, and mistakes can occur. These errors can result in significant physical, emotional, and financial harm to patients, underscoring the importance of continuous efforts to improve patient safety and minimize the occurrence of medical errors in healthcare settings. Correct, medical negligence occurs when a healthcare provider fails to meet the standard of care expected under similar circumstances, resulting in harm to the patient. The fairness of compensation for such malpractice depends on the legal system of the country where the incident occurs. Medical malpractice actions aim to improve quality control in healthcare and provide compensation for the physical and emotional harm suffered by patients due to negligence or errors.

The history of medical negligence spans over 4000 years, with ancient civilizations such as the Babylonians, Egyptians, and Romans having laws and penalties for malpractice. For instance, Hammurabi's Code included punishments like a physician losing his hand if a patient lost an eye due to surgery. However, the traditional physician-patient relationship, based on mutual respect, has evolved into a more business oriented model in recent times. With increasing awareness of patients' rights, inappropriate medical actions resulting in harm are now often seen as opportunities for financial compensation in some countries. The "information age" has made medical negligence information more accessible to the public, leading to heightened concerns about liability and a perceived crisis in medical malpractice.

MEDICAL NEGLIGENCE SUITS:

In a medical malpractice suit, the plaintiff must establish four key elements to prevail:

- The physician had a duty to treat or provide a service to the plaintiff, establishing a physicianpatient relationship.
- The physician breached that duty by failing to meet the minimally acceptable standard of care, typically demonstrated through medical expert testimony.
- This breach of duty caused harm to the plaintiff.
- The plaintiff suffered actual damages, which must be proven with specificity.

SCENARIO OF MEDICAL NEGLIGENCE IN INDIA:

India is experiencing a significant number of medical injuries, with 5.2 million incidents annually attributed to medical errors and adverse events. The primary causes of these injuries are medication mishaps, hospital-acquired infections, and blood clots that develop in the legs due to immobilization in hospitals. A report by an Indian doctor from the Harvard School of Public Health (HSPH) indicates that globally, over 43 million people are injured each year due to unsafe medical care, resulting in the loss of approximately 3 million healthy life years in India annually. Medical mishaps have become the 8th leading cause of death worldwide.

Over 7 million people worldwide suffer from preventable surgical injuries each year. With 234 million surgeries taking place globally annually, approximately one in every 25 people undergoes surgery at any given time. In developing countries, the death rate for major surgeries is nearly 10%.

Mortality due to general anesthesia affects one in 150 patients, and infections are reported in 3% of surgeries, with an overall mortality rate of 0.5%. Nearly 50% of adverse effects related to surgery are preventable.

In India, 5.2 million medical injuries are recorded each year. Globally, 43 million people are injured annually due to unsafe medical care. About two-thirds of medical injuries occur in low and middle-income countries like India, which records approximately 3.2 million cases annually. These cases range from incorrect prescriptions, wrong doses, wrong patients, and wrong surgeries to wrong timings and wrong drugs. Such malpractice incidents are not new; for instance, in 1953, a boy with a fractured limb died in Pune due to a doctor operating without proper anesthesia.

Sometimes, these errors have serious consequences, such as lifethreatening situations or unintended outcomes, like in the case of a poor labour woman who developed pregnancy and gave birth to a female child despite undergoing a sterilization operation that failed. With increased public awareness, the number of claims and litigations is rising in the country's consumer courts, now topping the list of 350,000 pending cases.

According to Dr. Girish Tyagi, registrar of the Delhi Medical Council, complaints have surged in the last two years, increasing from about 15 per month to 40. These complaints range from overcharging and unnecessary procedures to mistakes by wrong doctors and incorrect decisions.

Providing consistent solutions to eliminate or minimize these events and improve patient safety is challenging. It is essential for healthcare system

governing bodies to enforce hospitals to establish a litigation system. This system should include guidelines and steps to resolve matters either by outofcourt settlements or full court trials. It must also encompass effective policies and procedures to ensure high standards of effectiveness, transparency, and justice for all parties involved.

Problem in Different States of India

West Bengal

West Bengal is one of the states with the highest number of medical negligence cases in India. Reports suggest that nearly 150 suits are filed per year in this state, with serious allegations against both government and private hospitals. Currently, over 500 medical negligence cases are pending in the state.

In response to a query under the Right to Information Act, 2005, it was revealed that the West Bengal Medical Council (WBMC) has taken action against just four doctors in the past four years. Members of the Medical Council of India (MCI) have criticized three State Medical Councils, including the WBMC, for not addressing complaints in a timely manner, which has led complainants to approach the MCI directly.

This situation highlights significant issues within the state's healthcare system and regulatory bodies, emphasizing the need for more effective and prompt handling of medical negligence complaints to ensure accountability and justice for affected patients.

Uttar Pradesh

Cases of medical negligence are frequently reported in Uttar Pradesh. Health professionals, politicians, and media commentators often cite a "culture of blame" as a significant cause of litigation related to medical errors. In August 2017, a tragic incident occurred when over 70 children, mostly new borns, died at the biggest government hospital in Gorakhpur due to a shortage of oxygen supply. A probe committee formed by Chief Minister Yogi Adityanath submitted its report, but the findings are not yet public. The UP government has stated that those found guilty in the probe will face action.

The most common types of medical negligence in Uttar Pradesh occur during operations and childbirth. Numerous cases have been filed against doctors for negligently leaving surgical instruments inside patients' bodies, which can be fatal. Despite this, a cultural tendency exists where doctors are often revered and

their mistakes are seen as acts of fate rather than negligence. This reverence, coupled with widespread illiteracy, prevents many people from recognizing and addressing medical negligence.

These issues highlight the urgent need for systemic reforms to improve accountability and education regarding medical care standards in Uttar Pradesh.

Rajasthan and Maharashtra

Both Rajasthan and Maharashtra, among the largest states in India, have a persistent history of medical negligence. The frequency of these incidents has neither escalated nor decreased significantly over time, highlighting an ongoing issue in the healthcare systems of these states.

Rajasthan

In Rajasthan, medical negligence cases frequently make the news. The state's healthcare system faces challenges such as inadequate infrastructure, staff shortages, and a lack of rigorous enforcement of medical standards. Instances of negligence range from incorrect diagnoses and surgical errors to inadequate postoperative care and lack of hygiene leading to infections.

Maharashtra

Maharashtra, with its mix of urban and rural healthcare facilities, also grapples with persistent medical negligence. High-profile cases in cities like Mumbai and Pune often involve private hospitals, where issues like overcharging, misdiagnosis, and surgical errors are reported. In rural areas, the problem is compounded by a lack of medical facilities and qualified professionals, leading to delayed treatments and improper medical practices.

Common Issues

Both states share common issues such as:

- **Inadequate Training and Oversight:** There is a need for better training programs for medical staff and stringent oversight to ensure adherence to medical protocols.
- **Infrastructure Gaps:** Both states suffer from gaps in healthcare infrastructure, affecting the quality of care provided.
- **Legal and Regulatory Challenges:** There is often a lack of timely and effective legal recourse for victims of medical negligence, contributing to a culture of impunity among medical practitioners.

- **Public Awareness:** Limited public awareness about patients' rights and medical standards exacerbates the issue, as many cases go unreported or unresolved.

Addressing these issues requires comprehensive reforms in the healthcare system, including improved training for healthcare professionals, better infrastructure, strict regulatory oversight, and increased public awareness to ensure accountability and enhance patient safety.

Kerala and Tamil Nadu

As the southernmost states of India, both Kerala and Tamil Nadu have maintained a relatively constant range of medical negligence cases. Despite generally providing excellent medical assistance to citizens, both states have recorded numerous cases, possibly due to the high literacy rates, which make people more aware of the process of filing suits.

Kerala

Kerala, known for its high literacy rates and robust healthcare system, has faced its share of medical negligence cases. The state's emphasis on education and healthcare has contributed to a population that is more aware of their rights and willing to seek legal recourse in case of medical malpractice.

Tamil Nadu

Similarly, Tamil Nadu, with its well-developed healthcare infrastructure, has also encountered instances of medical negligence. The state's efforts in improving healthcare access and quality have been commendable, but challenges persist in ensuring accountability and preventing errors in medical practice.

COMMON ISSUES:

While Kerala and Tamil Nadu excel in many aspects of healthcare, including high literacy rates and well developed healthcare systems, they continue to grapple with medical negligence cases. Efforts to address these issues must focus on improving accountability, enhancing patient safety measures, and

promoting a culture of transparency and ethical medical practice. Through continued vigilance and proactive measures, both states can strive towards

further reducing instances of medical negligence and ensuring better healthcare outcomes for their citizens.

The situation you described highlights significant challenges in the healthcare system, particularly regarding staffing, security, and communication between medical professionals and patients.

Staffing Issues: Understaffed hospitals, with one doctor responsible for hundreds of patients, can lead to dissatisfaction among patients and compromise the quality of care provided.

Security Concerns: Doctors working late shifts face additional risks, dealing with individuals with criminal backgrounds or those in an inebriated state. Overcrowding and inadequate security measures further exacerbate these challenges.

Communication Breakdown: The breakdown of trust between patients and the medical community is a fundamental issue. While advancements in healthcare technology have improved patient safety, the message that not all medical complications are due to human error needs to be effectively communicated to the public.

Addressing these issues requires comprehensive reforms, including increasing staffing levels, improving security arrangements, and enhancing communication and trust-building efforts between healthcare providers and patients. By prioritizing patient safety and well-being, healthcare systems can work towards restoring trust and improving overall healthcare outcomes.

Sikkim, Meghalaya, and Mizoram

The north eastern states of India, including Sikkim, Meghalaya, and Mizoram, have shown commendable progress in minimizing medical negligence cases. With a maximum of only 10 cases per year in most of these states, they boast the lowest number of cases compared to other states in India. This achievement reflects the dedication of the healthcare sector in providing quality medical assistance to the public.

Healthcare Initiatives

Several healthcare initiatives have been implemented to improve maternal and child health outcomes in these states:

National Rural Health Mission (NRHM): Maternal healthcare policies under NRHM focus on increasing safe institutional deliveries and antenatal care coverage.

Integrated Child Development Programme (ICDP): This program aims to enhance child health outcomes by providing comprehensive healthcare services.

Janani Suraksha Yojana (JSY): JSY incentivizes institutional deliveries, contributing to better maternal and child health outcomes.

Healthcare Infrastructure: Introduction of ambulance services (108 & 102), Mobile Medical Units, and recruitment of frontline health workers like ANMs and ASHAs have strengthened healthcare accessibility in rural areas.

State-Specific Initiatives

Assam: The government has launched Mission Tejaswi to eradicate anaemia, and initiatives like Adoroni provide ambulance services for pregnant women and new born .

Conclusion

The north eastern states of India have demonstrated impressive health indicators and achieved significant progress in healthcare delivery. With proper guidance and resources, they have the potential to further improve healthcare outcomes and set a benchmark for other states to follow. Continued support from national agencies and sustained efforts by local governments will be crucial in realizing this potential and ensuring the well-being of the population in these states.

Zones of India

North Zone

The North Zone of India comprises the states of Uttar Pradesh, Uttarakhand, Himachal Pradesh, Punjab, and Haryana. This region is characterized by diverse landscapes, including the Himalayan mountains, fertile plains, and arid deserts. It is known for its rich cultural heritage, historical monuments, and vibrant traditions.

North Eastern Zone

The North Eastern Zone of India includes Assam, Sikkim, Nagaland, Meghalaya, Manipur, Mizoram, Tripura, and Arunachal Pradesh. This region is known for its lush greenery, diverse ethnicities, and unique cultural practices. It is home to several indigenous communities and boasts stunning natural landscapes, including dense forests, majestic mountains, and cascading waterfalls.

East Zone

The East Zone comprises the states of Bihar, Odisha, West Bengal, and Jharkhand. This region is known for its rich cultural heritage, historical significance, and diverse landscapes. It is home to the holy river Ganges, lush greenery, and vibrant festivals. The East Zone plays a crucial role in India's economy and is known for its agricultural productivity, industrial development, and educational institutions.

West Zone

The West Zone includes the states of Gujarat, Goa, Madhya Pradesh, Rajasthan and Maharashtra. This region is characterized by its coastal beauty, diverse culture, and rich history. It is known for its vibrant cities, bustling markets, and ancient monuments. The West Zone is a major hub for trade, commerce, and tourism, contributing significantly to India's economic growth and cultural diversity.

South Zone

The South Zone comprises the states of Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, and Telangana. This region is known for its picturesque landscapes, cultural diversity, and rich traditions. It is home to ancient temples, serene backwaters, and stunning beaches. The South Zone is a major center for technology, education, and tourism, attracting visitors from across the globe.



Each of these zones contributes to India's cultural tapestry, economic development, and overall progress, showcasing the country's diversity and resilience.

Medical negligence refers to a breach of duty of care by a healthcare professional, resulting in harm or injury to a patient. There are instances where certain actions or decisions by a doctor may not amount to medical negligence:

- **Error of Judgment:** If a doctor makes a decision based on their professional judgment, and it turns out to be incorrect or unsuccessful, it may not necessarily constitute medical negligence. Doctors are human and prone to errors, and as long as they have exercised reasonable care and skill in their decision-making process, they may not be held liable for negligence.
- **Unfavourable Outcomes:** Merely because the outcome of a medical procedure or treatment is unfavourable does not automatically imply medical negligence. If the doctor has followed standard protocols and

acted in the best interest of the patient, they may not be held responsible for the outcome, especially if unforeseen complications arise.

- **Different Treatment Approach:** If a doctor chooses a different treatment or procedure to address a patient's condition, and it does not yield the desired results, it may not amount to negligence as long as the chosen approach was based on sound medical reasoning and practiced within accepted standards of care.

- **Due Care and Caution:** If a doctor performs their duties with due care, caution, and in accordance with established medical practices, they may not be held liable for negligence. It is essential to demonstrate a breach of duty on the part of the doctor to establish medical negligence.

While doctors are expected to adhere to high standards of care and professionalism, not every unfavourable outcome or medical complication necessarily indicates negligence. Courts consider various factors, including the doctor's actions, intentions, and adherence to medical standards, before determining whether medical negligence has occurred in a particular case. The aims and objectives outlined for the present study on medical negligence in India are:

- **Study the Pattern of Medical Negligence Cases:** Examine the trends and patterns of medical negligence cases occurring in India to understand the frequency and nature of these incidents.
- **Explore Reasons for Medical Negligence:** Investigate the underlying factors contributing to medical negligence in India, including systemic issues, human error, and other relevant factors.
- **analyse Pattern of Cases in Different States:** Analyse the distribution of medical negligence cases across different states of India to identify regional variations and trends.
- **Compare States with Similar Data:** Compare states with similar data of medical negligence cases to identify any significant differences or similarities in factors contributing to these incidents.
- **Forecast Future Cases:** Use statistical analysis to forecast the number of medical negligence cases expected in the future, both nationally and in different states, based on current trends and patterns.
- **Study Overall Trend:** Examine the overall trend of medical negligence in India over a specific period, identifying any significant changes or patterns.

- **Identify Top Contributing States:** Determine the states that contribute the most to medical negligence cases and assess the impact of these incidents on healthcare systems and patient outcomes.
- **Analyse Factors Affecting Cases:** Analyse the factors influencing the occurrence of medical negligence cases in different states, including demographic, socioeconomic, and healthcare system-related factors. By addressing these aims and objectives, the study aims to provide valuable insights into the phenomenon of medical negligence in India, identify areas for improvement in healthcare delivery, and inform policy and practice to enhance patient safety and quality of care.

CHAPTER 2

STATISTICAL TOOLS

The statistical tools used in the study on medical negligence in India include:

Bar Graphs:

Bar graphs are used to visually represent categorical data, with rectangular bars whose lengths are proportional to the values they represent. They are effective

for comparing discrete categories and can be plotted vertically or horizontally. Grouped bar charts, where multiple bars are used to represent different categories or groupings, are also utilized for more complex comparisons of data.

By utilizing bar graphs, the study can effectively present patterns, trends, and comparisons of medical negligence cases across different states, reasons for medical negligence, and other relevant variables. These visual representations aid in the interpretation and understanding of complex data sets, making it easier for readers to grasp key findings and insights.

In the study on medical negligence in India, line graphs can be used to illustrate trends in the number of cases over time, compare the incidence of medical negligence across different states or regions, and analyze the impact of various factors on the occurrence of medical negligence. By plotting data points chronologically, line graphs help to identify patterns, fluctuations, and longterm trends in medical negligence cases, aiding in the interpretation and analysis of the data. The data can be constructed using various mathematical techniques, such as linear regression, polynomial regression, exponential regression, and others, depending on the nature of the data and the desired form of the best-fit curve.

In the context of the study on medical negligence in India, the best-fit curve can be used to visualize the overall trend in the number of cases over time or to analyze the relationship between medical negligence and various factors, such as healthcare infrastructure, population demographics, and socio-economic indicators. By fitting a continuous mathematical function to the data points, researchers can better understand the underlying patterns and dynamics of medical negligence and make more informed decisions for policy and practice.

Your explanation provides a clear guideline for making decisions based on the results of a two-way ANOVA analysis, helping researchers determine the significance of factors and their interaction effect on the dependent variable. If you have any further questions or need clarification on any specific aspect 1. Tukey's Honestly Significant Difference (HSD)**: Tukey's HSD test is one of the most widely used post hoc tests. It compares all possible pairs of group means and determines whether the difference between any two means is statistically significant.

Statistical Hypothesis

In many situations the statisticians are asked to make a decision about the population of its parameters. In order to reach such decision the statisticians may

take the help of some guesses about the population or its parameters such guesses or statements are called as statistical hypothesis.

Null Hypothesis

The null hypothesis generally a hypothesis of no significant difference and is denoted by H_0 . According to Prof. R.A. Fisher. “A null hypothesis is the hypothesis which is tested for possible rejection under the assumption that is true”.

Alternative Hypothesis

Any hypothesis that completely opposes what the null hypothesis states is called as the alternative hypothesis. If the null hypothesis is that the population mean is not different from μ i.e. $H : \mu = \mu$, then the alternative hypothesis are:

- $H : \mu \neq \mu$
- $H : \mu < \mu$
- $H : \mu > \mu$

Simple and Composite Hypothesis

A statistical hypothesis that completely specifies the population is known as the simple hypothesis. On the other hand, a composite hypothesis is the hypothesis which does not specify the population completely. **Test Statistic**

The test statistic is used to compare the results obtained from the sample with the expected results. If the difference is significant then the null hypothesis is rejected else it is accepted.

Level of Significance

The level of significance, often denoted by α , is the probability of rejecting the null hypothesis when it is actually true. In hypothesis testing, it helps determine the threshold for deciding whether to accept or reject the null hypothesis based on the observed data.

Analysis of Variance

According to Prof. R.A. Fisher, Analysis of Variance (ANOVA) is the “Separation of variance ascribable to one group of causes from the variance ascribable to the other group.” The ANOVA consists in the estimation of the amount of variation due to each of the independent factors (causes) separately

and then comparing these estimates due to chance factors(causes), the later being known as experimental error or simply error.

Assumptions for ANOVA test

ANOVA test is based on the test statistics F (or variance ratio).

For the validity of the F-test in ANOVA, the following assumptions are made:

- i. The observations are independent.
- ii. Parent population from which observation are taken is normal, and
- iii. Various treatment and environmental effects are additive in nature.

Two-Way Analysis of Variance

Suppose n observations are classified into k categories say A_1, A_2, \dots, A_k according to some criterion A; and into h categories, say, B_1, B_2, \dots, B_h according to some criterion B, having kh combinations A_i, B_j ; $i = 1, 2, 3, \dots, k$ and $j = 1, 2, 3, \dots, h$; often called cells. This scheme of classification according to two factors or criteria is called two-way classification and its analysis is called two-way analysis of variance. The number of observations in each cell may be equal or different, but we shall consider the case of one observation per cell so that $n = hk$, i.e., the total number of cells is $n = hk$. The fixed effect model is:

$$y = \mu + \epsilon$$

The model is

$$y = \mu + \alpha + \beta + \epsilon$$

Where, y is the yield from the j^{th} observation, field on the i^{th} treatment.

μ is the general mean effect.

α is the effect due to i^{th} treatment.

β is the effect due to the j^{th} observation. ϵ is

the error effect due to chance.

When to Use Two-Way ANOVA

ANOVA (Analysis of Variance) is a statistical test used to analyse the difference between the means of more than two groups.

A two-way ANOVA is used to estimate how the mean of a quantitative variable changes according to the levels of two categorical variables. Use a two-way

ANOVA when you want to know how two independent variables, in combination, affect a dependent variable.

You can use a two-way ANOVA when you have collected data on a quantitative dependent variable at multiple levels of two categorical independent variables.

A quantitative variable represents amounts or counts of things. It can be divided to find a group mean.

A categorical variable represents types or categories of things. A level is an individual category within the categorical variable.

You should have enough observations in your data set to be able to find the mean of the quantitative dependent variable at each combination of levels of the independent variables.

Both of your independent variables should be categorical. If one of your independent variables is categorical and one is quantitative, use an ANCOVA instead.

ANOVA Table

The sum of squares SST and SSV and SSE computed for the two-way ANOVA are use three mean squares, one for treatment, one for variety and other for error. These mean squares are MST, MSV and MSE respectively. These are typically displayed in a tabular form, known as Table. The ANOVA table also shows the statistics used to test hypothesis about the population.

When the null hypothesis of equal means is true, the three mean squares estimate the same (error variance), and should be of approximately equal magnitude. In other words, their ratio is close to 1.

If the null hypothesis is false, MST should be larger than MSE.

The mean squares are formed by dividing the sum of squares by the associated degrees of freedom. Let $N = \sum n$

Then the degrees of freedom for treatments are $(DFT) = k-1$

The degrees of freedom for varieties are $(DFV) = h-1$

And the degrees of freedom for error are $(DFE) = (k-1)(h-1)$

The corresponding mean squares are

$$MST = SST/DFT$$

$$MSV = SSV/DFV$$

$$MSE = SSE/DFE$$

The test statistic used in testing the equality of treatment means is

$$F = MST/MSE \sim F_{(K-1, (K-1)(H-1))}$$

$$F = MSV/MSE \sim F_{(H-1, (K-1)(H-1))}$$

Thus, if $F > F_{(\cdot, (\cdot))}(\alpha)$, H_0 is rejected at ' α ' level of significance, otherwise we fail to reject H_0 .

The critical value is the tabular value of the F distribution, based on the chosen ' α ' level and the degrees of freedom.

Source of variation	Sum of squares	Degree of freedom	Mean sum of squares	Variance ratio
Treatments	SST	k-1	MST	MST/MSE
Variety	SSV	h-1	MSV	MSV/MSE
Error	SSE	(k-1)(h-1)	MSE	
Total	TSS	Kh-1		

Post-Hoc Test

Post hoc in Latin means 'after this'. A post-hoc test is done to identify exactly which groups differ from each other. Therefore, such tests are also called multiple comparison tests.

- Purpose of Post-Hoc Test

A priori comparisons are performed before the data are collected, and post-hoc (or a posteriori) comparisons are done after the data have been collected. When the null hypothesis of an analysis of variance (ANOVA) model is rejected, posthoc tests are used to identify the population means that are different.

When the null hypothesis is rejected in an omnibus test (a test that provides overall result for study data, e.g. ANOVA), it means that at least one parameter is significant.

CHAPTER 3 DATA REPRESENTATION

The following data represents the yearly medical negligence cases in different states of India from year 2017 to 2022. The data has been taken from the NCBR Report.

YEAR	2017	2018	2019	2020	2021	2022
Uttar Pradesh	29	23	26	29	20	25
Jharkhand	0	63	13	10	18	2

Rajasthan	15	13	17	23	26	11
Telangana	20	19	19	16	9	11
Haryana	6	24	19	7	12	6
Madhya Pradesh	4	9	21	11	14	12
Maharashtra	11	12	8	4	14	17
West Bengal	28	17	17	3	1	0
Bihar	23	4	31	0	0	0
Kerala	10	13	8	5	6	12
Goa	0	0	0	0	0	0
Mizoram	0	0	0	0	0	0
Nagaland	0	0	0	0	0	0
Odisha	0	0	0	0	0	0
Uttarakhand	0	0	0	0	0	0
Karnataka	13	4	7	3	0	3

Representing the data in 5 zones of India:

- East zone- Bihar, Chhattisgarh, Jharkhand, Odisha, West Bengal
- West zone-Goa, Gujarat, Maharashtra, Madhya Pradesh, Rajasthan
- North zone-Haryana, Himachal Pradesh, Punjab, Uttar Pradesh, Uttarakhand

<ul style="list-style-type: none"> South 	Assam	14	1	2	9	1	1	zone- Andhra Pradesh,
	Punjab	3	4	6	1	4	6	
	Gujarat	8	5	2	1	2	0	
	Chhattisgarh	3	0	0	1	2	1	
	Tripura	0	1	2	2		0	
	Tamil Nadu	1	0	1	1	0	0	
	Himachal Pradesh	1	0	1	0	0	0	
	Sikkim	1	0	0	0	0	1	
	Arunachal Pradesh	0	0	0	0	1	0	
	Manipur	0	1	0	0	0	0	
	Meghalaya	0	1	0	0	0	0	
	Andhra Pradesh	4	1	8	3	6	5	

Karnataka, Kerala, Tamil Nadu, Telangana

- North East zone-Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura, Sikkim

The zone wise data from year 2017 to 2022 is represented below:

Year	EAST	WEST	NORTH	SOUTH	N-E	
2017	54	38	39	48	15	194
2018	84	39	51	37	4	215
2019	61	48	52	43	4	208
2020	14	39	37	28	11	129
2021	21	56	36	21	4	138
2022	3	40	37	32	2	114
	237	260	252	209	40	

Yearly Variation in Number of Cases Across Different Zones:

Now representing the data of different zones through bar chart, so as to visualize the increasing and decrease in number of cases in each zone,

BAR CHART

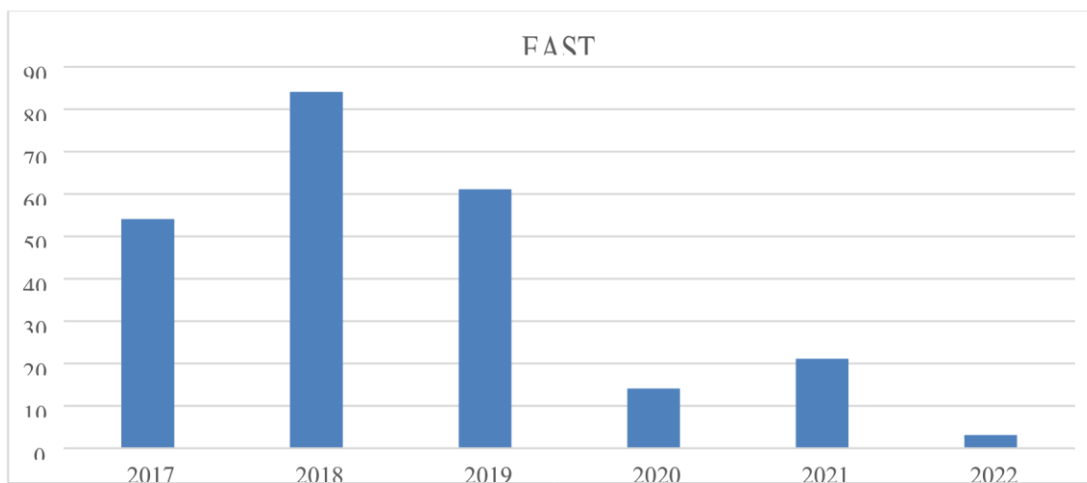


Fig.1 Number of medical negligence cases in EAST INDIA from 2017 to 2022
The number of medical negligence cases in EAST INDIA saw a peak in 2018 with around 80 cases. From 2019 onwards, there has been a consistent decline in the number of cases, dropping to about 20 by 2022. The decline could be indicative of improved medical practices, better regulatory measures, or other factors influencing a reduction in medical negligence incidents.

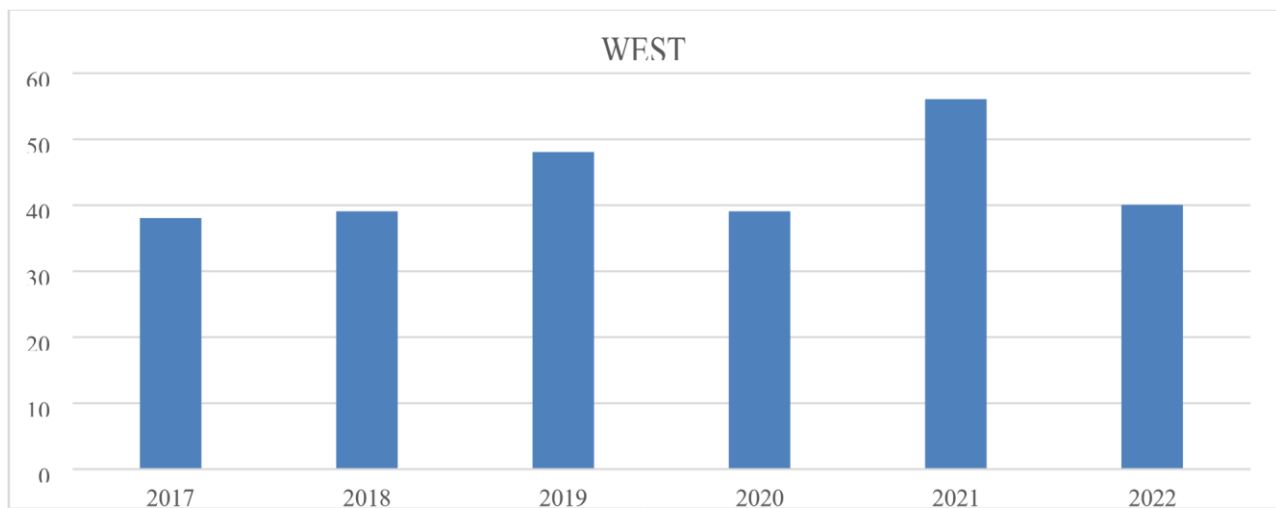


Fig. 2 number of medical negligence cases in WEST INDIA from 2017 to 2022

The number of medical negligence cases in West INDIA has been fluctuated over the years. The highest number of cases is observed in 2021. The trend shows a rise in cases from 2017 to 2019, a dip in 2020, a peak in 2021, and another decrease in 2022. These fluctuations could be due to various factors such as changes in healthcare policies, awareness, and reporting mechanisms in the region.

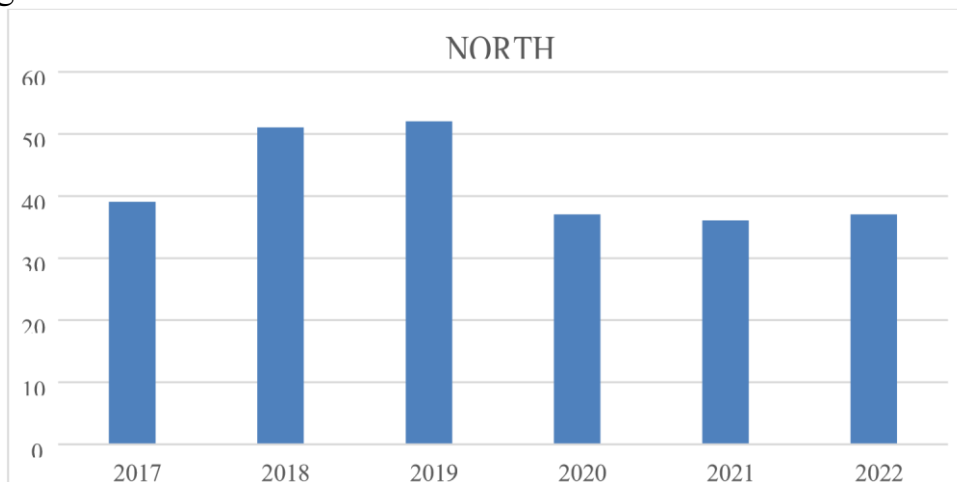
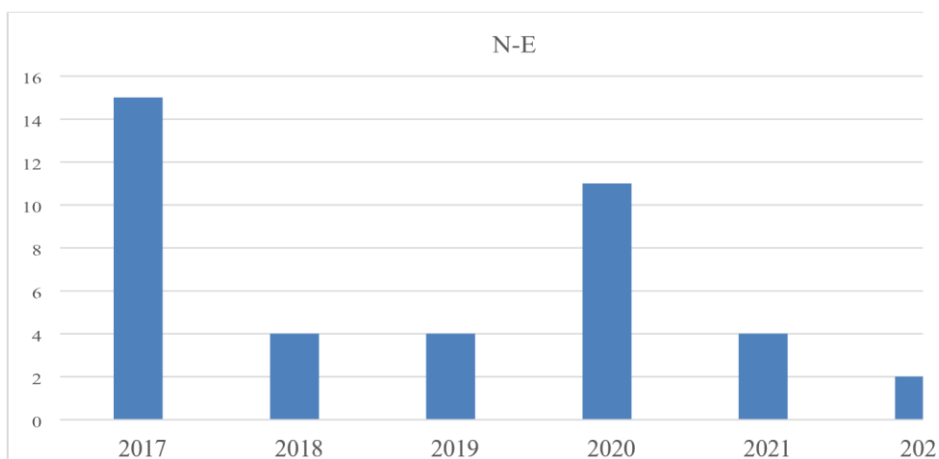
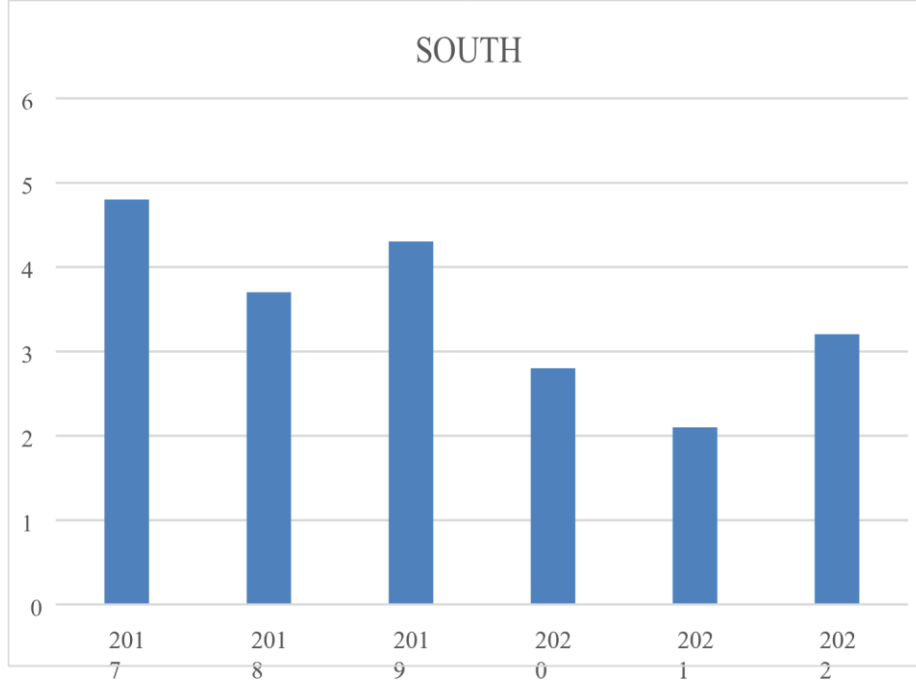


Fig. 3 number of medical negligence cases in NORTH INDIA

The number of medical negligence cases in North India saw a rise from 2017 to 2019, peaking at around 50 cases in 2019. A significant drop is observed in 2020, reducing the number of cases. From 2020 onwards, there is a gradual increase in cases.

Fig. 4 Number of medical negligence in SOUTH INDIA

The number of medical negligence cases in south India has been fluctuated over the years. The highest number of cases is observed in 2017. There has been a consistent decline in the number of cases, dropping to about 20 by 2021. Fig. 5 Number of medical negligence in NORTH-EAST INDIA



The number of medical negligence cases in north-east India has been fluctuated over the years. The highest number of cases in observed in 2017. There has been a consistent decline in the number of cases, dropping to about 2 by 2022.

CHAPTER 4

STATISTICAL ANALYSIS OF DATA

OBJECTIVE:

Comparative analysis of medical negligence cases between different zones of India.

For the following data of the yearly medical negligence cases in different states of India from year 2017 to 2022. The hypothesis are taken below as:

HYPOTHESIS

Null hypothesis: There is no significant difference between the medical negligence cases in different zones of India.

Alternative hypothesis: There is significant difference between the medical negligence cases in different zones of India.

Level of significance: 0.05

		N
ZONE	EAST	6
	N-E	6
	NORTH	6
	SOUTH	6
	WEST	6
YEAR	2017	5
	2018	5
	2019	5
	2020	5
	2021	5
	2022	5

Tests of Between-Subjects Effects					
Dependent Variable: MEDICAL					
Source	Type III Sum of Squares	d.f	Mean Square	F	Sig.
Corrected Model	7519.933 ^a	9	835.548	4.004	.005
Intercept	33200.133	1	33200.133	159.083	.000
ZONE	5558.867	4	1389.717	6.659	.001
YEAR	1961.067	5	392.213	1.879	.143
Error	4173.933	20	208.697		
Total	44894.000	30			
Corrected Total	11693.867	29			

a. R Squared = .643 (Adjusted R Squared = .482)

POST HOC TEST

A **post hoc test** is a statistical procedure conducted after an analysis of variance (ANOVA) reveals that there are significant differences among group means. The purpose of a post hoc test is to identify **which specific groups differ** from each other while controlling for the risk of false positives (Type I errors) caused by multiple comparisons.

Why Post Hoc Tests Are Necessary

- When ANOVA indicates a significant effect, it tells us that at least one group mean is different but does not specify which groups differ.
- Post hoc tests perform pairwise comparisons between group means to pinpoint where the differences lie.

- They also control the family-wise error rate, ensuring the probability of making a Type I error remains acceptable.

POST HOC TEST

MULTIPLE COMPARIONS

Dependent variable: ZONE

Multiple Comparisons				
Dependent Variable:				
Tukey HSD				
(I) ZONE	Mean	Std.	Sig.	95% Confidence Interval

		Difference (I-J)	Error		Lower Bound	Upper Bound
EAST	N-E	32.83*	8.3 41	0.0 06	7.88	57.79
	NORTH	-2.50	8.3 41	0.9 98	- 27.4 6	22.46
	SOUTH	4.67	8.3 41	0.9 79	- 20.2 9	29.62
	WEST	-3.83	8.3 41	0.9 90	- 28.7 9	21.12
N-E	EAST	-32.83*	8.3 41	0.0 06	- 57.7 9	-7.88
	NORTH	-35.33*	8.3 41	0.0 03	- 60.2 9	-10.38
	SOUTH	-28.17*	8.3 41	0.0 22	- 53.1 2	-3.21
	WEST	-36.67*	8.3 41	0.0 02	- 61.6 2	-11.71

NORTH	EAST	2.50	8.3 41	0.9 98	- 22.4 6	27.46
	N-E	35.33*	8.3 41	0.0 03	10.3 8	60.29
	SOUTH	7.17	8.3 41	0.9 08	- 17.7 9	32.12
	WEST	-1.33	8.3 41	1.9 99	- 26.2 9	23.62
SOUTH	EAST	-4.67	8.3 41	0.9 79	- 29.6 2	20.29
	N-E	28.17*	8.3 41	0.0 22	3.21	53.12
	NORTH	-7.17	8.3 41	0.9 08	- 32.1 2	17.79
	WEST	-8.50	8.3 41	0.8 44	- 33.4 6	16.46
WEST	EAST	3.83	8.3 41	0.9 90	- 21.1 2	28.79
	N-E	36.67*	8.3 41	0.0 02	11.7 1	61.62
	NORTH	1.33	8.3 41	1.9 99	- 23.6 2	26.29
	SOUTH	8.50	8.3 41	0.8 44	- 16.4 6	33.46

Based on observed means.

The error term is Mean Square (Error) =
208.697.

*. The mean difference is significant at the .05 level.

Below is the interpretation:

Key Terms from the Table

1. **Mean Difference (I-J):** The difference in means between the compared groups (e.g., EAST vs. N-E).
2. **Standard Error:** The variability in the mean difference estimate.
3. **Sig.:** Significance level (p-value). If the p-value is below 0.05, the difference is statistically significant.
4. **95% Confidence Interval (Lower Bound and Upper Bound):** Range within which the true mean difference lies with 95% confidence. If the interval does not include zero, the difference is significant.

Interpretation

- Since the p value of difference between east and north east is 0.006 which is less than 0.05 so we reject the null hypothesis and conclude that there is a significant difference between the average number of medical negligence of east and north east zones
- Since the p value of difference between east and north is 0.998 which is more than 0.05 so we fail to reject the null hypothesis and conclude that there is no significant difference between the average number of medical negligence of east and north zones
- Since the p value of difference between east to south is 0.978 which is more than 0.05 so we fail to reject the null hypothesis and conclude that there is no significant difference between the average number of medical negligence of east and south zones.
- Since the p value of difference between east to west is 0.990 which is more than 0.05 so we fail to reject the null hypothesis and conclude that there is no significant difference between the average number of medical negligence of east and west zones.
- Since the p value of difference between north-east to north is 0.003 which is less than 0.05 so we reject the null hypothesis and conclude that there is significant difference between the average number of medical negligence of north-east to north zones
- Since the p value of difference between north-east to west which is less than 0.05 so we reject the null hypothesis and conclude that there is significant difference between the average number of medical negligence of north east to west zones
- Since the p value of difference between north to south is 0.908 which is more than 0.05 so we fail to reject the null hypothesis and conclude that there is no significant difference between the average number of medical negligence of north to south zones.

- Since the p value of difference between north-east to north is 0.003 which is less than 0.05 so we reject the null hypothesis and conclude that there is significant difference between the average number of medical negligence of north-east to north zones.
- Since the p value of difference between north-east to south is 0.022 which is more than 0.05 so we fail to reject the null hypothesis and conclude that there is no significant difference between the average number of medical negligence of north-east and south zones
- Since the p value of difference between north-east to south is 0.022 which is more than 0.05 so we fail to reject the null hypothesis and conclude that there is no significant difference between the average number of medical negligence of north-east and south zones.
- Since the p value of difference between north-east to west which is less than 0.05 so we reject the null hypothesis and conclude that there is significant difference between the average number of medical negligence of north east to west zones.
- Since the p value of difference between north to south is 0.908 which is more than 0.05 so we fail to reject the null hypothesis and conclude that there is no significant difference between the average number of medical negligence of north to south zones.
- Since the p value of difference between north to west 0.999 which is more than 0.05 so we fail to reject the null hypothesis and conclude that there is no significant difference between the average number of medical negligence of north and west zones.
- Since the p value of difference between south to west is 0.844 which is more than 0.05 so we fail to reject the null hypothesis and conclude that there is no significant difference between the average number of medical negligence of south to west zones.

Summary

1. Significant differences exist between the **N-E zone** and other zones (EAST, NORTH, SOUTH, and WEST). N-E generally has significantly lower means compared to others.
2. No significant differences are observed among EAST, NORTH, SOUTH, and WEST except in their comparisons with N-E.
3. The zones EAST, NORTH, SOUTH, and WEST are relatively similar in terms of the dependent variable.

CONCLUSION

The Tukey HSD post hoc test indicates the following key insights:

1. Significant Differences Between Zones:

- The N-E (Northeast) zone stands out as significantly different from the other zones (EAST, NORTH, SOUTH, and WEST). Its lower mean values suggest it may face unique challenges or conditions compared to the others.

2. Homogeneity Among Other Zones:

- There are no statistically significant differences between the EAST, NORTH, SOUTH, and WEST zones. This indicates that these zones share similar characteristics in the context of the dependent variable being analyzed.

3. Key Insight:

- The N-E zone requires focused attention, as it is an outlier with substantially different outcomes, while the other zones can be treated as a cohesive group in terms of their performance or conditions.

SUGGESTIONS

1. Addressing the N-E Zone:

- Investigate the underlying causes of the lower performance or distinct characteristics in the N-E zone. This may involve socio-economic, infrastructure, or policy-related factors.
- Implement targeted strategies such as increased funding, infrastructure development, or tailored programs to improve conditions in this zone.

2. Leverage Similarities Among Other Zones:

- Utilize the homogeneity among EAST, NORTH, SOUTH, and WEST zones to implement standardized policies or interventions that are costeffective and scalable.
- Share best practices among these zones to improve overall performance further.

3. Further Research:

- Conduct qualitative and quantitative research to identify the root causes of the differences between the N-E zone and the rest of the zones.
- Consider other contextual factors (geographical, cultural, economic) that might explain the observed disparities.

4. Policy Recommendations:

- Develop region-specific policies that consider the unique challenges of the N-E zone while promoting uniform growth across other zones.
- Create monitoring mechanisms to track progress in addressing disparities over time.

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