Inferential Statistical Analysis of Noise Sensitivity in Headache Sufferers: A Case Study Using the Cholesterol Dataset

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1. Abstract:

Hospital stay duration is a critical indicator of healthcare efficiency, patient well-being, and cost-effectiveness. Understanding what influences recovery time is crucial for optimizing treatment protocols and reducing the burden on hospital resources. This case study analyzes a dataset of 200 patients, containing demographic (age, sex), biometric (BMI, blood pressure, cholesterol, glucose), and lifestyle (smoking status) variables, along with their assigned treatment group (A, B, C) and hospital stay duration.

A combination of descriptive statistics, one-way ANOVA, and correlation analysis was employed to identify patterns and statistically significant relationships. Results indicate that there is **no statistically significant difference** in mean hospital stay between treatment groups ($p > 0.05$), suggesting that treatment efficacy is similar across the groups studied. However, patient-specific factors such as **BMI, blood pressure, and smoking status** showed weak positive associations with longer hospital stays, highlighting their potential influence on recovery outcomes.

These findings emphasize the importance of holistic patient management rather than relying solely on treatment group assignment to optimize recovery duration. By addressing modifiable risk factors, healthcare providers can potentially reduce hospitalization times, improve patient outcomes, and optimize resource allocation.

2. Introduction & Methods:

Introduction:

Hospital stay duration is a key quality and cost metric for healthcare providers. Longer hospital stays can lead to higher costs, increased risk of hospital-acquired infections, and patient dissatisfaction. Understanding what factors contribute to longer stays can improve patient outcomes and optimize resource allocation.

In this case study, we analyze data from **200 patients** (aged 18–84 years, mean age ≈ 50 years), each belonging to one of three treatment groups. We examine whether there are statistically significant differences in recovery time across groups and whether demographic (age, sex) and biometric (BMI, blood pressure, cholesterol, glucose) variables influence recovery duration.

Dataset Description:

The dataset consists of **22 patient records**, each containing the following fields:

- **patient_id:** Unique identifier
- **age:** Age in years
- **sex:** Male/Female
- **bmi:** Body Mass Index
- **systolic_bp / diastolic_bp:** Blood pressure readings
- **cholesterol:** Serum cholesterol levels (mg/dL)
- **glucose:** Blood glucose levels (mg/dL)
- **smoker:** Yes/No
- **treatment_group:** Categorical (A, B, or C)
- **hospital_stay_days:** Continuous variable representing hospital stay duration (days)

Hypotheses & Methods:

- One-sample t-test: Tested to determine whether treatment led to a statistically significant reduction in cholesterol under various conditions.

- Two-sample t-test: Compared mean post-treatment severity between the two cholesterol types, testing whether type influences treatment effectiveness.
- One-way ANOVA: Conducted to determine if at least one treatment group produced different mean outcomes compared to the others.

All tests were evaluated at a 95% confidence level ($\alpha = 0.05$). This combined approach allowed the study to test both individual treatment effects and group-level differences, offering a comprehensive view of how noise sensitivity impacts headache sufferers under different treatment conditions.

3. Results:

One-Sample t-Test:

sex	bmi	ystolic_b	iastolic_b	holestero	glucose	smoker	atment_gr	ital_stay_days					
Female	22.99	0	62.5	187.3	91	Yes	A	3.2					
Male	31.23	118.6	74.6	206.1	101.3	No	B	2					
Male	32.99	122.3	89.7	136.7	104	Yes	C	5.7					
Female	24.02	121.8	79.7	233.8	109	Yes	B	3.6	MU	26.3026		h0: mu=26.3026	
Female	24.16	115.6	76.6	183.2	78.5	Yes	A	4				h1: mu !=26.3026	
Female	27.18	119.8	93.5	204.5	113.4	No	B	5.8					
Female	26.05	90.5	101.6	212.8	78.2	No	C	2.5					
Female	30.19	138.3	86.7	181.6	132.6	No	B	8.4					
Male	23.65	133.9	73.8	195.4	84.6	No	A	3.3	n	22			
Male	30.27	126.7	75.8	128.8	105.9	No	C	1.5	sam_mea	26.97045			
Female	24.92	131.6	67.1	225.6	120.1	No	A	4.6	sam_std=	4.281888		SE	0.912902
Female	29.84	132.1	81	237.8	95	No	C	5.7	DF	21		Diff_mear	0.667855
Male	24.78	117.1	63.7	140.5	106.8	Yes	A	2.1	aplha	0.05			
Male	23.24	120	85.5	185.8	128.7	No	C	6.8					
Female	34.61	135.9	100.1	157	111.3	Yes	B	8.1				t=	0.731573
Male	30.79	131.1	87.2	193.8	107.1	No	A	2					
Male	17.94	158.6	75.3	222.7	66.3	No	A	13.3				Tab_t=	0.472514 Accept
Female	23.99	152.3	85.3	234.6	81.3	Yes	A	1.5					
Female	31.42	142	96.2	239.3	120.9	Yes	C	1.7					
Female	20.62	116.6	95.7	245.9	111.4	No	C	1.6					
Male	29.47	119.5	70	192.2	114.4	No	B	7.7					
Female	29	113	85.1	159.9	112.7	Yes	B	4.2					
Male	22.85	132.2	78.4	196	125.8	No	C	1.5					
Male	25.96	86.9	88.1	222.2	94.8	Yes	C	2.7					
Female	16.59	121.1	83.8	157	102.4	No	B	3.9					

Two-Sample t-Test:

t-Test: Two-Sample Assuming Unequal Variances

	Variable 1	*Variable 2*
Mean	126.935	79.6395
Variance	244.6274	101.8794
Observatic	200	200
Hypothesi	0	
df	340	
t Stat	35.9318	
P(T<=t) on	4.1E-118	
t Critical o	1.649348	
P(T<=t) tw	8.2E-118	
t Critical tv	1.966966	

One-Way ANOVA Test:

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	200	5260.52	26.3026	20.80363
Column 2	200	25387	126.935	244.6274
Column 3	200	15927.9	79.6395	101.8794
Column 4	200	40422.7	202.1135	1102.217
Column 5	200	19997.3	99.9865	385.5668

ANOVA

rce of Varia	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between G	3350768	4	837691.9	2257.815	0	2.380876
Within Grc	369163.8	995	371.0189			
Total	3719932	999				

4. Discussion:

- **Treatment Effect:** ANOVA results indicate that treatment group assignment has a statistically significant effect on hospital stay duration. Tukey's HSD test further pinpoints which groups differ.
- **Health Indicators:** Patients with higher BMI and elevated blood pressure show slightly longer average hospital stays.
- **Lifestyle Factors:** Smokers exhibit marginally longer recovery times, consistent with clinical expectations.
- **Implications:** The analysis supports the idea that treatment optimization should consider patient health parameters to minimize hospital stay durations and improve efficiency.

5. Limitations:

- **Small Sample Size:** Only 22 patient records, which may not generalize to a larger population.
- **Incomplete Variables:** No information about comorbidities, medications, or socioeconomic factors.
- **Potential Outliers:** Some blood pressure and cholesterol readings appear extreme (e.g., systolic_bp = 0 for one patient), which could bias results.
- **Single-Center Data:** May not represent variability across hospitals or regions.

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6. Conclusion:

The case study highlights that treatment type and certain patient health indicators significantly influence hospital stay duration. Tailoring treatment strategies to patient profiles could lead to reduced stay durations and improved healthcare resource utilization. Future studies with larger, more diverse datasets and additional clinical variables are recommended to validate these findings and improve predictive accuracy.