TESTING HYPOTHESIS ABOUT MEANS

PROBLEM 1: TESTING HYPOTHESIS ABOUT A POPULATION MEAN

Norepinephrine (also referred to as adrenaline) is a is a hormone and neurotransmitter used as a drug to treat cardiac arrest and other cardiac dysrhythmias resulting in diminished or absent cardiac output. It is found as ampule of 1 ml and contains 1 mg of active substance.

On a given producer, there is some variation from on ampule to another because the filling machinery is not work properly. The distribution of the content is normal with standard deviation of σ = 0.05. A research was done in order to measure the contents of 10 ampules and the results are as follows:

0.94	0.97	1.10	0.99	1.05	0.89	1.02	0.91	0.82	1.04

Is it convincing evidence that the mean contents of Norepinephrine of ampules is less than the adertised 1 ml?

1. What is the H_0? H_0:
2. What is the H_1? H_1:

    Think about whether your hypotheses are one-sided or two-sided!!!
    This will affect the way you calculate probabilities!!
3. What is the sample size?
    - n =
4. Find the mean of the sample and its associated confidence interval:
    - m =
    - 95% CI =

Hint:

- The formula for arithmetic mean is $m = \frac{1}{n}\sum_{i=1}^{n} x_i$
- The formula for 95% confidence interval for mean is: $m \pm 1.96 \cdot \frac{\sigma}{\sqrt{n}}$

5. Calculate the z test statistic for this sample (the value of z for the sample allows us to perform a probability calculation to test the significance of this finding against the H_0)

z =

Hint: The formula for the z test statistic is: $z = \frac{m-\mu}{\frac{\sigma}{\sqrt{n}}}$

6. Interpret from statistical point of view the obtained result.

7. So, is this convincing evidence that the mean contents of ampules are less than the imposed 1 ml?

PROBLEM 2: ONE-SAMPLE T TEST

Occupational medicine is a relatively new field in medicine, whereby specific health hazards are identified for particular occupations. One topic of recent interest is the effect of fire fighting on pulmonary function. Suppose a group of 26, 25-35 year-old male fire fighters are identified and change in their pulmonary function over a 5-year period is measured. Over 5 years it is found that the fire fighters have a mean decline in forced expiratory volume (FED, the volume of air expelled in 1 second) of 0.27 litres with a sample standard deviation of 0.32 litres. Can any conclusions be drawn about the occupational exposure if the expected change over 5 years is 0.10 litres in normal male in this age group?

Assume that the decline in FEV is normally distributed with mean μ and unknown variance σ^2.

1. What is the H_0? H_0:
2. What is the H_1? H_1:

    Think about whether your hypotheses are one-sided or two-sided!!!
    This will affect the way you calculate probabilities!!

3. What is the sample size?
    - n =
4. Find the mean value of
    - the sample: m =
    - the population: μ =
5. Find a 95% confidence interval for the appropriate parameter. Interpret your result.
    - 95% CI =
    - The formula for 95% confidence interval for mean is: $m \pm 1.96 \cdot \frac{s}{\sqrt{n}}$

5. Calculate the t test statistic for this sample:

    t =

Hint: The formula for the z test statistic is: $t = \frac{m - \mu}{\frac{s}{\sqrt{n}}}$

6. Interpret from statistical point of view the obtained result.

7. So, 5 years occupational exposure leads to decrease in the forced expiratory volume compared with reduction in normal male?

PROBLEM 3: INDEPENDENT SAMPLES AND KNOWN POPULATION VARIANCES – NORMAL TEST

The alkanlinity (mg/L) of water in the upper reaches of Someşului Cald river is known to be normally distributed with a standard deviation of 10 mg/L. Alkalinity readings in the lower reaches of the Someşului Cald river is also known to be normally distributed with a standard deviation of 15 mg/L. Ten alkanility readings are made in the upper reaches of Someşului Cald and twelve in the lower reaches with the following results

Upper	90	76	92	87	90	67	80	70	69	78		
Lower	120	115	135	87	95	64	68	105	113	79	145	121

Investigate at a 5% significance level the claim that the true alkalinity of water in the lower reaches of the river is greater than that in the upper reaches.

1. What is the H_0? H_0:
2. What is the H_1? H_1:
3. Find the mean of alkalinity in upper and lower reaches of the river:
   - m_1 =
   - m_2=

Hint:

- The formula for arithmetic mean is $m = \frac{1}{n}\sum_{i=1}^{n} x_i$

4. Significance level: α =
5. z-critical: 2.09. If calculated z ≥ 2.09 → reject H_0.
6. Calculate the z test statistic for this sample (the value of z for the sample allows us to perform a probability calculation to test the significance of this finding against the H_0)

   z =

Hint: The formula for the z test statistic is: $z = \frac{(m_1 - m_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$

7. Interpret from statistical point of view the obtained result.

8. So, alkalinity of water in the lower reaches of the river is greater than that in the upper reaches?

Problem 4: Independent Samples and Unknown BUT Equal Population Variances – T-Test

Suppose a group of 8, 25-35 year-old male smoking fire fighters are identified; this sample have a mean systolic blood pressure of 135 mmHg and a sample deviation of 10 mmHg. A sample of 20 25-35 year-old male non-smoking fire fighters were similarly identified who have mean systolic blood pressure of 125 mmHg and a standard deviation of 10 mmHg. Investigate the difference between means of systolic blood pressure of these two samples.

1. What is the H_0? H_0:
2. What is the H_1? H_1:
3. What are the sample sizes?
    - n_1 =
    - n_2 =
4. Significance level: α = 0.05
    - m_1 =
    - m_2 =
5. t critical = 2.06
6. Calculate the t test statistic for this sample:

t =

Hint: The formula for the z test statistic is: $t = \frac{(m_1 - m_2)}{\sqrt{s\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$

7. Interpret from statistical point of view the obtained result.

8. So, the mean of systolic blood pressure of smoking fire fighters is significantly different compared to the non-smoking fire fighters?

PROBLEM 5: PAIRED SAMPLES – T-TEST

A study was conduct in order to assess a daily therapeutic schema for treatment of ferriprive anemia (Fe deficiency) in newborn child. There were included into the study 10 breast feed newborn from urban environments. The biochemical expression of the ferriprive anemia is hemoglobin blood level expressed in mg/dl. The data were collected at baseline and after 3 months of treatment and are presented in the table below:

Hemoglobin (mg/dl) baseline	12.1	13.2	10.1	9.2	10.6	12.3	12.3	11.4	10.5	13.1
Hemoglobin (mg/dl) 3 months of treatment	13.2	13.2	13.3	12.1	12.2	13	12.9	12.9	11.2	12.7

Was the treatment efficient?

1. What is the H_0? H_0:
2. What is the H_1? H_1:
3. Compute the differences between baseline and 3 months determination of hemoglobin levels:

Hemoglobin (mg/dl) baseline	12.1	13.2	10.1	9.2	10.6	12.3	12.3	11.4	10.5	13.1
Hemoglobin (mg/dl) 3 months of treatment	13.2	13.2	13.3	12.1	12.2	13	12.9	12.9	11.2	12.7
d										

4. Significance level: $\alpha = 0.05$
5. Critical region for two-tailed test: degrees of freedom = 9; t > 2.69
6. Summarize the ***differences***:
   - n =
   - $\bar{d}$ =
   - s_d =

Formulas:

- $$t = \frac{\bar{d}}{\frac{s_d}{\sqrt{n}}}$$
- $$\bar{d} = \frac{(d_1 + d_2 + \ldots + d_n)}{n}$$
- $$s_d = \sqrt{\left[\sum_{i=1}^{n} d_i^2 - \left(\sum_{i=1}^{n} d_i\right)^2 / n\right] / (n-1)}$$

7. Interpret from statistical point of view the obtained result.

8. So, was the treatment efficient?