Høgskolen i Telemark

EXAM

4301 – NATURAL SCIENCE METHODS

25.09.2015

Time:	*9-14*
Language:	*English*
Pages:	*11 (this page included)*
Help means:	*Calculator, statistical tables, English dictionary*
Notes:	*None*
Appendices:	*None*

The exam results will be made available on Studentweb.

Fakultet for allmennvitenskapelige fag

EXAM IN NATURAL SCIENCES METHODS
25.09.2015, kl. 09.00 - 14.00

All main questions (1-7) count the same and within each main question all sub-questions count the same.

1. Explain briefly the following statistical concepts:
   a. discrete numerical variable,
   b. interval scale,
   c. median,
   d. SD,
   e. Poisson probability distribution,
   f. Central Limit Theorem,
   g. test statistic,
   h. P value,
   i. Type I error,
   j. Type II error.

2. Niederkorn (1872) measured 114 human corpses and provided the frist quantitative study on the development of rigor mortis. The data in the following table give the number of bodies achieving rigor mortis in each hour after death.

Hours	Number of bodies
1	0
2	2
3	14
4	31
5	14
6	20
7	11
8	7
9	4
10	7
11	1
12	1
13	2
Total	114

   a. Calculate the mean number of hours after death that it took for rigor mortis to set in.
   b. The SD was 2.4 hours. What fraction of observations lie within one standard deviation of the mean?
   c. Calculate standard error of the mean. Explain what this standard error measures.
   d. Calculate rule-of-thumb confidence intervals for the mean.
   e. Calculate median number of hours until rigor mortis sets in. What is the likely explanation for the difference between the median and the mean?

3. Assume a random sample. What effect does increasing the sample size have on:
   a. The probability of committing a Type I error?
   b. The probability of committing a Type II error?
   c. The power of a test?
   d. The effect size?
   e. The significance level?

4. Eight students participated in a study of the effect of alcohol on the response time in a simulated car accident. After several practice runs each student's reaction time in seconds was recorded twice, one before drinking 3 bottles of beer and again half an hour after drinking the beers. The resulting reaction times in seconds are shown below:

Student	1	2	3	4	5	6	7	8
Initial time	34	41	36	29	37	50	42	39
After beers	39	42	35	29	41	52	46	46
Differences	5	1	-1	0	4	2	4	7

a. Which test would you use to test if there is sufficient evidence to claim that the average reaction time increases after drinking 3 bottles of beer? And why this test?
b. Perform the test (tip: $= \frac{\bar{d}}{SE_{\bar{d}}}$). Is it significant or not?
c. What assumptions do you make when you carry out the test?

5. Can the songs of extinct species be predicted? Gun et al (2012) used measurements of living species of katydid to predict the call frequency, od 'pitch', of the extinct *Archaeboikus musicus* based on a 65 mill year old fossil. Male katydids call by stridulating, rubbing forewings together so that a scraper on one wing rubs against a 'file' on the other. Call frequency is predicted by file length. File length of a single well-preserved fossil was 9.34 mm. What was its call frequency? Summary for log-transformed data are as follows: $n=58$, $\Sigma x_i=33.241$, $\Sigma y_i=189.936$, $\Sigma x_i^2=42.615$, $\Sigma y_i^2=609.994$, $\Sigma x_i y_i=86.720$.

a. Calculate the regression line from the summary numbers provided (see attached formulae sheet). Assume that the data points are independent.
b. On the basis of this regression, what is the predicted log-transformed call frequency of the extinct *Archaeboikus musicus.* The log file length for this species is 2.25.

6. An ANOVA carried out to test the null hypothesis of zero slope for a regression yielded the following results
:

Source of variation	Sum of Squares	*Df*	Mean squares	*F*-ratio
Regression	3758539	1		
Residual	7303662	9		
Total				

a. Complete the ANOVA table.
b. Using the *F*-statistic, test the null hypothesis of zero slope at the significance level of $\alpha = 0,05$.
c. What are your assumptions in part c?
d. What does the $MS_{residual}$ measure?
e. Calculate the R^2 statistic. What does it measure?

7. Attached is the Abstract for a scientific paper by Udani et al 2009. Evaluation of Mangosteen jucie blend on biomarkers of inflammation in obese subjects: a pilot, dose finding study, in Nutrition Journal 2009, 8:48. Read the Abstract carefully and answer the questions:

a. Which is the explanatory variable(s) and what type of variable is it?
b. Which is the response variable(s) and what type of variable is it?
c. Formulate the likely H_0 and H_A hypothesis' in words.
d. Which of the five basic study design principles are met here?
e. Which type of statistical test(s) do you believe was used here, and why?
f. Below you will also find details about the sample demographics (Table I). Do you consider this a representative sample of 'obese subjects' as stated in the title?

Research

Open Access

Evaluation of Mangosteen juice blend on biomarkers of inflammation in obese subjects: a pilot, dose finding study

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Abstract

Background: The ability to reduce inflammation in overweight and obese individuals may be valuable in preventing the progression to metabolic syndrome with associated risks for heart disease and diabetes. The purpose of this study was to evaluate the effect of multiple dosages of a proprietary Mangosteen Juice blend on indicators of inflammation and antioxidant levels in obese patients with elevated C-reactive protein (CRP) levels.

Methods: The study was an 8 week randomized, double-blind, placebo-controlled study with a pre-study 2 week washout period. The study included four groups including placebo and three difference doses of the test product, XanGo Juice™: 3, 6 or 9 oz twice daily. The primary outcome measure of this study was high-sensitivity (HS)-CRP. Secondary outcome measures included other biochemical indicators of inflammation, anthropomorphic measures and a safety evaluation.

Results: One hundred twenty two (122) persons were screened for the study. 44 were randomized and 40 completed the study. HS-CRP measurements dropped after 8 weeks treatment compared to baseline in all 3 dose groups and increased in the placebo group. The changes from baseline were not significant but the comparison of change from baseline was significant for the 18 oz group when compared to placebo (p = 0.02). Other markers of inflammation (inflammatory cytokines) and a marker for lipid peroxidation (F2 isoprostane) did not show any significant differences when compared with placebo. There was a trend towards a decrease in BMI in the juice groups. There were no side effects reported in any of the groups and none of the laboratory or EKG safety assessments indicated clinically significant changes for any subject.

Conclusion: In this pilot, dose-finding study, a proprietary mangosteen juice blend (XanGo Juice™) reduced CRP levels (increased change from baseline) compared to placebo for those taking the highest dose of 18 oz per day. Further studies with a larger population are required to confirm and further define the benefits of this juice. The juice was administered safely.

Trial Registration: ISRCTN9300027

Table 1: Baseline Demographics

	6 oz Xango	12 oz Xango	18 oz Xango	Placebo
N	11	12	9	8
Male	1	0	1	0
Female	10	12	8	8
Age	52	33	50	45
BMI	33.7	32.6	34.1	34.8
Body Fat %	41.5	39.3	37.8	39.3

Baseline characteristics of the 40 subjects who completed the study, by study group. Means are given for age, CRP levels, BMI and percentage body fat.

Formulae for Basic Statistics

$$\bar{Y} = \frac{\sum_{i=1}^{n} Y_i}{n}$$

$$s = \sqrt{\frac{\Sigma(Y_i - \bar{Y})^2}{n-1}} \qquad s = \sqrt{\frac{\Sigma\left(Y_i^2\right) - n\bar{Y}^2}{n-1}}$$

Standard error of the mean

$$s/\sqrt{n}$$

χ^2 test of goodness-of-fit

$$\chi^2 = \sum_i \frac{\left(O_i - E_i\right)^2}{E_i}$$

$$\ln(\hat{OR}) - Z_{\alpha}\ SE[\ln(\hat{OR})] \le \ln(OR) \le \ln(\hat{OR}) + Z_{\alpha}\ SE[\ln(\hat{OR})]$$

$$\hat{OR} = \frac{ad}{bc}$$

Poisson Probability Distribution

$$P[x] = \frac{\mu^x e^{-\mu}}{x!}$$

Binomial Probability Distribution

$$P[x] = \binom{N}{x} p^x (1-p)^{N-x}$$

Normal Probability Distribution

$$P[x] = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

Confidence Interval for the mean of a normal distribution

$$\bar{Y} \pm SE_{\bar{Y}} t_{\alpha(2),df}$$

Confidence Interval for the variance of a normal distribution

$$\frac{df\ s^2}{\chi^2_{\frac{\alpha}{2},df}} \le \sigma^2 \le \frac{df\ s^2}{\chi^2_{1-\frac{\alpha}{2},df}}$$

Formulae for regression and correlation

$$\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y}) = \left(\sum X_i Y_i\right) - \frac{\sum X_i \sum Y_i}{n}$$

$$\sum_{i=1}^{n}(X_i - \bar{X})^2 = \sum\left(X_i^2\right) - \frac{\left(\sum X_i\right)^2}{n}$$

$$\sum_{i=1}^{n}(Y_i - \bar{Y})^2 = \sum\left(Y_i^2\right) - \frac{\left(\sum Y_i\right)^2}{n}$$

Formulae for regression and correlation

$$\sum(X-\bar{X})(Y-\bar{Y})=\sum(XY)-\frac{(\sum X)(\sum Y)}{n}$$

$$b=\frac{\sum(X_i-\bar{X})(Y_i-\bar{Y})}{\sum(X_i-\bar{X})^2}$$

$$a=\bar{Y}-b\bar{X}$$

$$SS_{Total}=\sum Y_i^2-\frac{\left(\sum Y_i\right)^2}{n}$$

$$SS_{regression}=b\sum(X_i-\bar{X})(Y_i-\bar{Y})$$

$$SS_{residual}+SS_{regression}=SS_{Total}$$

$$MS_x=\frac{SS_x}{DF_x}$$

$$r^2=\frac{SS_{regression}}{SS_{Total}}$$

$$SE_b=\sqrt{\frac{MS_{residual}}{\sum(X_i-\bar{X})^2}}$$

$$MS_{residual}=\frac{\sum(Y_i-\bar{Y})^2-b\sum(X_i-\bar{X})(Y_i-\bar{Y})}{n-2}$$

$$b\pm t_{\alpha[2],v}SE_b$$

$$\hat{Y}\pm t_{\alpha[2],v}SE_{\hat{Y}}$$

$$t=\frac{b-\beta_0}{SE_b}$$

$$t=\frac{(b_1-b_2)-(\beta_1-\beta_2)}{SE_{b1-b2}}$$

$$(MS_{error})_p=\frac{(SS_{error})_1+(SS_{error})_2}{(DF_{error})_1+(DF_{error})_2}$$

$$SE_{b1-b2}=\sqrt{\frac{(MS_{error})_p}{\left(\sum(X-\bar{X})^2\right)_1}+\frac{(MS_{error})_p}{\left(\sum(X-\bar{X})^2\right)_2}}$$

$$r = \frac{\sum (X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum (X_i - \bar{X})^2 \sum (Y_i - \bar{Y})^2}}$$

$$SE_r = \sqrt{\frac{1 - r^2}{n - 2}}$$

$$z = 0.5 \ln\left(\frac{1 + r}{1 - r}\right)$$

$$\sigma_z = \sqrt{\frac{1}{n - 3}}$$

$$r_s = 1 - \frac{6 \sum d_i^2}{n^3 - n}$$

ANOVA etc.

$$F = \frac{MS_{\text{groups}}}{MS_{\text{error}}}$$

$$MS_{\text{error}} = s^2_{\text{pooled}} = \frac{\sum s_i^2 (n_i - 1)}{N - k}$$

$$MS_{\text{groups}} = \frac{\sum n_i (\bar{Y}_i - \bar{Y})^2}{k - 1}$$

$$\bar{Y} = \frac{\sum n_i (\bar{Y}_i)}{N}$$

$$R^2 = \frac{SS_{\text{groups}}}{SS_{\text{total}}}$$

Kruskal-Wallis

$$H = \frac{12}{N(N + 1)} \left[\sum \frac{R_i^2}{n_i} \right] - 3(N + 1)$$

Tukey-Kramer:

$$q = \frac{\bar{Y}_i - \bar{Y}_j}{SE} \qquad SE = \sqrt{s^2_{\text{pooled}} \left(\frac{1}{n_i} + \frac{1}{n_j} \right)}.$$

Mann-Whitney U

$$U = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1$$

$$U' = n_1 n_2 - U$$

$$Z = \frac{2U - n_1 n_2}{\sqrt{n_1 n_2 (n_1 + n_2 + 1)/3}}$$

Critical value of *F*, *α(1)*=0.05, *α(2)*=0.10

	Numerator *df*									
den. *df*	1	2	3	4	5	6	7	8	9	10
1	161.45	199.50	215.71	224.58	230.16	233.99	236.77	238.88	240.54	241.88
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38	19.40
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32

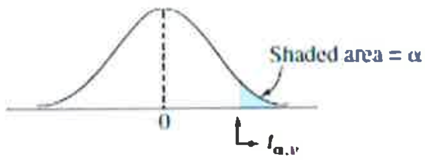

TABLE 2

Percentage points of Student's *t* distribution

df/α =	.40	.25	.10	.05	.025	.01	.005	.001	.0005
1	0.325	1.000	3.078	6.314	12.706	31.821	63.657	318.309	636.619
2	0.289	0.816	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.277	0.765	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.271	0.741	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.267	0.727	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.265	0.718	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.263	0.711	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.262	0.706	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.261	0.703	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.260	0.700	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.260	0.697	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.259	0.695	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.259	0.694	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.258	0.692	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.258	0.691	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.258	0.690	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.257	0.689	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.257	0.688	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.257	0.688	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.257	0.687	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.257	0.686	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.256	0.686	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.256	0.685	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.256	0.685	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.256	0.684	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.256	0.684	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.256	0.684	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.256	0.683	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.256	0.683	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.256	0.683	1.310	1.697	2.042	2.457	2.750	3.385	3.646
35	0.255	0.682	1.306	1.690	2.030	2.438	2.724	3.340	3.591
40	0.255	0.681	1.303	1.684	2.021	2.423	2.704	3.307	3.551
50	0.255	0.679	1.299	1.676	2.009	2.403	2.678	3.261	3.496
60	0.254	0.679	1.296	1.671	2.000	2.390	2.660	3.232	3.460
120	0.254	0.677	1.289	1.658	1.980	2.358	2.617	3.160	3.373
inf.	0.253	0.674	1.282	1.645	1.960	2.326	2.576	3.090	3.291

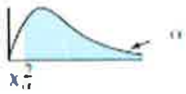

TABLE 7
Percentage points of the chi-square distribution

α = .10	.05	.025	.01	.005	.001	df
2.706	3.841	5.024	6.635	7.879	10.83	1
4.605	5.991	7.378	9.210	10.60	13.82	2
6.251	7.815	9.348	11.34	12.84	16.27	3
7.779	9.488	11.14	13.28	14.86	18.47	4
9.236	11.07	12.83	15.09	16.75	20.52	5
10.64	12.59	14.45	16.81	18.55	22.46	6
12.02	14.07	16.01	18.48	20.28	24.32	7
13.36	15.51	17.53	20.09	21.95	26.12	8
14.68	16.92	19.02	21.67	23.59	27.88	9
15.99	18.31	20.48	23.21	25.19	29.59	10
17.28	19.68	21.92	24.72	26.76	31.27	11
18.55	21.03	23.34	26.22	28.30	32.91	12
19.81	22.36	24.74	27.69	29.82	34.53	13
21.06	23.68	26.12	29.14	31.32	36.12	14
22.31	25.00	27.49	30.58	32.80	37.70	15
23.54	26.30	28.85	32.00	34.27	39.25	16
24.77	27.59	30.19	33.41	35.72	40.79	17
25.99	28.87	31.53	34.81	37.16	42.31	18
27.20	30.14	32.85	36.19	38.58	43.82	19
28.41	31.41	34.17	37.57	40.00	45.31	20
29.62	32.67	35.48	38.93	41.40	46.80	21
30.81	33.92	36.78	40.29	42.80	48.27	22
32.01	35.17	38.08	41.64	44.18	49.73	23
33.20	36.42	39.36	42.98	45.56	51.18	24
34.38	37.65	40.65	44.31	46.93	52.62	25
35.56	38.89	41.92	45.64	48.29	54.05	26
36.74	40.11	43.19	46.96	49.65	55.48	27
37.92	41.34	44.46	48.28	50.99	56.89	28
39.09	42.56	45.72	49.59	52.34	58.30	29
40.26	43.77	46.98	50.89	53.67	59.70	30
51.81	55.76	59.34	63.69	66.77	73.40	40
63.17	67.50	71.42	76.15	79.49	86.66	50
74.40	79.08	83.30	88.38	91.95	99.61	60
85.53	90.53	95.02	100.43	104.21	112.32	70
96.58	101.88	106.63	112.33	116.32	124.84	80
107.57	113.15	118.14	124.12	128.30	137.21	90
118.50	124.34	129.56	135.81	140.17	149.45	100
140.23	146.57	152.21	158.95	163.65	173.62	120
268.47	277.14	284.80	293.89	300.18	313.44	240