

## Introductory Statistics Tutorial

### Chapter 11 – Tables of Counts

#### Section A: One-way Tables

1. There are three TV channels (A, B and C) operating in a particular region. The current market shares of the three channels during peak viewing time (6pm to 9pm) are 10%, 40% and 50% for channels A, B and C respectively. Channel A has altered its programming. Management has decided to conduct a statistical test to determine whether this affected relative market shares. A random sample of 300 viewers is asked to indicate their preferences between the newly programmed channel A and the traditional programming of channels B and C. The sample reveals the following frequencies:

Channel	Frequency
A	40
B	125
C	135

- (a) State the null and alternative hypotheses for the appropriate statistical test.
- (b) Calculate the degrees of freedom associated with this statistical test.
- (c) Assuming that the null hypothesis is true, calculate the expected count for the three channels.

- (d) The expected count of the Channel B cell is 120. Calculate the contribution of the Channel B cell to the value of the Chi-square test statistic.

- (e) The value of the Chi-square test statistic is 5.0417. The MINITAB output for the test is shown below.

#### Cumulative Distribution Function

Chi-Square with 2 DF

x	P ( X ≤ x )
5.0417	0.9196

- (i) State the *P-value* for this test.
- (ii) Interpret this test in terms of what the management was trying to determine.
- (f) Are the results of this Chi-square test valid? Explain briefly.



2. In a genetics experiment the types BC, Bc, bC and bc are expected to occur with frequencies in the ratio 9:3:3:1. The observed frequencies are shown in the table below.

Type	BC	Bc	bC	bc	Total
Observed frequencies	102	16	35	7	160

A researcher wanted to investigate whether the observed frequencies for the genetic types provided evidence against the stated theoretical ratios.

- (a) State the null and alternative hypotheses for the appropriate statistical test.
- (b) Calculate the degrees of freedom associated with this statistical test.
- (c) Under the null hypothesis, calculate the expected count for type BC.
- (d) The expected count for type Bc is 30. Calculate the contribution of the type Bc cell to the value of the Chi-square test statistic.

- (e) The value of the Chi-square test statistic is 9.8667. The MINITAB output for the test is shown below.

### Cumulative Distribution Function

Chi-Square with 3 DF

x	P( X ≤ x)
9.8667	0.9803

- (i) State the *P-value* for this test.

- (ii) Interpret this test.



## Section B: Two-way Tables

1. A TV channel's advertising manager is attempting to sell advertising time during the commercial breaks that segment news broadcasts. Since potential advertisers often ask questions about the age of the viewers and their primary source of news, she decides to conduct a survey to see whether there is evidence to suggest that TV is the primary source of news for a large number of people regardless of their age. A random sample of 1000 people in a metropolitan area was asked to participate in the survey. Researchers obtained the following data:

Age group	Primary news source			Row totals
	Radio	TV	Newspaper	
Under 30	100	130	20	250
30 - 49	100	300	175	575
50 and over	25	50	100	175
<b>Column totals</b>	225	480	295	1000

Do these data present sufficient evidence to indicate that there is a relationship between a person's age and his or her primary source of news? To help answer this question a statistical test will be carried out.

- (a) State the null and alternative hypotheses for the appropriate Chi-square test.
- (b) Would it be possible to use the data to test whether the distribution of primary news source is the same for each age group? Briefly explain.
- (c) Calculate the degrees of freedom associated with this statistical test.

- (d) Assuming that the null hypothesis is true, calculate the expected cell count for those who are under 30 and who use radio as their primary news source.
- (e) The expected cell count for those who are 50 and over and who use newspapers as their primary news source is 51.625. Calculate the contribution of the (50 and over, Newspaper) cell to the value of the Chi-square test statistic.

- (f) The MINITAB output for the test is shown below.

### Chi-Square Test

Expected counts are printed below observed counts

	Radio	TV	Newspape	Total
1	100 56.25	130 120.00	20 73.75	250
2	100 129.38	300 276.00	175 169.62	575
3	25 39.38	50 84.00	100 51.63	175
Total	225	480	295	1000

$\text{Chi-Sq} = 34.028 + 0.833 + 39.174 + 6.670 + 2.087 + 0.170 + 5.248 + 13.762 + 45.330 = 147.301$   
 $\text{DF} = 4, \text{P-Value} = 0.000$

Interpret the test.

- (g) Are the results of this Chi-square test valid? Explain briefly.

2. During times of business decline and recession, many suggestions are offered to spur the economy into a turn around. A survey was conducted among three groups (business executives, economists and government officials) in order to determine their opinions as to the best way of reversing the trend of business decline. The options given for reversing the trend in business decline were: increase government expenditure, reduce taxation, reduce interest rates and provide other business incentives.

Opinion	Group			Row totals
	Business executives	Economists	Government officials	
Increase government expenditure	10	15	39	64
Reduce taxation	37	37	33	107
Reduce interest rates	24	34	15	73
Other business incentives	29	14	13	56
<b>Column totals</b>	100	100	100	300

Do these data present sufficient evidence to suggest that opinion differs between the groups? To help answer this question a statistical test will be carried out.

- (a) State the null and alternative hypotheses for the appropriate Chi-square test.
- (b) Would it be possible to use the data to test whether the opinions about the best way to reverse the trend in business decline is independent of the group? Briefly explain.
- (c) Calculate the degrees of freedom associated with this statistical test.

- (d) Assuming that the null hypothesis is true, calculate the expected count for the (Increase government expenditure, Economists) cell.

- (e) The MINITAB output for the test is shown below.

#### Chi-Square Test

Expected counts are printed below observed counts

	Bus exec	Economis	Govt off	Total
1	10 21.33	15 21.33	39 21.33	64
2	37 35.67	37 35.67	33 35.67	107
3	24 24.33	34 24.33	15 24.33	73
4	29 18.67	14 18.67	13 18.67	56
Total	100	100	100	300

Chi-Sq = 6.021 + 1.880 + 14.630 +  
0.050 + 0.050 + 0.199 +  
0.005 + 3.840 + 3.580 +  
5.720 + 1.167 + 1.720 = 38.862  
DF = 6, P-Value = 0.000

- (i) Write down the contribution of the (Reduce interest rates, Business executives) cell to the Chi-square test statistic.
- (ii) Name the three cells that contributed most to the very large value of the Chi-square test statistic.
- (iii) Interpret the test.