

Chapter 2: Displaying and Describing Categorical Data

1. **Graphs in the news** Answers will vary.
2. **Graphs in the news II** Answers will vary.
3. **Tables in the news** Answers will vary.
4. **Tables in the news II** Answers will vary.
5. **Forest fires 2010** The relative frequency distribution is shown below:

Cause of fire	Percentage
Lightning	46.94
Human activities	51.64
Unknown	1.42

Causes for forest fires are about equally split between human activities and lightning. Only 1.42% of forest fires are due to unknown causes.
(Example: $46.94\% = 0.4694 = 3279/6986$)

6. **Forest fires 2010 by region**

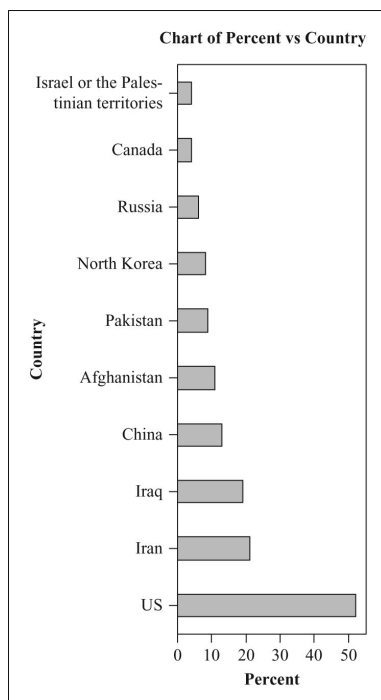
Location	Percentage
Quebec	10.55
Ontario	13.33
Alberta	26.41
BC	23.95
Other	25.76

Most forest fires occurred in Alberta and BC. By comparison, Quebec and Ontario had less than half as many fires. The four provinces account for $\frac{3}{4}$ of all forest fires in Canada.

7. **Teen smokers** According to the Monitoring the Future study, teen smoking brand preferences differ somewhat by region. Although Marlboro is the most popular brand in each region, with about 58% of teen smokers preferring this brand in each region, teen smokers from the South prefer Newports at a higher percentage than teen smokers from the West, with 22.5% of teen smokers preferring this brand, compared to only 10.1% in the South. Teen smokers in the West are also more likely to have no particular brand than teen smokers in the South. 12.9% of teen smokers in the West have no particular brand, compared to only 6.7% in the South. Both regions have about 9% of teen smokers that prefer one of over 20 other brands.

8. **Bad countries**

- a) A bar chart is appropriate, because the variable we want to display is a categorical variable. Some individuals can choose more than one country as bad, and for this reason a pie chart is not appropriate.



- b) No, it is not possible to determine what percent of individuals could not name any country as a negative force. It is possible that only the individuals who listed the U.S. as a negative force (52%) listed other countries also, and all others (i.e., 48%) did not name any country as a negative force.
- c) This not true. Some (or maybe even all) who named Iran also named Iraq and Pakistan, and in this case this proportion is less than 49% ($21 + 19 + 9$).

9. **Oil spills as of 2010**

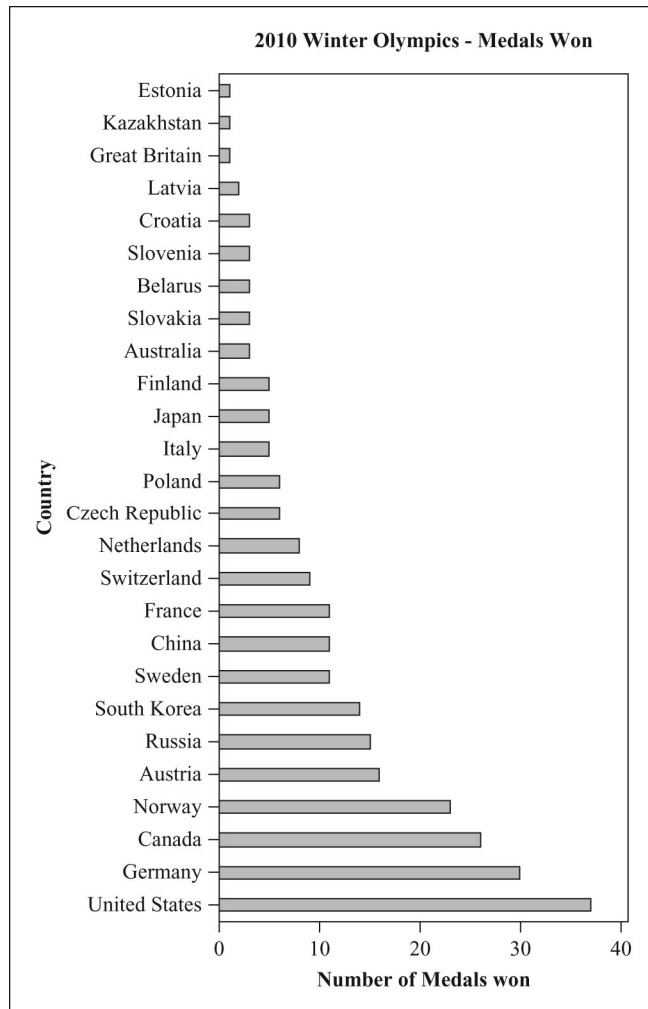
- a) Grounding, accounting for 160 spills, is the most frequent cause of oil spillage for these 460 spills. A substantial number of spills, 132, were caused by collision. Less prevalent causes of oil spillage in descending order of frequency

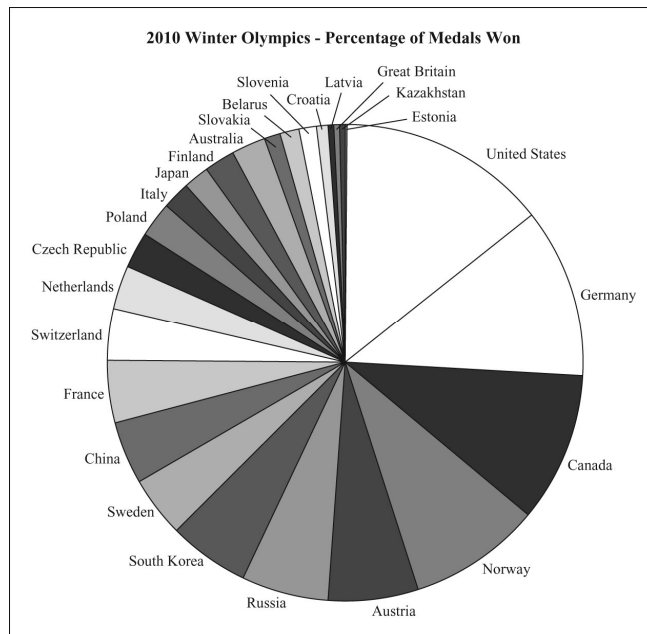
were loading/discharging, other/unknown causes, fire/explosions, and hull failures.

- b) If being able to differentiate between these close counts is required, use the bar chart. Since each spill only has one cause, the pie chart is also acceptable as a display, but it's difficult to tell whether, for example, there is a greater percentage of spills caused by fire/explosions or hull failure. If you want to showcase the causes of oil spills as a fraction of all 460 spills, use the pie chart.

10. Winter Olympics 2010

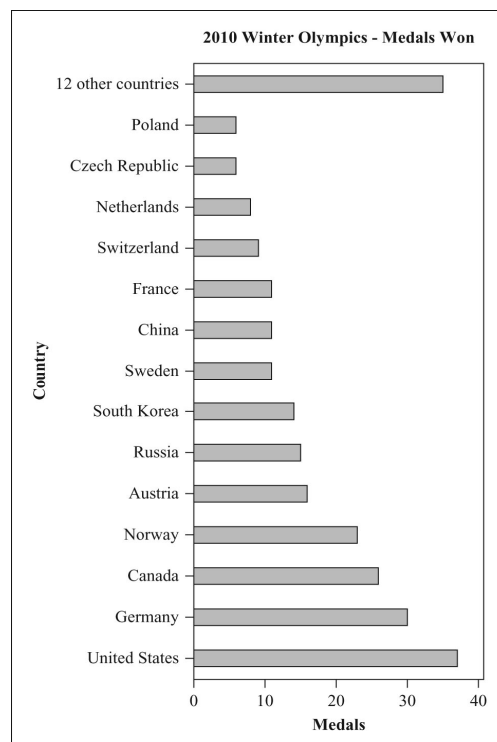
- a) Here are two displays of the data:





The bar chart is confusing. There are simply too many categories! A pie chart of the percentage of medals won by each country is even more confusing. The sections of the chart representing countries that won fewer than 5 medals are too small to even label properly.

- b) Perhaps we are primarily interested in countries that won many medals. Let's combine all countries that won fewer than 6 medals into a single category. This will make our chart easier to read. We are probably interested in number of medals won, rather than percentage of total medals won, so we'll stick with the bar chart. A bar chart is also better for comparisons.



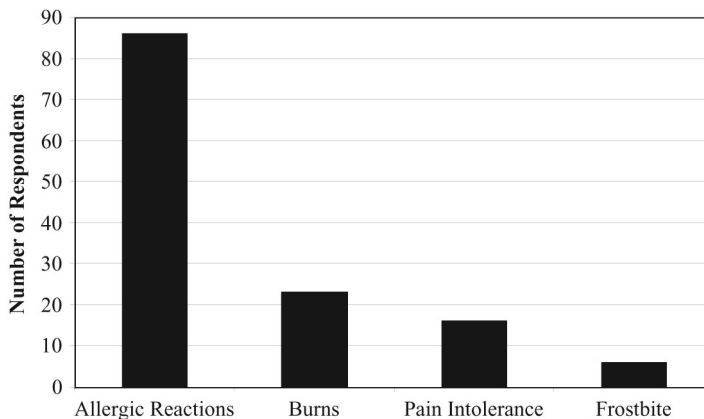
11. Global warming Perhaps the most obvious error is that the percentages in the pie chart only add up to 93%, when they should, of course, add up to 100%. Furthermore, the three-dimensional perspective view distorts the regions in the graph, violating the area principle. The regions corresponding to No Solid Evidence and Due to Human Activity should be roughly the same size, at 32% and 34% of respondents, respectively. However, the 32% region looks bigger, and the angle for the 34% region makes it look only slightly bigger than the 18% region. Always use simple, two-dimensional graphs.

12. Modalities

- The bars have false depth, which can be misleading. This is a bar chart, so the bars should have space between them.
- The percentages sum to 100%. Normally, we would take this as a sign that all of the observations had been correctly accounted for. But in this case, it is extremely unlikely. Each of the respondents was asked to list *three* modalities. For example, it would be possible for 80% of respondents to say they use ice to treat an injury, and 75% to use electric stimulation. In this case, the fact that the percentages total greater than 100% would not be odd. In fact, it seems wrong that the percentages add up to 100%.

13. Complications

- A bar chart is the proper display for these data. A pie chart is not appropriate



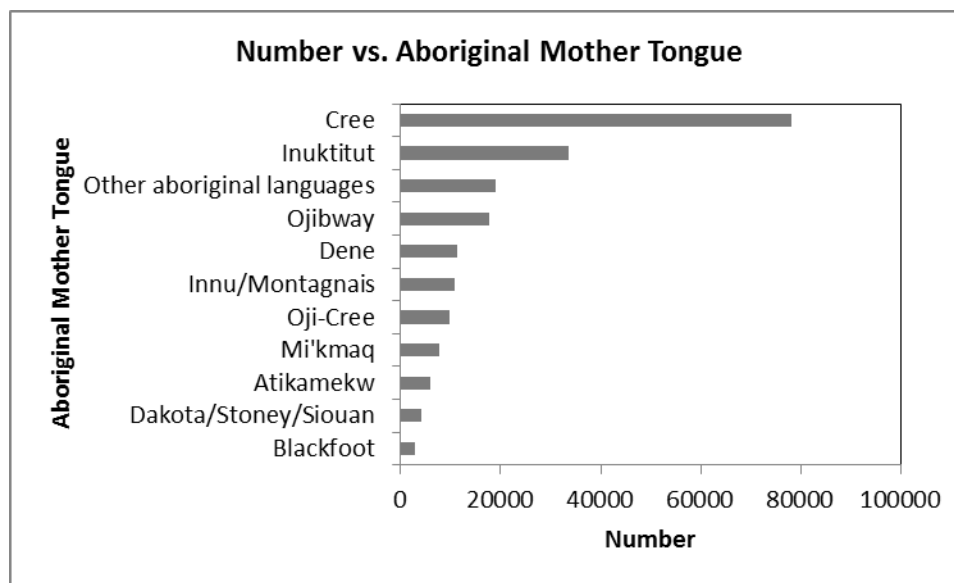
- The *Who* for these data is athletic trainers who used cryotherapy, which should be a cause for concern. A trainer who treated many patients with cryotherapy would be more likely to have seen complications than one who used cryotherapy rarely. We would prefer a study in which the *Who* referred to patients so we could assess the risks of each complication.

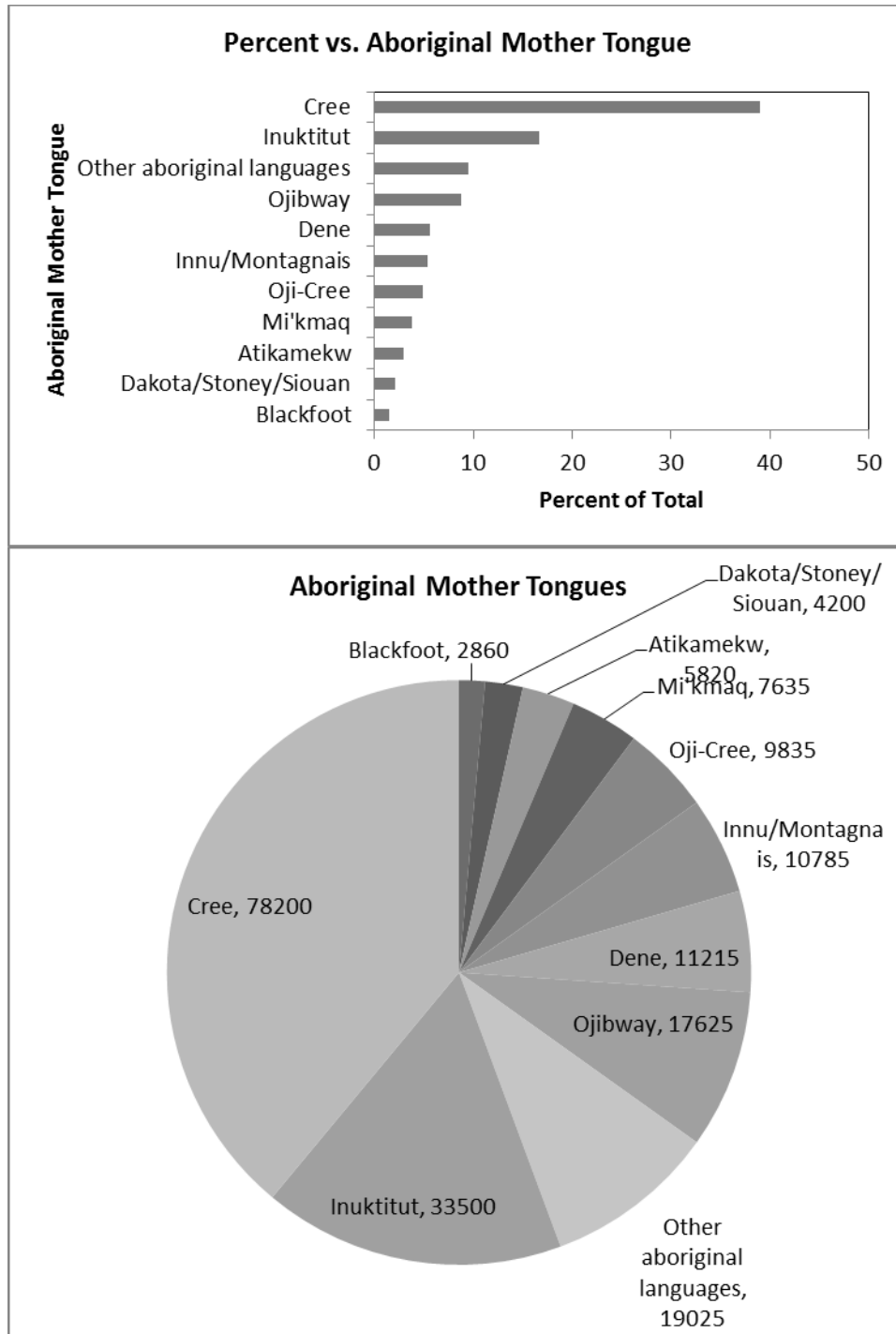
14. Aboriginal languages 2011

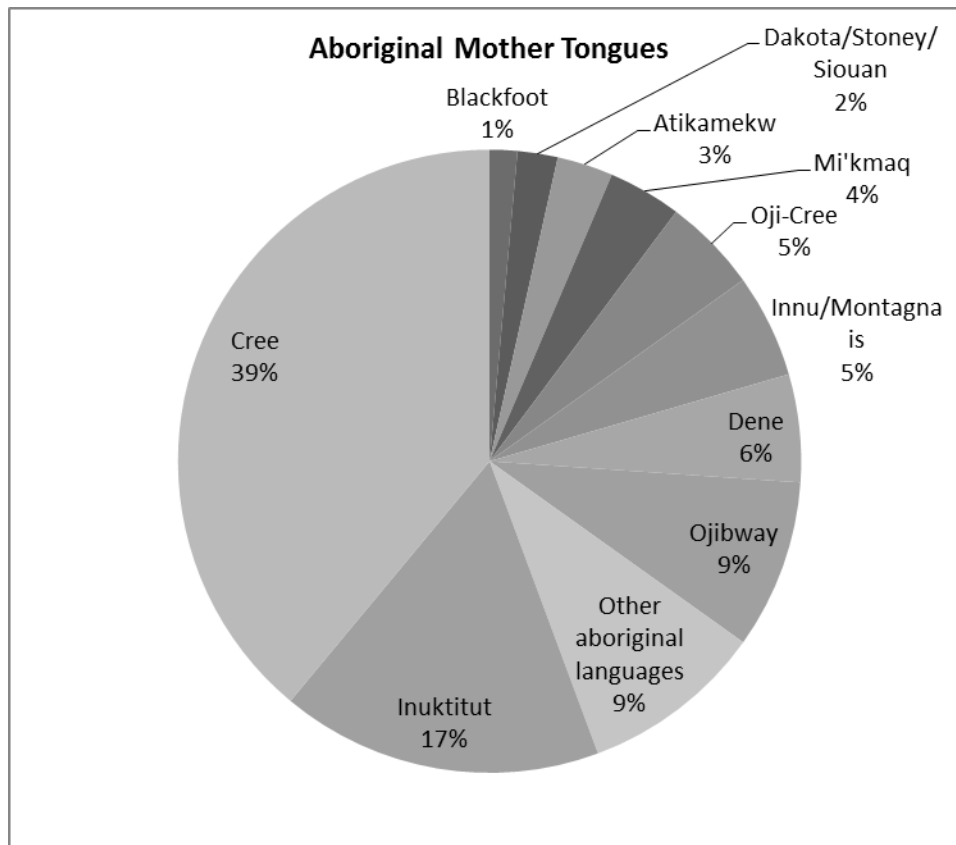
- a) The relative frequency (percentages) distribution of Aboriginal mother tongue is given below.

Aboriginal mother tongue	%
Cree	38.9636
Ojibway	8.7818
Oji-Cree	4.9003
Innu/Montagnais	5.3737
Mi'kmaq	3.8042
Atikamekw	2.8999
Blackfoot	1.4250
Inuktitut	16.6916
Dene	5.5879
Dakota/Stoney/Siouan	2.0927
Other	9.4793

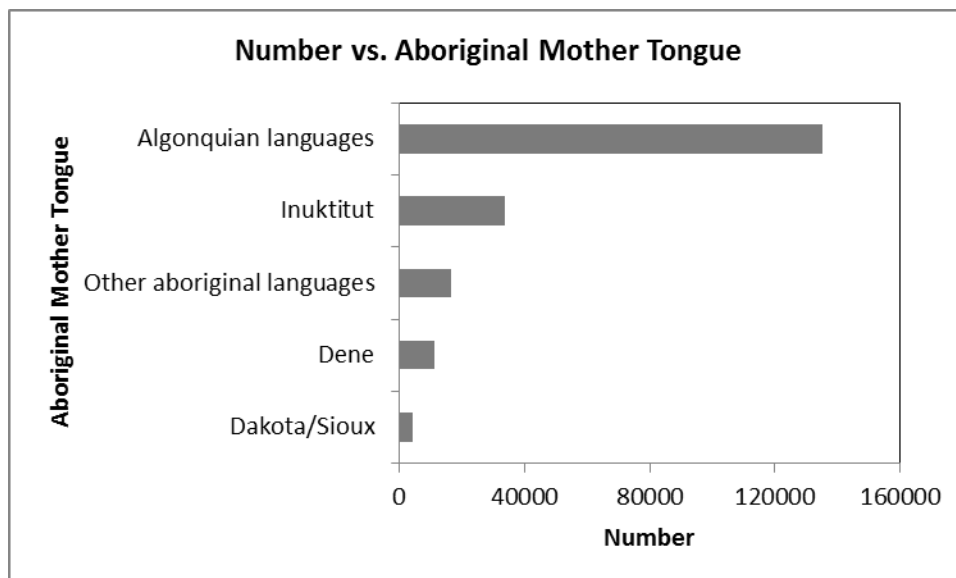
- b) Bar charts and pie charts are shown below. Cree is the mother tongue of the most and Blackfoot the least. Both bar charts and pie charts are good. It is a bit easier to compare the relative frequencies on the bar chart.

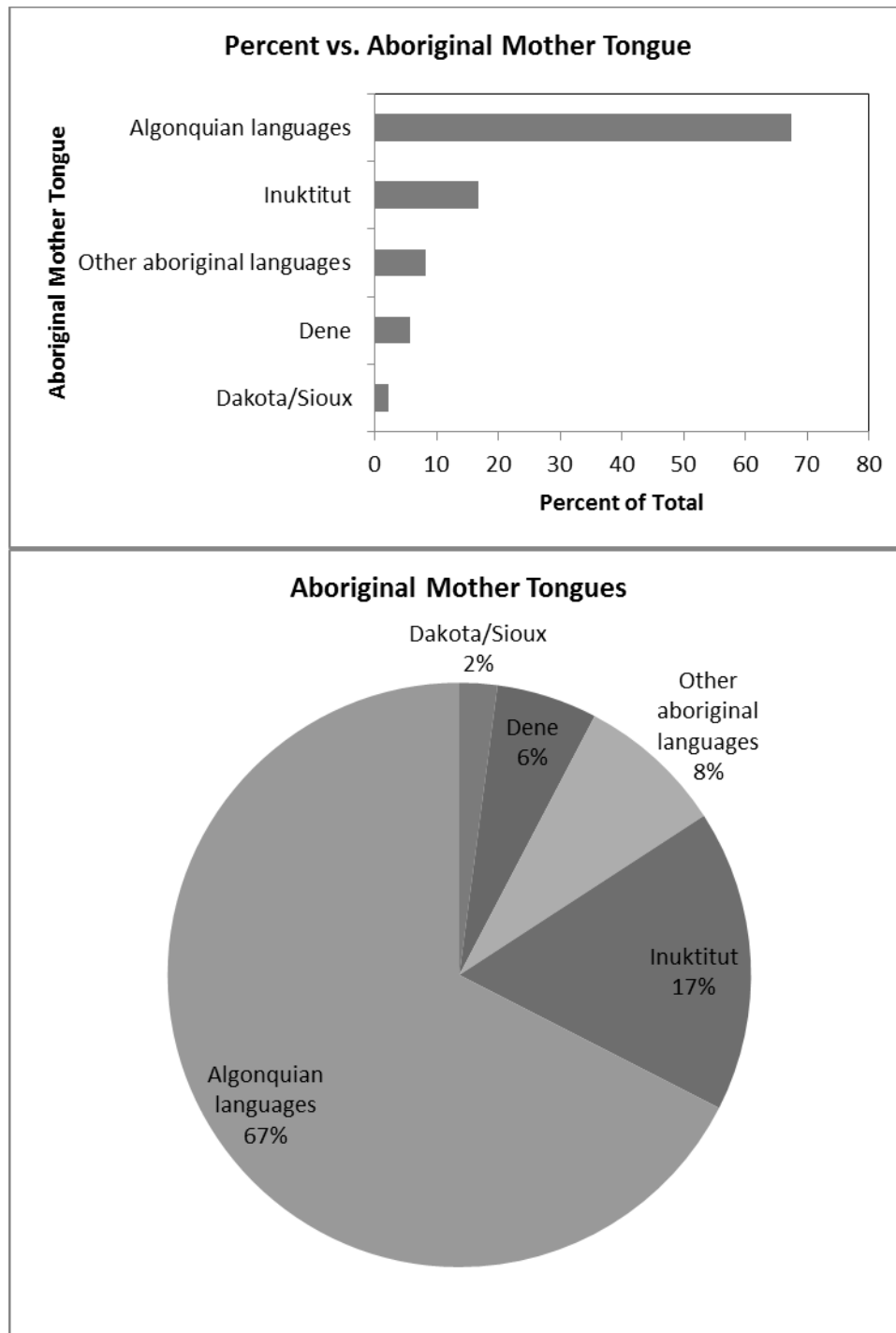


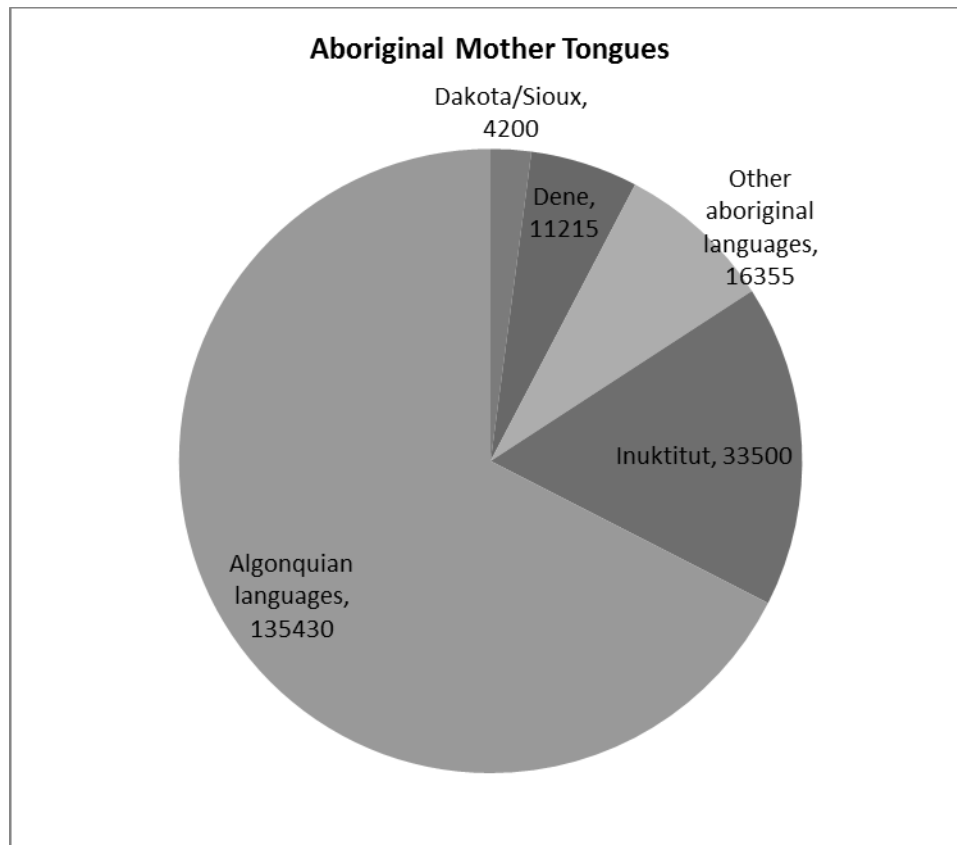




- c) Bar charts and pie charts are shown below. More than 67% reported an *Algonquian* language as their mother tongue and Dakota/Sioux is the least spoken as the mother tongue (of those we have data for).







15. Spatial distribution

- a) The relative frequency distribution of quadrant location is given below. Not all proportions are equal. In particular, the relative frequency for Quadrant 4 is approximately twice the other frequencies.

Quadrant	Quadrant 1	Quadrant 2	Quadrant 3	Quadrant 4
Relative Frequency	0.18	0.21	0.22	0.39

- b) The relative frequency distribution of quadrant location is given below. There seems to have some similarity with that in part a. For example, Quadrant 4 has the highest relative frequency and Quadrant 1 has the lowest.

Quadrant	Quadrant 1	Quadrant 2	Quadrant 3	Quadrant 4
Relative Frequency	0.12	0.24	0.28	0.36

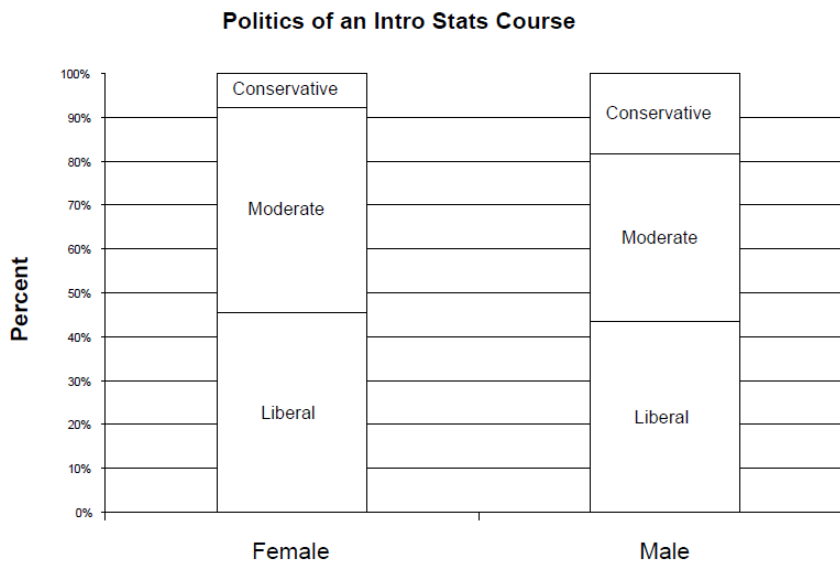
16. Politics

- a) There are 192 students taking Intro Stats. Of those, 115, or about 59.9%, are male.
- b) There are 192 students taking Intro Stats. Of those, 27, or about 14.1%, consider themselves to be "Conservative."

- c) There are 115 males taking Intro Stats. Of those, 21, or about 18.3%, consider themselves to be “Conservative.”
- d) There are 192 students taking Intro Stats. Of those, 21, or about 10.9%, are males who consider themselves to be “Conservative.”

17. Politics revisited

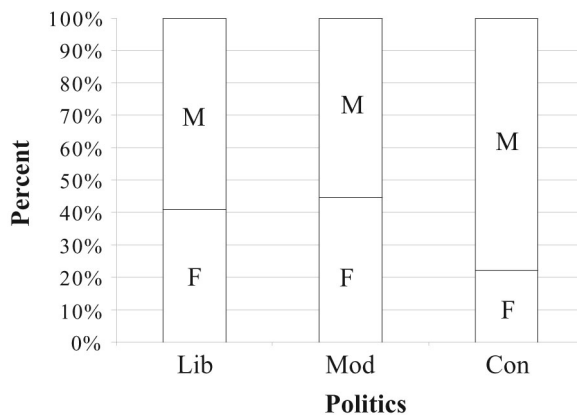
- a) The females in this course were 45.5% Liberal, 46.8% Moderate, and 7.8% Conservative. (They don’t add up to exactly 100% due to the roundoffs.)
- b) The males in this course were 43.5% Liberal, 38.3% Moderate, and 18.3% Conservative.
- c) A segmented bar chart comparing the distributions is below.



- d) Politics and sex do not appear to be independent in this course. Although the percentage of liberals was roughly the same for each sex, females had a greater percentage of moderates and a lower percentage of conservatives than males.

18. More politics

- a) **Distribution of Sex Across Political Categories**

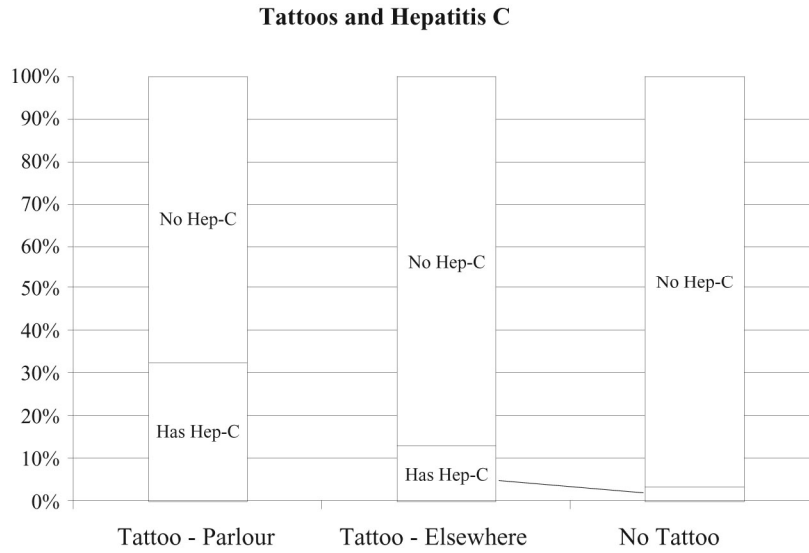


- b) The percentage of males and females varies across political categories. The percentage of self-identified Liberals and Moderates who are female is about twice the percentage of self-identified Conservatives who are female. This suggests that *sex* and *politics* are not independent.

19. Canadian languages 2011

- a) 22,564,665 Canadians speak English only. $22,564,665 / 33,121,175$ total Canadians $\approx 68.1\%$
- b) 4,165,015 Canadians speak French only and 5,795,575 speak both French and English, for a total of 9,960,590 French speakers. $9,960,590 / 33,121,175$ total Canadians $\approx 30.1\%$
- c) 4,047,175 French and 3,328,725 French and English speakers yield a total of 7,375,900 French speakers in Quebec. $7,375,900 / 7,815,955$ Quebec residents $\approx 94.4\%$
- d) 7,375,900 Quebec residents speak French and 9,960,590 Canadians speak French. The percentage of French-speaking Canadians who live in Quebec is $7,375,900 / 9,960,590 \approx 74.1\%$
- e) If language knowledge were independent of province, we would expect the percentage of French-speaking residents of Quebec to be the same as the overall percentage of Canadians who speak French. Since 30.1% of all Canadians speak French while 94.4% of residents of Quebec speak French, there is evidence of an association between language knowledge and province.

- 20. Tattoos** The study by the University of Texas Southwestern Medical Center provides evidence of an association between having a tattoo and contracting hepatitis C. Around 33% of the subjects who were tattooed in a commercial parlour had hepatitis C, compared with 13% of those tattooed elsewhere, and only 3.5% of those with no tattoo. If having a tattoo and having hepatitis C were independent, we would have expected these percentages to be roughly the same.



21. Weather forecasts

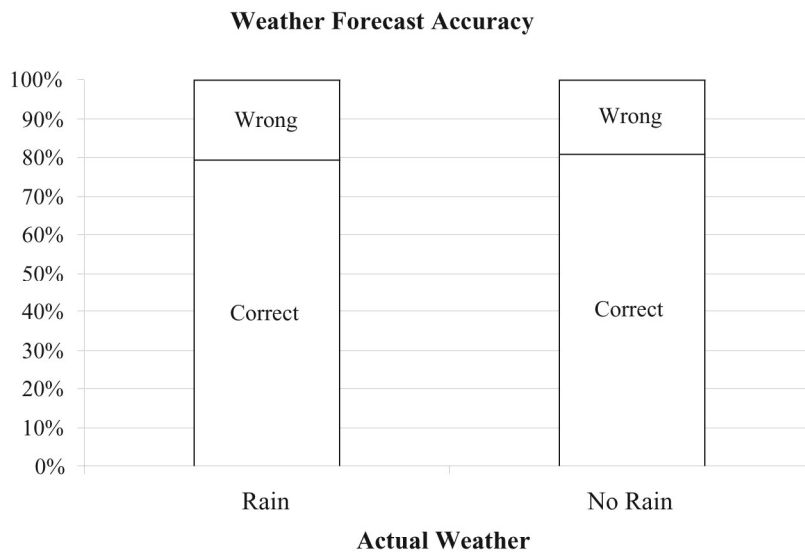
a) The table shows the marginal totals. It rained on 34 of 365 days, or 9.3% of the days.

b) Rain was predicted on 90 of 365 days. $90/365 \approx 24.7\%$ of the days.

c) The forecast of rain was correct on 27 of the days it actually rained and the forecast of No Rain was correct on 268 of the days it didn't rain. So, the forecast was correct a total of 295 times. $295/365 \approx 80.8\%$ of the days.

d) On rainy days, rain had been predicted 27 out of 34 times (79.4%). On days when it did not rain, forecasters were correct in their predictions 268 out of 331 times (81.0%). These two percentages are very close. There is no evidence of an association between the type of weather and the ability of the forecasters to make an accurate prediction.

		Actual Weather		Total
		Rain	No Rain	
Forecast	Rain	27	63	90
	No Rain	7	268	275
	Total	34	331	365



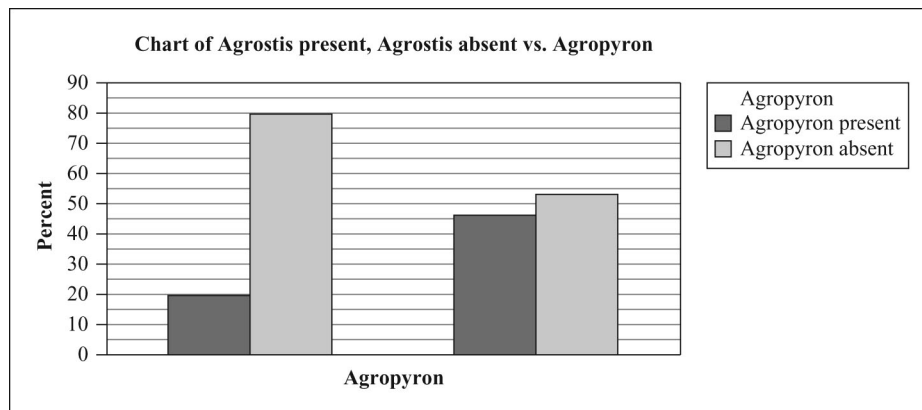
22. Attraction, repulsion

- a) There are $10 + 70 = 80$ quadrants in which Agropyron is present. Ten of these 80 quadrants have Agrostis, i.e., $(10/80) \times 100 = 12.5\%$.
There are $40 + 80 = 120$ quadrants in which Agropyron is absent. Forty of these 120 quadrants have Agrostis, i.e., $(40/120) \times 100 = 33.33\%$.
- b) Conditional distribution of Agropyron presence/absence when Agrostis is present:

	Agrostis present
Agropyron present	$10/50 = 1/5 = 20\%$
Agropyron absent	$40/50 = 4/5 = 80\%$

Conditional distribution of Agropyron presence/absence when Agrostis is absent:

	Agrostis absent
Agropyron present	$70/150 = 7/15 = 46.7\%$
Agropyron absent	$80/150 = 8/15 = 53.3\%$

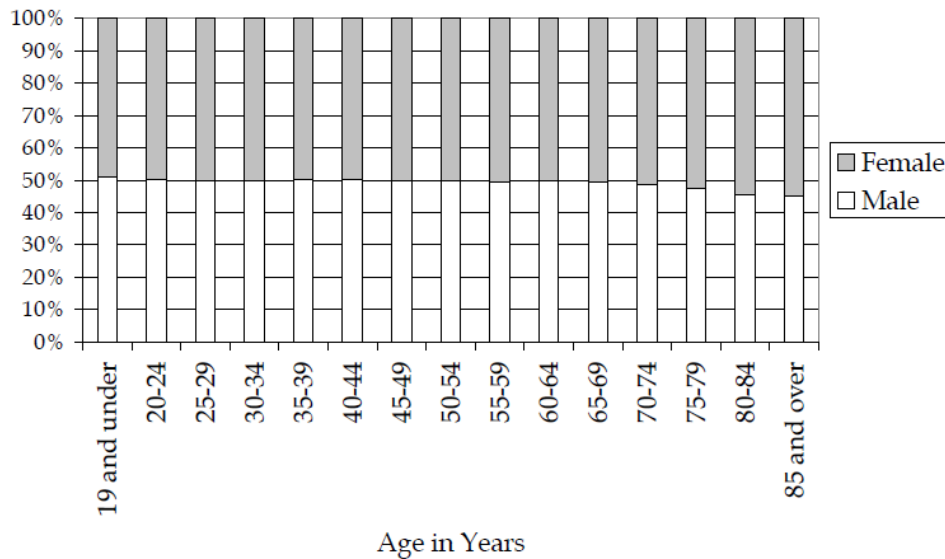


Presence of Agrostis is associated with less Agropyron. Thus they repel.

23. Driver's licenses 2011

- There are 10.0 million drivers under 20 and a total of 208.3 million drivers in the U.S. That's about 4.8% of U.S. drivers under 20.
- There are 103.5 million males out of 208.4 million total U.S. drivers, or about 49.7%.
- Each age category appears to have about 50% male and 50% female drivers. The segmented bar chart shows a pattern in the deviations from 50%. At younger ages, males form the slight majority of drivers. The percentage of male drivers continues to shrink until, at around age 45, female drivers hold a slight majority. This continues into the 85 and over category.

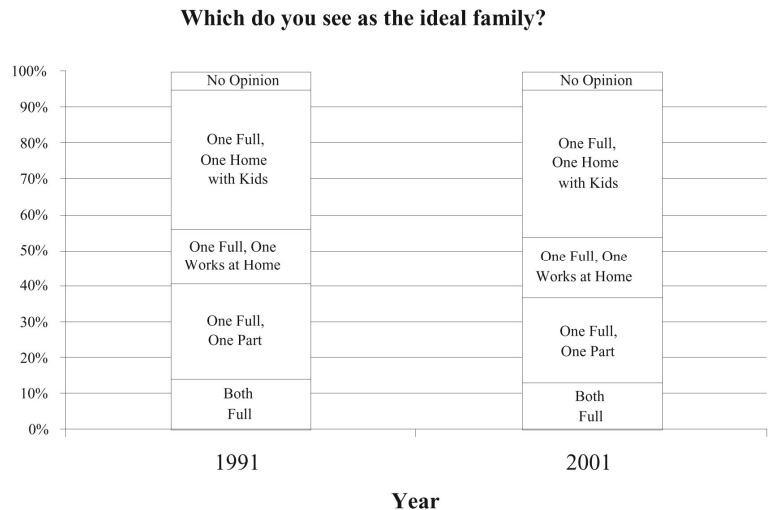
Registered U.S. Drivers by Age and Gender



- There appears to be a slight association between age and gender of U.S. drivers. Younger drivers are slightly more likely to be male, and older drivers are slightly more likely to be female.

24. Fat and fatter

- $(4850/14807) \times 100 = 32.8\%$. The table with the marginal totals is given below.



	2005				
1995	Underweight	Normal	Overweight	Obese	Total
Underweight	91	241	0	0	332
Normal	110	4850	2348	265	7573
Overweight	0	547	3188	1383	5118
Obese	0	66	270	1448	1784
Total	201	5704	5806	3096	14807

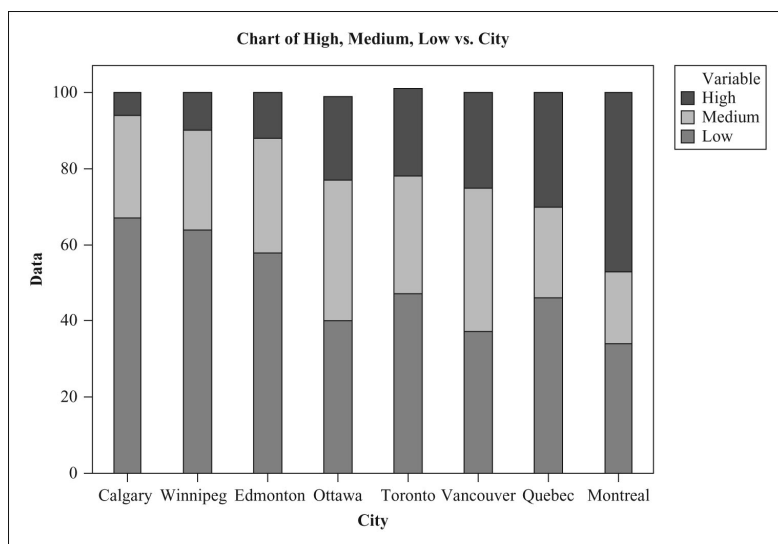
- b) $(5806+3096)/14807 \times 100 = 60.1\%$
- c) There were 7573 normal weight Canadians in 1995 and $2348 + 265$ of them became overweight or obese by 2005. That is, $(2348+265)/7573 \times 100 = 34.5\%$ of normal weight Canadians in 1995 became overweight or obese by 2005.
- d) There were 5704 normal weight Canadians in 2005 and $547 + 66$ of them were overweight or obese by 1995. That is, $(547 + 66)/5704 \times 100 = 10.7\%$ of normal weight Canadians in 2005 were overweight or obese in 1995.
- e) There were a total of $5118 + 1784 = 6902$ overweight or obese Canadians in 1995 and $547 + 66 = 613$ of them got their weight down to normal by 2005. That is, $613/6902 \times 100 = 8.9\%$ of overweight or obese Canadians in 1995 got their weight down to normal by 2005.

25. Anorexia

These data provide no evidence that Prozac might be helpful in treating anorexia. About 71% of the patients who took Prozac were diagnosed as "Healthy." Even though the percentage was higher for the placebo patients, this does not mean that Prozac is hurting patients. The difference between 71% and 73% is not likely to be statistically significant (will be discussed in later chapters).

26. Neighbourhood density

- a) They are row percentages. The rows add up to 100.
- b) The segmented bar chart (showing the conditional distribution of density, by city) is given below.



- c) To construct such a table we would also need the total counts for each city (i.e., row total counts). If we knew the row total counts we could calculate the cell counts for each row by multiplying the row percents by the row totals. If we had the total sample size and the marginal distribution of each city, we could calculate the total counts for each city (just multiply the marginal proportions by the total sample size).
- d) Yes, these data suggests that the Latin and French temperament causes people to live closer to each other. Cities like Quebec and Montreal have higher percentage of high density than cities like Calgary.

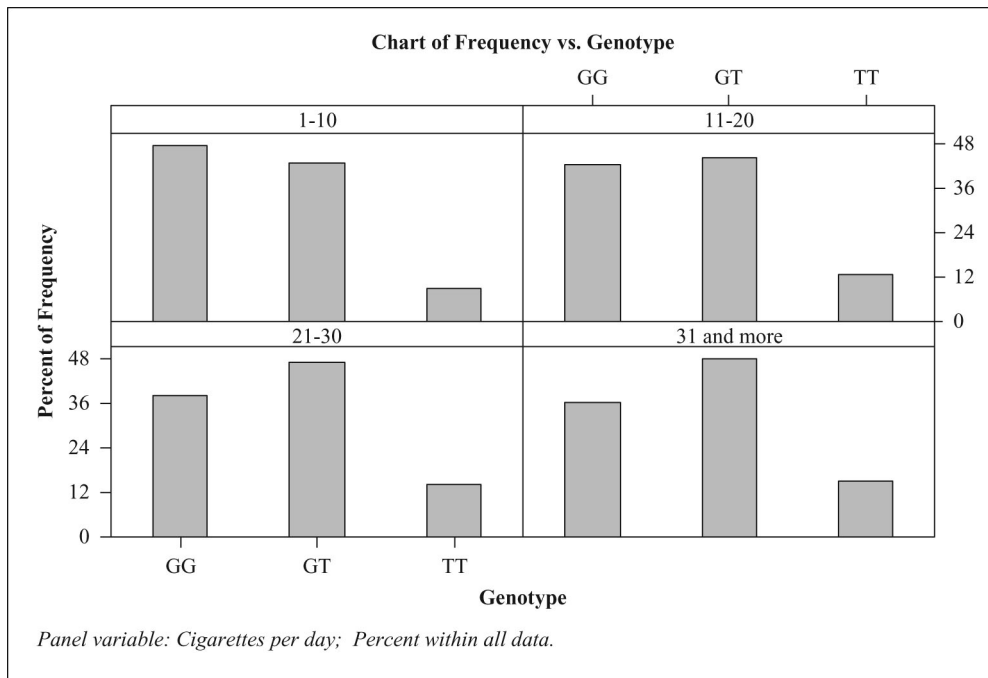
27. Smoking gene?

- a) The marginal distribution of genotype is given below:

Genotype	Marginal percentage
GG	42.71
GT	45.08
TT	12.21

- b) The conditional distributions of genotype for the four categories of smokers are given in columns 2-5 of the table below.

Genotype	Cigarettes per day				
	1-10	11-20	21-30	31 and more	All
GG	48.06	42.60	38.32	36.75	42.71
GT	42.96	44.75	47.39	48.28	45.08
TT	8.99	12.65	14.29	14.98	12.21
All	100.00	100.00	100.00	100.00	100.00

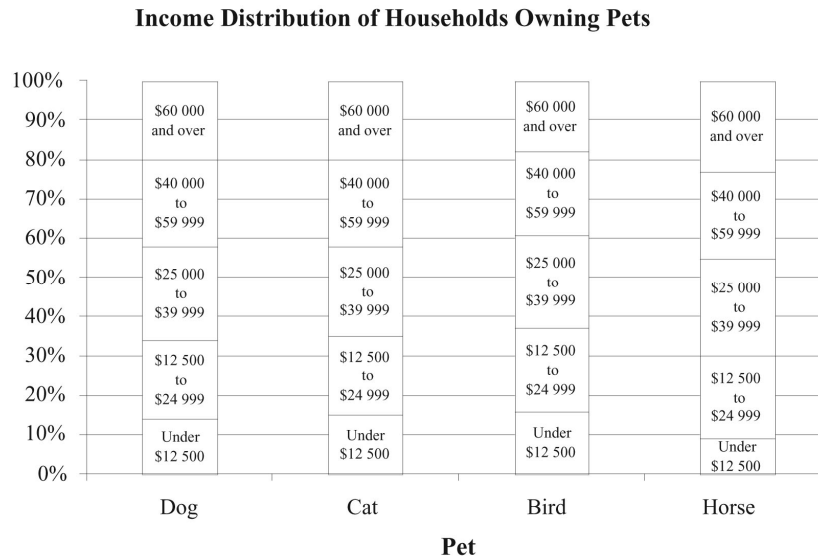


- c) Though not a very noticeable difference, the percentages of smokers with genotype GT (also TT) are slightly higher among heavy smokers. However, this is only an observed association. This does not prove that presence of the T allele increases susceptibility to nicotine addiction. We cannot conclude that this increase was caused by the presence of the T allele. There can be many factors associated with the presence of the T allele, and some of these factors might be the reason for the increase in susceptibility to nicotine addiction.

28. Pet ownership

- No, the income distributions of households by pet ownership shouldn't be the same. Caring for a horse is much more expensive, generally, than caring for a dog, cat, or bird. Households with horses as pets should be in the higher income categories.
- These are the percentages of income levels for each type of animal owned. Each pet was classified as belonging to a family in one of the income level categories.

c)



The data support the initial guess to a certain extent. The percentage of horses whose owners have income less than \$12 500 is only 9%, compared to percentages in the 20s for other income levels, while the income levels of owners of other pets were distributed in roughly the same percentages. However, with the exception of those earning less than \$12 500, the percentages in each income level among horse owners weren't much different.

- 29. Antidepressants and bone fractures** These data provide evidence that taking a certain class of antidepressants (SSRI) might be associated with a greater risk of bone fractures. Approximately 10% of the patients taking this class of antidepressants experience bone fractures. This is compared to only approximately 5% in the group that were not taking the antidepressants.
- 30. Blood proteins** The two-way table and the conditional distribution (percentages) of protein (presence or absence) for each blood type are given below. It looks like the proportion of individuals with this protein is higher among the individuals with blood type B.

Protein	Blood Type		
	Type A	Type B	All
Absent	35	40	75
Present	5	20	25
All	40	60	100

Tabulated statistics: Protein, Blood Type
Using frequencies in Count

Protein	Blood Type		
	Type A	Type B	All
Absent	87.50	66.67	75.00
Present	12.50	33.33	25.00
All	100.00	100.00	100.00

31. Cell phones

- a) The two-way table and the conditional distributions (percentages) of 'car accident' (crash or non-crash) for cell phone owners and non-cell phone owners are given below. The proportion of crashes is higher for cell phone owners than for non-cell phone owners.

Car accident	Cell phone ownership		
	Cell phone owner	Non-cell phone owner	All
Crash	20	10	30
Non-crash	58	92	150
All	78	102	180

Car accident	Cell phone ownership		
	Cell phone owner	Non-cell phone owner	All
Crash	25.64	9.80	16.67
Non-crash	74.36	90.20	83.33
All	100.00	100.00	100.00

- b) On the basis of this study, we cannot conclude that the use of a cell phone increases the risk of a car accident. This is only an observed association between cell phone ownership and the risk of car accidents. We cannot conclude that the higher proportion of accidents was caused by the use of a cell phone. There can be lots of other factors common to cell phone owners, and some of those factors can be the reason for the accidents.

32. Twin.

- a) Of the 278 000 mothers who had twins in 1995–1997, 63 000 had inadequate health care during their pregnancies.

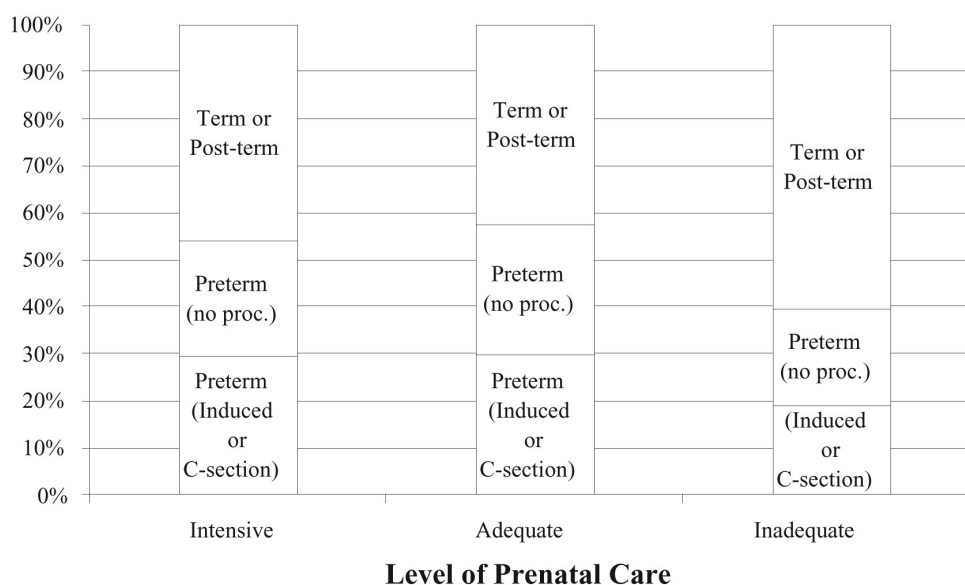
Twin Births 1995-97 (in thousands)				
Level of Prenatal Care	Preterm (Induced or Caesarean)	Preterm (without procedures)	Term or Postterm	Total
Intensive	18	15	28	61
Adequate	46	43	65	154
Inadequate	12	13	38	63
Total	76	71	131	278

$$63\,000/278\,000 = 22.7\%$$

- b) There were 76 000 induced or Caesarean births and 71 000 preterm births without these procedures. $(76\,000 + 71\,000)/278\,000 = 52.9\%$
- c) Among the mothers who did not receive adequate medical care, there were 12 000 induced or Caesarean births and 13 000 preterm births without these procedures. 63 000 mothers of twins did not receive adequate medical care. $(12\,000 + 13\,000)/63\,000 = 39.7\%$

d)

Twin Birth Outcome 1995-1997



- e) 52.9% of all twin births were preterm, while only 39.7% of births in which inadequate medical care was received were preterm. This is evidence of an association between level of prenatal care and twin birth outcome. If these variables were independent, we would expect the percentages to be roughly the same. Generally, those mothers who received adequate or intensive medical care were more likely to have preterm births than mothers who received inadequate health care. This does *not* imply that mothers should receive inadequate health care to decrease their chances of having a preterm birth, since it is likely that women that have some complication *during* their

pregnancy (that might lead to a preterm birth), would seek intensive or adequate prenatal care.

33. Blood pressure

- a) The marginal distribution of blood pressure for the employees of the company is the total column of the table,

Blood pressure	under 30	30 - 49	over 50	Total
low	27	37	31	95
normal	48	91	93	232
high	23	51	73	147
Total	98	179	197	474

converted to percentages. 20% low, 49% normal, and 31% high blood pressure.

- b) The conditional distribution of blood pressure within each age category is:

Under 30: 28% low, 49% normal, 23% high

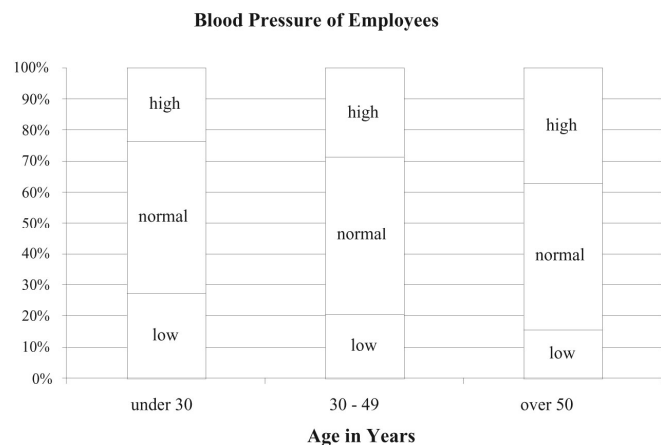
30–49: 21% low, 51% normal, 28% high

Over 50: 16% low, 47% normal, 37% high

- c) A segmented bar chart of the conditional distributions of blood pressure by age category is at the right.

- d) In this company, as age increases, the percentage of employees with low blood pressure decreases, and the percentage of employees with high blood pressure increases.

- e) No, this does not prove that people's blood pressure increases as they age. Generally, an association between two variables does not imply a cause-and-effect relationship. Specifically, these data come from only one company and cannot be applied to all people. Furthermore, there may be some other variable that is linked to both age and blood pressure.



34. Self-reported BMI

- a) Conditional distributions (percentages) of self-reported BMI for the three measured overweight classes are given below (the last three columns of the table).

Self-reported BMI	Overweight (25.0 to 29.9)	Obese class I (30.0 to 34.9)	Obese class II/III (35 or more)
Underweight (less than 18.5)	0.0114	0.1399	0.0000
Normal weight (18.5 to 24.9)	30.3075	2.7979	0.2559
Overweight (25.0 to 29.9)	66.8915	44.1595	8.5733
Obese class I (30.0 to 34.9)	2.7895	52.3898	38.5797
Obese class II/III (35.0 or more)	0.0000	0.5129	52.5912

- b) Conditional distributions (percentages) of measured BMI for the three self-reported overweight classes are given below (the last three columns of the table).

Measured BMI	Overweight (25.0 to 29.9)	Obese class I (30.0 to 34.9)	Obese class II/III (35 or more)
Underweight (less than 18.5)	0.0000	0.0000	0.0000
Normal weight (18.5 to 24.9)	4.6934	0.0000	0.0000
Overweight (25.0 to 29.9)	70.7754	7.8862	0.0000
Obese class I (30.0 to 34.9)	22.9104	72.6244	2.6066
Obese class II/III (35.0 or more)	1.6209	19.4893	97.3934

- c) It is reasonable to expect the self-reported BMI values to be close to the measured BMI values at least to some extent, and so not to be independent. The table (for example, column 3 of the table given in part a above) shows the conditional distribution of the self-reported BMI for each measured BMI class. These conditional distributions do not look very similar. In fact, they look very different. This means that the two variables (self-reported and measured BMI) are not independent.
- d) A considerable percentage of people tend to understate their weight and overstate their height (i.e., report a smaller BMI). From the conditional distributions of self-reported BMI for the three measured overweight classes in part a, we see that approximately 47% of obese class II/III people have done

this. This proportion is similar (i.e., approximately 47%) for obese class I people, and is about 30% for overweight people.

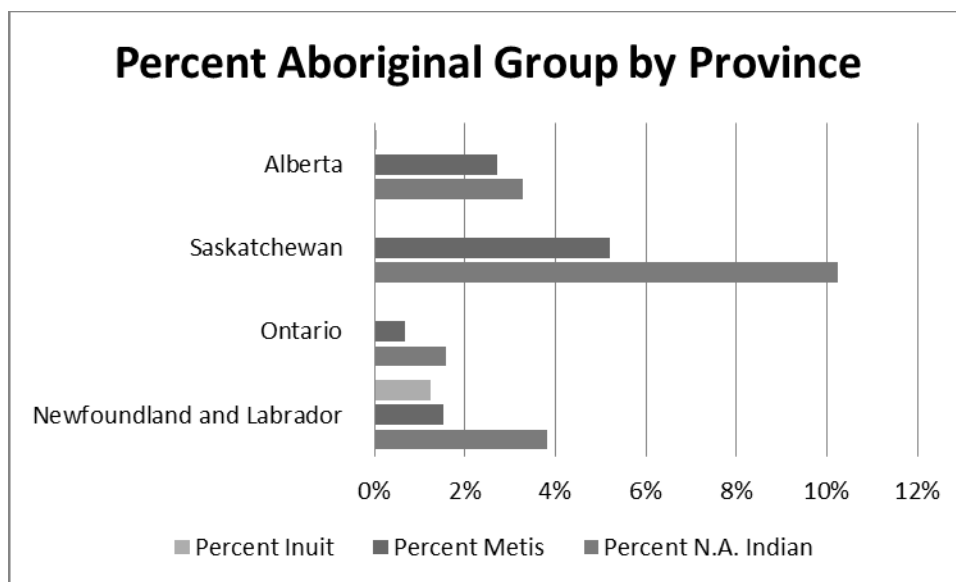
- e) Answers might vary. Gender and age (young, old) are some examples.
- f) Risk of overweight to health will be overestimated. For example, if those with BMI of 35 or more have high diabetes rates and are misclassified as having a BMI of 30, we will think it is only those with a BMI of 30 who have a high diabetes risk.

35. **Aboriginal identity 2011**

- a) The second column includes some individuals in the 3rd, 4th, and 5th columns, so it is not a standard contingency table.
- b) Use the label “Aboriginal population not included in columns 3, 4, and 5” (or call them “other Aboriginals”). Use the value in second column minus those in the third, fourth and fifth columns as the new value.
- c) There are 27 070 Canadians who are Inuit from Nunavut. The Canadian population is 32 852 320, so the proportion of Canadians who are Inuit from Nunavut is $27\,070/32\,852\,320 = 0.00082 = 0.08\%$ (approx.).
- d) There are 27 070 Canadians who are Inuit from Nunavut. The total Canadian Aboriginal population is 1 400 685, so the proportion of Canadian Aboriginals who are Inuit from Nunavut is $27\,070/1\,400\,685 = 0.0193 = 1.93\%$ (approx.).
- e) The total Canadian Aboriginal population is 1 400 685 and of them 59 440 are Inuit. So $59\,440/1\,400\,685 = 0.0424 = 4.24\%$ of Canadian Aboriginals are Inuit.
- f) The total Canadian Aboriginal population is 1 400 685 and of them 27 360 are from Nunavut. So $27\,360/1\,400\,685 = 0.0195 = 1.95\%$ of Canadian Aboriginals are from Nunavut.
- g) The total population in Nunavut is 31 700 and 27 360 of them are Inuit. So $27\,360/31\,700 = 0.8539 = 85.39\%$ of the people from Nunavut are Inuit.
- h) There are 27 360 Nunavut Aboriginals and 27 070 of them are Inuit. So $27\,070/27\,360 = 0.9894 = 98.94\%$ of Nunavut Aboriginals are Inuit.
- i) The total Inuit population is 59 440 and of them 27 070 are from Nunavut. So $27\,070/59\,440 = 0.4554 = 45.54\%$ of Inuit live in Nunavut.
- j) The total number of Ontario Aboriginals is 301 430, and $301\,430 - 201\,105 - 86\,015 - 3360 = 10\,950$ of them are other Aboriginals (i.e., other than Inuit, Metis, or N.A. Indian) and so $10\,950/301\,430 = 0.0363 = 3.63\%$ of Ontario Aboriginals could not be simply classified as Inuit, Metis, or N.A. Indian.
- k) A table of percentages of total provincial population for each Aboriginal identity group (Inuit, Metis, N.A. Indian) for Newfoundland, Ontario, Saskatchewan, and Alberta is given below. The second table is a bit easier if using MINITAB. The side-by-side bar charts below show that Saskatchewan has the highest proportion of N.A. Indian and Metis. Ontario, Saskatchewan, and Alberta have very small proportions of Inuit.

Region	Percent N.A. Indian	Percent Metis	Percent Inuit
Newfoundland and Labrador	3.80764%	1.51004%	1.23504%
Ontario	1.58954%	0.67986%	0.02656%
Saskatchewan	10.23137%	5.19945%	0.02875%
Alberta	3.26992%	2.71498%	0.05563%

Group	Newfoundland and Labrador	Ontario	Saskatchewan	Alberta
N.A. Indian	3.80764%	1.58954%	10.23137%	3.26992%
Metis	1.51004%	0.67986%	5.19945%	2.71498%
Inuit	1.23504%	0.02656%	0.02875%	0.05563%



36. Dim sum 2011

- There are three categorical variables, namely city (Calgary, Toronto, or Oshawa), spoken Chinese dialect (Cantonese or Mandarin), and year (2011 or 2006).
- The conditional distribution of spoken Chinese dialect for 2011, in Toronto:
Cantonese: $156\,425 / (156\,425 + 91\,670) = 0.631$
Mandarin: $91\,670 / (156\,425 + 91\,670) = 0.369$
The conditional distribution of spoken Chinese dialect for 2006, in Toronto:
Cantonese: $129\,925 / (129\,925 + 44\,990) = 0.743$
Mandarin: $44\,990 / (129\,925 + 44\,990) = 0.257$
The conditional distribution of spoken Chinese dialect for 2011, in Calgary:

Cantonese: $16\,920 / (16\,920 + 9\,900) = 0.631$

Mandarin: $9\,900 / (16\,920 + 9\,900) = 0.369$

The conditional distribution of spoken Chinese dialect for 2006, in Calgary:

Cantonese: $12\,785 / (12\,785 + 5\,345) = 0.705$

Mandarin: $5\,345 / (12\,785 + 5\,345) = 0.295$

The conditional distribution of spoken Chinese dialect for 2011, in Vancouver:

Cantonese: $113\,610 / (113\,610 + 83\,825) = 0.575$

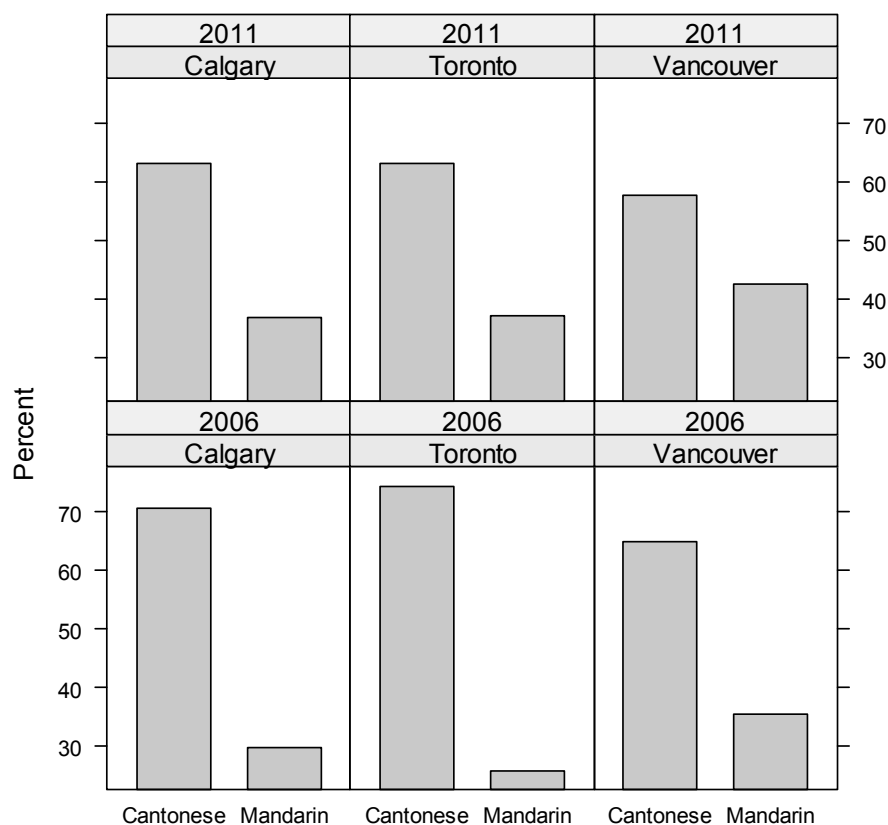
Mandarin: $83\,825 / (113\,610 + 83\,825) = 0.425$

The conditional distribution of spoken Chinese dialect for 2006, in Vancouver:

Cantonese: $94\,760 / (94\,760 + 51\,465) = 0.648$

Mandarin: $51\,465 / (94\,760 + 51\,465) = 0.352$

- c) Can't determine since we don't know how many speak other Chinese dialects.
- d) Bar charts can be used as we might want to compare between 2011 and 2006 and also between different cities. A pie chart may be used if our interest is in comparing the relative proportions of those who speak only these two dialects, but it might give the reader the impression that these are the only two dialects spoken. The percentage bar charts are shown below. In each city and each year the proportion of Mandarin speakers is relatively low, but in each city this proportion is higher in 2011 than in 2006. Vancouver has a higher proportion of Mandarin speakers compared to Calgary and Toronto.



- e) Two-way table by year and dialect is shown below.

Year	Dialect		
	Cantonese	Mandarin	All
2011	286 955	185 395	472 350
2006	237 470	101 800	339 270
All	524 425	287 195	811 620

The conditional distribution of dialect for each year:

Year	Dialect		
	Cantonese	Mandarin	All
2011	60.75%	39.25%	100%
2006	69.99%	30.01%	100%

The proportion of Mandarin speakers has increased from 30.01% (in 2006) to 39.25% (in 2011). It looks like more immigrants have come from other parts of China.

- f) The marginal distribution of dialect (using 2011 data) is given in the fifth column of the table below. The conditional distributions of dialect for Calgary, Toronto, and Vancouver are given in the second, third, and the fourth columns, respectively. The conditional distribution for Vancouver differs the most from the marginal distribution; Calgary and Toronto have nearly identical distributions, but Vancouver has a higher percentage of Mandarin speakers.

Dialect	City			
	Calgary	Toronto	Vancouver	All
Cantonese	63.09%	63.05%	57.54%	60.75%
Mandarin	36.91%	36.95%	42.46%	39.25%
All	100%	100%	100%	100%

37. Hospitals

- a) The marginal totals have been added to the table:

Procedure	Discharge delayed		
	Large Hospital	Small Hospital	Total
Major surgery	120 of 800	10 of 50	130 of 850
Minor surgery	10 of 200	20 of 250	30 of 450
Total	130 of 1000	30 of 300	160 of 1300

160 of 1300, or about 12.3%, of the patients had a delayed discharge.

- b) Yes. Major surgery patients were delayed 130 of 850 times, or about 15.3% of the time. Minor surgery patients were delayed 30 of 450 times, or about 6.7% of the time.

- c) Large Hospital had a delay rate of 130 of 1000, or 13%. Small Hospital had a delay rate of 30 of 300, or 10%. The small hospital has the lower overall rate of delayed discharge.
- d) Large Hospital: Major Surgery 15% delayed and Minor Surgery 5% delayed. Small Hospital: Major Surgery 20% delayed and Minor Surgery 8% delayed. Even though small hospital had the lower overall rate of delayed discharge, the large hospital had a lower rate of delayed discharge for each type of surgery.
- e) No. While the overall rate of delayed discharge is lower for the small hospital, the large hospital did better with *both* major surgery and minor surgery.
- f) The small hospital performs a higher percentage of minor surgeries than major surgeries. 250 of 300 surgeries at the small hospital were minor (83%). Only 200 of the large hospital's 1000 surgeries were minor (20%). Minor surgery had a lower delay rate than major surgery (6.7% to 15.3%), so the small hospital's overall rate was artificially inflated. Simply put, it is a mistake to look at the overall percentages. The real truth is found by looking at the rates after the information is broken down by type of surgery, since the delay rates for each type of surgery are so different. The larger hospital is the better hospital when comparing discharge delay rates.

38. Delivery service

- a) Pack Rats has delivered a total of 28 late packages (12 regular + 16 overnight), out of a total of 500 deliveries (400 regular + 100 overnight). $28/500 = 5.6\%$ of the packages are late. Boxes R Us has delivered a total of 30 late packages (2 regular + 28 overnight) out of a total of 500 deliveries (100 regular + 400 overnight). $30/500 = 6\%$ of the packages are late.
- b) The company should have hired Boxes R Us instead of Pack Rats. Boxes R Us only delivers 2% (2 out of 100) of its regular packages late, compared to Pack Rats, who deliver 3% (12 out of 400) of its regular packages late. Additionally, Boxes R Us only delivers 7% (28 out of 400) of its overnight packages late, compared to Pack Rats, who delivers 16% of its overnight packages late. Boxes R Us is better at delivering regular and overnight packages.
- c) This is an instance of Simpson's Paradox, because the overall late delivery rates are unfair averages. Boxes R Us delivers a greater percentage of its packages overnight, where it is comparatively harder to deliver on time. Pack Rats delivers many regular packages, where it is easier to make an on-time delivery.

39. Graduate admissions

- a) 1284 applicants were admitted out of a total of 3014 applicants. $1284/3014 = 42.6\%$

Program	Males Accepted (of applicants)	Females Accepted (of applicants)	Total
1	511 of 825	89 of 108	600 of 933
2	352 of 560	17 of 25	369 of 585
3	137 of 407	132 of 375	269 of 782
4	22 of 373	24 of 341	46 of 714
Total	1022 of 2165	262 of 849	1284 of 3014

b) 1022 of 2165 (47.2%) males were admitted. 262 of 849 (30.9%) females were admitted.

c) Since there are four comparisons to make, the table at the right organizes the percentages of males and females accepted in each program. Females are accepted at a higher rate in every program.

Program	Males	Females
1	61.9%	82.4%
2	62.9%	68.0%
3	33.7%	35.2%
4	5.9%	7%

d) The comparison of acceptance rate within each program is most valid. The overall percentage is an unfair average. It fails to take the different numbers of applicants and different acceptance rates of each program. Women tended to apply to the programs in which gaining acceptance was difficult for everyone. This is an example of Simpson's Paradox.

40. **Be a Simpson!** Answers will vary. The three-way table below shows one possibility. The number of local hires out of new hires is shown in each cell.

	Company A	Company B
Full-time New Employees	40 of 100 = 40%	90 of 200 = 45%
Part-time New Employees	170 of 200 = 85%	90 of 100 = 90%
Total	210 of 300 = 70%	180 of 300 = 60%