Which Car Seats Are Safest?

Many people believe that the back seat of a car is the safest place to sit, but is it? University of Buffalo researchers analyzed more than 60,000 fatal car crashes and found that the middle back seat is the safest place to sit in a car. They found that sitting in that seat makes a passenger 86% more likely to survive than those who sit in the front seats, and they are 25% more likely to survive than those sitting in either of the back seats nearest the windows. An analysis of seat belt use showed that when not wearing a seat belt in the back seat, passengers are three times more likely to die in a crash than those wearing seat belts in that same seat. Passengers concerned with safety should sit in the middle back seat wearing a seat belt.

Step 7: If we use the *P*-value method of testing hypotheses, we see that the *P*-value is small (less than 0.0001), so we reject the null hypothesis. If we use the critical value method of testing hypotheses, Figure 11-2 shows that the test statistic falls in the critical region, so there is sufficient evidence to reject the null hypothesis.

Step 8: There is sufficient evidence to support the claim that the last digits do not occur with the same relative frequency.

Interpretation

This goodness-of-fit test suggests that the last digits do not provide a good fit with the claimed uniform distribution of equally likely frequencies. Instead of actually weighing the subjects, it appears that the subjects reported their weights. In fact, the weights are from the California Health Interview Survey (CHIS), and the title of that survey indicates that subjects were interviewed, not measured. Because those weights are reported, the reliability of the data is very questionable.

Example 1 involves a situation in which the expected frequencies E for the different categories are all equal. The methods of this section can also be used when the expected frequencies are different, as shown in Example 2.

Table 11-3 Calculating the χ^2 Test Statistic for the Last Digits of Weights

Last Digit	Observed Frequency O	Expected Frequency E	$O - E$	$(O - E)^2$	$\frac{(O - E)^2}{E}$
0	46	10	36	1296	129.6
1	1	10	−9	81	8.1
2	2	10	−8	64	6.4
3	3	10	−7	49	4.9
4	3	10	−7	49	4.9
5	30	10	20	400	40.0
6	4	10	−6	36	3.6
7	0	10	−10	100	10.0
8	8	10	−2	4	0.4
9	3	10	−7	49	4.9

$$\chi^2 = \sum \frac{(O - E)^2}{E} = 212.8$$

Example 2 Benford's Law: County Populations

According to *Benford's law*, a variety of different data sets includes numbers with leading (first) digits that follow the distribution shown in the first two rows of Table 11-4. The bottom row lists the frequencies of leading digits of the populations of all 120 counties from New York and California combined. Test the claim that those 120 counties have populations with leading digits that follow Benford's law.

Table 11-4 Leading Digits of Populations from NY and CA Counties

Leading Digit	1	2	3	4	5	6	7	8	9
Benford's Law: Distribution of Leading Digits	30.1%	17.6%	12.5%	9.7%	7.9%	6.7%	5.8%	5.1%	4.6%
CA and NY County Populations	33	22	10	15	10	9	5	7	9