

Chapter 25 – Two Categorical Variables: The Chi-Square Test

25.5 (a) Expected counts are below observed counts in the table provided. For example, for Hispanics under 25, the expected count is $\frac{(260)(317)}{1625} = 50.72$. **(b)** We find that the observed counts are much greater than the expected counts for all three younger age groups of Hispanics. The actual count of Hispanics over 45 (44) is much smaller than the expected count (120).

	Caucasian	Hispanic	All
Under25	181 209.3	79 50.7	260
25to34	324 357.4	120 86.6	444
35to44	232 246.3	74 59.7	306
Over45	571 495.0	44 120.0	615
All	1308	317	1625

25.6 (a) The expected counts are shown in the table below. For example, for boys who play video games, the expected count earning A's and B's is $\frac{(1379)(941)}{1808} = 717.72$.

	A&B	C	D&F	All
Never plays	205 223.3	144 140.9	80 64.8	429 429.0
Plays	736 717.7	450 453.1	193 208.2	1379 1379.0
Total	941	594	273	1808

(b) By informal examination, there appears to be somewhat large differences between observed counts and expected counts. For example, for boys who get D's and F's and never play video games, the difference is $80 - 64.78 = 15.22$, which is fairly large relative to the expected cell count of 64.78.

25.7 (a) All expected counts are well above 5 (the smallest is 50.72). **(b)** We test H_0 : there is no relationship between age and ethnic group for Monterey Bay Aquarium visitors versus H_a : there is a relationship between age and ethnic group. From the SAS output, we have $\chi^2 = 99.6058$ and $P < 0.0001$. **(c)** The largest contributions generally come from the Hispanics, reflecting that that group tends to visit the aquarium at younger ages.

25.8 (a) Inspecting Figure 25.4, we see that all expected cell counts are more than 5 (the smallest is 64.78), so conditions required for use of the chi-square test are satisfied. **(b)** $\chi^2 = 6.739$ and $P = 0.034$, by inspection of the output. Rejecting H_0 here means we believe there is an association between playing video games and grades (at least for teenage boys in Connecticut). This does not indicate the direction of the relationship. **(c)** There is strong evidence of an association between grades and video game playing. In the output, we see that of boys who played video games, more than expected earned A's and B's, while fewer than expected earned D's and F's. Conversely, for boys who do not play games, fewer than expected earned A's and B's, and more than expected earned D's and F's.

25.12 (a) $df = (r - 1)(c - 1) = (4 - 1)(2 - 1) = 3$ **(b)** The largest critical value shown for $df = 3$ is 17.73; because the computed value (99.6058) is greater than this, we conclude that $P < 0.0005$. **(c)** With $r = 4$ and $c = 4$, the appropriate degrees of freedom would be $df = 9$.

25.13 (a) $df = (r - 1)(c - 1) = (2 - 1)(3 - 1) = 2$ **(b)** The computed value (6.739) is between the table values 5.99 and 7.38; we conclude that $0.025 < P < 0.05$, which is consistent with output's reported $P = 0.034$. **(c)** Under the null hypothesis of no association, the mean value of χ^2 is $df = 2$. Our computed value is larger than this. The small P -value suggests that random chance does not easily explain the larger than expected value of χ^2 .

25.37 STATE: Does sexual content of ads differ in magazines aimed at different audiences? **PLAN:** We test H_0 : there is no relationship between sexual content of ads and magazine audience versus H_a : there is some relationship between sexual content of ads and magazine audience. **SOLVE:** Examining the Minitab output in Figure 25.9, we see that conditions for use of the chi-square test are satisfied because all expected cell counts exceed 5 (the smallest is 82.4). We have $\chi^2 = 80.874$ with $df = 2$, leading to $P < 0.0005$. **CONCLUDE:** Magazines aimed at women are much more likely to have sexual depictions of models than the other two types of magazines. Specifically, about 39% of ads in women's magazines show sexual depictions of models, compared with 21% and 17% of ads in general-audience and men's magazines, respectively. The two women's chi-squared terms account for over half of the total chi-square value.