6.1 **Decision Rule:** Reject $H_0$ if coin comes up heads every time in $n$ tosses
Retain $H_0$ if tails comes up at least once in $n$ tosses

\[ \alpha = \Pr(\text{Reject } H_0 \mid H_0 \text{ is true}) = \Pr(\text{All heads } \mid \text{The coin is fair}) = f(n) = \binom{n}{0}(1/2)^n(1-1/2)^0 = 1/2^n \]

\[ \beta = \Pr(\text{Retain } H_0 \mid H_0 \text{ is false}) = \Pr(\text{At least one tails } \mid \text{Coin is two-headed}) = 0 \]

a. $\alpha = 1/2 = 0.50$, \hspace{1cm} $\beta = 0$

b. $\alpha = 1/16 = 0.0625$, \hspace{1cm} $\beta = 0$

c. $\alpha = 1/33554432 = 2.9 \times 10^{-8}$, \hspace{1cm} $\beta = 0$

d. $\alpha = 2^{-100} = 7.8 \times 10^{31}$, \hspace{1cm} $\beta = 0$

6.3 **Decision Rule:**
Reject $H_0$ if coin comes up heads 12 times
Retain $H_0$ if tails comes up at least once in the 12 tosses

\[ \alpha = \Pr(\text{Reject } H_0 \mid H_0 \text{ is true}) = \Pr(12 \text{ heads } \mid \text{The coin is fair}) = 2^{-12} \]

\[ \beta = \Pr(\text{Retain } H_0 \mid H_0 \text{ is false}) = \Pr(\text{At least one tails } \mid \text{Coin is bent}) = 1 - (0.75)^{12} = 0.9683 \]

6.5 **Decision Rule:**
Reject $H_0$ if $K \geq 11$ 
Retain $H_0$ if $K < 11$

a. $\alpha = \Pr(\text{Reject } H_0 \mid H_0 \text{ is true}) = \Pr(K \geq 11 \mid \pi = .5) = \Pr(K = 11) + \Pr(K = 12) = \binom{12}{11}(.5)^{11}(1-.5) + \binom{12}{12}(.5)^{12}(1-.5)^0 = 13/(2^{12}) = .0032$

b. $\beta = \Pr(\text{Retain } H_0 \mid H_0 \text{ is false}) = \Pr(K < 11 \mid \pi = .80) = 1 - \{\Pr(K = 11) + \Pr(K = 12)\} = 1 - \{\binom{12}{11}(.80)^{11}(.20)^1 + \binom{12}{12}(.80)^{12}(.20)^0\} = 1 - 0.2749 = 0.7251$

c. $\beta = \Pr(\text{Retain } H_0 \mid H_0 \text{ is false}) = \Pr(K < 11 \mid \pi = .95) = 1 - \{\Pr(K = 11) + \Pr(K = 12)\} = 1 - \{\binom{12}{11}(.95)^{11}(.05)^1 + \binom{12}{12}(.95)^{12}(.05)^0\} = 1 - 0.8816 = 0.1184$. 

29  Chapter 6
6.7  $H_0$: The preferences for Pepsi and Coke are the same.  $H_a$: People prefer Pepsi
Let $K$ be the number in the sample who prefer Pepsi
Decision Rule:  Reject $H_0$ if $K \geq 6$  Retain $H_0$ if $K < 6$

a. $\alpha = \Pr(\text{Reject } H_0 \mid H_0 \text{ is true}) = \Pr(K \geq 6 \mid \pi = .5) = 1 - 0.6230 = 0.3770$

b. $\beta = \Pr(\text{Retain } H_0 \mid H_0 \text{ is false}) = \Pr(K \leq 5 \mid \pi = .60) = 0.3669$

c. $\beta = \Pr(\text{Retain } H_0 \mid H_0 \text{ is false}) = \Pr(K < 5 \mid \pi = .70) = 0.1503$

6.9  This is the six-step procedure to test the hypothesis that the pulse goes down after a physical
fitness program, using the sign test.
Let $\pi$ be the proportion of times that the pulse goes down.

Step 1:  $H_0$: $\pi = .5$

Step 2:  $H_a$: $\pi > .5$

Step 3:  $\alpha = 0.10$

Step 4:  Look at the sample of 5 subjects. Assign (+) if pulse goes down, assign (–) if the pulse
goes up, and assign (0) if they are tied. We have $k(0) = 1$, $k(+) = 4$, and $k(–) = 0$.
This makes $n = 5 - 1 = 4$.

Test statistic is $k_s = 4$, $n = 4$. Having 4 successes out of 4 is evidence for the alternative
hypothesis. So we continue with the next step.

Step 5:  $P$-value $= \Pr(K \geq k_s) = \Pr(K \geq 4) = \binom{4}{4}(.5)^4(1 - .5)^0 = 2^{-4} = 1/16 = 0.0625 < \alpha$. So we
reject $H_0$.

Step 6:  Conclusion in English. There is sufficient evidence ($P$-value $= 0.0625$) to conclude that
the at-rest pulse goes down after a three-month physical fitness program.

6.11  This is the six-step procedure to test the hypothesis that men tend to exaggerate their
height, using the sign test.
Let $\pi$ be the proportion of times that the reported height is greater than the measured height.

Step 1:  $H_0$: $\pi = .5$

Step 2:  $H_a$: $\pi > .5$

Step 3:  $\alpha = 0.10$
Step 4: Look at the sample of 12 subjects. Assign (+) if reported height is greater than measured height, assign (−) if it’s the other way around, and assign (0) if they are tied. We have \( k_{(0)} = 1 \), \( k_{(+)} = 10 \), and \( k_{(−)} = 1 \). This makes \( n = 12 − 1 = 11 \).

Test statistic is \( k = 10 \), \( n = 11 \). Having 10 successes out of 9 is evidence for the alternative hypothesis. So we continue with the next step.

Step 5: P-value = \( \Pr(K \geq k) = \Pr(K \geq 10) = \frac{11!}{10!1!}(0.5)^1(1-0.5)^{11} + \frac{11!}{11!0!}(0.5)^0(1-0.5)^{11} = \frac{12}{2^{11}} = 0.0059 < \alpha \). So we reject \( H_0 \).

Step 6: Conclusion in English. There is strong evidence (P-value = 0.0059) to conclude that men exaggerate their height.

6.13 This is the six-step procedure to test the hypothesis that consumers prefer the new formulation, using the sign test.

Step 1: \( H_0: \ \pi = .5 \)

Step 2: \( H_a: \ \pi > .5 \)

Step 3: \( \alpha = .05 \)

Step 4: There were 5 people who could not tell the difference between the two; so \( k_{(0)} = 5 \). This makes \( n = 100 − 5 = 95 \). There are 57 who prefer the new formulation; so \( k_{(+)} = 57 \). There are 38 who prefer to old formulation; so \( k_{(−)} = 38 \). Test statistic is \( k = 57 \) and \( n = 95 \). Having 57 successes out of 95 is consistent with alternative hypothesis. So we continue with the next step.

Step 5: P-value = \( \Pr(K \geq k) = \Pr(K \geq 2) = 1 - \text{binomcdf}(95,.5,56) = 1 - 0.9679 = 0.0321 < \alpha \). So we reject \( H_0 \).

Step 6: Conclusion in English. There is sufficient evidence (P-value = 0.0321) to conclude that the consumers prefer the new formulation.

6.15

<table>
<thead>
<tr>
<th>Color-blind</th>
<th>Not</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>50</td>
<td>950</td>
</tr>
<tr>
<td>Women</td>
<td>4</td>
<td>996</td>
</tr>
<tr>
<td>Totals</td>
<td>54</td>
<td>1946</td>
</tr>
</tbody>
</table>

Among color-blind subjects, let \( \pi \) be the proportion of those who are men.

Step 1: \( H_0: \ \text{Men and women are just as likely to be color-blind:} \ \pi = 0.50 \)

Step 2: \( H_a: \ A \text{ higher percentage of color-blind people are men:} \ \pi > .5 \)
Step 3: $\alpha = .01$

Step 4: In the sample of 54 color-blind subjects, let $k_s$ be the sample count of the men. $k_s = 50$

Step 5: $P$-value = $\Pr(K \geq k_s) = \Pr(K \geq 50) = 1 - \Pr(K \leq 49) = 1 - \text{binomcdf}(54,.5,49) = 1.901 \times 10^{-11} < \alpha$. Reject null hypothesis.

Step 6: Conclusion in English. There is very strong evidence ($P$-value $= 1.901 \times 10^{-11}$) to conclude that men are more likely than women to be color-blind.

### 6.17

<table>
<thead>
<tr>
<th></th>
<th>Fatigue</th>
<th>No fatigue</th>
<th>Row total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skipped breakfast</td>
<td>38</td>
<td>62</td>
<td>100</td>
</tr>
<tr>
<td>Ate breakfast</td>
<td>45</td>
<td>155</td>
<td>200</td>
</tr>
<tr>
<td>Column Total</td>
<td>83</td>
<td>547</td>
<td>300</td>
</tr>
</tbody>
</table>

Among the fatigued people, let $\pi$ be the proportion of those who skipped breakfast.

Step 1: $H_0$: People who skip breakfast are not more fatigued. Since those who skipped breakfast comprise $100/300 = 1/3$ of the sample, this means that $\pi = 1/3$

Step 2: $H_1$: People who skip breakfast are more likely to suffer late morning fatigue. $\pi > 1/3$

Step 3: $\alpha = .05$

Step 4: In the sample of 83 who suffer late morning fatigue, 38 skipped breakfast, $k_s = 38$.

Step 5: $P$-value = $\Pr(K \geq k_s) = \Pr(K \geq 38) = 1 - \Pr(K \leq 37) = 1 - \text{binomcdf}(83,1/3,37) = 1 - 0.9877 = 0.0123 < \alpha$. Reject null hypothesis.

Step 6: Conclusion in English. There is sufficient evidence ($P$-value $= 0.0123$) to conclude that people who skip breakfast are more likely to suffer late morning fatigue.

### 6.19

<table>
<thead>
<tr>
<th></th>
<th>Headache</th>
<th>No Headache</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drug Treatment</td>
<td>9</td>
<td>111</td>
<td>120</td>
</tr>
<tr>
<td>Placebo</td>
<td>3</td>
<td>117</td>
<td>120</td>
</tr>
<tr>
<td>Totals</td>
<td>12</td>
<td>228</td>
<td>240</td>
</tr>
</tbody>
</table>

Among subjects with headaches, let $\pi$ be the probability the subject is found in the drug treatment group.

Step 1: $H_0$: The drug group has headaches with probability equal to the proportion of subjects in this group: $\pi = 120/2140 = .5$
Step 2: \( H_1: \) Those taking drug have headaches with probability higher than .5: \( \pi > .5 \)

Step 3: \( \alpha = .05 \)

Step 4: In the sample of 12 subjects complaining of headaches, let \( k_s \) be the sample count of in the drug treatment group. \( k_s = 9 \)

Step 5: P-value = \( Pr(K \geq k_s) = Pr(K \geq 9) = 1 - Pr(K \leq 8) = 1 - \text{binomcdf}(12, .5, 8) = .0730 > \alpha. \) So we retain \( H_0. \)

Step 6: Conclusion in English. There is insufficient evidence (P-value = .0730) to conclude that the drug treatment increases incidence of headaches.

### 6.21

<table>
<thead>
<tr>
<th></th>
<th>Fatal</th>
<th>Other</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaccine</td>
<td>0</td>
<td>200745</td>
<td>200745</td>
</tr>
<tr>
<td>Placebo</td>
<td>4</td>
<td>201225</td>
<td>201229</td>
</tr>
<tr>
<td>Totals</td>
<td>4</td>
<td>11</td>
<td>401964</td>
</tr>
</tbody>
</table>

Step 1: \( H_0: \) Vaccine is not effective in preventing polio deaths.

Step 2: \( H_1: \) Vaccine is effective in preventing polio deaths.

Step 3: No \( \alpha \) given; let’s choose \( \alpha = .05 \) to show significance.

Step 4: Among the 4 subjects in the fatal group, let \( k_s = 0 \) be the number observed in the vaccine group. Then \( N = 401964, N_1 = 200745, \) and \( n = 4. \)

Step 5: P-value = \( Pr(K \geq k_s) = Pr(K \geq 4) = \frac{\binom{200745}{0} \cdot \binom{201229}{4}}{\binom{401964}{4}} = \frac{201229 \cdot 201228 \cdot 201227 \cdot 201226}{401964 \cdot 401963 \cdot 401962 \cdot 401961} = 0.0628 > \alpha. \) Retain the null hypothesis.

Step 6: Conclusion in English. There is insufficient evidence (P-value = 0.0628) to conclude that the vaccine prevents polio deaths. Clearly because of the small number of deaths in the study, the test is weak. That is, it is difficult to disprove the null. This is like trying to prove that a coin is not fair based on four tosses. Even if all four tosses come up heads, there is insufficient evidence to conclude that the coin is not fair.

### 6.23

<table>
<thead>
<tr>
<th></th>
<th>Loan officer</th>
<th>Teller</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>1</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Men</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Totals</td>
<td>4</td>
<td>10</td>
<td>14</td>
</tr>
</tbody>
</table>
a. Binomial exact test.

Step 1: \( H_0 \): A fair number of women were hired for the loan officer positions.

Step 2: \( H_a \): Women were less likely to be hired as loan officers. That is, there was sex discrimination in the hiring.

Step 3: \( \alpha = .05 \)

Step 4: Among the 4 loan officer positions, let \( k_s = 1 \) be the number of women hired.

Step 5: P-value = \( \text{Pr}(K \leq k_s) = \text{Pr}(K \leq 1) = \binom{4}{0}(.5)^0(1-.5)^4 + \binom{4}{1}(.5)^1(1-.5)^3 = 0.0733 > \alpha. \) Retain the null hypothesis.

Step 6: Conclusion in English. There is insufficient evidence (P-value = 0.0733) to conclude that the company practiced sex discrimination in hiring. Since the binomial exact test failed to show the that the evidence was significant and because \( n = 4 \) is less than 5% of the total number of employees hired \( N = 14 \), Fisher’s exact test is recommended.

b. Fisher’s exact test. Steps 1 – 3 are the same as above.

Step 4: Among the 4 loan officer positions, let \( k_s = 1 \) be the number of women hired. Here \( N = 14, N_1 = 1, \) and \( n = 4. \)

Step 5: P-value = \( \text{Pr}(K \leq k_s) = \frac{\binom{10}{4}(14)}{\binom{14}{4}} + \frac{\binom{10}{4}(4)}{\binom{14}{4}} = 0.0410 < \alpha. \) Reject the null hypothesis.

Step 6: Conclusion in English: There is sufficient evidence (P-value = .0410) to conclude that the bank discriminated against women in hiring. Since Fisher’s exact test has more power than the binomial exact, Fisher’s showed significant discrimination, whereas the binomial exact test failed to do so.

6.25

<table>
<thead>
<tr>
<th></th>
<th>Endometriosis</th>
<th>No endometriosis</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-cal</td>
<td>1</td>
<td>59</td>
<td>60</td>
</tr>
<tr>
<td>Well-fed</td>
<td>6</td>
<td>54</td>
<td>60</td>
</tr>
<tr>
<td>Totals</td>
<td>7</td>
<td>113</td>
<td>120</td>
</tr>
</tbody>
</table>

Step 1: \( H_0 \): A low-calorie diet does not reduce the risk of endometriosis in rhesus monkeys.

Step 2: \( H_a \): A low-calorie diet reduces the risk of endometriosis in rhesus monkeys.

Step 3: \( \alpha = .05 \)

Step 4: Among the 7 cases of endometriosis, let \( k_s = 1 \) be the number in the low-calorie group.

Step 5: P-value = \( \text{Pr}(K \leq k_s) = \text{Pr}(K \leq 1) = \frac{\binom{60}{60} \binom{60}{60}}{\binom{120}{7}} + \frac{\binom{60}{60} \binom{60}{6}}{\binom{120}{7}} = 0.0570 > \alpha. \) Retain the null.
Step 6: Conclusion in English. There is insufficient evidence (P-value = 0.0570) to conclude that a low-calorie diet reduced the risk of endometriosis in rhesus monkeys.

Remark: The binomial exact test produces a larger P-value = binomcdf(7,.5,1) = 0.0625. This is the probability of getting 1 or fewer heads in 7 tosses of a fair coin.

6.27 This is the six-step procedure to test the hypothesis more than half of families in Wilmette have income of $50,000 or more.

Let \( \pi \) be the proportion of families in Wilmette with income of at least $50,000 (in 1989).

Step 1: \( H_0: \pi = .5 \)
Step 2: \( H_a: \pi > .5 \)
Step 3: \( \alpha = .05 \)
Step 4: Look at the sample of 20 families. For each family, assign (+) if the income is above $50,000, assign (–) if below $50,000, and assign (0) if it is exactly $50,000. We have \( k_0 = 0, k_+ = 12, \) and \( k_- = 8. \) This makes \( n = 20 - 0 = 20. \)

Test statistic is \( k_s = 12, n = 20. \) Having as many as 12 successes out of 20, is consistent with the alternative hypothesis. So we continue with the next step.

Step 5: P-value = \( Pr(K \geq k_s) = Pr(K \geq 12) = 1 - \text{binomcdf}(20,.5,11) = 1 - 0.7483 = 0.2517 > \alpha. \) Retain the null.

Step 6: Conclusion in English. There is insufficient evidence (P-value =0.2517) to conclude that the median income in Wilmette is more than $50,000.

6.29 This is the six-step procedure to test the hypothesis more than half of white non-Hispanic girls have BMI above the 50th percentile of the CDC growth chart.

Let \( \pi \) be the proportion of white non-Hispanic girls who are above the CDC 50th percentile.

Step 1: \( H_0: \pi = .5 \)
Step 2: \( H_a: \pi > .5 \)
Step 3: \( \alpha = .01 \)
Step 4: Look at the sample of 34 white non-Hispanic girls. Assign (+) if BMI percentile on the CDC growth chart is above 50, assign (–) if it’s below 50, and assign (0) if it is exactly 50. We have \( k_0 = 0, k_+ = 20, \) and \( k_- = 14. \) This makes \( n = 34 - 0 = 34. \)
Test statistic is $k_s = 20$, $n = 34$. Having as many as 20 successes out of 34 is consistent with the alternative hypothesis. So we continue with the next step.

Step 5: P-value = $Pr(K \geq k_s) = Pr(K \geq 20) = 1 - \text{binomcdf}(34,.5,19) = 1 - 0.8042 = 0.1958 > \alpha$.
Retain the null.

Step 6: Conclusion in English. There is insufficient evidence (P-value = 0.1958) to conclude that more than half of the white non-Hispanic girls exceed the 50th percentile on the CDC growth chart.

6.31 Let $\pi$ be the failure rate of the computer chips.

Step 1: $H_0$: Computer chips fail at the historic 8% rate: $\pi = 0.08$

Step 2: $H_a$: Computer chips fail at a higher rate: $\pi > 0.08$

Step 3: $\alpha = .05$

Step 4: In the sample of 100 computer chips, let $k_s$ be the number that failed: $k_s = 15$

Step 5: P-value = $Pr(K \geq k_s) = Pr(K \geq 15) = 1 - \text{binomcdf}(100,0.08,14) = 1 - 0.9867 = 0.0133 < \alpha$.
Reject null hypothesis.

Step 6: Conclusion in English. There is sufficient evidence (P-value = 0.0133) to conclude that the computer chips are failing at a rate higher than usual.

6.33 Among the panel of 350, let $\pi$ be the probability chosen juror is a woman.

Step 1: $H_0$: There was no bias against women by judge: $\pi = 102/350$

Step 2: $H_a$: There was bias against women: $\pi < 102/350$

Step 3: $\alpha = .01$

Step 4: In the jury of 100, let $k_s$ be the number of women: $k_s = 9$

Step 5: P-value = $Pr(K \leq k_s) = Pr(K \leq 9) = \text{binomcdf}(100,102/350,9) = 9.08 \times 10^{-7} < \alpha$.
Reject null hypothesis.

Step 6: Conclusion in English. There is very strong evidence (P-value = $9.08 \times 10^{-7}$) to conclude sex bias in the choosing of jurors.
6.35

<table>
<thead>
<tr>
<th></th>
<th>Success</th>
<th>Failure</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Drug</td>
<td>22</td>
<td>4</td>
<td>42</td>
</tr>
<tr>
<td>Standard Treatment</td>
<td>14</td>
<td>7</td>
<td>21</td>
</tr>
<tr>
<td>Totals</td>
<td>62</td>
<td>11</td>
<td>63</td>
</tr>
</tbody>
</table>

Step 1: \( H_0: \) New drug is not better than standard treatment.

Step 2: \( H_1: \) New drug is better than standard treatment.

Step 3: \( \alpha = .01 \)

Step 4: Among the 48 subjects in the failure group, let \( k_s = 4 \) be the number observed in the new drug group. Then \( N = 63, N_1 = 42, \) and \( n = 11 \).

Step 5: P-value = \( \Pr(K \leq k_s) = \Pr(K \leq 4) = \sum_{k=0}^{4} \left( \binom{42}{k} \right) \binom{21}{11-k} \left( \binom{63}{11} \right)^{-1} = 0.0254 > \alpha. \) Retain the null.

Step 6: Conclusion in English. There is insufficient evidence (P-value = 0.0254) to conclude that new drug treatment is better than the standard treatment.

6.37

<table>
<thead>
<tr>
<th></th>
<th>Flu</th>
<th>No flu</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shot</td>
<td>3</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>No shot</td>
<td>18</td>
<td>15</td>
<td>33</td>
</tr>
<tr>
<td>Totals</td>
<td>21</td>
<td>27</td>
<td>48</td>
</tr>
</tbody>
</table>

Among those in the flu population, let \( \pi \) be the proportion of those who are in the shot group.

Step 1: \( H_0: \) The flu shot does not reduce the risk of the getting the flu: \( \pi = 15/48. \)

Step 2: \( H_1: \) The flu shot reduces the risk of getting the flu: \( \pi < 15/48. \)

Step 3: \( \alpha = .05 \)

Step 4: In the sample of 21 students who got the flu, let \( k_s \) be the sample count of those who received the shot: \( k_s = 3. \)

Step 5: P-value = \( \Pr(K \leq k_s) = \Pr(K \leq 3) = \text{binomcdf}(21,15/48,3) = 0.0684 > \alpha. \) Retain null.

Step 6: Conclusion in English. There is insufficient evidence (P-value = 0.0684) to conclude that the flu shot reduces the risk of getting the flu.

Note: The binomial exact test is not recommended because \( 20n = 20(21) > 48 = N. \)
Chapter 6

6.39

<table>
<thead>
<tr>
<th></th>
<th>Success</th>
<th>Failure</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acupuncture</td>
<td>7</td>
<td>21</td>
<td>28</td>
</tr>
<tr>
<td>Placebo</td>
<td>4</td>
<td>23</td>
<td>27</td>
</tr>
<tr>
<td>Totals</td>
<td>11</td>
<td>44</td>
<td>55</td>
</tr>
</tbody>
</table>

Among those in the success population, let \( \pi \) be the proportion of those who are in the acupuncture group.

Step 1: \( H_0: \) Acupuncture does not increase success rate: \( \pi = 0.50 \)

Step 2: \( H_a: \) Acupuncture increases success rate: \( \pi > 0.50 \)

Step 3: \( \alpha = 0.05 \)

Step 4: In the sample of 11 subjects in the success group, let \( k_s \) be the sample count of those who received acupuncture: \( k_s = 7 \).

Step 5: P-value = \( \Pr(K \geq k_s) = 1 - \text{binomcdf}(11,0.50,6) = 0.2744 > \alpha \). Retain null hypothesis.

Step 6: Conclusion in English. There is insufficient evidence (P-value = 0.2744) to conclude that acupuncture drug treatment is better than the placebo.

6.41

<table>
<thead>
<tr>
<th></th>
<th>Success</th>
<th>Failure</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acupuncture</td>
<td>7</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Placebo</td>
<td>4</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td>Totals</td>
<td>11</td>
<td>19</td>
<td>30</td>
</tr>
</tbody>
</table>

Step 1: \( H_0: \) Acupuncture is same as placebo.

Step 2: \( H_1: \) Acupuncture is better than placebo.

Step 3: \( \alpha = 0.05 \)

Step 4: Among the \( n = 11 \) subjects in the success group, let \( k_s = 7 \) be the number observed in the acupuncture group. Then \( N = 30, N_1 = 13, \) and \( n = 11 \).

Step 5: P-value = \( \Pr(K \geq k_s) = 1 - \Pr(K \leq 6) = 1 - \sum_{k=0}^{6} \binom{13}{k} \binom{17}{11-k} = 0.0927 > \alpha \). Retain null hypothesis.

Step 6: Conclusion in English. There is insufficient evidence (P-value = 0.0927) to conclude that acupuncture drug treatment is better than the placebo.