**Chapter 18**

**Nonparametric Methods**

**Learning Objectives**

1. Learn the difference between parametric and nonparametric methods.

2. Know the advantages of nonparametric methods and when they are applicable.

3. Be able to use the sign test to conduct hypothesis tests about a median.

4. Learn how to use the sign test to test a hypothesis with matched samples.

5. Be able to use the Wilcoxon signed–rank test to test a hypothesis with matched samples and to test a hypothesis about the median of a symmetric population.

6. Be able to use the Mann–Whitney–Wilcoxon test for the comparison of two populations when using independent random samples from each population.

7. Be able to use the Kruskal–Wallis test for the comparison of *k* populations when using independent random samples from each population.

8. Be able to compute the Spearman rank–correlation coefficient and test for a significant rank correlation for two variables that use ordinal or rank–ordered data.

**Solutions:**

1. *H*0: Median < 150

*H*a: Median > 150

There are 22 + 5 = 27 observations where the value is different from 150.

Use the normal approximation with *µ* = *.*5*n* = .5(27) = 13.5 and



With the number of plus signs = 22 in the upper tail, we use the continuity correction factor and the normal distribution approximation as follows

*P*(22 or more plus signs) = 

The upper–tail *p*–value = (1.0000 – .9990) = .0010

*p*–value < .01; reject *H*0

Conclusion: The population median is greater than 150.

2. Let *p* = the probability of a preference for brand A

*H*0: *p*  .50

*H*a: *p* ≠ .50

Dropping the individual with no preference, the binomial probabilities for *n* = 9 and *p* = .50 are as follows.

|  |  |
| --- | --- |
| *x* | Probability |
| 0 | 0.0020 |
| 1 | 0.0176 |
| 2 | 0.0703 |
| 3 | 0.1641 |
| 4 | 0.2461 |
| 5 | 0.2461 |
| 6 | 0.1641 |
| 7 | 0.0703 |
| 8 | 0.0176 |
| 9 | 0.0020 |

Number of plus signs = 7

*P*(*x* > 7) = *P*(7) + *P*(8) +*P*(9) = .0703 + .0176 + .0020 = .0899

Two–tailed *p*–value = 2(.0899) = .1798

*p*–value > .05, do not reject *H*0. There is no indication that a difference in preference exists. A larger sample size should be considered.

3. *H*0: Median < 18

*H*a: Median > 18

Dropping the restaurant with 18 part–time employees, the binomial probabilities for *n* = 8 and *p* = .50 are as follows.

|  |  |
| --- | --- |
| *x* | Probability |
| 0 | .0039 |
| 1 | .0313 |
| 2 | .1094 |
| 3 | .2188 |
| 4 | .2734 |
| 5 | .2188 |
| 6 | .1094 |
| 7 | .0313 |
| 8 | .0039 |

Number of plus signs = 7

*P*(*x* > 7) = *P*(7) + *P*(8) = .0313 + .0039 = .0352

Since this is an upper–tailed test, *p*–value = .0352

*p*–value < .05, reject *H*0. Conclude that the population median is greater than 18. There has been an increase in the median number of part–time employees.

4. a. *H*0: Median > 15

*H*a: Median < 15

b. Dropping Vanguard GNMA with net assets of $15 billion, the binomial probabilities for *n* = 9 and *p* = .50 are as follows.

|  |  |
| --- | --- |
| *x* | Probability |
| 0 | .0020 |
| 1 | .0176 |
| 2 | .0703 |
| 3 | .1641 |
| 4 | .2461 |
| 5 | .2461 |
| 6 | .1641 |
| 7 | .0703 |
| 8 | .0176 |
| 9 | .0020 |

Number of plus signs = 1 American Funds with net assets of $22.4 billion.

*P*(*x* < 1) =*P*(0) + *P*(1) = . 0020 + .0176 = .0196

*p*–value = .0196

*p*–value <.05, reject *H0*. Conclude that Bond Mutual Funds have a significantly lower median net assets than Stock Mutual Funds.

5. *H*0: Median = 75,000

*H*a: Median ≠ 75,000

Use the normal approximation with *µ* = .5*n* = .5(300) = 150 and



With the number of plus signs= 165 in the upper tail, we use the continuity correction factor and the normal distribution approximation as follows

*P*(165 or more plus signs) =

The two–tailed *p*–value =2(1.0000 –. 9525) = .0950

*p*–value > .05;do not reject *H*0. We are unable to conclude that the median annual income for *Popular Photography & Imagining* subscribers differs from $75,000.

6. *H*0: Median < 56.2

*H*a: Median > 56.2

There are *n* = 31 + 17 = 48 observations where the value is different from 56.2.

Use the normal approximation with *µ* = .5*n* = .5(48) = 24 and



With the number of plus signs = 31in the upper tail, we use the continuity correction factor and the normal distribution approximation as follows

*P*(31or more plus signs) = 

Upper–tail *p*–value = (1.0000 – .9699) = .0301

*p*–value < .05; reject *H*0. Conclude that the median annual income for families living in Chicago is greater that $56.2 thousand.

7. a. Let *p* = probability the shares held will be worth more after the split

*H*0: *p*  .50

*H*a: *p* > .50

b. Let the number of plus signs be the number of increases in value.

Use the binomial probability tables with *n* = 18 (there were 2 ties in the 20 observations)

With *x* = 14 plus signs,

*P*(*x*  14) = *P*(14) + *P*(15) + *P*(16) + *P*(17) + *P*(18)

= .0117 + .0031 + .0006 + .0001 + .0000 = .0155

Upper–tailed *p*–value = .0155

*p*–value .05, reject *H*0. The results support the conclusion that stock splits are beneficial for shareholders.

8. a. *H*0: *p*  .50

*H*a: *p* ≠ .50

Dropping the individual with no preference, selected binomial probabilities for *n* = 15 and *p* = .50 are as follows.

|  |  |
| --- | --- |
| *x* | Probability |
| 0 | .0000 |
| 1 | .0005 |
| 2 | .0032 |
| 3 | .0139 |
| 4 | .0417 |

Let the response faster pace be a plus sign. Number of plus signs = 4.

Since this is in the lower tail of binomial distribution, we compute

*P*(*x* < 4) = *P*(0) + *P*(1) + *P*(2) + *P*(3) + *P*4)

*= .*0000 + .0005 + .0032 + .0139 + .0417 = .0593

Two–tailed *p*–value = 2(.0593) = .1186

*p*–value > .05, do not reject *H*0. The sample does not allow the conclusion that a difference in preference exists for the fast pace or slower pace of life.

b. Of the original 16 respondents, 4/16(100) = 25% favored a faster pace of life and

11/16(100) = 68.8% favored a slower pace of life. There is an almost 3 to 1 in favor of the slower pace of life. In addition, the *p*–value .1186 is low, but not low enough to detect a difference in preference. Continuing to study and taking a larger sample should be considered.

9. Let *p* = proportion of adults who feel children will have a better future.

*H*0: *p*  .50

*H*a: *p* ≠ .50

Eliminating the responses that said about the same, we have

*n*  = 242 + 310 = 552

Using the normal distribution, we have

*µ* = .5 *n* = .5(552) = 276



With the number of plus signs = 242 in the lower tail, we will use the continuity correction factor and the normal distribution approximation as follows:

*P*(242 or fewer plus signs) = 

The two–tailed *p*–value =2(.0022) = .0044

*p*–value .05, reject *H*0.  Conclude that there is a significant difference between the adults projecting a better future and adults projects a worse future. In 2008, more adults were projecting a worse future for their children.

10. Let *p* = proportion who favor *America Idol*

*H*0: *p*  .50

*H*a: *p* ≠ .50

Eliminating the responses that said about the same, we have

*n*  = 330+ 270 = 600

Using the normal distribution, we have

*µ* = .5 *n* = .5(600) = 300



With the number of plus signs = 330 in the upper tail, we will use the continuity correction factor and the normal distribution approximation as follows

*P*(330 or more plus signs) =

The two–tailed *p*–value = 2(1.0000 – .9920) = .0160

*p*–value .05, reject *H*0.  Conclude that there is a significant difference between the preference for *American Idol* and *Dancing with the Stars.* Based on the data, *American Idol* is most preferred.

11. Let *p* = proportion who purchase brand A computers

*H*0: *p*  .50

*H*a: *p* ≠ .50

Eliminating purchases of other computers, we have

*n*  = 202+ 175 = 377

Using the normal distribution, we have

*µ* = .5 *n* = .5(377) = 188.5



With the number of plus signs = 202 in the upper tail, we will use the continuity correction factor and the normal distribution approximation as follows

*P*(202 or more plus signs) =

The two–tailed *p*–value = 2(1.0000 – .9099) = .1802

*p*–value > .05, do not reject *H*0.  We are unable to conclude that there is a difference between the market shares for the two brands of computers.

12. *H*0: Median for Additive 1 – Median for Additive 2 = 0

*H*a: Median for Additive 1 – Median for Additive 2 ≠ 0

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Additive | |  | Absolute |  | Signed Ranks | |
| Car | 1 | 2 | Difference | Difference | Rank | Negative | Positive |
| 1 | 20.12 | 18.05 | 2.07 | 2.07 | 9 |  | 9 |
| 2 | 23.56 | 21.77 | 1.79 | 1.79 | 7 |  | 7 |
| 3 | 22.03 | 22.57 | -0.54 | 0.54 | 3 | -3 |  |
| 4 | 19.15 | 17.06 | 2.09 | 2.09 | 10 |  | 10 |
| 5 | 21.23 | 21.22 | 0.01 | 0.01 | 1 |  | 1 |
| 6 | 24.77 | 23.80 | 0.97 | 0.97 | 4 |  | 4 |
| 7 | 16.16 | 17.20 | -1.04 | 1.04 | 5 | -5 |  |
| 8 | 18.55 | 14.98 | 3.57 | 3.57 | 12 |  | 12 |
| 9 | 21.87 | 20.03 | 1.84 | 1.84 | 8 |  | 8 |
| 10 | 24.23 | 21.15 | 3.08 | 3.08 | 11 |  | 11 |
| 11 | 23.21 | 22.78 | 0.43 | 0.43 | 2 |  | 2 |
| 12 | 25.02 | 23.70 | 1.32 | 1.32 | 6 |  | 6 |
|  |  |  |  |  |  |  |  |
|  |  |  |  | Sum of Positive Signed Ranks | | | *T* += 70 |





*T* += 70 is in the upper tail of the sampling distribution. Using the continuity correction factor, we have:



Using *z* = 2.39, the *p*–value = 2(1.0000 – .9916) = .0168

*p*–value < .05, reject *H*0. Conclude that there is a significant difference in the median miles per gallon for the two additives.

13. *H*0: Median time without Relaxant – Median time with Relaxant < 0

*H*a: Median time without Relaxant – Median time with Relaxant > 0

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Relaxant | |  | Absolute |  | Signed Ranks | |
| Subject | No | Yes | Difference | Difference | Rank | Negative | Positive |
| 1 | 15 | 10 | 5 | 5 | 9 |  | 9 |
| 2 | 12 | 10 | 2 | 2 | 3 |  | 3 |
| 3 | 22 | 12 | 10 | 10 | 10 |  | 10 |
| 4 | 8 | 11 | -3 | 3 | 6.5 | -6.5 |  |
| 5 | 10 | 9 | 1 | 1 | 1 |  | 1 |
| 6 | 7 | 5 | 2 | 2 | 3 |  | 3 |
| 7 | 8 | 10 | -2 | 2 | 3 | -3 |  |
| 8 | 10 | 7 | 3 | 3 | 6.5 |  | 6.5 |
| 9 | 14 | 11 | 3 | 3 | 6.5 |  | 6.5 |
| 10 | 9 | 6 | 3 | 3 | 6.5 |  | 6.5 |
|  |  |  |  |  |  |  |  |
|  |  |  |  | Sum of Positive Signed Ranks | | | *T* += 45.5 |





*T* += 45.5 is in the upper tail of the sampling distribution. Using the continuity correction factor, we have:



Using *z* = 1.78, *p*–value = (1.0000 – .9925) = .0375

*p*–value < .05, reject *H*0. Conclude that there is a significant difference in the median times to fall asleep. The median time without the relaxant is significantly greater than the median time with the relaxant.

14. *H*0: Median percent on–time in 2006 – Median percent on time in 2007 = 0

*H*a: Median percent on–time in 2006 – Median percent on time in 2007 ≠ 0

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Year | |  | Absolute |  | Signed Ranks | |
| Airport | 2006 | 2007 | Difference | Difference | Rank | Negative | Positive |
| 1 | 71.78% | 69.69% | 2.09% | 2.09% | 4 |  | 4 |
| 2 | 68.23% | 65.88% | 2.35% | 2.35% | 5 |  | 5 |
| 3 | 77.98% | 78.40% | -0.42% | 0.42% | 2 | -2 |  |
| 4 | 78.71% | 75.78% | 2.93% | 2.93% | 6 |  | 6 |
| 5 | 77.59% | 73.45% | 4.14% | 4.14% | 9 |  | 9 |
| 6 | 77.67% | 78.68% | -1.01% | 1.01% | 3 | -3 |  |
| 7 | 76.67% | 76.38% | 0.29% | 0.29% | 1 |  | 1 |
| 8 | 76.29% | 70.98% | 5.31% | 5.31% | 10 |  | 10 |
| 9 | 69.39% | 62.84% | 6.55% | 6.55% | 11 |  | 11 |
| 10 | 79.91% | 76.49% | 3.42% | 3.42% | 8 |  | 8 |
| 11 | 75.55% | 72.42% | 3.13% | 3.13% | 7 |  | 7 |
|  |  |  |  |  |  |  |  |
|  |  |  |  | Sum of Positive Signed Ranks | | | *T* + = 61 |





*T* += 61 is in the upper tail of the sampling distribution. Using the continuity correction factor, we have:



Using *z* = 2.45, *p*–value = 2(1.0000 – .9929) = .0142

*p*–value < .05, reject *H*0. Conclude that there is a significance difference between the median percentage of on–time flights for the two years. Median percentage of on–time flights was better in 2006.

15. *H*0: Median time for Service 1 – Median time for Service 2 = 0

*H*a: Median time for Service 1 – Median time for Service 2 ≠ 0

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Service | |  | Absolute |  | Signed Ranks | |
| Delivery | 1 | 2 | Difference | Difference | Rank | Negative | Positive |
| 1 | 24.5 | 28.0 | -3.50 | 3.50 | 7.5 | -7.5 |  |
| 2 | 26.0 | 25.5 | 0.50 | 0.50 | 1.5 |  | 1.5 |
| 3 | 28.0 | 32.0 | -4.00 | 4.00 | 9.5 | -9.5 |  |
| 4 | 21.0 | 20.0 | 1.00 | 1.00 | 4 |  | 4 |
| 5 | 18.0 | 19.5 | -1.50 | 1.50 | 6 | -6 |  |
| 6 | 36.0 | 28.0 | 8.00 | 8.00 | 11 |  | 11 |
| 7 | 25.0 | 29.0 | -4.00 | 4.00 | 9.5 | -9.5 |  |
| 8 | 21.0 | 22.0 | -1.00 | 1.00 | 4 | -4 |  |
| 9 | 24.0 | 23.5 | 0.50 | 0.50 | 1.5 |  | 1.5 |
| 10 | 26.0 | 29.5 | -3.50 | 3.50 | 7.5 | -7.5 |  |
| 11 | 31.0 | 30.0 | 1.00 | 1.00 | 4 |  | 4 |
|  |  |  |  |  |  |  |  |
|  |  |  |  | Sum of Positive Signed Ranks | | | *T* + = 22 |





*T* += 22 is in the lower tail of the sampling distribution. Using the continuity correction factor, we have:



Using *z* = , area = .1762

*p*–value = 2(.1762) = .3524

*p*–value > .05, do not reject *H*0. There is no significant difference between the median delivery times for the two services.

16. *H*0: Median score for Round 1 – Median score for Round 2 = 0

*H*a: Median score for Round 1 – Median score for Round 2 ≠ 0

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Round | |  | Absolute |  | Signed Ranks | |
| Golfer | 1 | 2 | Difference | Difference | Rank | Negative | Positive |
| 1 | 63 | 74 | -11 | 11 | 10 | -10 |  |
| 2 | 70 | 73 | -3 | 3 | 5.5 | -5.5 |  |
| 3 | 72 | 70 | 2 | 2 | 3 |  | 3 |
| 4 | 65 | 71 | -6 | 6 | 9 | -9 |  |
| 5 | 70 | 74 | -4 | 4 | 7.5 | -7.5 |  |
| 6 | 69 | 73 | -4 | 4 | 7.5 | -7.5 |  |
| 7 | 72 | 71 | 1 | 1 | 1 |  | 1 |
| 8 | 68 | 70 | -2 | 2 | 3 | -3 |  |
| 9 | 70 | 68 | 2 | 2 | 3 |  | 3 |
| 10 | 71 | 71 | 0 |  |  |  |  |
| 11 | 72 | 69 | 3 | 3 | 5.5 |  | 5.5 |
|  |  |  |  |  |  |  |  |
|  |  |  |  | Sum of Positive Signed Ranks | | | *T* += 12.5 |

Carlos Franco (10) had the same score on both rounds and is removed from the sample. Thus, *n* = 10.





*T* += 12.5 is in the lower tail of the sampling distribution. Using the continuity correction factor, we have:



Using *z* = –1.48, *p*–value = 2(.0694) = .1388

*p*–value > .05, do not reject *H*0. There is no significant difference between the median scores for the two rounds of golf.

17. *H*0: Median = 500

*H*a: Median ≠ 500

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | |  | Absolute |  | Signed Ranks | |
| Student | Score | Median | Difference | Difference | Rank | Negative | Positive |
| 1 | 635 | 500 | 135 | 135 | 13 |  | 13 |
| 2 | 502 | 500 | 2 | 2 | 1 |  | 1 |
| 3 | 447 | 500 | -53 | 53 | 7.5 | -7.5 |  |
| 4 | 701 | 500 | 201 | 201 | 15 |  | 15 |
| 5 | 405 | 500 | -95 | 95 | 11 | -11 |  |
| 6 | 590 | 500 | 90 | 90 | 10 |  | 10 |
| 7 | 439 | 500 | -61 | 61 | 9 | -9 |  |
| 8 | 453 | 500 | -47 | 47 | 6 | -6 |  |
| 9 | 337 | 500 | -163 | 163 | 14 | -14 |  |
| 10 | 447 | 500 | -53 | 53 | 7.5 | -7.5 |  |
| 11 | 471 | 500 | -29 | 29 | 4 | -4 |  |
| 12 | 387 | 500 | -113 | 113 | 12 | -12 |  |
| 13 | 464 | 500 | -36 | 36 | 5 | -5 |  |
| 14 | 476 | 500 | -24 | 24 | 3 | -3 |  |
| 15 | 514 | 500 | 14 | 14 | 2 |  | 2 |
|  |  |  |  |  |  |  |  |
|  |  |  |  | Sum of Positive Signed Ranks | | | *T* += 41 |





*T* += 41 is in the lower tail of the sampling distribution. Using the continuity correction factor, we have:



Using *z* = –1.05, *p*–value = 2(.1469) = .2938

*p*–value > .05, do not reject *H*0. We cannot reject the hypothesis that the population median writing test score is 500.

18. *H*0: The two populations of additives are identical

*H*a: The two populations of additives are not identical

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Additive 1 | Rank |  | Additive 2 | Rank |
| 17.3 | 2 |  | 18.7 | 8.5 |
| 18.4 | 6 |  | 17.8 | 4 |
| 19.1 | 10 |  | 21.3 | 15 |
| 16.7 | 1 |  | 21.0 | 14 |
| 18.2 | 5 |  | 22.1 | 16 |
| 18.6 | 7 |  | 18.7 | 8.5 |
| 17.5 | 3 |  | 19.8 | 11 |
|  |  |  | 20.7 | 13 |
|  |  |  | 20.2 | 12 |
| *W =* | 34 |  |  |  |





With *W*  = 34 in the lower tail, we will use the continuity correction factor and the normal distribution approximation as follows



Using *z* = –2.65, the two–tailed *p*–value =2(.0040) = .0080

*p*–value < .05; reject *H*0

Conclusion: The two populations of fuel additives are not identical. The population with additive 2 tends to provide higher miles per gallon.

19. a. *H*0: The two populations of salaries are identical

*H*a: The two populations of salaries are not identical

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Public |  |  | Financial |  |
| Accountant | Rank |  | Planner | Rank |
| 50.2 | 5 |  | 49.0 | 2 |
| 58.8 | 19 |  | 49.2 | 3 |
| 56.3 | 16 |  | 53.1 | 10 |
| 58.2 | 18 |  | 55.9 | 15 |
| 54.2 | 13 |  | 51.9 | 8.5 |
| 55.0 | 14 |  | 53.6 | 11 |
| 50.9 | 6 |  | 49.7 | 4 |
| 59.5 | 20 |  | 53.9 | 12 |
| 57.0 | 17 |  | 51.8 | 7 |
| 51.9 | 8.5 |  | 48.9 | 1 |
| *W =* | 136.5 |  |  |  |





With *W*  = 136.5 in the upper tail, we will use the continuity correction factor and the normal distribution approximation as follows



Using *z* = 2.34, the two–tailed *p*–value =2(1.0000 – .9904) = .0192

*p*–value < .05; reject *H*0

Conclusion: The two populations of salaries are not identical. The population of public accountants tends to have the higher salaries.

b. Public Accountant Median = (55.0+56.3)/2 = 55.65 $55,650

Financial Planner Median = (51.8+51.9)/2 = 51.85 $51,850

20. a. Median salary for men $54,900 (4th position when ranked)

Median salary for women $40,400 (4th position when ranked)

b. *H*0: The two populations of salaries are identical

*H*a: The two populations of salaries are not identical

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Men | Rank |  | Women | Rank |
| 35.6 | 4 |  | 49.5 | 8 |
| 80.5 | 14 |  | 40.4 | 5 |
| 50.2 | 9 |  | 32.9 | 3 |
| 67.2 | 13 |  | 45.5 | 7 |
| 43.2 | 6 |  | 30.8 | 2 |
| 54.9 | 11 |  | 52.5 | 10 |
| 60.3 | 12 |  | 29.8 | 1 |
| *W =* | 69 |  |  |  |





With *W*  = 69 in the upper tail, we will use the continuity correction factor and the normal distribution approximation as follows



Using *z* = 2.04, the two–tailed *p*–value =2(1.000–.9793) = .0414

*p*–value < .05; reject *H*0

Conclusion: The two populations of salaries are not identical. The population of men tends to have the higher salaries.

21. *H*0: The two populations of hurricane wind speeds are identical

*H*a: The two populations of hurricane wind speeds are not identical

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Atlantic |  |  | Pacific |  |
| Wind Speed | Rank |  | Wind Speed | Rank |
| 125 | 19 |  | 105 | 14.5 |
| 110 | 16.5 |  | 75 | 8.5 |
| 65 | 3.5 |  | 65 | 3.5 |
| 135 | 21 |  | 90 | 12 |
| 80 | 10.5 |  | 70 | 6.5 |
| 150 | 23.5 |  | 110 | 16.5 |
| 150 | 23.5 |  | 130 | 20 |
| 65 | 3.5 |  | 95 | 13 |
| 80 | 10.5 |  | 65 | 3.5 |
| 105 | 14.5 |  | 120 | 18 |
| 145 | 22 |  | 75 | 8.5 |
| 60 | 1 |  | 70 | 6.5 |
| *W =* | 169 |  |  |  |





With *W*  = 169 in the upper tail, we will use the continuity correction factor and the normal distribution approximation as follows



Using *z* = 1.07, the two–tailed *p*–value =2(1.0000 – .8577) = .2846

*p*–value > .05; do not reject *H*0

Conclusion: We cannot reject the null hypothesis that the two populations of hurricane wind speeds are identical. There is no indication that there is a difference between the populations of hurricane wind speeds in the Atlantic/Caribbean/Gulf of Mexico and the Eastern Pacific Ocean.

22. *H*0: The two populations of P/E ratios are identical

*H*a: The two populations of P/E ratios are not identical

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Japan |  |  | U.S. |  |
| P/E Ratio | Rank |  | P/E Ratio | Rank |
| 153 | 20 |  | 19 | 6 |
| 21 | 8 |  | 24 | 11.5 |
| 18 | 5 |  | 24 | 11.5 |
| 125 | 19 |  | 43 | 16 |
| 31 | 13 |  | 22 | 10 |
| 213 | 21 |  | 14 | 2 |
| 64 | 17 |  | 21 | 8 |
| 666 | 22 |  | 14 | 2 |
| 33 | 14 |  | 21 | 8 |
| 68 | 18 |  | 38 | 15 |
|  |  |  | 15 | 4 |
|  |  |  | 14 | 2 |
| *W =* | 157 |  |  |  |





With *W*  = 157 in the upper tail, we will use the continuity correction factor and the normal distribution approximation as follows



Using *z* = 2.74, the two–tailed *p*–value =2(1.0000 – .9969) = .0062

*p*–value < .01; reject *H*0

Conclusion: The two populations of P/E ratios are not identical. The population of Japanese companies tends to have higher P/E ratios than the population of United States companies.

23. *H*0: The two populations of daily crimes are identical

*H*a: The two populations of daily crimes are not identical

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Winter | Rank |  | Summer | Rank |
| 18 | 6.5 |  | 28 | 16.5 |
| 20 | 11 |  | 18 | 6.5 |
| 15 | 2 |  | 24 | 15 |
| 16 | 3.5 |  | 32 | 19 |
| 21 | 13 |  | 18 | 6.5 |
| 20 | 11 |  | 29 | 18 |
| 12 | 1 |  | 23 | 14 |
| 16 | 3.5 |  | 38 | 20 |
| 19 | 9 |  | 28 | 16.5 |
| 20 | 11 |  | 18 | 6.5 |
| *W =* | 71.5 |  |  |  |





With *W*  = 71.5 in the lower tail, we will use the continuity correction factor and the normal distribution approximation as follows



Using *z* = –.2.49, the two–tailed *p*–value =2(.0064) = .0128

*p*–value < .05; reject *H*0

Conclusion: The two populations of daily crimes are not identical. The population of daily crimes in winter months tends to be less than the population of daily crimes in the summer months.

24. *H*0: The two populations of microwave prices are identical

*H*a: The two populations of microwave prices are not identical

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Dallas | Rank |  | San Antonio | Rank |
| 445 | 14.5 |  | 460 | 19 |
| 489 | 23 |  | 451 | 17 |
| 405 | 1.5 |  | 435 | 11 |
| 485 | 22 |  | 479 | 21 |
| 439 | 13 |  | 475 | 20 |
| 449 | 16 |  | 445 | 14.5 |
| 436 | 12 |  | 429 | 7 |
| 420 | 4 |  | 434 | 10 |
| 430 | 8.5 |  | 410 | 3 |
| 405 | 1.5 |  | 422 | 5 |
|  |  |  | 425 | 6 |
|  |  |  | 459 | 18 |
|  |  |  | 430 | 8.5 |
| *W =* | 116 |  |  |  |





With *W*  = 116 in the lower tail, we will use the continuity correction factor and the normal distribution approximation as follows



Using *z* = –.22, the two–tailed *p*–value =2(.4129) = .8258

*p*–value > .05; do not reject *H*0

Conclusion: We cannot reject the null hypothesis that the two populations of microware prices are identical. There is no indication that there is a difference between the populations of microwave prices for the two cities.

25. *H*0: The two populations of draft positions are identical

*H*a: The two populations of draft positions are not identical

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Southeastern Conference | | |  | Atlantic Coast Conference | | |
|  |  |  |  |  |  |  |
| Player's | Projected |  |  | Player's | Projected |  |
| College | Draft Position | Rank |  | College | Draft Position | Rank |
| Georgia | 1 | 1 |  | Georgia Tech | 3 | 3 |
| Alabama | 2 | 2 |  | Wake Forrest | 6 | 4 |
| Vanderbilt | 14 | 6 |  | Virginia | 8 | 5 |
| Florida | 18 | 7 |  | Wake Forrest | 23 | 9 |
| Mississippi | 20 | 8 |  | Florida State | 25 | 11 |
| Mississippi | 24 | 10 |  | Maryland | 26 | 12 |
| Auburn | 27 | 13 |  | Virginia | 29 | 14 |
|  | *W =* | 47 |  |  |  |  |





With *W*  = 47 in the lower tail, we will use the continuity correction factor and the normal distribution approximation as follows



Using *z* = –.64, the two–tailed *p*–value =2(.2611) = .5211

*p*–value > .05; do not reject *H*0

Conclusion: We cannot reject the null hypothesis that the two populations of draft positions are identical. There is no indication that there is a difference between the populations of draft position preferences for the players from the two conferences.

26. *H*0: All populations of product ratings are identical

*H*a: Not all populations of product ratings are identical

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| A | Rank |  | B | Rank |  | C | Rank |
| 50 | 4 |  | 80 | 11 |  | 60 | 7 |
| 62 | 8 |  | 95 | 14 |  | 45 | 2 |
| 75 | 10 |  | 98 | 15 |  | 30 | 1 |
| 48 | 3 |  | 87 | 12 |  | 58 | 6 |
| 65 | 9 |  | 90 | 13 |  | 57 | 5 |
| Sum of Ranks | 34 |  |  | 65 |  |  | 21 |



Using the *χ*2 table with *df*  = 2, *χ*2 = 10.22 shows the *p*–value is between .005 and .01

Using Excel or Minitab, the *p*–value for  *χ*2 = 10.22 is .0060.

*p*–value < .01, reject *H*0. Conclude that the populations of product ratings are not identical.

27. *H*0: All populations of test scores are identical

*H*a: Not all populations of test score are identical

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| A | Rank |  | B | Rank |  | C | Rank |
| 540 | 11.5 |  | 450 | 5 |  | 600 | 17 |
| 400 | 2.5 |  | 540 | 11.5 |  | 630 | 20 |
| 490 | 8 |  | 400 | 2.5 |  | 580 | 15 |
| 530 | 10 |  | 410 | 4 |  | 490 | 8 |
| 490 | 8 |  | 480 | 6 |  | 590 | 16 |
| 610 | 18 |  | 370 | 1 |  | 620 | 19 |
|  |  |  | 550 | 13 |  | 570 | 14 |
| Sum of Ranks | 58 |  |  | 43 |  |  | 109 |



Using the *χ*2 table with *df* = 2, *χ*2 = 9.06 shows the *p*–value is between .025 and .01

Using Excel or Minitab, the *p*–value for  *χ*2 = 9.06 is .0108.

*p*–value < .05, reject *H*0. Conclude that the populations of test scores are not identical. In particular, program C appears to provide the higher test scores.

28. *H*0: All populations of calories burned are identical

*H*a: Not all populations of calories burned are identical

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Swimming | Rank |  | Tennis | Rank |  | Cycling | Rank |
| 408 | 8 |  | 415 | 9 |  | 385 | 5 |
| 380 | 4 |  | 485 | 14 |  | 250 | 1 |
| 425 | 11 |  | 450 | 13 |  | 295 | 3 |
| 400 | 6 |  | 420 | 10 |  | 402 | 7 |
| 427 | 12 |  | 530 | 15 |  | 268 | 2 |
| Sum of Ranks | 41 |  |  | 61 |  |  | 18 |



Using the *χ*2 table with *df*  = 2, *χ*2 = 9.26 shows the *p*–value is between .005 and .01

Using Excel or Minitab, the *p*–value for  *χ*2 = 9.26 is .0098.

*p*–value < .05, reject *H*0. Conclude that the populations of calories burned by the three activities are not identical. Cycling tends to have the lowest calories burned.

29. *H*0: All populations of cruise ship ratings are identical

*H*a: Not all populations of cruise ship ratings are identical

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Holland |  |  |  |  |  | Royal |  |
| America | Rank |  | Princess | Rank |  | Caribbean | Rank |
| 84.5 | 11 |  | 85.1 | 13 |  | 84.8 | 12 |
| 81.4 | 5 |  | 79.0 | 2 |  | 81.8 | 6 |
| 84.0 | 9.5 |  | 83.9 | 8 |  | 84.0 | 9.5 |
| 78.5 | 1 |  | 81.1 | 4 |  | 85.9 | 14 |
| 80.9 | 3 |  | 83.7 | 7 |  | 87.4 | 15 |
| Sum of Ranks | 29.5 |  |  | 34 |  |  | 56.5 |



Using the *χ*2 table with *df* = 2, *χ*2 = 4.19 shows the *p*–value is greater than .10.

Using Excel or Minitab, the *p*–value for  *χ*2 = 4.19 is .1231.

*p*–value > .05, do not reject *H*0.

We cannot reject the null hypothesis that the three populations of cruise ship rating are identical. There is no indication that there is a difference among the populations of rating for the three cruise ship lines.

30. *H*0: All populations of training courses are identical

*H*a: Not all populations of training courses are identical

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Course | | | |
|  | A | B | C | D |
|  | 3 | 2 | 19 | 20 |
|  | 14 | 7 | 16 | 4 |
|  | 10 | 1 | 9 | 15 |
|  | 12 | 5 | 18 | 6 |
|  | 13 | 11 | 17 | 8 |
| Sum of Ranks | 52 | 26 | 79 | 53 |



Using the *χ*2 table with *df* = 3, *χ*2 = 8.03 shows the *p*–value is between .025 and .05.

Using Excel or Minitab, the *p*–value for  *χ*2 = 8.03 is .0454.

*p*–value < .05, reject *H*0. Conclude that the populations are not identical. There is a significant difference in the quality of the courses offered at the four management development centers.

31. *H*0: All populations of calories are identical

*H*a: Not all populations of calories are identical

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| M&Ms | Rank |  | Kit Kat | Rank |  | Milky Way II | Rank |
| 230 | 10 |  | 225 | 9 |  | 200 | 3 |
| 210 | 7 |  | 205 | 5 |  | 208 | 6 |
| 240 | 13 |  | 245 | 14 |  | 202 | 4 |
| 250 | 15 |  | 235 | 12 |  | 190 | 2 |
| 230 | 11 |  | 220 | 8 |  | 180 | 1 |
| Sum of Ranks | 56 |  |  | 48 |  |  | 16 |



Using the *χ*2 table with *df* = 2, *χ*2 = 8.96 shows the *p*–value is between .01 and .025.

Using Excel or Minitab, the *p*–value for  *χ*2 = 8.96 is .0113.

*p*–value < .05, reject *H*0. Conclude that the populations of calories are not identical for the three candies.

Milky Way II appears to have the lowest number of calories.

32. a. = 52



b. 



*p*–value = 2(1.0000 – .9798) = .0404

*p*–value .05, reject H0. Conclude that significant positive rank correlation exists.

33. Case 1: = 0



Case 2:= 70



With perfect agreement, rank correlation coefficient *rs* = 1.

With exact opposite ranking, rank correlation coefficient *rs* = –1.

34. = 250







*p*–value = 2(.3336) = .6672

*p*–value > .05, do not reject *H*0. We cannot conclude that there is a significant relationship between ranking based on the expenditure per student and the ranking based on the student–teacher ratio.

35. a. = 54



b. 







*p*–value = 1.0000 – .9783 = .0217

c. *p*–value .05, reject *H*0. Conclude that there is a significant positive rank correlation between a company’s reputation and having stock that is desirable to purchase.

36.

|  |  |  |  |
| --- | --- | --- | --- |
| Driving Distance | Putting | *di* |  |
| 1 | 5 | -4 | 16 |
| 5 | 6 | -1 | 1 |
| 4 | 10 | -6 | 36 |
| 9 | 2 | 7 | 49 |
| 6 | 7 | -1 | 1 |
| 10 | 3 | 7 | 49 |
| 2 | 8 | -6 | 36 |
| 3 | 9 | -6 | 36 |
| 7 | 4 | 3 | 9 |
| 8 | 1 | 7 | 49 |
|  |  | = 282 | |







*p*–value = 2(.0166) = .0332

*p*–value .10, reject *H*0. There is a significant rank correlation between driving distance and putting. Professional golfers who rank high in driving distance tend to rank low in putting.

37. = 38







*p*–value = 2(1.0000 – .9896) = .0208

*p*–value .10, reject *H*0. Conclude that there is a significant rank correlation between current students and recent graduates in terms of professor teaching ability.

38. Let *p* = proportion who favor the proposal

*H*0: *p*  .50

*H*a: *p* ≠ .50

Eliminating the 60 responses that offered no opinion, we have

*n*  = 905 + 1045 = 1950

Using the normal distribution, we have

*µ* = .5 *n* = .5(1950) = 975



With the number of plus signs = 905 in the lower tail, we will use the continuity correction factor and the normal distribution approximation as follows

*P*(905 or fewer plus signs) =

Area in lower tail area is less than .0010

The two–tailed *p*–value is less than 2(.0010) = .0020

*p*–value .05, reject *H*0.  Conclude that there is a significant difference between the preferences for the tax–funded vouchers or tax deductions for parents who send their children to private schools. The greater percentage opposed the proposal.

39. St. Louis

*H*0: Median > 180,000

*H*a: Median < 180,000

There are *n* = 32 + 18 = 50 observations where the value is different from 180,000

Use the normal approximation with *µ* = .5*n* = .5(50) = 25 and



With the number of plus signs= 18 in the lower tail, we use the continuity correction factor and the normal distribution approximation as follows

*P*(18 or fewer plus signs) = 

Lower–tail *p*–value = .0329

*p*–value < .05; reject *H*0. Conclude that the median sale price for single–family homes in St. Louis is less than the national median price of $180,000.

Denver

*H*0: Median < 180,000

*H*a: Median > 180,000

There are *n* = 13 + 27 = 40 observations where the value is different from 180,000

Use the normal approximation with *µ* = .5*n* = .5(40) = 20 and



With the number of plus signs= 27 in the upper tail, we use the continuity correction factor and the normal distribution approximation as follows

*P*(27 or more plus signs) = 

Upper–tail *p*–value = (1.0000 – .9803) = .0197

*p*–value < .05; reject *H*0. Conclude that the median sale price for single–family homes in Denver is greater than the national median price of $180,000.

40. *H*0: Median price for Model 1 – Median price for Model 2 = 0

*H*a: Median price for Model 1 – Median price for Model 2 ≠ 0

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | |  | Absolute |  | Signed Ranks | |
| Homemaker | Model 1 | Model 2 | Difference | Difference | Rank | Negative | Positive |
| 1 | 850 | 1100 | -250 | 250 | 11 | -11 |  |
| 2 | 960 | 920 | 40 | 40 | 2 |  | 2 |
| 3 | 940 | 890 | 50 | 50 | 3 |  | 3 |
| 4 | 900 | 1050 | -150 | 150 | 6 | -6 |  |
| 5 | 790 | 1120 | -330 | 330 | 12 | -12 |  |
| 6 | 820 | 1000 | -180 | 180 | 7 | -7 |  |
| 7 | 900 | 1090 | -190 | 190 | 8.5 | -8.5 |  |
| 8 | 890 | 1120 | -230 | 230 | 10 | -10 |  |
| 9 | 1100 | 1200 | -100 | 100 | 5 | -5 |  |
| 10 | 700 | 890 | -190 | 190 | 8.5 | -8.5 |  |
| 11 | 810 | 900 | -90 | 90 | 4 | -4 |  |
| 12 | 920 | 900 | 20 | 20 | 1 |  | 1 |
|  |  |  |  |  |  |  |  |
|  |  |  |  | Sum of Positive Signed Ranks | | | *T+*= 6 |





*T* += 6 is in the lower tail of the sampling distribution. Using the continuity correction factor, we have:



Using *z* = –2.55, the *p*–value = 2(.0054) = .0108

*p*–value < .05, reject *H*0. Conclude that there is a significance difference between the median prices of the two models. The housewives are estimating Model 2 to have the higher median price.

41. *H*0: Median weight After – Median weight Before < 0

*H*a: Median weight After – Median weight Before > 0

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | Absolute |  | Signed Ranks | |
| Chicken | Difference | Difference | Rank | Negative | Positive |
| 1 | 1.5 | 1.5 | 10 |  | 10 |
| 2 | 1.2 | 1.2 | 9 |  | 9 |
| 3 | -0.2 | 0.2 | 2.5 | -2.5 |  |
| 4 | 0 | 0 |  |  |  |
| 5 | 0.5 | 0.5 | 4 |  | 4 |
| 6 | 0.7 | 0.7 | 6 |  | 6 |
| 7 | 0.8 | 0.8 | 7 |  | 7 |
| 8 | 1 | 1 | 8 |  | 8 |
| 9 | 0 | 0 |  |  |  |
| 10 | 0.6 | 0.6 | 5 |  | 5 |
| 11 | 0.2 | 0.2 | 2.5 |  | 2.5 |
| 12 | -0.01 | 0.01 | 1 | -1 |  |
|  |  |  |  |  |  |
|  |  | Sum of Positive Signed Ranks | | | *T+*= 51.5 |

Chickens 4 and 9 had no weight change. They are removed from the sample making *n* = 10.





*T* += 51.5 is in the upper tail of the sampling distribution. Using the continuity correction factor, we have:



Using *z* = 2.40, *p*–value = (1.0000 – .9918) = .0082

*p*–value < .05, reject *H*0. Conclude that median weight after is greater than the median weight before.

The feed provides a significant gain in the median weight.

42. *H*0: The two populations of product weights are identical

*H*a: The two populations of product weights are not identical

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Line 1 | Rank |  | Line 2 | Rank |
| 13.6 | 6.5 |  | 13.7 | 8 |
| 13.8 | 9 |  | 14.1 | 13 |
| 14.0 | 11.5 |  | 14.2 | 14 |
| 13.9 | 10 |  | 14.0 | 11.5 |
| 13.4 | 4 |  | 14.6 | 19 |
| 13.2 | 2 |  | 13.5 | 5 |
| 13.3 | 3 |  | 14.4 | 16.5 |
| 13.6 | 6.5 |  | 14.8 | 20 |
| 12.9 | 1 |  | 14.5 | 18 |
| 14.4 | 16.5 |  | 14.3 | 15 |
|  |  |  | 15.0 | 22 |
|  |  |  | 14.9 | 21 |
|  | *W* = 70 |  |  |  |





With *W*  = 70 is in the lower tail, we will use the continuity correction factor and the normal distribution approximation as follows



Using z = –2.93, the two–tailed *p*–value = 2(.0017) = .0034

*p*–value < .05; reject *H*0

Conclusion: The two populations of product weights are not identical. The population of product weights from production line 1 tends to be less that the population of product weights from production line 2.

43. *H*0: All populations of times are identical

*H*a: Not all populations of times are identical

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Method 1 | Rank |  | Method 2 | Rank |  | Method 3 | Rank |
| 68 | 8.5 |  | 62 | 4.5 |  | 58 | 2 |
| 74 | 15 |  | 73 | 14 |  | 67 | 7 |
| 65 | 6 |  | 75 | 16 |  | 69 | 10 |
| 76 | 17 |  | 68 | 8.5 |  | 57 | 1 |
| 77 | 18 |  | 72 | 12.5 |  | 59 | 3 |
| 72 | 12.5 |  | 70 | 11 |  | 62 | 4.5 |
| Sum of Ranks | 77 |  |  | 66.5 |  |  | 27.5 |



Using the *χ*2 table with *df*  = 2, *χ*2 = 7.96 shows the *p*–value is between .01 and .025

Using Excel or Minitab, the *p*–value for  *χ*2 = 7.96 is .0187.

*p*–value < .05, reject *H*0. Conclude that the three populations of times to complete a program evaluation are not identical. Method 3 tends to require the lowest times.

44. *H*0: All populations of managerial potential ratings are identical

*H*a: Not all populations of managerial potential ratings are identical

|  |  |  |  |
| --- | --- | --- | --- |
|  | No Program | Company | Off–Site |
|  | 16 | 12 | 7 |
|  | 9 | 20 | 1 |
|  | 10 | 17 | 4 |
|  | 15 | 19 | 2 |
|  | 11 | 6 | 3 |
|  | 13 | 18 | 8 |
|  |  | 14 | 5 |
| Sum of Ranks | 74 | 106 | 30 |



Using the *χ*2 table with *df*  = 2, *χ*2 = 12.61 shows the *p*–value is less than .005.

Using Excel or Minitab, the *p*–value for  *χ*2 = 12.61 is .0018.

*p*–value < .05, reject *H*0. Conclude that the three populations of managerial potential ratings are not identical. Engineers who attended the Off–Site program tend to have the highest potential ratings.

45. *H*0: All populations of teaching evaluations are identical

*H*a: Not all populations of teaching evaluations courses are identical

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Black | Rank | Jennings | Rank | Swanson | Rank | Wilson | Rank |
| 88 | 23.5 | 87 | 21.5 | 88 | 23.5 | 80 | 9.5 |
| 80 | 9.5 | 78 | 7 | 76 | 6 | 85 | 18.5 |
| 79 | 8 | 82 | 13 | 68 | 2.5 | 56 | 1 |
| 68 | 2.5 | 85 | 18.5 | 82 | 13 | 71 | 5 |
| 96 | 27 | 99 | 28.5 | 85 | 18.5 | 89 | 25 |
| 69 | 4 | 99 | 28.5 | 82 | 13 | 87 | 21.5 |
|  |  | 85 | 18.5 | 84 | 16 |  |  |
|  |  | 94 | 26 | 83 | 15 |  |  |
|  |  |  |  | 81 | 11 |  |  |
| Sum of Ranks | 74.5 |  | 161.5 |  | 118.5 |  | 80.5 |



Using the *χ*2 table with *df*  = 3, *χ*2 = 4.15 shows the *p*–value is greater than .10.

Using Excel or Minitab, the *p*–value for  *χ*2 = 4.15 is .2457.

*p*–value >.05, do not reject *H*0. We cannot reject the null hypothesis that the four populations of teaching evaluations are identical. There is no indication that there is a difference among the instructors based on these ratings.

46. = 136







*p*–value = 2(1.0000 – .9977) = .0046

*p*–value .10, reject H0. Conclude that there is a significant positive rank correlation between the two exams. Students who rank high on the midterm exam tend to rank high on the final exam.

47. Use the Kruskal–Wallis test for this exercise. Due to the size of the data set, we recommend using a computer solution.

Here are some of the calculations. The total sample size is 84.

*H*0: All populations of show ratings are identical

*H*a: Not all populations of show ratings are identical

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | ABC | CBS | FOX | NBC |
| Sample Size | 19 | 23 | 20 | 22 |
| Sum of Ranks | 820.5 | 764.5 | 956 | 1029 |



Using the *χ*2 table with *df* = 3, *χ*2 = 4.95 shows the *p*–value is greater than .10.

Using Excel or Minitab, the *p*–value for  *χ*2 = 4.95 is .1755.

*p*–value >.05, do not reject *H*0. We cannot reject the null hypothesis that the four populations of network shows are identical. There is no indication that there is a difference among the ratings for the four networks based on the sample ratings.

The printout from the Minitab Kruskal–Wallis test is as follows.

Kruskal–Wallis Test on Ratings

Network N Median Ave Rank Z

ABC 19 42.00 43.2 0.14

CBS 23 31.00 33.2 -2.14

FOX 20 55.50 47.8 1.11

NBC 22 48.00 46.8 0.96

Overall 84 42.5

H = 4.95 DF = 3 P = 0.176

Although we do not reject *H*0, the printout shows CBS with a median rating of 31 and an average rank of 33.2 appears to be doing the best of the four networks in terms of Nielsen ratings.