

Appendix F Methodology

Calculation of Risk Ratios

To calculate the risk ratio for ticketing for a particular group of students -- for example African-American students:

1. Calculate the rate of ticketing for African-American students. This is done by dividing the number of tickets African-American students received by the number of African-American students in the student body.
2. Calculate the rate of ticketing for all other students. This is done by dividing the number of tickets all other students received by the number of students, excluding African Americans, in the student body.
3. Divide the risk for African-American students by the risk for all other students to determine the risk ratio.

Example: Calculation of Risk Ratio for African-American students for Disruption of Class tickets:

1. 143 (number of tickets received by A-A students) / 3252 (no of A-A students in student body) = $.04397294$
2. 128 (number of tickets received by all other students) / 12359 (number of all other students) = $.010356825$
3. $.04397294 / .010356825 = 4.245793454$

Calculation of Standard Deviations Away from Expected Value:

To calculate standard deviations away from the expected value:

1. Calculate the expected number of tickets that would be issued to African-American students by multiplying the total number of tickets given times the African-American proportion of the student enrollment.
2. Calculate the standard deviation by taking the square root of the product of the total number of tickets issued times the probability of an African-American student receiving a ticket times the probability of a student of any other race or ethnicity receiving a ticket.
3. Calculate the difference between the expected number of tickets issued and the actual number of tickets issued to African-American students by subtracting the smaller number from the larger number.
4. Divide the standard deviation into the difference between the expected number and the actual number of tickets to find the number of standard deviations between the expected number and the actual number of tickets.

Applying the standard deviation analysis to the issuance of 2011-12 Bryan ISD “Disruption of Class” tickets: $271 \times .2083 = 56.45$; $271 \times .2083 \times .7916 = 44.58$ $\sqrt{44.58} = 6.68$; $143 - 56 = 87$ /
 $6.68 = 12.94$

- There were a total of 271 tickets; of those, African-American students received 143. *See* Table 3.
- African Americans were 20.83 percent of the total student enrollment (thus all other students were 79.16 percent of total enrollment).
- The expected number of “Disruption of Class” tickets based on the proportion of African-American students: 20.83 percent of 271 (total number of “Disruption of Class” tickets) equals 56.45.
- The standard deviation: 271 (total “Disruption of Class” tickets) times .2083 (proportion of student body who are African -American) times .7916 (proportion of student body who are not African -American) equals 44.58; the square root of which is 6.68. Thus the standard deviation is 6.68.
- The difference between the expected number and the actual number of tickets given to African-American students: 143 minus 56 equals 87.
- The number of standard deviations between the expected number and the actual number of tickets: 87 divided by 6.64 equals 12.94 standard deviations between the expected number and the actual number of “Disruption of Class” tickets.

Using the same analysis of the 2011-12 “Disorderly Conduct – Language” tickets: $105 \times .2083 = 22$; $105 \times .2083 \times .7916 = 17.27$ $\sqrt{17.27} = 4.16$; $54 - 22 = 32$ / $4.16 = 7.72$

- There were a total of 105 tickets; of those, African-American students received 54. *See* Table 3.
- African Americans were 20.83 percent of the total student enrollment (thus all other students were 79.16 percent of total enrollment).

- The expected number of “Disorderly Conduct – Language” tickets based on the proportion of African-American students: 20.83 percent of 105 (total number of “Disorderly Conduct – Language” tickets) equals 21.87.
- The standard deviation: 105 (total “Disorderly Conduct – Language” tickets) times .2083 (proportion of student body who are African-American) times .7916 (proportion of student body who are not African-American) equals 17.27; the square root of which is 4.16. Thus the standard deviation is 4.16.
- The difference between the expected number and the actual number of tickets given to African-American students: 54 minus 22 equals 32.
- The number of standard deviations between the expected number and the actual number of tickets: 32 divided by 4.16 equals 7.72 standard deviations between the expected number and the actual number of “Disorderly Conduct – Language” tickets.

Chi-Square Statistical Significance of Risk Ratios:

The chi-square test is a statistical test used to determine how likely it is that random chance causes the difference between the “observed” and “expected” frequencies of an event. As applied to the risk ratios for “Disruption of Class” and “Disorderly Conduct – Language” ticketing, “observed frequencies” are the actual number of tickets issued to African-American students and all other students. “Expected frequencies” are the number of tickets that would be issued if there were no relationship between a student’s race and his or her risk of being issued a ticket. The chi-square test shows that it is highly unlikely that the disparities in the risk ratios for “Disruption of Class” and “Disorderly Conduct – Language” ticketing are caused by random chance.

To calculate the chi-square, *first*, construct a table with the observed frequencies of tickets:

“Disruption of Class” Observed Frequencies	African-American Students	All Other Students	Total
Tickets Received	143	128	271
Not ticketed	3109	12231	15340
Total	3252	12359	15611

Second, construct a table with the expected frequencies of tickets received by students and who were not ticketed. To calculate the expected frequencies:

1. Divide the total number of African-American students by the total number of students to determine the proportion of African-American students in the student body (20.83%);
2. Multiply that proportion with the total number of “Disruption of Class” tickets to determine the number of tickets that would be expected to be issued to African-American students (56.45);
3. Multiply that proportion with the total number of students who did not receive tickets to determine the minimum number of African-American students who would be expected not to be ticketed (3195.55);
4. Divide the total number of all other students by the total number of students to determine the proportion of all other students in the student body (79.17%);
5. Multiply that proportion with the total number of tickets received by students to determine the number of tickets that would be expected to be issued to all other students (214.55);
6. Multiply that proportion with the total number of students who did not receive tickets to determine the minimum number of all other students who would be expected not to be ticketed (12144.45).

“Disruption of Class” Expected Frequencies	African-American Students	All Other Students	Total
Tickets Received	56.45	214.55	271
Not ticketed	3195.55	12144.45	15340
Total	3252	12359	15611

Third, calculate the chi-square value:

1. Determine the difference between each of the observed and expected frequencies;
2. Square that result; and
3. Divide that value by the expected frequency.

“Disruption of Class” Tickets	Tickets Received by African-American Students	Minimum Number of African-American Students <u>Not</u> Receiving Tickets	Tickets Received by All Other Students	Minimum Number of All Other Students <u>Not</u> Receiving Tickets
Difference between Observed and Expected Frequencies	86.55	86.55	86.55	86.55
Square of Difference between Frequencies	7490.90	7490.90	7490.90	7490.90
Divide Square by Expected Frequency	132.70	2.34	34.91	0.62

The chi-square is the sum of the resulting values (132.70; 2.34; 34.91; 0.62) which equals 170.57.

Finally, determine whether the chi-square value is significant:

1. Determine the degrees of freedom for these tables:
 - a. Figure out the number of possible values for each variable in these tables: there are two possible values for each of the variables in these tables (a student is either African-American or not; a student is either ticketed or not);
 - b. Subtract one from each of those numbers, leaving you with 1 for each variable;
 - c. Multiply the values for each variable, resulting in 1 degree of freedom.
2. Use a chi-square distribution table¹ to determine what value of chi-squared would be significant for one degree of freedom. For one degree of freedom:

Chi-Square Greater than	Level of Significance
3.84	.05
5.41	.02
6.64	.01
10.38	.001

¹ See, e.g., *Critical Values of the Chi-Square Distribution*, U.S. Department of Commerce, National Institute of Standards and Technology, available at: <http://www.itl.nist.gov/div898/handbook/eda/section3/eda3674.htm>.

3. Compare the calculated chi-square value to the table's values.

Because 170.57 is greater than 10.38, the chi-square value for “Disruption of Class” tickets is statistically significant at the level of .001, meaning that there is a greater than 99.9% chance that African-American students experience an increased risk of being ticketed for “Disruption of Class.”

Using the same methodology for “Disorderly Conduct – Language” tickets shows that the risk ratio for African-American students receiving tickets for “Disorderly Conduct – Language” is also statistically significant.

“Disorderly Conduct –Language” Observed Frequencies	African-American Students	All Other Students	Total
Tickets Received	54	51	105
Not ticketed	3198	12308	15506
Total	3252	12359	15611

“Disorderly Conduct –Language” Expected Frequencies	African-American Students	All Other Students	Total
Tickets Received	21.87	83.13	105
Not ticketed	3230.13	12275.87	15506
Total	3252	12359	15611

“Disorderly Conduct – Language” Tickets	Tickets Received by African- American Students	Minimum Number of African-American Students <u>Not</u> Receiving Tickets	Tickets Received by All Other Students	Minimum Number of All Other Students <u>Not</u> Receiving Tickets
Difference between Observed and Expected Frequencies	32.13	32.13	32.13	32.13
Square of Difference between Frequencies	1032.34	1032.34	1032.34	1032.34
Divide Square by Expected Frequency	47.20	0.32	12.42	.08

For “Disorderly Conduct – Language” tickets, the chi-square value is 60.02, meaning that there is also a greater than 99.9% chance that African-American students experience an increased risk of being ticketed for “Disorderly Conduct – Language.”