



Disparate Impact Analysis

(an On-Line Internet based application)

Instructions: Please fill out the information into the form below. Once you have entered your data below, you may select the types of analysis to be conducted by checking the appropriate boxes. Then press the compute button at the bottom of the form to view the results.

Select the type of employment decision: Selection ▼

Enter a title for your report:

Firefighter 2020

Sex

Number of Male

56 Applicants

48 Selected

Number of Female

2 Applicants

2 Selected

Race

Number of Non-Minority

45 Applicants

38 Selected

Number of Minority

13 Applicants

12 Selected

Age

Number of Younger

Applicants

Selected

Number of Older

Applicants

Selected

Disability

Number of Non-Disabled

Applicants

Selected

Number of Disabled

Applicants

Selected

- ☒ -Adverse Impact
- ☒ -Chi-Square
- ☒ -Standard Deviation
- ☒ -Confidence Intervals
- ☒ Probability Distribution

Select the Statistical Tests you wish to execute by checking or unchecking the boxes on the left. Then press the 'Compute' button below.

Compute

Display: ☒ Description of Statistic ☒ Interpretation of Results

Firefighter 2020

Adverse-Impact Report

[Adverse Impact](#) and the "four-fifths rule." - A selection rate for any race, sex, or ethnic group which is less than four-fifths (4/5ths) (or eighty percent) of the rate for the group with the highest rate will generally be regarded by the Federal enforcement agencies as evidence of adverse impact. [Uniform Guidelines on Employee Selection Procedures](#)

Rate of Female Applicants Selected	Rate of Male Applicants Selected	Adverse Impact Ratio for Female	Adverse Impact Ratio for Male
$(2/2) = 1$	$(48/56) = 0.8571$	$(1/0.8571)=1.17$	$(0.8571/1)=0.86$
Adverse impact as defined by the 4/5ths rule was not found in the above data.			

Rate of Minority Applicants Selected	Rate of NonMinority Applicants Selected	Adverse Impact Ratio for Minority	Adverse Impact Ratio for NonMinority
$(12/13) = 0.9231$	$(38/45) = 0.8444$	$(0.9231/0.8444)=1.09$	$(0.8444/0.9231)=0.91$
Adverse impact as defined by the 4/5ths rule was not found in the above data.			

Chi-Square Report

Observed Expected	Selected	Not Selected	Row Totals
Male	48 48.2759	8 7.7241	56
Female	2 1.7241	0 0.2759	2
Column Total	50	8	58

Chi-Square = 0.3314

The value of the statistic is less than 3.841. This indicates that there is a 95 percent chance that these results have been obtained absent any form of bias. Therefore, you may conclude that these results fall within normal random variations and are not the result of bias.

Observed Expected	Selected	Not Selected	Row Totals
NonMinority	38 38.7931	7 6.2069	45
Minority	12 11.2069	1 1.7931	13
Column Total	50	8	58

Chi-Square = 0.5245

The value of the statistic is less than 3.841. This indicates that there is a 95 percent chance that these results have been obtained absent any form of bias. Therefore, you may conclude that these results fall within normal random variations and are not the result of bias.

Standard-Deviation Report

The difference between the proportion of the protected class Selected and the proportion of all Applicants Selected has a normal distribution with a mean and standard deviation. The statistic is shown below:

$$\frac{(r / n) - p}{\sqrt{p * (1-p) / n} * \sqrt{1-q}}$$

*Analysis of proportion of Female Selected*where:

- **r = number of Female Selected.**
- **n = number of Selected (Female and Male).**
- **p = proportion of Applicants that are Female.**
- **q = proportion of Applicants Selected.**

	Selected	Not Selected	Row Totals
Male	48	8	56
Female	2	0	2
Column Total	50	8	58

$$r = 2$$

$$n = 50$$

$$p = 2 / 58 = 0.034$$

$$q = (2 + 48) / (2 + 56) = 0.862$$

Standard Deviation Statistic = 0.576

These results show that the proportion of Female Selected is 0.576 standard deviations above the proportion of Applicants Selected. A result of less than 2 standard deviations is generally considered non-significant.

*Analysis of proportion of Minority Selected*where:

- **r = number of Minority Selected.**
- **n = number of Selected (Minority and NonMinority).**
- **p = proportion of Applicants that are Minority.**
- **q = proportion of Applicants Selected.**

	Selected	Not Selected	Row Totals
NonMinority	38	7	45
Minority	12	1	13
Column Total	50	8	58

$$r = 12$$

$$n = 50$$

$$p = 13 / 58 = 0.224$$

$$q = (12 + 38) / (13 + 45) = 0.862$$

Standard Deviation Statistic = 0.724

These results show that the proportion of Minority Selected is 0.724 standard deviations above the proportion of Applicants Selected. A result of less than 2 standard deviations is generally considered non-significant.

Confidence Interval Report

The proportion of the protected class Selected has an expected value that would fall within a specified confidence interval.
The statistic is shown below:

Observed value = (r / n)

Expected value = p

Standard Deviation = $\sqrt{p * (1-p) / n} * \sqrt{1-q}$

Confidence Interval:

Lower Bound = $p - 1.96 * \text{Std Dev}$

Upper Bound = $p + 1.96 * \text{Std Dev}$

Analysis of proportion of Female Applicants Selectedwhere:

- **r = number of Female Selected.**
- **n = number of Applicants Selected.**
- **p = proportion of Female among those Selected.**
- **q = proportion of Applicants Selected.**

r = 2

n = 50

p = $(2/(2+56))=0.034$

q = $((2 + 48)/(2 + 56))=0.862$

(r/n)= $2/50=0.04$

The lower bound of the confidence interval is: $0.034-(1.96*0.01)=0.0157$

The upper bound of the confidence interval is: $0.034+(1.96*0.01)=0.0533$

Confidence Interval = 0.0157 to 0.0533

**These results show that the proportion of Female Female (r/n=0.04) is contained in the confidence interval.
Therefore a finding of disparate impact is not supported by this data.**

Analysis of proportion of Minority Applicants Selectedwhere:

- **r = number of Minority Selected.**
- **n = number of Applicants Selected.**
- **p = proportion of Minority among those Selected.**
- **q = proportion of Applicants Selected.**

r = 12

n = 50

p = $(13/(13+45))=0.224$

q = $((12 + 38)/(13 + 45))=0.862$

(r/n)= $12/50=0.24$

The lower bound of the confidence interval is: $0.224-(1.96*0.022)=0.1812$

The upper bound of the confidence interval is: $0.224+(1.96*0.022)=0.2671$

Confidence Interval = 0.1812 to 0.2671

**These results show that the proportion of Minority Minority (r/n=0.24) is contained in the confidence interval.
Therefore a finding of disparate impact is not supported by this data.**

Probability Distribution Report

Number Female Selected	Number Male Selected	Rate of Female Applicants Selected	Rate of Male Applicants Selected	Adverse Impact Ratio of Female	Adverse Impact against Female ?	Probability	Cumulative Probability
0	50	(0/2)	(50/56)	0	YES	0.016939	0.016939
1	49	(1/2)	(49/56)	0.5714	YES	0.241984	0.258923
Selected->2	48	(2/2)	(48/56)	1.1667	NO	0.741077	1

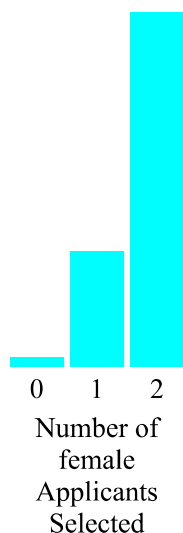
Given that 50 were Selected from a pool of 56 Male and 2 Female it was possible to have Selected from 0 to 2 females.

Adverse Impact would be found if you Selected 1 or fewer Female.

The probability of Adverse Impact occurring even if the employment decisions were random (i.e. unbiased) is 0.2589 (the sum of the probabilities of having Selected 1 or fewer Female).

Since the probability of Adverse Impact occurring even if the employment decisions were random (i.e. unbiased) is greater than 10%, an observed Adverse Impact may be not significant since the probability is greater than 1 in 10 that Adverse Impact would have occurred due to chance.

Probability Distribution of the variable: Number of Female Selected.



The probability distribution of having Selected from 0 to 2 females is displayed above. As can be seen, the most likely event (highest probability) to have occurred by chance (or decisions not affected by any form of bias) is to have Selected 2 female Applicants. This represents the mean of the probability distribution. Approximately half of the probability distribution is above this point and approximately half is below this point. The total area contained in the probability distribution is equal to 1. Thus, probabilities for each number of female Applicants Selected are a fraction of the total probability distribution. The larger areas of the distribution represent higher probabilities of occurrence. Adding the individual probabilities up to a certain point enable you to compute the probability of having Selected that many or fewer females Applicants. Adding the individual probabilities from a certain point and higher enable you to compute the probability of having Selected that many or more females Applicants.

The characteristics of the probability distribution--its mean and standard deviation--are a function of the number of female and male Applicants and the number of Applicants to be Selected. Though it is possible to have Selected from 0 to 2 female Applicants, the individual probabilities of having Selected each number of female Applicants can be computed and accumulated. As noted before, these individual probabilities are a function of the number of female and male Applicants and the number of Applicants to be Selected.

Using the distribution above, a 90 percent confidence interval on the variable 'Number of Female Selected' would have a lower bound of 1 and an upper bound of 2.

The significance of having Selected 2 or fewer Female is graphically displayed below.



As noted earlier, Adverse Impact, according to the 4/5ths rule, would be found if you Selected 1 *or fewer* female Applicants.

You have Selected 2 female Applicants. The probability of having Selected 2 *or fewer* Female is equal to the cumulative probability for having Selected 2 Female Applicants. The cumulative probability of having Selected 2 female Applicants is 1 and is graphically displayed, in red, above.

Since the probability is greater than 10%, we are unable to reject the hypothesis that the decisions occurred due to chance. Therefore, we must conclude that it is entirely possible that having Selected 2 or fewer female Applicants is an event that occurred due to chance and not from discriminatory actions by the employer.

Probability Distribution Report

Number Minority Selected	Number NonMinority Selected	Rate of Minority Applicants Selected	Rate of NonMinority Applicants Selected	Adverse Impact Ratio of Minority	Adverse Impact against Minority ?	Probability	Cumulative Probability
5	45	(5/13)	(45/45)	0.3846	YES	0.000001	0.000001
6	44	(6/13)	(44/45)	0.472	YES	0.000004	0.000041
7	43	(7/13)	(43/45)	0.5635	YES	0.000886	0.000927
8	42	(8/13)	(42/45)	0.6593	YES	0.009528	0.010455
9	41	(9/13)	(41/45)	0.7598	YES	0.055578	0.066033
10	40	(10/13)	(40/45)	0.8654	NO	0.182295	0.248328
11	39	(11/13)	(39/45)	0.9763	NO	0.331446	0.579774
Selected->12	38	(12/13)	(38/45)	1.0931	NO	0.307771	0.887545
13	37	(13/13)	(37/45)	1.2162	NO	0.112455	1

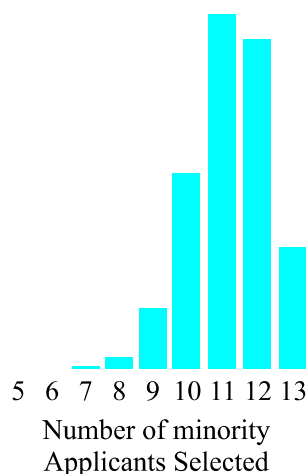
Given that 50 were Selected from a pool of 45 NonMinority and 13 Minority it was possible to have Selected from 5 to 13 minorities.

Adverse Impact would be found if you Selected 9 or fewer Minority.

The probability of Adverse Impact occurring even if the employment decisions were random (i.e. unbiased) is 0.066 (the sum of the probabilities of having Selected 9 or fewer Minority).

Since the probability of Adverse Impact occurring even if the selection was random (i.e. unbiased) is less than 10%, an observed Adverse Impact may be significant since there is a low probability that Adverse Impact would have occurred by chance.

Probability Distribution of the variable: Number of Minority Selected.

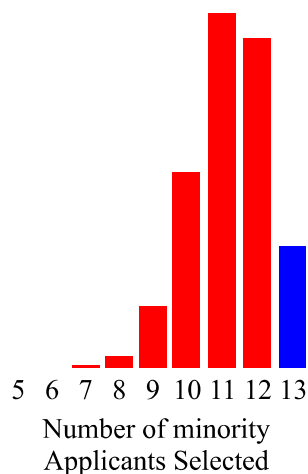


The probability distribution of having Selected from 5 to 13 minorities is displayed above. The graph above is shown starting with 5 since the probabilities below this point are near zero. As can be seen, the most likely event (highest probability) to have occurred by chance (or decisions not affected by any form of bias) is to have Selected 11 minority Applicants. This represents the mean of the probability distribution. Approximately half of the probability distribution is above this point and approximately half is below this point. The total area contained in the probability distribution is equal to 1. Thus, probabilities for each number of minority Applicants Selected are a fraction of the total probability distribution. The larger areas of the distribution represent higher probabilities of occurrence. Adding the individual probabilities up to a certain point enable you to compute the probability of having Selected that many or fewer minorities Applicants. Adding the individual probabilities from a certain point and higher enable you to compute the probability of having Selected that many or more minorities Applicants.

The characteristics of the probability distribution--its mean and standard deviation--are a function of the number of minority and non-minority Applicants and the number of Applicants to be Selected. Though it is possible to have Selected from 5 to 13 minority Applicants, the individual probabilities of having Selected each number of minority Applicants can be computed and accumulated. As noted before, these individual probabilities are a function of the number of minority and non-minority Applicants and the number of Applicants to be Selected.

Using the distribution above, a 90 percent confidence interval on the variable 'Number of Minority Selected' would have a lower bound of 9 and an upper bound of 13.

The significance of having Selected 12 or fewer Minority is graphically displayed below.



As noted earlier, Adverse Impact, according to the 4/5ths rule, would be found if you Selected 9 *or fewer* minority Applicants.

You have Selected 12 minority Applicants. The probability of having Selected 12 *or fewer* Minority is equal to the cumulative probability for having Selected 12 Minority Applicants. The cumulative probability of having Selected 12 minority Applicants is 0.8875 and is graphically displayed, in red, above.

Since the probability is greater than 10%, we are unable to reject the hypothesis that the decisions occurred due to chance. Therefore, we must conclude that it is entirely possible that having Selected 12 or fewer minority Applicants is an event that occurred due to chance and not from discriminatory actions by the employer.

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