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Introduction

Certain attire restrictions are imposed on students of ABC University. Students who fail to abide the regulations will receive summonses from the security guards at ABC UNIVERSITY. Some students complain about the restrictions as they claim that the restrictions imposed are not reasonable. On the contrary, the authorities insist on upholding the rules as they intend to promote professionalism among the students. Therefore, it is the intention of our group to find out the number of summonses received by female students and which restrictions they think should be abolished. The four restrictions under investigation are restriction of wearing short shirt (does not cover bottom), shirt with sleeves which do not reach wrists, pants which are too tight, and pants which are shorter than ankle length.

The method of random sampling in this investigation was cluster sampling. The population of our investigation was all ABC University female students. Since all ABC University female students stay in block 1, we took 20 students from three entrances each to fill in the questionnaire. The entrances were the first entrance, the forth entrance, and the sixth entrance. Hence, the sample size was 60. The questionnaire was as followed:-

Hello! We are doing a survey for our Mathematics project. Your help of answering the following questions is appreciated. This survey is anonymous, so please answer honestly. Thank you very much!

Gender:

How many summons(es) have you received due to improper attire from June 2005 to June 2006?

0 ☐	5 ☐
1 ☐	6 ☐
2 ☐	7 ☐
3 ☐	8 ☐
☐	☐

4	9	Others:____________

Which type(s) of restrictions do you think should be abolished? (If you think none of these should be abolished, you may leave it blank.)

☐ Short shirt (does not cover bottom)

☐ Sleeves of shirt do not reach wrists

☐ Too tight pants

☐ Pants must be at least ankle length

Our purpose of investigation is to find out the number of ABC University female students who receive summonses during the period June 2005 to June 2006 and the opinions of the students about whether or not the restrictions should be abolished. We have analysed each of the four restrictions under investigation in details.

To analyse the data, we have seek assistance from the graphic calculator. We have analysed discrete random distribution of number of female students of ABC University who received summonses from June 2005 to June 2006. For each restriction under investigation, we have investigated binomial distribution. Approximation to normal distribution was also used to analyse each restriction. In addition, number of restrictions students wish to abolish was examined as well. Furthermore, pie charts, dots plot, box-and-whisker plot, frequency distribution histogram, and bar graphs were used to describe the distribution. As for inferential statistics, we have estimated the true proportion of students who wish to abolish one restriction by a confidence level of 95%. The effects of varying sample size and confidence level on the confidence interval were also shown in this study.

There were limitations in this study and one of them was bias. This was because there was large proportion of Muslim students who dressed according to their religion belief which requires them to cover their ‘aourah’. Therefore, most Muslim students did not receive any summons. Another limitation was the statistical error. This was because we did not seek for evidence to prove the number of summonses they received. Some students may have forgotten the exact number of summonses they have received from June 2005 to June 2006 as this period was quite long. Furthermore, there would be a certain amount of chance variation even though all aspects of the sample were conducted properly. Thus, these were limitations that caused inaccuracy in our study.

Investigation 1: Number of summons received by female student of Ausmat 17

The Centre of a Distribution

Let X = number of summons issued

x_i	0	1	2	3	4	5	6
f_i	31	8	8	6	2	1	1
Relative frequency	0.517	0.133	0.133	0.100	0.0333	0.0167	0.0167
x_i	7	8	9	10	11	12	
f_i	0	1	0	1	0	1	
Relative frequency	0	0.0167	0	0.0167	0	0.0167	

Mean

By mean formula:

$$\bar{x} = \frac{\sum f_i x_i}{n}$$

$$= \frac{31(0)+8(1)+8(2)+6(3)+2(4)+1(5)+1(6)+0(7)+1(8)+0(9)+1(10)+0(11)+1(12)}{60}$$

= 1.52

Median

Median is the $\left[\frac{n+1}{2}\right]^{th}$ summons

$$= \frac{(60+1)}{2}$$

= 30.5

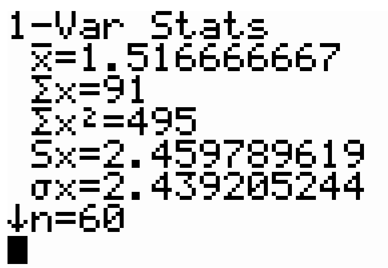
Therefore, the median lies between 30 and 31

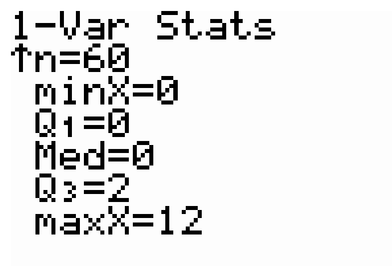
$= \frac{(0+0)}{2}$

$= 0$

Median = 0

By Graphic Calculator,

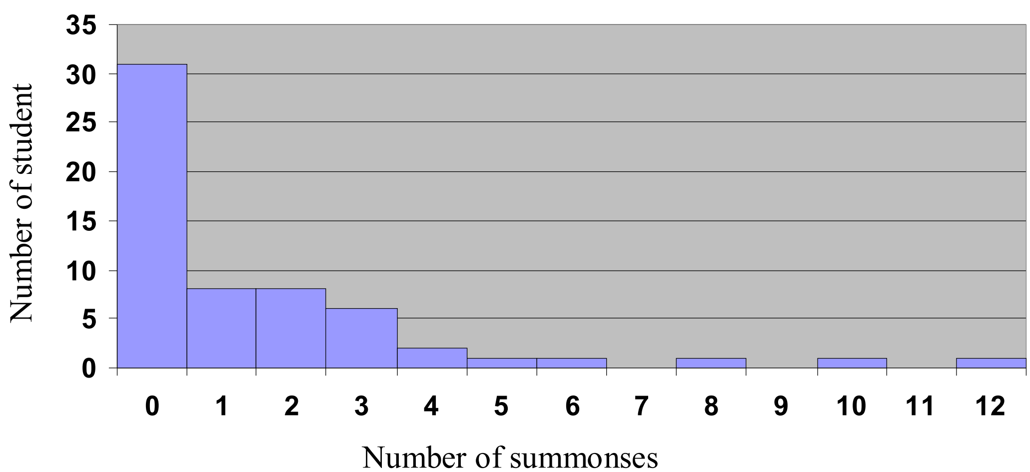




i.e.

Mean Sample = 1.52

Median = 0



Mode = 0

From the mean, it can be said that the average summonses received by ABC University female student is 1.52.

Median shows the middle value of the summons received by students which is zero.

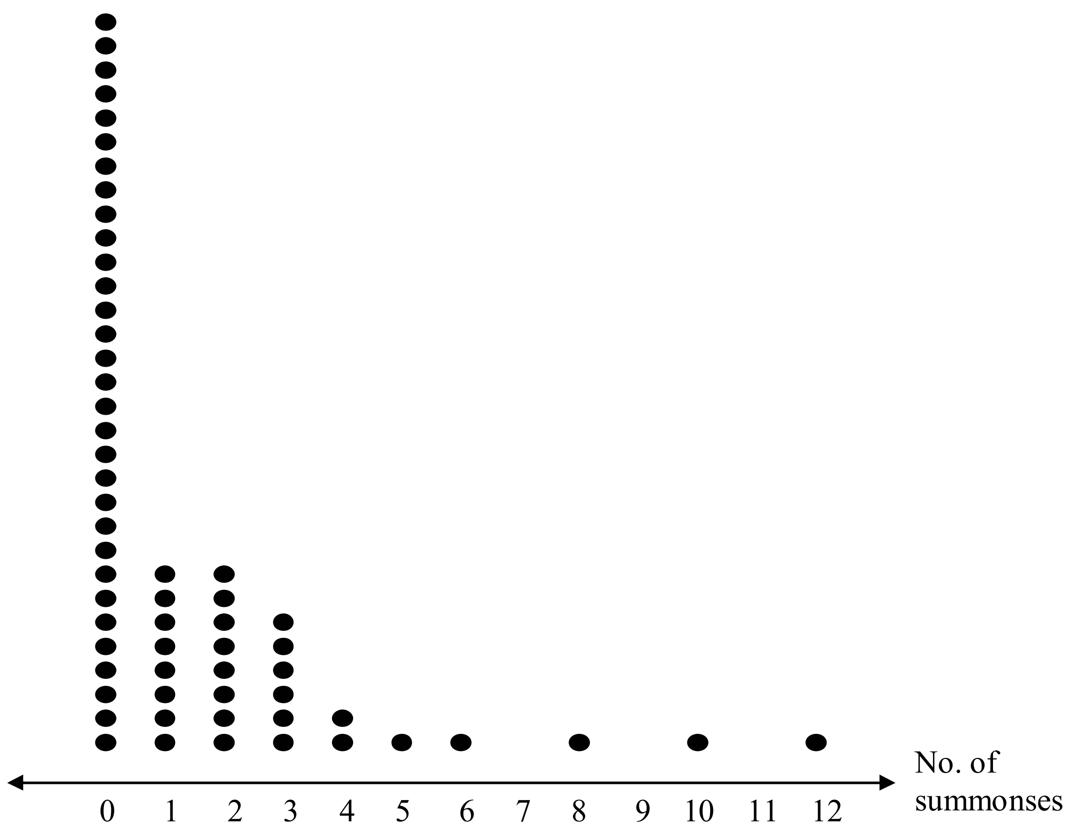
Also, from the distribution graph, it can be seen that the data is skewed to the right where only small number of students received more than 3 summonses.

The Variability (Spread) of a Distribution

Let X = Number of summonses that female students of ABC University received

x_i	0	1	2	3	4	5	6	7	8	9	10	11	12
f_i	31	8	8	6	2	1	1	0	1	0	1	0	1
p_i	$\frac{31}{60}$	$\frac{8}{60}$	$\frac{8}{60}$	$\frac{6}{60}$	$\frac{2}{60}$	$\frac{1}{60}$	$\frac{1}{60}$	0	$\frac{1}{60}$	0	$\frac{1}{60}$	0	$\frac{1}{60}$

Dots Plot



Dots plot shows the number of student received 0 to 12 summonses. It can be seen that the majority of student got 0 summon while there are 8 students got 1 summons and other 8 received 2 summonses. There are 6 students received 3 summonses, 2 students received 4 summonses and 1 student received 5, 6, 8, 10 and 12 summonses each.

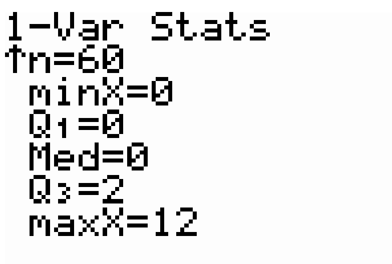
Range

= 12 – 0

= 12

Range shows the difference between the most summonses received and the minimum summonses received which is 12. However, for analysing the spread of the distribution, range is considered to be not as reliable as it involves only two data.

Interquartile Range



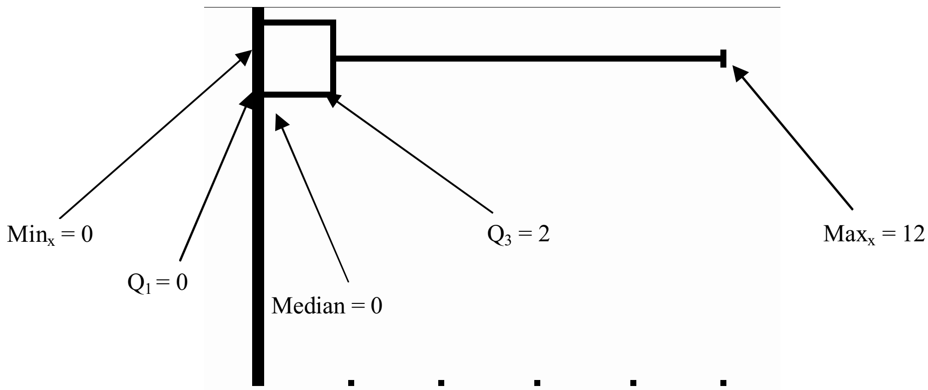
From the information from the Graphic Calculator, the

Interquartile range = $Q_3 - Q_1$

= 2 – 0

= 2

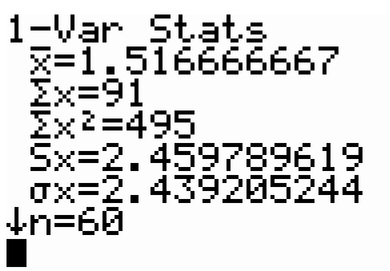
Box-and-whisker plot



The box-and-whisker plot shows that the probability distribution from minimum x value to median is 50%. From median to the 3rd quartile is 25% data and 25% of data lies between the 3rd quartile to maximum value. Same goes to the 1st quartile, from median to the 1st quartile is 25% and from the 1st quartile to minimum value is another 25% of data.

Standard Deviation

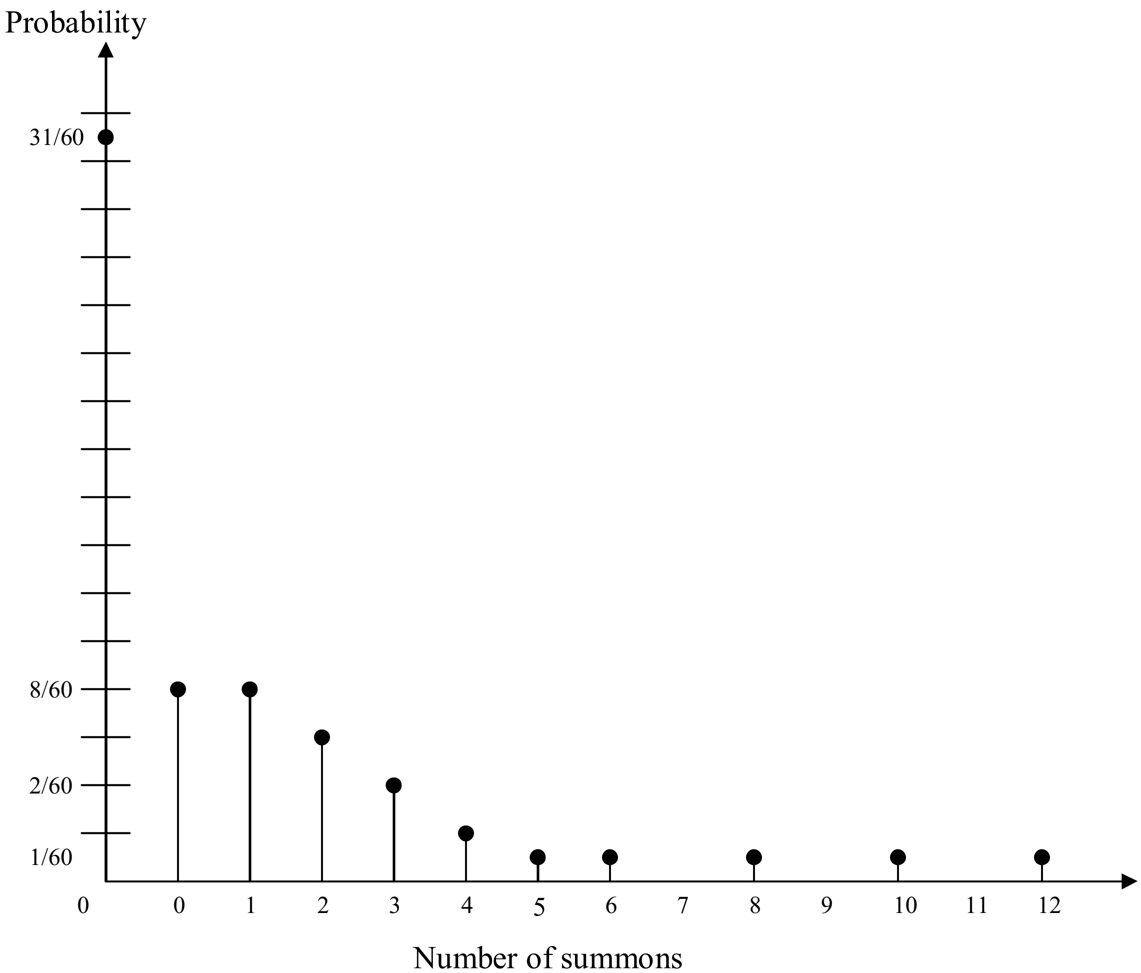
The standard deviation for the sample, s



By Graphic calculator, the standard deviation, s is 2.46.

This shows that the average deviation of the mean and the data of summonses received by students is 2.46.

Spike Plot



The spike plot shows the probability of students getting summons. The highest probability is 0.517 which is students do not receive any summons at all.

Conclusion

This investigation is divided into two parts that is the analysing of the centre distribution and the spread of the data. As for the centre distribution, it is found out that the average number of summonses received by student is 1.52 and the median is 0. It is also found out that the most number of summonses received is 0 which is the mode.

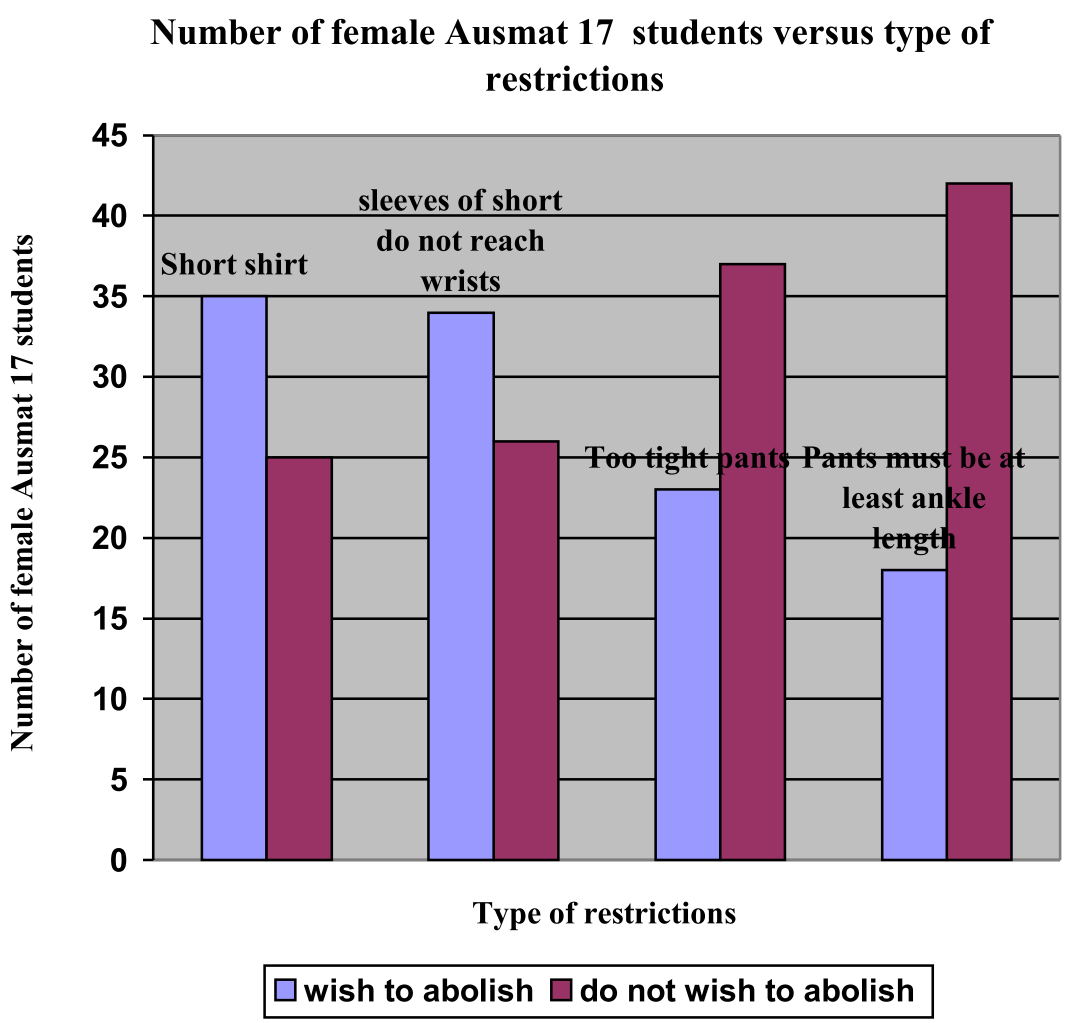
The second part of the investigation, the spread of data, shows how the data were distributed. The dot plot shows the numbers of student getting summons according to the sum of their summonses. For spike plot, it shows the probability of students who got 0, 1, 2, 3, and 4 summonses. The spread of the data can be seen when the box and whisker plot is constructed which shows that most data actually concentrated at 0.

As a conclusion, for sample of 60 female ABC University students from the period of June 2005 to June 2006, the highest probability of getting summonses which is 51.67%, is 0 summon. Also, the data are not evenly distributed as it tends to focused on 0, 1 and 2 summonses.

Investigation 2: Restrictions that female ABC University students wish to abolish

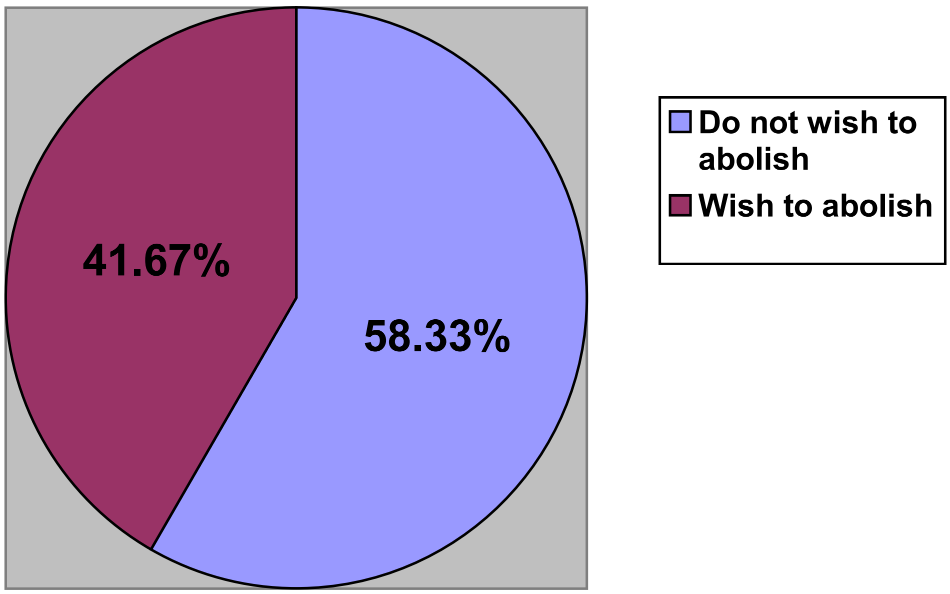
Number of ABC University female students who wish to abolish restrictions

Type of restrictions	Number of ABC University female students who wish to abolish restrictions
Short shirt (does not cover bottom)	35
Sleeves of shirt do not reach wrists	34
Too tight pants	23
Pants shorter than ankle length	18



Restriction 1: Short Shirt (does not cover bottom)

Type of restrictions	Number of ABC University female students who wish to abolish restrictions
Short shirt (does not cover bottom)	35



Percentage of female Ausmat 17 students who wish and do not wish to abolish the restriction of wearing short shirt

The Centre of a distribution

Binomial Distribution

X = Number of ABC University female students who wish to abolish the restriction of wearing short shirt which does not cover bottom

Sample size, n = 60

Probability of success, $p = \frac{35}{60} = 0.583$

Probability of failure, $q = 1 - p$

$= 1 - 0.583$

$= 0.417$

Mean, $\mu = np$

$= 60(0.583)$

$= 34.98$

≈ 35.0

Standard deviation, $\sigma = \sqrt{npq}$

$= \sqrt{(60)(0.583)(0.417)}$

$= 3.819$

≈ 3.82

X ~ Bin (60, 0.583)

What is the probability that majority of the female ABC University students wish to abolish the restriction of wearing short shirt which does not cover bottom?

$\Pr(x \geq 30) = 1 - \Pr(x \leq 29)$

$= 1 -$ binomcdf(60, 0.583, 29)

$= 0.9236$

≈ 0.924

Normal approximation

$$\left.\begin{array}{l} \text{Sample size, } n = 60 \\ np = 60(0.583) = 34.98 \\ nq = 60(0.417) = 25.02 \end{array}\right\} \quad \begin{array}{l} n \geq 30 \\ np \geq 10 \\ nq \geq 10 \end{array} \qquad \text{All conditions satisfied}$$

Mean, $\mu = 35.0$

Standard deviation, $\sigma = 3.82$

What is the probability that majority of the female ABC University students wish to abolish the restriction of wearing short shirt which does not cover bottom?

$$\begin{aligned} \Pr(x \geq 30) &= \Pr(x^* \geq 29.5) \\ &= \Pr\left(\frac{x^* - \mu}{\sigma} \geq \frac{29.5 - 35.0}{3.82}\right) \\ &= \Pr(z \geq -1.440) \\ &= \text{normalcdf}(-1.440, \text{E99}) \\ &= 0.925 \end{aligned}$$

Confidence Interval for a Proportion

To estimate the proportion of female ABC University students who wish to abolish the restriction of wearing short shirt which does not cover bottom, a sample proportion is examined.

Sample size, n = 60

Number of success, $x = 35$

Sample proportion, $\hat{p} = \frac{x}{n}$

$= \frac{35}{60}$

$= 0.583$

$\hat{q} = 1 - \hat{p}$

$= 1 - 0.583$

$= 0.417$

Confidence level = 95 %

Confidence interval

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.583 - 1.96\sqrt{\frac{(0.583)(0.417)}{60}} < p < 0.583 + 1.96\sqrt{\frac{(0.583)(0.417)}{60}}$$

$$0.459 < p < 0.708$$

We are 95% confident that the actual proportion of female ABC University who wishes to abolish the restriction of wearing short shirt which does not cover bottom lies between 45.9% and 70.8%.

The effect of increasing sample size, n on confidence interval

Consider samples of different size but all with p = 0.583 and q = 0.417 at 95% confidence level.

Sample size, n = 20

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.583 - 1.96\sqrt{\frac{(0.583)(0.417)}{20}} < p < 0.583 + 1.96\sqrt{\frac{(0.583)(0.417)}{20}}$$

$$0.367 < p < 0.799$$

Sample size, n = 40

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.583 - 1.96\sqrt{\frac{(0.583)(0.417)}{40}} < p < 0.583 + 1.96\sqrt{\frac{(0.583)(0.417)}{40}}$$

$$0.430 < p < 0.734$$

Sample size, n = 80

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.583 - 1.96\sqrt{\frac{(0.583)(0.417)}{80}} < p < 0.583 + 1.96\sqrt{\frac{(0.583)(0.417)}{80}}$$

$$0.475 < p < 0.691$$

Sample size, n = 100

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.583 - 1.96\sqrt{\frac{(0.583)(0.417)}{100}} < p < 0.583 + 1.96\sqrt{\frac{(0.583)(0.417)}{100}}$$

$$0.486 < p < 0.680$$

For various values of n we have:

Sample size, n	Confidence interval
20	0.367 < p < 0.799
40	0.430 < p < 0.734
60	0.459 < p < 0.708
80	0.475 < p < 0.691
100	0.486 < p < 0.680

We see that increasing the sample size, n produces confidence intervals for proportion of narrower width.

The effect of increasing confidence level on confidence interval

Consider different confidence level but all with p = 0.583 and q = 0.417 with sample size, n = 60.

Confidence level = 90%

$$\hat{p} - 1.645\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.645\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.583 - 1.645\sqrt{\frac{(0.583)(0.417)}{60}} < p < 0.583 + 1.645\sqrt{\frac{(0.583)(0.417)}{60}}$$

$$0.478 < p < 0.688$$

Confidence level = 98%

$$\hat{p} - 2.326\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 2.326\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.583 - 2.326\sqrt{\frac{(0.583)(0.417)}{60}} < p < 0.583 + 2.326\sqrt{\frac{(0.583)(0.417)}{60}}$$

$$0.435 < p < 0.731$$

Confidence level = 99%

$$\hat{p} - 2.576\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 2.576\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.583 - 2.576\sqrt{\frac{(0.583)(0.417)}{60}} < p < 0.583 + 2.576\sqrt{\frac{(0.583)(0.417)}{60}}$$

$$0.419 < p < 0.747$$

For various values of confidence level, we have:

Confidence level	a	Confidence interval
90%	1.645	$0.478 < p < 0.688$
95%	1.960	$0.459 < p < 0.708$
98%	2.326	$0.435 < p < 0.731$
99%	2.576	$0.419 < p < 0.747$

We see that increasing the confidence level produces wider confidence interval.

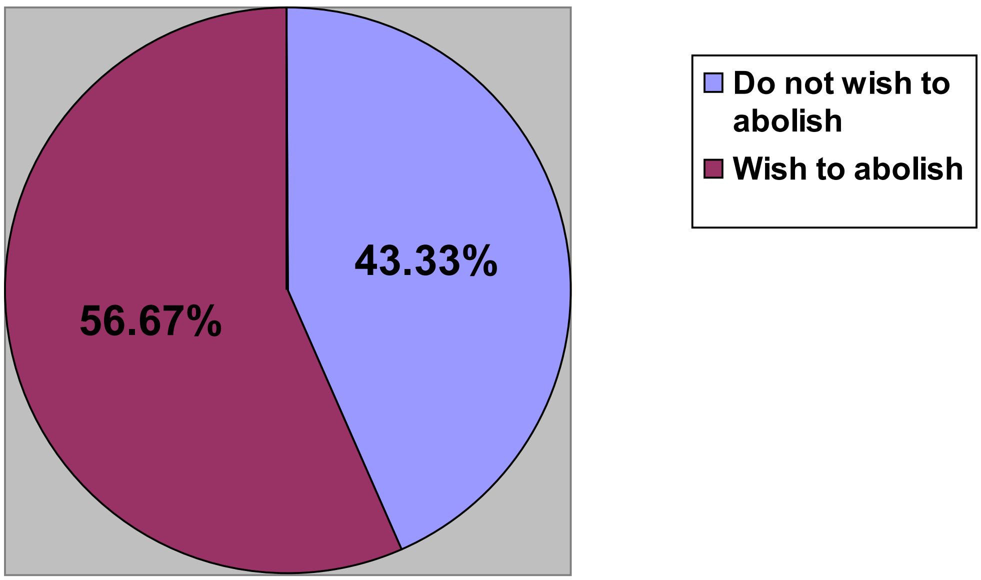
Conclusion

By using binomial distribution and normal approximation, we discover that the chance of majority of the female ABC University students who wish to abolish the restriction of wearing short shirt which does not cover bottom is 92.5%. This is supported by the fact that the estimated true proportion of female ABC University who wish to abolish the restriction of wearing short shirt which does not cover bottom lies between 45.9% and 70.8% at 95% confidence level. Although this indicates that it is possible that less than 50% of the students wish to abolish the restriction, there is a greater chance that majority, which is more than 50%, of the female ABC University students wish to abolish the restriction as 50% lies near the lower end of the confidence interval while the confidence interval is towards the majority.

Therefore, we are 95% confident that the true proportion of the female ABC University students wish to abolish the restriction of wearing short shirt which does not cover bottom lies between 45.9% and 70.8% and that there is 92.5% chance that majority of the female ABC University students wish to abolish the restriction.

Restriction 2: Sleeves of shirt do not reach wrists

Type of restrictions	Number of ABC University female students who wish to abolish restrictions
Sleeves of shirt do not reach wrists	34



Percentage of female Ausmat 17 students who wish and do not wish to abolish the restriction of wearing shirts with sleeves which do not reach wrists

The Centre of a distribution

Binomial Distribution

X = Number of ABC University female students who wish to abolish the restriction of wearing shirt with sleeves not reaching wrists

Sample size, n = 60

Probability of success, $p = \frac{34}{60} = 0.567$

Probability of failure, $q = 1 - p$

$= 1 - 0.567$

$= 0.433$

Mean, $\mu = np$

$= 60(0.567)$

$= 34.02$

≈ 34.0

Standard deviation, $\sigma = \sqrt{npq}$

$= \sqrt{(60)(0.567)(0.433)}$

$= 3.838$

≈ 3.84

X ~ Bin (60, 0.567)

What is the probability that majority of the female ABC University students wish to abolish the restriction of wearing shirt with sleeves not reaching wrists?

$\Pr(x \geq 30) = 1 - \Pr(x \leq 29)$

$= 1 -$ binomcdf(60, 0.567, 29)

$= 0.8802$

≈ 0.880

Normal approximation

$$\left.\begin{array}{l} \text{Sample size, } n = 60 \\ np = 60(0.567) = 34.02 \\ nq = 60(0.433) = 25.98 \end{array}\right\} \quad \begin{array}{l} n \geq 30 \\ np \geq 10 \\ nq \geq 10 \end{array} \quad \text{conditions satisfied}$$

Mean, $\mu = 34.0$

Standard deviation, $\sigma = 3.84$

What is the probability that majority of the female ABC University students wish to abolish the restriction of wearing shirt with sleeves not reaching wrists?

$$\begin{aligned} \Pr(x \geq 30) &= \Pr(x^* \geq 29.5) \\ &= \Pr\left(\frac{x^* - \mu}{\sigma} \geq \frac{29.5 - 34.0}{3.84}\right) \\ &= \Pr(z \geq -1.172) \\ &= \text{normalcdf}(-1.172, \text{E99}) \\ &= 0.879 \end{aligned}$$

Confidence Interval for a Proportion

To estimate the proportion of female ABC University students who wish to abolish the restriction of wearing shirt with sleeves not reaching wrists, a sample proportion is examined.

Sample size, n = 60

Number of success, $x = 34$

Sample proportion, $\hat{p} = \dfrac{x}{n}$

$$= \frac{34}{60}$$

$$= 0.567$$

$\hat{q} = 1 - \hat{p}$

$= 1 - 0.567$

$= 0.433$

Confidence level = 95 %

Confidence interval

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.567 - 1.96\sqrt{\frac{(0.567)(0.433)}{60}} < p < 0.576 + 1.96\sqrt{\frac{(0.567)(0.433)}{60}}$$

$$0.441 < p < 0.692$$

We are 95% confident that the actual proportion of female ABC University who wish to abolish the restriction of wearing shirt with sleeves not reaching wrists lies between 44.1% and 69.2%.

The effect of increasing sample size, n on confidence interval

Consider samples of different size but all with p = 0.567 and q = 0.433 at 95% confidence level.

Sample size, n = 20

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.567 - 1.96\sqrt{\frac{(0.567)(0.433)}{20}} < p < 0.576 + 1.96\sqrt{\frac{(0.567)(0.433)}{20}}$$

$$0.350 < p < 0.784$$

Sample size, n = 40

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.567 - 1.96\sqrt{\frac{(0.567)(0.433)}{40}} < p < 0.576 + 1.96\sqrt{\frac{(0.567)(0.433)}{40}}$$

$$0.413 < p < 0.721$$

Sample size, n = 80

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.567 - 1.96\sqrt{\frac{(0.567)(0.433)}{80}} < p < 0.576 + 1.96\sqrt{\frac{(0.567)(0.433)}{80}}$$

$$0.458 < p < 0.676$$

Sample size, n = 100

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.567 - 1.96\sqrt{\frac{(0.567)(0.433)}{100}} < p < 0.576 + 1.96\sqrt{\frac{(0.567)(0.433)}{100}}$$

$$0.470 < p < 0.664$$

For various values of n we have:

Sample size, n	Confidence interval
20	0.350 < p < 0.784
40	0.413 < p < 0.721
60	0.441 < p < 0.692
80	0.458 < p < 0.676
100	0.470 < p < 0.664

We see that increasing the sample size, n produces confidence intervals for proportion of narrower width.

The effect of increasing confidence level on confidence interval

Consider different confidence level but all with p = 0.567 and q = 0.433 with sample size, n = 60.

Confidence level = 90%

$$\hat{p} - 1.645\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.645\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.567 - 1.645\sqrt{\frac{(0.567)(0.433)}{60}} < p < 0.567 + 1.645\sqrt{\frac{(0.567)(0.433)}{60}}$$

0.462 < p < 0.672

Confidence level = 98%

$$\hat{p} - 2.326\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 2.326\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.567 - 2.326\sqrt{\frac{(0.567)(0.433)}{60}} < p < 0.567 + 2.326\sqrt{\frac{(0.567)(0.433)}{60}}$$

0.418 < p < 0.716

Confidence level = 99%

$$\hat{p} - 2.576\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 2.576\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.567 - 2.576\sqrt{\frac{(0.567)(0.433)}{60}} < p < 0.567 + 2.576\sqrt{\frac{(0.567)(0.433)}{60}}$$

$$0.402 < p < 0.732$$

For various values of confidence level, we have:

Confidence level	a	Confidence interval
90%	1.645	$0.462 < p < 0.672$
95%	1.960	$0.441 < p < 0.692$
98%	2.326	$0.418 < p < 0.716$
99%	2.576	$0.402 < p < 0.732$

We see that increasing the confidence level produces wider confidence interval.

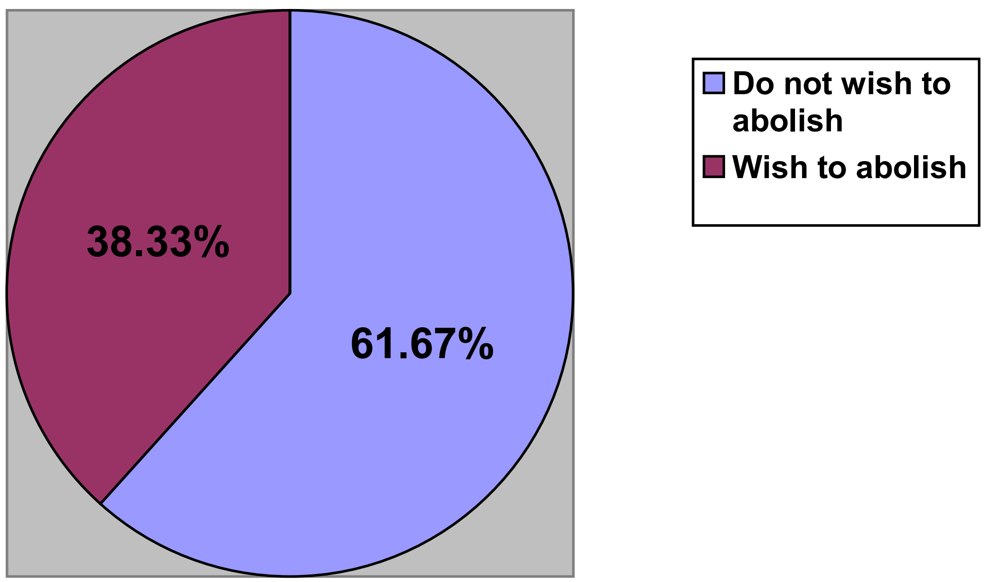
Conclusion

By using binomial distribution and normal approximation, we discover that the chance of majority of the female ABC University students who wish to abolish the restriction of wearing shirt with sleeves not reaching wrists is 88.0%. This is supported by the fact that the estimated true proportion of female ABC University who wish to abolish the restriction of wearing short shirt which does not cover bottom lies between 44.1% and 69.2% at 95% confidence level. Although this indicates that it is possible that less than 50% of the students wish to abolish the restriction, there is a greater chance that majority, which is more than 50%, of the female ABC University students wish to abolish the restriction as 50% lies near the lower end of the confidence interval while the confidence interval is towards the majority.

Therefore, we are 95% confident that the true proportion of the female ABC University students wish to abolish the restriction of wearing short shirt which does not cover bottom lies between 44.1% and 69.2% and that there is 88.0% chance that majority of the female ABC University students wish to abolish the restriction.

Restriction 3: Too tight pants

Type of restrictions	Number of ABC University female students who wish to abolish restrictions
Too tight pants	23



Percentage of female ABC University students who wish and do not wish to abolish the restriction of wearing too tight pants

The Centre of a distribution

Binomial Distribution

X = Number of ABC University female students who wish to abolish the restriction of wearing too tight pants

Sample size, n = 60

Probability of success, $p = \frac{23}{60} = 0.383$

Probability of failure, $q = 1 - p$

$= 1 - 0.383$

$= 0.617$

Mean, $\mu = np$

$= 60(0.383)$

$= 22.98$

≈ 23.0

Standard deviation, $\sigma = \sqrt{npq}$

$= \sqrt{60\,(0.383)(0.617)}$

$= 3.765$

≈ 3.77

X ~ Bin (60, 0.383)

What is the probability that majority of the female ABC University students wish to abolish the restriction of wearing too tight pants?

$\Pr(x \geq 30) = 1 - \Pr(x \leq 29)$

$= 1 -$ binomcdf(60, 0.383, 29)

$= 0.04305$

≈ 0.0431

Normal approximation

Sample size, n = 60	$n \geq 30$	
np = 60(0.383) = 22.98	$np \geq 10$	conditions satisfied
nq = 60(0.617) = 37.02	$nq \geq 10$	

Mean, $\mu = 23.0$

Standard deviation, $\sigma = 3.77$

What is the probability that majority of the female ABC University students wish to abolish the restriction of wearing too tight pants?

$$\Pr(x \geq 30) = \Pr(x^* \geq 29.5)$$

$$= \Pr\left(\frac{x^* - \mu}{\sigma} \geq \frac{29.5 - 23.0}{3.77}\right)$$

$$= \Pr(z \geq 1.724)$$

$$= \text{normalcdf}(-1.724, \text{E99})$$

$$= 0.0424$$

Confidence Interval for a Proportion

To estimate the proportion of female ABC University students who wish to abolish the restriction of wearing too tight pants, a sample proportion is examined.

Sample size, n = 60

Number of success, x = 23

Sample proportion, $\hat{p} = \dfrac{x}{n}$

$= \dfrac{23}{60}$

$= 0.383$

$\hat{q} = 1 - \hat{p}$

$= 1 - 0.567$

$= 0.617$

Confidence level = 95 %

Confidence interval

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.383 - 1.96\sqrt{\frac{(0.383)(0.617)}{60}} < p < 0.383 + 1.96\sqrt{\frac{(0.383)(0.617)}{60}}$$

$$0.260 < p < 0.506$$

We are 95% confident that the actual proportion of female ABC University who wish to abolish the restriction of wearing too tight pants lies between 26.0% and 50.6%.

The effect of increasing sample size, n on confidence interval

Consider samples of different size but all with p = 0.383 and q = 0.617 at 95% confidence level.

Sample size, n = 20

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.383 - 1.96\sqrt{\frac{(0.383)(0.617)}{20}} < p < 0.383 + 1.96\sqrt{\frac{(0.383)(0.617)}{20}}$$

$$0.170 < p < 0.796$$

Sample size, n = 40

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.383 - 1.96\sqrt{\frac{(0.383)(0.617)}{40}} < p < 0.383 + 1.96\sqrt{\frac{(0.383)(0.617)}{40}}$$

$$0.232 < p < 0.534$$

Sample size, n = 80

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.383 - 1.96\sqrt{\frac{(0.383)(0.617)}{80}} < p < 0.383 + 1.96\sqrt{\frac{(0.383)(0.617)}{80}}$$

$$0.276 < p < 0.490$$

Sample size, n = 100

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.383 - 1.96\sqrt{\frac{(0.383)(0.617)}{100}} < p < 0.383 + 1.96\sqrt{\frac{(0.383)(0.617)}{100}}$$

$$0.288 < p < 0.478$$

For various values of n we have:

Sample size, n	Confidence interval
20	0.170 < p < 0.796
40	0.232 < p < 0.534
60	0.260 < p < 0.506
80	0.276 < p < 0.490
100	0.288 < p < 0.478

We see that increasing the sample size, n produces confidence intervals for proportion of narrower width.

The effect of increasing confidence level on confidence interval

Consider different confidence level but all with p = 0.383 and q = 0.617 with sample size, n = 60.

Confidence level = 90%

$$\hat{p} - 1.645\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.645\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.383 - 1.645\sqrt{\frac{(0.383)(0.617)}{60}} < p < 0.383 + 1.645\sqrt{\frac{(0.383)(0.617)}{60}}$$

$$0.280 < p < 0.486$$

Confidence level = 98%

$$\hat{p} - 2.326\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 2.326\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.383 - 2.326\sqrt{\frac{(0.383)(0.617)}{60}} < p < 0.383 + 2.326\sqrt{\frac{(0.383)(0.617)}{60}}$$

$$0.237 < p < 0.529$$

Confidence level = 99%

$$\hat{p} - 2.576\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 2.576\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.383 - 2.576\sqrt{\frac{(0.383)(0.617)}{60}} < p < 0.383 + 2.576\sqrt{\frac{(0.383)(0.617)}{60}}$$

$$0.221 < p < 0.545$$

For various values of confidence level, we have:

Confidence level	a	Confidence interval
90%	1.645	0.280 < p < 0.486
95%	1.960	0.260 < p < 0.506
98%	2.326	0.237 < p < 0.529
99%	2.576	0.221 < p < 0.545

We see that increasing the confidence level produces wider confidence interval.

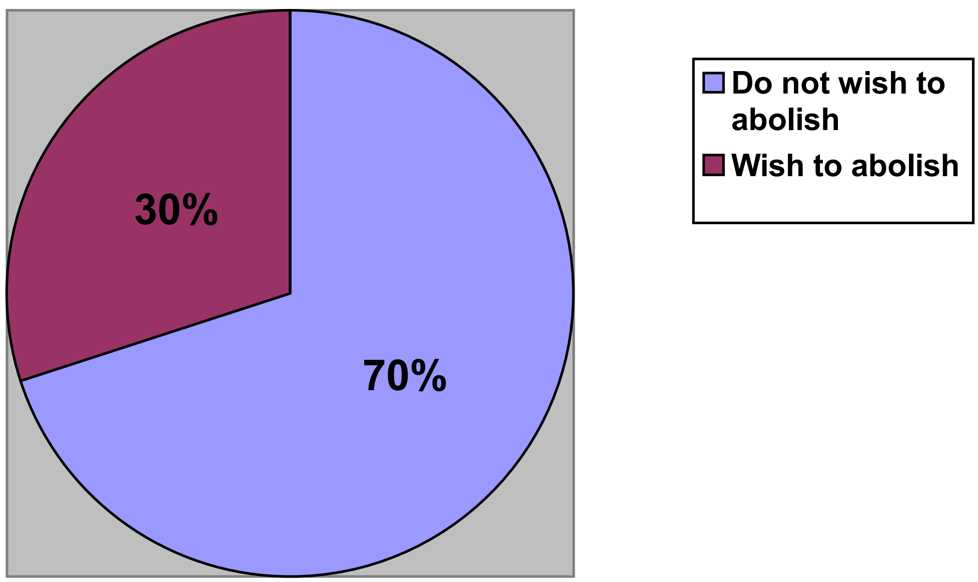
Conclusion

By using binomial distribution and normal approximation, we discover that the chance of majority of the female ABC University students who wish to abolish the restriction of wearing too tight pants is very small which is 4.31%. This is supported by the fact that the estimated true proportion of female ABC University who wish to abolish the restriction of wearing too tight pants lies between 26.0% and 50.6% at 95% confidence level. Although this indicates that it is possible that more than 50% of the students wish to abolish the restriction, there is a greater chance that minority, which is less than 50%, of the female ABC University students wish to abolish the restriction as 50% lies near the lower end of the confidence interval and the confidence interval is towards the minority.

Therefore, we are 95% confident that the true proportion of the female ABC University students wish to abolish the restriction of wearing too tight pants lies between 26.0% and 50.6% and that there is very small chance which is 4.31% that majority of the female ABC University students wish to abolish the restriction.

Restriction 4: Pants shorter than ankle length

Type of restrictions	Number of ABC Universityfemale students who wish to abolish restrictions
Pants shorter than ankle length	18



Percentage of female ABC University students who wish and do not wish to abolish the restriction of wearing pants shorter than ankle length

The Centre of a distribution

Binomial Distribution

X = Number of ABC University female students who wish to abolish the restriction of wearing pants shorter than ankle length

Sample size, n = 60

Probability of success, $p = \frac{18}{60} = 0.300$

Probability of failure, $q = 1 - p$

$= 1 - 0.300$

$= 0.700$

Mean, $\mu = np$

$= 60(0.300)$

$= 18.0$

Standard deviation, $\sigma = \sqrt{npq}$

$= \sqrt{(60)(0.300)(0.700)}$

$= 3.549$

≈ 3.55

$X \sim Bin\ (60, 0.300)$

What is the probability that majority of the female ABC University students wish to abolish the restriction of wearing pants shorter than ankle length?

$Pr\ (x \geq 30) = 1 - Pr\ (x \leq 29)$

$= 1 - \text{binomcdf}(60, 0.300, 29)$

$= 0.0009128$

≈ 0.000913

Normal approximation

Sample size, n = 60	$n \geq 30$	
np = 60(0.300) = 18.0	$np \geq 10$	conditions satisfied
nq = 60(0.700) = 42.0	$nq \geq 10$	

Mean, $\mu = 18.0$

Standard deviation, $\sigma = 3.55$

What is the probability that majority of the female ABC University students wish to abolish the restriction of wearing pants shorter than ankle length?

$$\Pr(x \geq 30) = \Pr(x^* \geq 29.5)$$

$$= \Pr\left(\frac{x^* - \mu}{\sigma} \geq \frac{29.5 - 18.0}{3.55}\right)$$

$$= \Pr(z \geq 3.239)$$

$$= \text{normalcdf}(3.239, E99)$$

$$= 0.0005998$$

Confidence Interval for a Proportion

To estimate the proportion of female ABC University students who wish to abolish the restriction of wearing pants shorter than ankle length, a sample proportion is examined.

Sample size, n = 60

Number of success, $x = 18$

Sample proportion, $\hat{p} = \frac{x}{n}$

$= \frac{18}{60}$

$= 0.300$

$\hat{q} = 1 - \hat{p}$

$= 1 - 0.300$

$= 0.700$

Confidence level = 95 %

Confidence interval

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.300 - 1.96\sqrt{\frac{(0.300)(0.700)}{60}} < p < 0.300 + 1.96\sqrt{\frac{(0.300)(0.700)}{60}}$$

$$0.184 < p < 0.416$$

We are 95% confident that the actual proportion of female ABC University who wishes to abolish the restriction of wearing pants shorter than ankle length lies between 18.4% and 41.6%.

The effect of increasing sample size, n on confidence interval

Consider samples of different size but all with p = 0.300 and q = 0.700 at 95% confidence level.

Sample size, n = 20

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.300 - 1.96\sqrt{\frac{(0.300)(0.700)}{20}} < p < 0.300 + \sqrt{\frac{(0.300)(0.700)}{20}}$$

$$0.0992 < p < 0.501$$

Sample size, n = 40

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.300 - 1.96\sqrt{\frac{(0.300)(0.7000)}{40}} < p < 0.300 - 1.96\sqrt{\frac{(0.300)(0.700)}{40}}$$

$$0.156 < p < 0.442$$

Sample size, n = 80

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.300 - 1.96\sqrt{\frac{(0.300)(0.700)}{80}} < p < 0.300 + 1.96\sqrt{\frac{(0.300)(0.700)}{80}}$$

$$0.200 < p < 0.400$$

Sample size, n = 100

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.96\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.300 - 1.96\sqrt{\frac{(0.300)(0.700)}{100}} < p < 0.300 + 1.96\sqrt{\frac{(0.300)(0.700)}{100}}$$

$$0.210 < p < 0.390$$

For various values of n we have:

Sample size, n	Confidence interval
20	0.0992 < p < 0.501
40	0.156 < p < 0.442
60	0.184 < p < 0.416
80	0.200 < p < 0.400
100	0.210 < p < 0.390

We see that increasing the sample size, n produces confidence intervals for proportion of narrower width.

The effect of increasing confidence level on confidence interval

Consider different confidence level but all with p = 0.300 and q = 0.700 with sample size, n = 60.

Confidence level = 90%

$$\hat{p} - 1.645\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 1.645\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.300 - 1.645\sqrt{\frac{(0.300)(0.700)}{60}} < p < 0.300 + 1.645\sqrt{\frac{(0.300)(0.700)}{60}}$$

$$0.203 < p < 0.397$$

Confidence level = 98%

$$\hat{p} - 2.326\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 2.326\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.300 - 2.326\sqrt{\frac{(0.300)(0.700)}{60}} < p < 0.300 + 2.326\sqrt{\frac{(0.300)(0.700)}{60}}$$

$$0.162 < p < 0.438$$

Confidence level = 99%

$$\hat{p} - 2.576\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + 2.576\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.300 - 2.576\sqrt{\frac{(0.300)(0.700)}{60}} < p < 0.300 + 2.576\sqrt{\frac{(0.300)(0.700)}{60}}$$

$$0.148 < p < 0.452$$

For various values of confidence level, we have:

Confidence level	a	Confidence interval
90%	1.645	0.203 < p < 0.397
95%	1.960	0.184 < p < 0.416
98%	2.326	0.162 < p < 0.438
99%	2.576	0.148 < p < 0.452

We see that increasing the confidence level produces wider confidence interval.

Conclusion

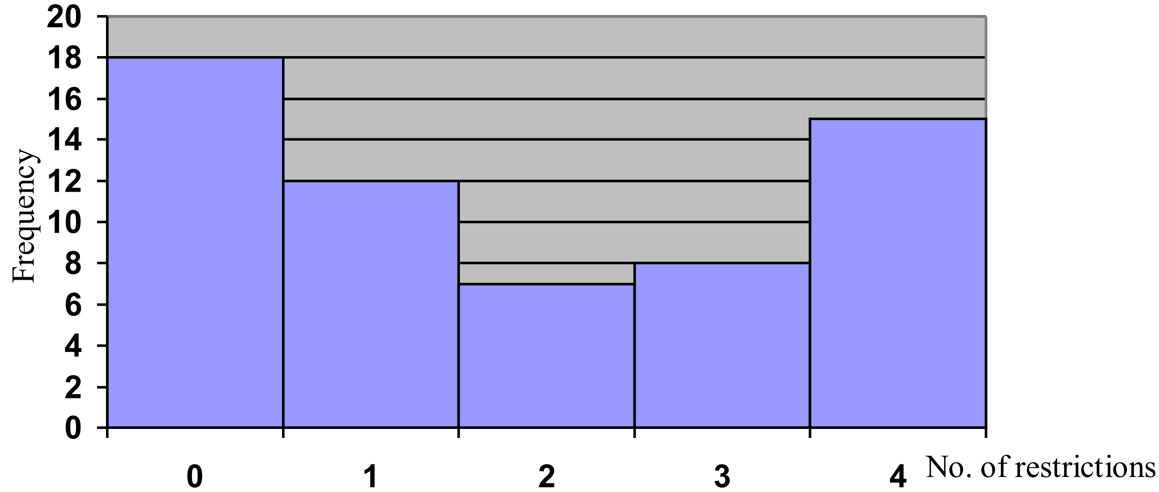
By using binomial distribution, we discover that the chance of majority of the female ABC University students who wish to abolish the restriction of wearing pants shorter than ankle length is 0.0913%. The normal approximation shows similar trend as calculated chance of majority of the female ABC University students who wish to abolish this restriction is 0.05998%. Both of the calculated value indicates that the chance of majority of the female ABC University students who wish to abolish this particular restriction is significantly small. This is supported by the fact that the estimated true proportion of female ABC University who wish to abolish the restriction of wearing pants shorter than ankle length lies between 18.4% and 41.6% at 95% confidence level. This indicates that it is impossible that more than 50% of the students wish to abolish the restriction as the confidence interval is towards the minority.

We are 95% confident that the true proportion of the female ABC University students wish to abolish the restriction of wearing pants shorter than ankle length lies between 18.4% and 41.6% and that there is very small chance that majority of the female

ABC University students wish to abolish the restriction. Therefore, we can say that only minority of the female ABC University students wish to abolish the restriction of wearing pants shorter than ankle length.

Investigation 3: Number of restrictions that ABC UNIVERSITY female students wish to abolish

x_i	0	1	2	3	4
f_i	18	12	7	8	15
Relative frequency	0.300	0.200	0.117	0.133	0.250



Frequency Histogram of number of restrictions that ABC UNIVERSITY students wish to abolish

The Centre of a Distribution

The mean

The mean of a sample, $\bar{x} = \dfrac{\sum f_i x_i}{f_i}$

$$= \frac{18\,(0) + 12\,(1) + 7(2) + 8(3) + 15\,(4)}{60}$$

$$= 1.833$$

Check by graphic calculator,

```
1-Var Stats
 x̄=1.833333333
 Σx=110
 Σx²=352
 Sx=1.596252674
 σx=1.582894676
↓n=60
```

```
1-Var Stats
↑n=60
 minX=0
 Q1=0
 Med=1.5
 Q3=3.5
 maxX=4
```

The mean, $\bar{x}$ = 1.833

The median

The median is the $\left(\frac{n+1}{2}\right)^{th}$ score

is the $\left(\frac{60+1}{2}\right)^{th}$ score = 30.5^{th} score

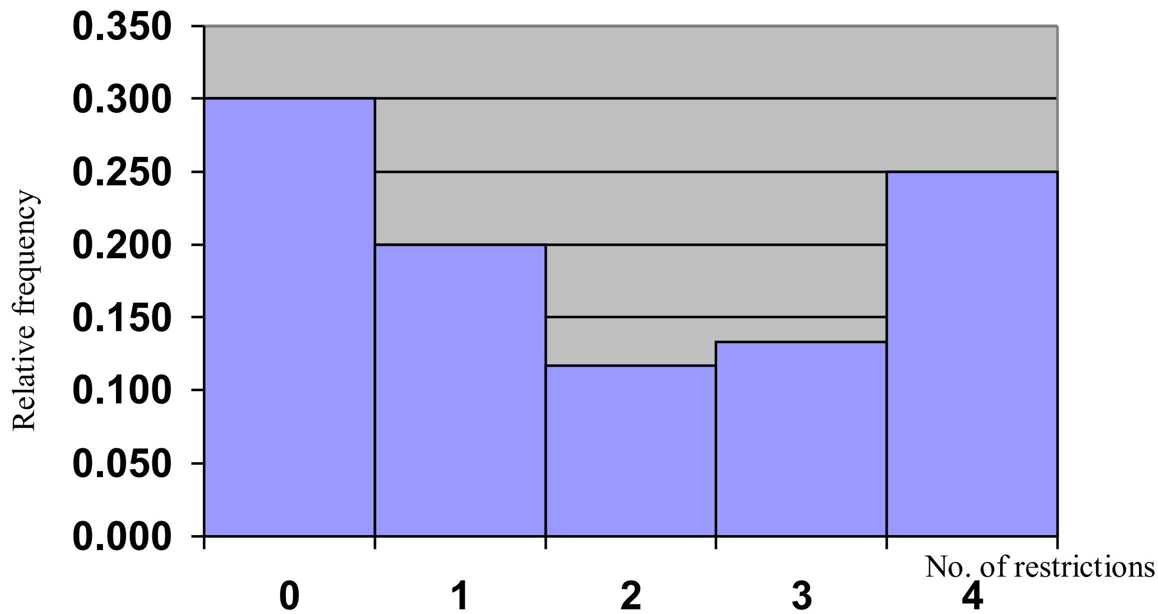
which is the average of the 30^{th} and 31^{st} score

$= \frac{1+2}{2}$

= 1.5

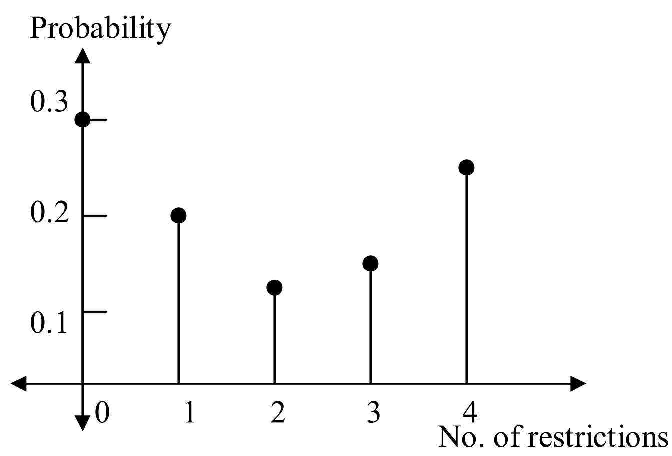
The mode

The mode is the most frequently occurring data value. From the frequency distribution histogram, the mode is 1.

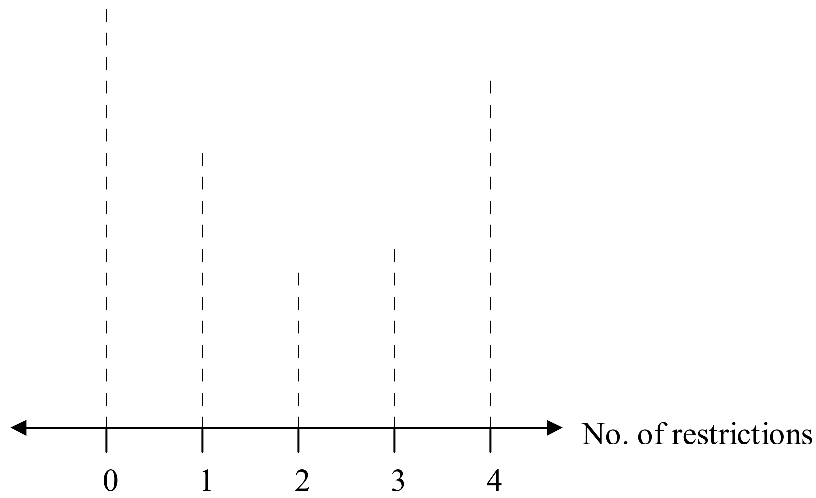


Relative Frequency Histogram of number of restrictions that ABC UNIVERSITY female students wish to abolish

Spike plot:



Dots plot:



The Variability (Spread) of a Distribution

The Range

The range of a given set of data is the difference between the maximum (largest) and the minimum (smallest) data values.

The range = 4 – 0 = 4

The Interquartile Range

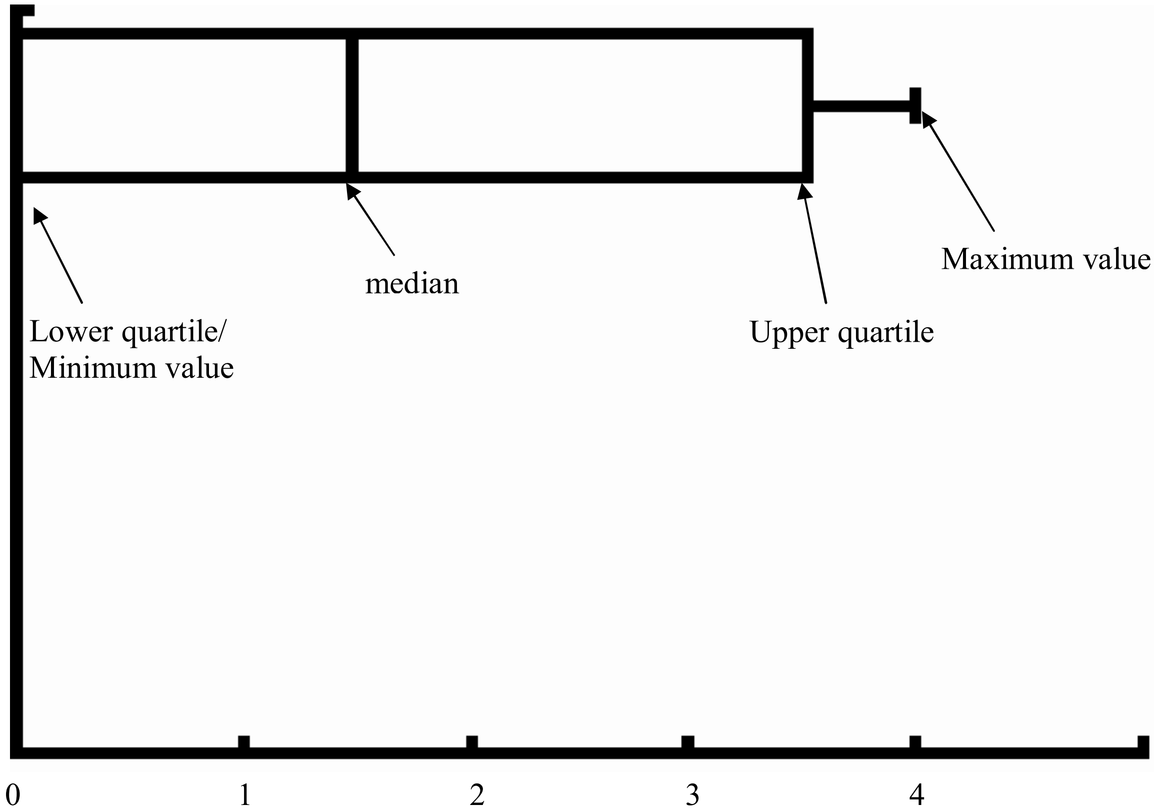
The interquartile range is the range of the middle half (50%) of the data.

Interquartile range = upper quartile – lower quartile

= middle value of the upper half – middle value of the lower half

= 3.5 - 0

= 3.5



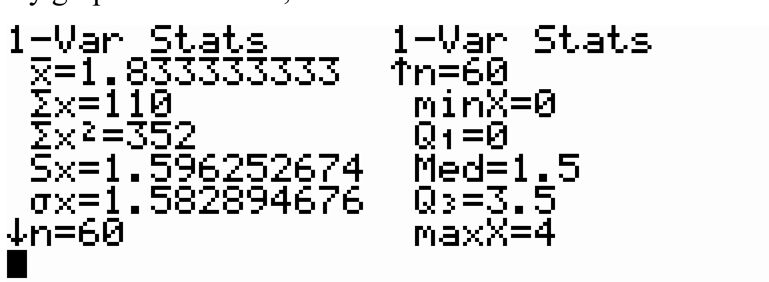
Box-and-whisker plot

The Standard Deviation

The standard deviation is a more useful measure of spread than range and interquartile range. Standard deviation can be found from the average variation from the mean of all data values.

Standard deviation, s = $\sqrt{\dfrac{\sum f_i \left(x_i - \bar{x}\right)^2}{\sum f_i - 1}}$ = 1.5963

By graphic calculator,



Conclusion

From the data, we observe that there are 18 female students of ABC University do not wish to abolish any of the four restrictions, 12 female students wish to abolish one of the four restrictions, 7 female students wish to abolish two of the four restrictions, 8 students wish to abolish three of the four restrictions, and 15 students wish to abolish all of the restrictions. In other words, we can say that 18 female students from ABC University do not wish to abolish any of the four restrictions under investigation and 42 female students wish to abolish at least one restriction from the four restrictions.

This is maybe because most of the students think that the restrictions are not reasonable and should be abolished at least one of them.

Overall Conclusion

In analysing the number of summonses received by students for centre distribution, it was found out that the average mean of summonses received by a student is 1.52. In addition, the median was 0 and the mode was 0 as well. Therefore, it showed that the majority of the students received 0 summon during the period of June 2005 to June 2006.

As a result, the distribution of the data was concentrated at the site where students received 0 summon. This may be due to the religion background of the students. Since the number of students who received 4 summonses and more was very small, the distribution was skewed to the right. This can also be clearly seen on the dots plot and frequency distribution histogram.

Among all the restrictions, the restriction of wearing short shirt which does not cover bottom had the largest proportion of female ABC UNIVERSITY students who wish to abolish this restriction. This maybe because the length of most of the blouses and shirts in the market do not cover bottom causing the students to have difficulty buying shirts that comply with the rules. Hence, the female students have no other options but to wear sweaters or jackets which are lengthy to prevent from getting summonses. This in turn becomes another reason for intending to abolish the restriction as the hot and humid weather in Malaysia is not suitable for this warm attire.

The second restriction most opposed by the female ABC UNIVERSITY students is the restriction of wearing shirts with sleeves do not reach wrists. This is again due to the inappropriateness of wearing shirts with long sleeves in the hot weather condition of Malaysia. The students may think that this restriction is impractical.

On the contrary, only a small proportion of female ABC UNIVERSITY students intend to abolish the restriction of wearing pants which are too tight and shorter than ankle length. This maybe because these restrictions are reasonable and that they can be obeyed without much inconveniences.

From our study, we found out that there were only a few students who received summonses from the period June 2005 to June 2006. This indicates that most student abide to the regulations of attire. However, most of the ABC University female students think that the restrictions imposed on them should be abolished. This shows that the students comply with the rules despite the fact that they are not satisfied with the restrictions.

In conclusion, there are several suggestions that can be made to rectify the current situation. Firstly, all the restrictions should be imposed on students within the ABC UNIVERSITY compound only. This is because proper dress code is vital in educational institutions to show respect to the lecturers and the school itself. However, students should be allowed to wear casual attire and should not be bound to the restrictions during after school hours as long as the students are not scantily clad.