

## Chapter 216

# Confidence Intervals for the Difference Between Two Proportions

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## Introduction

This routine calculates the group sample sizes necessary to achieve a specified interval width of the difference between two independent proportions.

Caution: These procedures assume that the proportions obtained from future samples will be the same as the proportions that are specified. If the sample proportions are different from those specified when running these procedures, the interval width may be narrower or wider than specified.

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## Technical Details

A background of the comparison of two proportions is given, followed by details of the confidence interval methods available in this procedure.

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## Comparing Two Proportions

Suppose you have two populations from which dichotomous (binary) responses will be recorded. The probability (or risk) of obtaining the event of interest in population 1 (the treatment group) is  $p_1$  and in population 2 (the control group) is  $p_2$ . The corresponding failure proportions are given by  $q_1 = 1 - p_1$  and  $q_2 = 1 - p_2$ .

The assumption is made that the responses from each group follow a binomial distribution. This means that the event probability  $p_i$  is the same for all subjects within a population and that the responses from one subject to the next are independent of one another.

Random samples of  $m$  and  $n$  individuals are obtained from these two populations. The data from these samples can be displayed in a 2-by-2 contingency table as follows

	Success	Failure	Total
Population 1	$a$	$c$	$m$
Population 2	$b$	$d$	$n$
Totals	$s$	$f$	$N$

## Confidence Intervals for the Difference Between Two Proportions

The following alternative notation is sometimes used:

	Success	Failure	Total
Population 1	$x_{11}$	$x_{12}$	$n_1$
Population 2	$x_{21}$	$x_{22}$	$n_2$
Totals	$m_1$	$m_2$	$N$

The binomial proportions  $p_1$  and  $p_2$  are estimated from these data using the formulae

$$\hat{p}_1 = \frac{a}{m} = \frac{x_{11}}{n_1} \text{ and } \hat{p}_2 = \frac{b}{n} = \frac{x_{21}}{n_2}$$

When analyzing studies such as these, you usually want to compare the two binomial probabilities  $p_1$  and  $p_2$ . The most direct methods of comparing these quantities are to calculate their difference or their ratio. If the binomial probability is expressed in terms of odds rather than probability, another measure is the odds ratio. Mathematically, these comparison parameters are

<u>Parameter</u>	<u>Computation</u>
Difference	$\delta = p_1 - p_2$
Risk Ratio	$\phi = p_1/p_2$
Odds Ratio	$\psi = \frac{p_1/q_1}{p_2/q_2} = \frac{p_1 q_2}{p_2 q_1}$

The choice of which of these measures is used might at first seem arbitrary, but it is important. Not only is their interpretation different, but, for small sample sizes, the coverage probabilities may be different. This procedure focuses on the difference. Other procedures are available in **PASS** for computing confidence intervals for the ratio and odds ratio.

## Difference

The (risk) difference  $\delta = p_1 - p_2$  is perhaps the most direct method of comparison between the two event probabilities. This parameter is easy to interpret and communicate. It gives the absolute impact of the treatment. However, there are subtle difficulties that can arise with its interpretation.

One interpretation difficulty occurs when the event of interest is rare. If a difference of 0.001 were reported for an event with a baseline probability of 0.40, we would probably dismiss this as being of little importance. That is, there is usually little interest in a treatment that decreases the probability from 0.400 to 0.399. However, if the baseline probability of a disease was 0.002 and 0.001 was the decrease in the disease probability, this would represent a reduction of 50%. Thus, we see that interpretation depends on the baseline probability of the event.

A similar situation occurs when the amount of possible difference is considered. Consider two events, one with a baseline event rate of 0.40 and the other with a rate of 0.02. What is the maximum decrease that can occur? Obviously, the first event rate can be decreased by an absolute amount of 0.40 which the second can only be decreased by a maximum of 0.02.

So, although creating the simple difference is a useful method of comparison, care must be taken that it fits the situation.

## Confidence Intervals for the Difference

Many methods have been devised for computing confidence intervals for the difference between two proportions  $\delta = p_1 - p_2$ . Seven of these methods are available in the Confidence Intervals for Two Proportions [Proportions] using Proportions and Confidence Intervals for Two Proportions [Differences] procedures. The seven confidence interval methods are

1. Score (Farrington and Manning)
2. Score (Miettinen and Nurminen)
3. Score with Correction for Skewness (Gart and Nam)
4. Score (Wilson)
5. Score with Continuity Correction (Wilson)
6. Chi-Square with Continuity Correction (Yates)
7. Chi-Square (Pearson)

Newcombe (1998b) conducted a comparative evaluation of eleven confidence interval methods. He recommended that the modified Wilson score method be used instead of the Pearson Chi-Square or the Yate's Corrected Chi-Square. Beal (1987) found that the Score methods performed very well. The lower  $L$  and upper  $U$  limits of these intervals are computed as follows. Note that, unless otherwise stated,  $z = |z_{\alpha/2}|$  is the appropriate percentile from the standard normal distribution.

### Farrington and Manning's Score

Farrington and Manning (1990) proposed a test statistic for testing whether the difference is equal to a specified value  $\delta_0$ . The regular MLE's  $\hat{p}_1$  and  $\hat{p}_2$  are used in the numerator of the score statistic while MLE's  $\tilde{p}_1$  and  $\tilde{p}_2$  constrained so that  $\tilde{p}_1 - \tilde{p}_2 = \delta_0$  are used in the denominator. The significance level of the test statistic is based on the asymptotic normality of the score statistic.

The test statistic formula is

$$z_{FMD} = \frac{\hat{p}_1 - \hat{p}_2 - \delta_0}{\sqrt{\left(\frac{\tilde{p}_1 \tilde{q}_1}{n_1} + \frac{\tilde{p}_2 \tilde{q}_2}{n_2}\right)}}$$

where the estimates  $\tilde{p}_1$  and  $\tilde{p}_2$  are computed as in the corresponding test of Miettinen and Nurminen (1985) given as

$$\tilde{p}_1 = \tilde{p}_2 + \delta_0$$

$$\tilde{p}_2 = 2B \cos(A) - \frac{L_2}{3L_3}$$

## Confidence Intervals for the Difference Between Two Proportions

$$A = \frac{1}{3} \left[ \pi + \cos^{-1} \left( \frac{C}{B^3} \right) \right]$$

$$B = \text{sign}(C) \sqrt{\frac{L_2^2}{9L_3^2} - \frac{L_1}{3L_3}}$$

$$C = \frac{L_2^3}{27L_3^3} - \frac{L_1L_2}{6L_3^2} + \frac{L_0}{2L_3}$$

$$L_0 = x_{21}\delta_0(1 - \delta_0)$$

$$L_1 = [n_2\delta_0 - N - 2x_{21}]\delta_0 + m_1$$

$$L_2 = (N + n_2)\delta_0 - N - m_1$$

$$L_3 = N$$

Farrington and Manning (1990) proposed inverting their score test to find the confidence interval. The lower limit is found by solving

$$z_{FMD} = |z_{\alpha/2}|$$

and the upper limit is the solution of

$$z_{FMD} = -|z_{\alpha/2}|$$

### Miettinen and Nurminen's Score

Miettinen and Nurminen (1985) proposed a test statistic for testing whether the difference is equal to a specified value  $\delta_0$ . The regular MLE's  $\hat{p}_1$  and  $\hat{p}_2$  are used in the numerator of the score statistic while MLE's  $\tilde{p}_1$  and  $\tilde{p}_2$  constrained so that  $\tilde{p}_1 - \tilde{p}_2 = \delta_0$  are used in the denominator. A correction factor of  $N/(N-1)$  is applied to make the variance estimate less biased. The significance level of the test statistic is based on the asymptotic normality of the score statistic.

The formula for computing this test statistic is

$$z_{MND} = \frac{\hat{p}_1 - \hat{p}_2 - \delta_0}{\sqrt{\left( \frac{\tilde{p}_1 \tilde{q}_1}{n_1} + \frac{\tilde{p}_2 \tilde{q}_2}{n_2} \right) \left( \frac{N}{N-1} \right)}}$$

## Confidence Intervals for the Difference Between Two Proportions

where

$$\tilde{p}_1 = \tilde{p}_2 + \delta_0$$

$$\tilde{p}_2 = 2B \cos(A) - \frac{L_2}{3L_3}$$

$$A = \frac{1}{3} \left[ \pi + \cos^{-1} \left( \frac{C}{B^3} \right) \right]$$

$$B = \text{sign}(C) \sqrt{\frac{L_2^2}{9L_3^2} - \frac{L_1}{3L_3}}$$

$$C = \frac{L_2^3}{27L_3^3} - \frac{L_1L_2}{6L_3^2} + \frac{L_0}{2L_3}$$

$$L_0 = x_{21}\delta_0(1 - \delta_0)$$

$$L_1 = [n_2\delta_0 - N - 2x_{21}]\delta_0 + m_1$$

$$L_2 = (N + n_2)\delta_0 - N - m_1$$

$$L_3 = N$$

Miettinen and Nurminen (1985) proposed inverting their score test to find the confidence interval. The lower limit is found by solving

$$z_{MND} = |z_{\alpha/2}|$$

and the upper limit is the solution of

$$z_{MND} = -|z_{\alpha/2}|$$

## Confidence Intervals for the Difference Between Two Proportions

## Gart and Nam's Score

Gart and Nam (1990) page 638 proposed a modification to the Farrington and Manning (1990) difference test that corrected for skewness. Let  $z_{FM}(\delta)$  stand for the Farrington and Manning difference test statistic described above. The skewness corrected test statistic  $z_{GN}$  is the appropriate solution to the quadratic equation

$$(-\tilde{Y})z_{GND}^2 + (-1)z_{GND} + (z_{FMD}(\delta) + \tilde{Y}) = 0$$

where

$$\tilde{Y} = \frac{\tilde{V}^{3/2}(\delta)}{6} \left( \frac{\tilde{p}_1 \tilde{q}_1 (\tilde{q}_1 - \tilde{p}_1)}{n_1^2} - \frac{\tilde{p}_2 \tilde{q}_2 (\tilde{q}_2 - \tilde{p}_2)}{n_2^2} \right)$$

Gart and Nam (1988) proposed inverting their score test to find the confidence interval. The lower limit is found by solving

$$z_{GND} = |z_{\alpha/2}|$$

and the upper limit is the solution of

$$z_{GND} = -|z_{\alpha/2}|$$

## Wilson's Score as Modified by Newcombe (with and without Continuity Correction)

For details, see Newcombe (1998b), page 876.

$$L = \hat{p}_1 - \hat{p}_2 - B$$

$$U = \hat{p}_1 - \hat{p}_2 + C$$

where

$$B = z \sqrt{\frac{l_1(1-l_1)}{m} + \frac{u_2(1-u_2)}{n}}$$

$$C = z \sqrt{\frac{u_1(1-u_1)}{m} + \frac{l_2(1-l_2)}{n}}$$

and  $l_1$  and  $u_1$  are the roots of

$$|p_1 - \hat{p}_1| - z \sqrt{\frac{p_1(1-p_1)}{m}} = 0$$

## Confidence Intervals for the Difference Between Two Proportions

and  $l_2$  and  $u_2$  are the roots of

$$|p_2 - \hat{p}_2| - z \sqrt{\frac{p_2(1 - p_2)}{n}} = 0$$

## Yate's Chi-Square with Continuity Correction

For details, see Newcombe (1998b), page 875.

$$L = \hat{p}_1 - \hat{p}_2 - z \sqrt{\left(\frac{\hat{p}_1(1 - \hat{p}_1)}{m} + \frac{\hat{p}_2(1 - \hat{p}_2)}{n}\right)} - \frac{1}{2}\left(\frac{1}{m} + \frac{1}{n}\right)$$

$$U = \hat{p}_1 - \hat{p}_2 + z \sqrt{\left(\frac{\hat{p}_1(1 - \hat{p}_1)}{m} + \frac{\hat{p}_2(1 - \hat{p}_2)}{n}\right)} + \frac{1}{2}\left(\frac{1}{m} + \frac{1}{n}\right)$$

## Pearson's Chi-Square

For details, see Newcombe (1998b), page 875.

$$L = \hat{p}_1 - \hat{p}_2 - z \sqrt{\left(\frac{\hat{p}_1(1 - \hat{p}_1)}{m} + \frac{\hat{p}_2(1 - \hat{p}_2)}{n}\right)}$$

$$U = \hat{p}_1 - \hat{p}_2 + z \sqrt{\left(\frac{\hat{p}_1(1 - \hat{p}_1)}{m} + \frac{\hat{p}_2(1 - \hat{p}_2)}{n}\right)}$$

For each of the seven methods, one-sided intervals may be obtained by replacing  $\alpha/2$  by  $\alpha$ .

For two-sided intervals, the distance from the difference in sample proportions to each of the limits may be different. Thus, instead of specifying the distance to the limits we specify the width of the interval,  $W$ .

The basic equation for determining sample size for a two-sided interval when  $W$  has been specified is

$$W = U - L$$

For one-sided intervals, the distance from the variance ratio to limit,  $D$ , is specified.

The basic equation for determining sample size for a one-sided upper limit when  $D$  has been specified is

$$D = U - (\hat{p}_1 - \hat{p}_2)$$

The basic equation for determining sample size for a one-sided lower limit when  $D$  has been specified is

$$D = (\hat{p}_1 - \hat{p}_2) - L$$

Each of these equations can be solved for any of the unknown quantities in terms of the others.

## Confidence Level

The confidence level,  $1 - \alpha$ , has the following interpretation. If thousands of random samples of size  $n_1$  and  $n_2$  are drawn from populations 1 and 2, respectively, and a confidence interval for the true difference/ratio/odds ratio of proportions is calculated for each pair of samples, the proportion of those intervals that will include the true difference/ratio/odds ratio of proportions is  $1 - \alpha$ .



## Example 1 – Calculating Sample Size using Differences

Suppose a study is planned in which the researcher wishes to construct a two-sided 95% confidence interval for the difference in proportions such that the width of the interval is no wider than 0.1. The confidence interval method to be used is the Yates chi-square simple asymptotic method with continuity correction. The confidence level is set at 0.95, but 0.99 is included for comparative purposes. The difference estimate to be used is 0.05, and the estimate for proportion 2 is 0.3. Instead of examining only the interval width of 0.1, a series of widths from 0.05 to 0.3 will also be considered.

The goal is to determine the necessary sample size.

### Setup

If the procedure window is not already open, use the PASS Home window to open it. The parameters for this example are listed below and are stored in the **Example 1** settings file. To load these settings to the procedure window, click **Open Example Settings File** in the Help Center or File menu.

#### Design Tab

Solve For .....	<b>Sample Size</b>
Confidence Interval Formula.....	<b>Chi-Square C.C. (Yates)</b>
Interval Type .....	<b>Two-Sided</b>
Confidence Level (1 - Alpha) .....	<b>0.95 0.99</b>
Group Allocation .....	<b>Equal (N1 = N2)</b>
Confidence Interval Width (Two-Sided) .....	<b>0.05 to 0.30 by 0.05</b>
Input Type.....	<b>Differences</b>
P1 - P2 (Difference in Sample Proportions) .....	<b>0.05</b>
P2 (Proportion Group 2).....	<b>0.3</b>

## Confidence Intervals for the Difference Between Two Proportions

## Output

Click the Calculate button to perform the calculations and generate the following output.

## Numeric Reports

## Numeric Results

Solve For: [Sample Size](#)  
 Confidence Interval Method: Chi-Square - Simple Asymptotic with Continuity Correction (Yates)  
 Interval Type: Two-Sided

Confidence Level	Sample Size			Confidence Interval Width		Sample Proportions		Difference P1 - P2	Confidence Interval Limits	
	N1	N2	N	Target	Actual	P1	P2		Lower	Upper
0.95	2769	2769	5538	0.05	0.050	0.35	0.3	0.05	0.03	0.07
0.95	712	712	1424	0.10	0.100	0.35	0.3	0.05	0.00	0.10
0.95	325	325	650	0.15	0.150	0.35	0.3	0.05	-0.02	0.12
0.95	188	188	376	0.20	0.200	0.35	0.3	0.05	-0.05	0.15
0.95	124	124	248	0.25	0.249	0.35	0.3	0.05	-0.07	0.17
0.95	88	88	176	0.30	0.299	0.35	0.3	0.05	-0.10	0.20
0.99	4725	4725	9450	0.05	0.050	0.35	0.3	0.05	0.03	0.07
0.99	1201	1201	2402	0.10	0.100	0.35	0.3	0.05	0.00	0.10
0.99	543	543	1086	0.15	0.150	0.35	0.3	0.05	-0.02	0.12
0.99	310	310	620	0.20	0.200	0.35	0.3	0.05	-0.05	0.15
0.99	202	202	404	0.25	0.250	0.35	0.3	0.05	-0.07	0.17
0.99	143	143	286	0.30	0.299	0.35	0.3	0.05	-0.10	0.20

Confidence Level The proportion of confidence intervals (constructed with this same confidence level, sample size, etc.) that would contain the true difference in population proportions.

N1 and N2 The number of items sampled from each population.

N The total sample size.  $N = N1 + N2$ .

Confidence Interval Width The distance from the lower limit to the upper limit.

Target Width The value of the width that is entered into the procedure.

Actual Width The value of the width that is obtained from the procedure.

P1 and P2 The assumed sample proportions for sample size calculations.

P1 - P2 The difference between sample proportions at which sample size calculations are made.

Confidence Interval Limits The lower and upper limits of the confidence interval for the true difference in proportions (Population Proportion 1 - Population Proportion 2).

## Summary Statements

A parallel two-group design will be used to obtain a two-sided 95% confidence interval for the difference of two proportions (P1 - P2). The Group 1 sample proportion is assumed to be 0.35 and the Group 2 sample proportion is assumed to be 0.3, giving a proportion difference of 0.05. The Chi-Square - Simple Asymptotic with Continuity Correction (Yates) method will be used to compute the confidence interval limits. To produce a confidence interval width of 0.05, the number of subjects needed will be 2769 in Group 1 and 2769 in Group 2.

## Confidence Intervals for the Difference Between Two Proportions

## Dropout-Inflated Sample Size

Dropout Rate	Sample Size			Dropout-Inflated Enrollment Sample Size			Expected Number of Dropouts		
	N1	N2	N	N1'	N2'	N'	D1	D2	D
20%	2769	2769	5538	3462	3462	6924	693	693	1386
20%	712	712	1424	890	890	1780	178	178	356
20%	325	325	650	407	407	814	82	82	164
20%	188	188	376	235	235	470	47	47	94
20%	124	124	248	155	155	310	31	31	62
20%	88	88	176	110	110	220	22	22	44
20%	4725	4725	9450	5907	5907	11814	1182	1182	2364
20%	1201	1201	2402	1502	1502	3004	301	301	602
20%	543	543	1086	679	679	1358	136	136	272
20%	310	310	620	388	388	776	78	78	156
20%	202	202	404	253	253	506	51	51	102
20%	143	143	286	179	179	358	36	36	72

Dropout Rate	The percentage of subjects (or items) that are expected to be lost at random during the course of the study and for whom no response data will be collected (i.e., will be treated as "missing"). Abbreviated as DR.
N1, N2, and N	The evaluable sample sizes at which the confidence interval is computed. If N1 and N2 subjects are evaluated out of the N1' and N2' subjects that are enrolled in the study, the design will achieve the stated confidence interval.
N1', N2', and N'	The number of subjects that should be enrolled in the study in order to obtain N1, N2, and N evaluable subjects, based on the assumed dropout rate. After solving for N1 and N2, N1' and N2' are calculated by inflating N1 and N2 using the formulas $N1' = N1 / (1 - DR)$ and $N2' = N2 / (1 - DR)$ , with N1' and N2' always rounded up. (See Julious, S.A. (2010) pages 52-53, or Chow, S.C., Shao, J., Wang, H., and Lokhnygina, Y. (2018) pages 32-33.)
D1, D2, and D	The expected number of dropouts. $D1 = N1' - N1$ , $D2 = N2' - N2$ , and $D = D1 + D2$ .

## Dropout Summary Statements

Anticipating a 20% dropout rate, 3462 subjects should be enrolled in Group 1, and 3462 in Group 2, to obtain final group sample sizes of 2769 and 2769, respectively.

## References

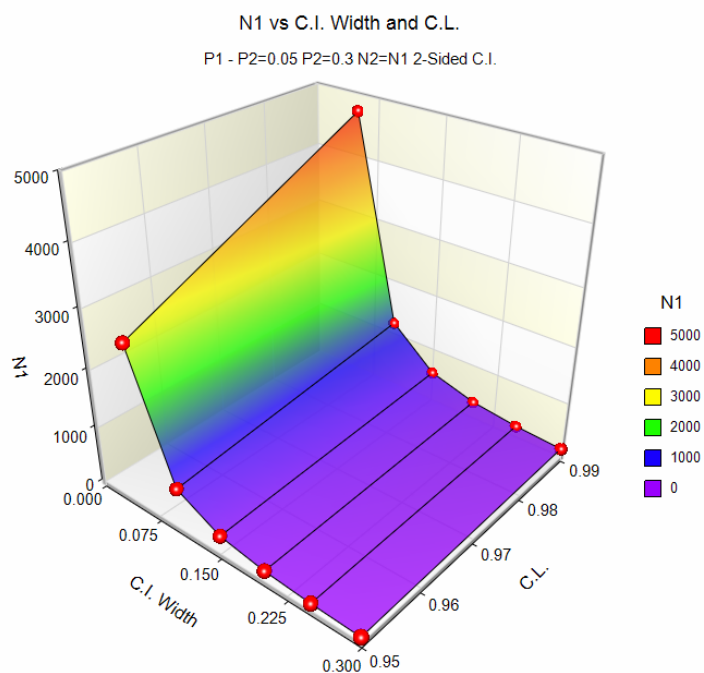
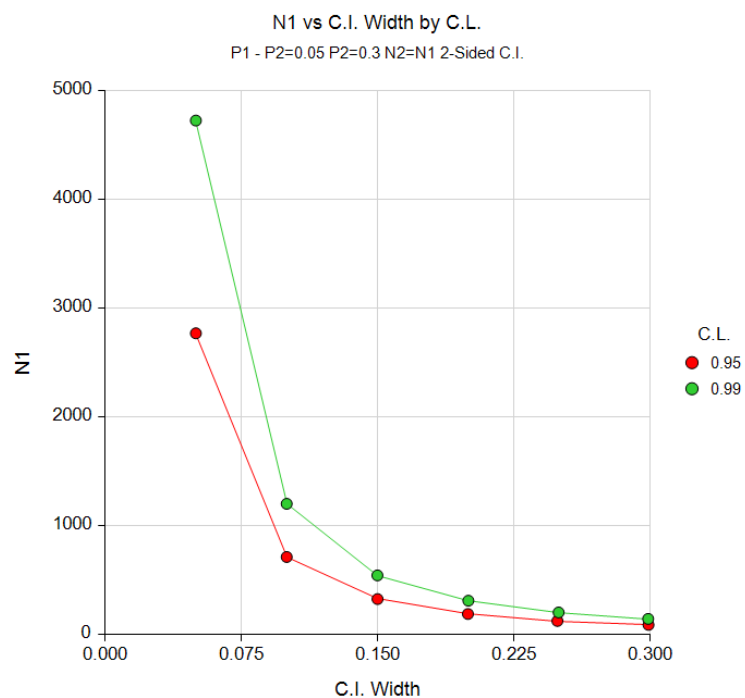
- Newcombe, R. G. 1998. 'Interval Estimation for the Difference Between Independent Proportions: Comparison of Eleven Methods.' *Statistics in Medicine*, 17, pp. 873-890.
- Fleiss, J. L., Levin, B., Paik, M.C. 2003. *Statistical Methods for Rates and Proportions*. Third Edition. John Wiley & Sons. New York.

This report shows the calculated sample sizes for each of the scenarios.

## Confidence Intervals for the Difference Between Two Proportions

## Plots Section

## Plots



These plots show the group sample size versus the confidence interval width for the two confidence levels.

## Example 2 – Calculating Sample Size using Proportions

Suppose a study is planned in which the researcher wishes to construct a two-sided 95% confidence interval for the difference in proportions such that the width of the interval is no wider than 0.1. The confidence interval method to be used is the Yates chi-square simple asymptotic method with continuity correction. The confidence level is set at 0.95, but 0.99 is included for comparative purposes. The proportion estimates to be used are 0.6 for Group 1, and 0.4 for Group 2. Instead of examining only the interval width of 0.1, a series of widths from 0.05 to 0.3 will also be considered.

The goal is to determine the necessary sample size.

### Setup

If the procedure window is not already open, use the PASS Home window to open it. The parameters for this example are listed below and are stored in the **Example 2** settings file. To load these settings to the procedure window, click **Open Example Settings File** in the Help Center or File menu.

#### Design Tab

Solve For .....	<b>Sample Size</b>
Confidence Interval Formula.....	<b>Chi-Square C.C. (Yates)</b>
Interval Type .....	<b>Two-Sided</b>
Confidence Level (1 - Alpha) .....	<b>0.95 0.99</b>
Group Allocation .....	<b>Equal (N1 = N2)</b>
Confidence Interval Width (Two-Sided) .....	<b>0.05 to 0.30 by 0.05</b>
Input Type.....	<b>Proportions</b>
P1 (Proportion Group 1).....	<b>0.6</b>
P2 (Proportion Group 2).....	<b>0.4</b>

## Confidence Intervals for the Difference Between Two Proportions

## Output

Click the Calculate button to perform the calculations and generate the following output.

## Numeric Results

Solve For: [Sample Size](#)  
 Confidence Interval Method: Chi-Square - Simple Asymptotic with Continuity Correction (Yates)  
 Interval Type: Two-Sided

Confidence Level	Sample Size			Confidence Interval Width		Sample Proportions		Difference P1 - P2	Confidence Interval Limits	
	N1	N2	N	Target	Actual	P1	P2		Lower	Upper
0.95	3030	3030	6060	0.05	0.05	0.6	0.4	0.2	0.18	0.22
0.95	778	778	1556	0.10	0.10	0.6	0.4	0.2	0.15	0.25
0.95	354	354	708	0.15	0.15	0.6	0.4	0.2	0.13	0.27
0.95	204	204	408	0.20	0.20	0.6	0.4	0.2	0.10	0.30
0.95	134	134	268	0.25	0.25	0.6	0.4	0.2	0.08	0.32
0.95	95	95	190	0.30	0.30	0.6	0.4	0.2	0.05	0.35
0.99	5176	5176	10352	0.05	0.05	0.6	0.4	0.2	0.18	0.22
0.99	1314	1314	2628	0.10	0.10	0.6	0.4	0.2	0.15	0.25
0.99	593	593	1186	0.15	0.15	0.6	0.4	0.2	0.13	0.27
0.99	339	339	678	0.20	0.20	0.6	0.4	0.2	0.10	0.30
0.99	220	220	440	0.25	0.25	0.6	0.4	0.2	0.08	0.32
0.99	155	155	310	0.30	0.30	0.6	0.4	0.2	0.05	0.35

This report shows the calculated sample sizes for each of the scenarios.

## Example 3 – Validation using Newcombe (1998b)

Newcombe (1998b) page 877 gives an example of a calculation for a confidence interval for the difference in proportions when the confidence level is 95%, the sample proportions are 0.9 and 0.3, and the interval width is 0.6790 for the Chi-Square (Pearson) method, 0.8395 for the Chi-Square C.C. (Yates) method, 0.67064 for the Score (Miettinen and Nurminen) method, 0.6385 for the Score (Wilson) method, and 0.7374 for the Score C.C. (Wilson) method. The necessary sample size in each case is 10 per group.

### Setup

If the procedure window is not already open, use the PASS Home window to open it. The parameters for this example are listed below and are stored in the **Example 3(a-e)** settings file. To load these settings to the procedure window, click **Open Example Settings File** in the Help Center or File menu.

#### Design Tab

Solve For .....	<b>Sample Size</b>
Confidence Interval Formula.....	<b>Varies [Chi-Square (Pearson), Chi-Square C.C. (Yates), Score (Miettinen &amp; Nurminen), Score (Wilson), Score C.C. (Wilson)]</b>
Interval Type .....	<b>Two-Sided</b>
Confidence Level (1 - Alpha) .....	<b>0.95</b>
Group Allocation .....	<b>Equal (N1 = N2)</b>
Confidence Interval Width (Two-Sided) .....	<b>0.6790</b>
Input Type.....	<b>Proportions</b>
P1 (Proportion Group 1).....	<b>0.9</b>
P2 (Proportion Group 2).....	<b>0.3</b>

### Output

Click the Calculate button to perform the calculations and generate the following output.

#### Chi-Square (Pearson)

##### Numeric Results

Solve For: [Sample Size](#)  
 Confidence Interval Method: Chi-Square - Simple Asymptotic (Pearson)  
 Interval Type: Two-Sided

Confidence Level	Sample Size			Confidence Interval Width		Sample Proportions		Difference P1 - P2	Confidence Interval Limits	
	N1	N2	N	Target	Actual	P1	P2		Lower	Upper
0.95	10	10	20	0.679	0.679	0.9	0.3	0.6	0.2605	0.9395

**PASS** also calculates the necessary sample size to be 10 per group.

## Confidence Intervals for the Difference Between Two Proportions

## Chi-Square C.C. (Yates)

## Numeric Results

Solve For: [Sample Size](#)  
 Confidence Interval Method: Chi-Square - Simple Asymptotic with Continuity Correction (Yates)  
 Interval Type: Two-Sided

Confidence Level	Sample Size			Confidence Interval Width		Sample Proportions		Difference P1 - P2	Confidence Interval Limits	
	N1	N2	N	Target	Actual	P1	P2		Lower	Upper
0.95	10	10	20	0.8395	0.8395	0.9	0.3	0.6	0.1605	1

PASS also calculates the necessary sample size to be 10 per group.

## Score (Miettinen &amp; Nurminen)

## Numeric Results

Solve For: [Sample Size](#)  
 Confidence Interval Method: Score (Miettinen and Nurminen)  
 Interval Type: Two-Sided

Confidence Level	Sample Size			Confidence Interval Width		Sample Proportions		Difference P1 - P2	Confidence Interval Limits	
	N1	N2	N	Target	Actual	P1	P2		Lower	Upper
0.95	10	10	20	0.6706	0.6706	0.9	0.3	0.6	0.17	0.8406

PASS also calculates the necessary sample size to be 10 per group.

## Score (Wilson)

## Numeric Results

Solve For: [Sample Size](#)  
 Confidence Interval Method: Score (Wilson)  
 Interval Type: Two-Sided

Confidence Level	Sample Size			Confidence Interval Width		Sample Proportions		Difference P1 - P2	Confidence Interval Limits	
	N1	N2	N	Target	Actual	P1	P2		Lower	Upper
0.95	10	10	20	0.6385	0.6385	0.9	0.3	0.6	0.1705	0.809

PASS also calculates the necessary sample size to be 10 per group.



## Confidence Intervals for the Difference Between Two Proportions

## Score C.C. (Wilson)

## Numeric Results

Solve For: [Sample Size](#)  
 Confidence Interval Method: Score with Continuity Correction (Wilson)  
 Interval Type: Two-Sided

Confidence Level	Sample Size			Confidence Interval Width		Sample Proportions		Difference P1 - P2	Confidence Interval Limits	
	N1	N2	N	Target	Actual	P1	P2		Lower	Upper
0.95	10	10	20	0.7374	0.7374	0.9	0.3	0.6	0.1013	0.8387

**PASS** also calculates the necessary sample size to be 10 per group.

## Example 4 – Validation using Gart and Nam (1990)

Gart and Nam (1990) page 640 give an example of a calculation for a confidence interval for the difference in proportions when the confidence level is 95%, the sample proportions are 0.28 and 0.08, and the interval width is 0.4281 for the Score (Gart and Nam) method. The necessary sample size in each case is 25 per group.

### Setup

If the procedure window is not already open, use the PASS Home window to open it. The parameters for this example are listed below and are stored in the **Example 4** settings file. To load these settings to the procedure window, click **Open Example Settings File** in the Help Center or File menu.

#### Design Tab

Solve For ..... **Sample Size**  
 Confidence Interval Formula..... **Score w/ Skewness (Gart & Nam)**  
 Interval Type ..... **Two-Sided**  
 Confidence Level (1 - Alpha) ..... **0.95**  
 Group Allocation ..... **Equal (N1 = N2)**  
 Confidence Interval Width (Two-Sided) ..... **0.4281**  
 Input Type..... **Proportions**  
 P1 (Proportion Group 1)..... **0.28**  
 P2 (Proportion Group 2)..... **0.08**

### Output

Click the Calculate button to perform the calculations and generate the following output.

#### Numeric Results

Solve For: [Sample Size](#)  
 Confidence Interval Method: Score with Correction for Skewness (Gart and Nam)  
 Interval Type: Two-Sided

Confidence Level	Sample Size			Confidence Interval Width		Sample Proportions		Difference P1 - P2	Confidence Interval Limits	
	N1	N2	N	Target	Actual	P1	P2		Lower	Upper
0.95	25	25	50	0.4281	0.4281	0.28	0.08	0.2	-0.0143	0.4137

**PASS** also calculates the necessary sample size to be 25 per group.