

# Package ‘crt2power’

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**Type** Package

**Title** Designing Cluster-Randomized Trials with Two Continuous Co-Primary Outcomes

**Version** 1.2.2

**Description** Provides methods for powering cluster-randomized trials with two continuous co-primary outcomes using five key design techniques. Includes functions for calculating required sample size and statistical power. For more details on methodology, see Owen et al. (2025) <doi:10.1002/sim.70015>, Yang et al. (2022) <doi:10.1111/biom.13692>, Pocock et al. (1987) <doi:10.1186/s12874-019-0754-4>, and Li et al. (2020) <doi:10.1111/biom.13212>.

**License** GPL-3

**Encoding** UTF-8

**URL** <https://github.com/melodyaowen/crt2power>

**Depends** R (>= 4.3)

**Imports** devtools (>= 2.4.5), knitr (>= 1.43), rootSolve (>= 1.8.2.3), tidyverse (>= 2.0.0), tableone (>= 0.13.2), foreach (>= 1.5.2), mvtnorm (>= 1.2), tibble (>= 3.2.1), dplyr (>= 1.1.4), tidyr (>= 1.3.0), stats (>= 3.6.2)

**RoxygenNote** 7.3.2

**Suggests** testthat (>= 3.0.0)

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calc_K_comb_outcome	<i>Calculate required number of clusters per treatment group for a cluster-randomized trial with co-primary endpoints using a combined outcomes approach.</i>
---------------------	---

---

## Description

Allows user to calculate the number of clusters per treatment arm of a cluster-randomized trial with two co-primary outcomes given a set of study design input values, including the number of clusters in each trial arm, and cluster size. Uses a combined outcomes approach where the two outcome effects are summed together.

## Usage

```
calc_K_comb_outcome(
  dist = "Chi2",
  power,
  m,
  alpha = 0.05,
  beta1,
  beta2,
  varY1,
  varY2,
  rho01,
  rho02,
  rho1,
```

```

    rho2,
    r = 1
  )

```

### Arguments

dist	Specification of which distribution to base calculation on, either 'Chi2' for Chi-Squared or 'F' for F-Distribution.
power	Desired statistical power in decimal form; numeric.
m	Individuals per cluster; numeric.
alpha	Type I error rate; numeric.
beta1	Effect size for the first outcome; numeric.
beta2	Effect size for the second outcome; numeric.
varY1	Total variance for the first outcome; numeric.
varY2	Total variance for the second outcome; numeric.
rho01	Correlation of the first outcome for two different individuals in the same cluster; numeric.
rho02	Correlation of the second outcome for two different individuals in the same cluster; numeric.
rho1	Correlation between the first and second outcomes for two individuals in the same cluster; numeric.
rho2	Correlation between the first and second outcomes for the same individual; numeric.
r	Treatment allocation ratio - $K2 = rK1$ where $K1$ is number of clusters in experimental group; numeric.

### Value

A data frame of numerical values.

### Examples

```

calc_K_comb_outcome(power = 0.8, m = 300, alpha = 0.05,
beta1 = 0.1, beta2 = 0.1, varY1 = 0.23, varY2 = 0.25,
rho01 = 0.025, rho02 = 0.025, rho1 = 0.01, rho2 = 0.05)

```

---

calc\_K\_conj\_test      *Calculate required number of clusters per treatment group for a cluster-randomized trial with co-primary endpoints using the conjunctive intersection-union test approach.*

---

### Description

Allows user to calculate the required number of clusters per treatment group of a cluster-randomized trial with two co-primary outcomes given a set of study design input values, including the statistical power, and cluster size. Uses the conjunctive intersection-union test approach. Code is adapted from "calSampleSize\_ttestIU()" from [https://github.com/siyunyang/coprimary\\_CRT](https://github.com/siyunyang/coprimary_CRT) written by Siyun Yang.

### Usage

```
calc_K_conj_test(
  dist = "T",
  power,
  m,
  alpha = 0.05,
  beta1,
  beta2,
  varY1,
  varY2,
  rho01,
  rho02,
  rho1,
  rho2,
  r = 1,
  cv = 0,
  deltas = c(0, 0),
  two_sided = FALSE
)
```

### Arguments

dist	Specification of which distribution to base calculation on, either 'T' for T-Distribution or 'MVN' for Multivariate Normal Distribution. Default is T-Distribution.
power	Desired statistical power in decimal form; numeric.
m	Individuals per cluster; numeric.
alpha	Type I error rate; numeric.
beta1	Effect size for the first outcome; numeric.
beta2	Effect size for the second outcome; numeric.
varY1	Total variance for the first outcome; numeric.
varY2	Total variance for the second outcome; numeric.

rho01	Correlation of the first outcome for two different individuals in the same cluster; numeric.
rho02	Correlation of the second outcome for two different individuals in the same cluster; numeric.
rho1	Correlation between the first and second outcomes for two individuals in the same cluster; numeric.
rho2	Correlation between the first and second outcomes for the same individual; numeric.
r	Treatment allocation ratio - $K2 = rK1$ where $K1$ is number of clusters in experimental group; numeric.
cv	Cluster variation parameter, set to 0 if assuming all cluster sizes are equal; numeric.
deltas	Vector of non-inferiority margins, set to $\text{delta}_1 = \text{delta}_2 = 0$ ; numeric vector.
two_sided	Specification of whether to conduct two 2-sided tests, 'TRUE', or two 1-sided tests, 'FALSE', default is FALSE; boolean.

**Value**

A data frame of numerical values.

**Examples**

```
calc_K_conj_test(power = 0.8, m = 300, alpha = 0.05,
  beta1 = 0.1, beta2 = 0.1, varY1 = 0.23, varY2 = 0.25,
  rho01 = 0.025, rho02 = 0.025, rho1 = 0.01, rho2 = 0.05)
```

---

calc_K_disj_2dftest	<i>Calculate required number of clusters per treatment group for a cluster-randomized trial with co-primary endpoints using a disjunctive 2-DF test approach.</i>
---------------------	---

---

**Description**

Allows user to calculate the number of clusters per treatment arm of a cluster-randomized trial with two co-primary outcomes given a set of study design input values, including the statistical power, and cluster size. Uses the disjunctive 2-DF test approach. Code is adapted from "calSampleSize\_omnibus()" from [https://github.com/siyunyang/coprimary\\_CRT](https://github.com/siyunyang/coprimary_CRT).

**Usage**

```
calc_K_disj_2dftest(
  dist = "Chi2",
  power,
  m,
  alpha = 0.05,
```

```

    beta1,
    beta2,
    varY1,
    varY2,
    rho01,
    rho02,
    rho1,
    rho2,
    r = 1
  )

```

### Arguments

dist	Specification of which distribution to base calculation on, either 'Chi2' for Chi-Squared or 'F' for F-Distribution.
power	Desired statistical power in decimal form; numeric.
m	Individuals per cluster; numeric.
alpha	Type I error rate; numeric.
beta1	Effect size for the first outcome; numeric.
beta2	Effect size for the second outcome; numeric.
varY1	Total variance for the first outcome; numeric.
varY2	Total variance for the second outcome; numeric.
rho01	Correlation of the first outcome for two different individuals in the same cluster; numeric.
rho02	Correlation of the second outcome for two different individuals in the same cluster; numeric.
rho1	Correlation between the first and second outcomes for two individuals in the same cluster; numeric.
rho2	Correlation between the first and second outcomes for the same individual; numeric.
r	Treatment allocation ratio - $K2 = rK1$ where $K1$ is number of clusters in experimental group; numeric.

### Value

A data frame of numerical values.

### Examples

```

calc_K_disj_2dftest(power = 0.8, m = 300, alpha = 0.05,
beta1 = 0.1, beta2 = 0.1, varY1 = 0.23, varY2 = 0.25,
rho01 = 0.025, rho02 = 0.025, rho1 = 0.01, rho2 = 0.05)

```

---

calc_K_pval_adj	<i>Calculate required number of clusters per treatment group for a cluster-randomized trial with co-primary endpoints using three common p-value adjustment methods</i>
-----------------	---

---

### Description

Allows user to calculate the number of clusters per treatment arm of a cluster-randomized trial with two co-primary endpoints given a set of study design input values, including the statistical power, and cluster size. Uses three common p-value adjustment methods.

### Usage

```
calc_K_pval_adj(
  dist = "Chi2",
  power,
  m,
  alpha = 0.05,
  beta1,
  beta2,
  varY1,
  varY2,
  rho01,
  rho02,
  rho2,
  r = 1
)
```

### Arguments

dist	Specification of which distribution to base calculation on, either 'Chi2' for Chi-Squared or 'F' for F-Distribution.
power	Desired statistical power in decimal form; numeric.
m	Individuals per cluster; numeric.
alpha	Type I error rate; numeric.
beta1	Effect size for the first outcome; numeric.
beta2	Effect size for the second outcome; numeric.
varY1	Total variance for the first outcome; numeric.
varY2	Total variance for the second outcome; numeric.
rho01	Correlation of the first outcome for two different individuals in the same cluster; numeric.
rho02	Correlation of the second outcome for two different individuals in the same cluster; numeric.

rho2	Correlation between the first and second outcomes for the same individual; numeric.
r	Treatment allocation ratio - $K2 = rK1$ where $K1$ is number of clusters in experimental group; numeric.

**Value**

A data frame of numerical values.

**Examples**

```
calc_K_pval_adj(power = 0.8, m = 300, alpha = 0.05,
beta1 = 0.1, beta2 = 0.1, varY1 = 0.23, varY2 = 0.25,
rho01 = 0.025, rho02 = 0.025, rho2 = 0.05)
```

---

calc\_K\_single\_1dftest *Calculate required number of clusters per treatment group for a cluster-randomized trial with co-primary endpoints using the single 1-DF combined test approach.*

---

**Description**

Allows user to calculate the number of clusters per treatment arm of a cluster-randomized trial with two co-primary endpoints given a set of study design input values, including the statistical power, and cluster size. Uses the single 1-DF combined test approach for clustered data and two outcomes.

**Usage**

```
calc_K_single_1dftest(
  dist = "Chi2",
  power,
  m,
  alpha = 0.05,
  beta1,
  beta2,
  varY1,
  varY2,
  rho01,
  rho02,
  rho1,
  rho2,
  r = 1
)
```



**Arguments**

dist	Specification of which distribution to base calculation on, either 'Chi2' for Chi-Squared or 'F' for F-Distribution.
power	Desired statistical power in decimal form; numeric.
m	Individuals per cluster; numeric.
alpha	Type I error rate; numeric.
beta1	Effect size for the first outcome; numeric.
beta2	Effect size for the second outcome; numeric.
varY1	Total variance for the first outcome; numeric.
varY2	Total variance for the second outcome; numeric.
rho01	Correlation of the first outcome for two different individuals in the same cluster; numeric.
rho02	Correlation of the second outcome for two different individuals in the same cluster; numeric.
rho1	Correlation between the first and second outcomes for two individuals in the same cluster; numeric.
rho2	Correlation between the first and second outcomes for the same individual; numeric.
r	Treatment allocation ratio - $K2 = rK1$ where $K1$ is number of clusters in experimental group; numeric.

**Value**

A data frame of numerical values.

**Examples**

```
calc_K_single_1dftest(power = 0.8, m = 300, alpha = 0.05,
beta1 = 0.1, beta2 = 0.1, varY1 = 0.23, varY2 = 0.25,
rho01 = 0.025, rho02 = 0.025, rho1 = 0.01, rho2 = 0.05)
```

---

calc_m_comb_outcome	<i>Calculate cluster size for a cluster-randomized trial with co-primary endpoints using a combined outcomes approach.</i>
---------------------	--

---

**Description**

Allows user to calculate the cluster size of a cluster-randomized trial with two co-primary endpoints given a set of study design input values, including the number of clusters in each trial arm, and statistical power. Uses a combined outcomes approach where the two outcome effects are summed together.

**Usage**

```
calc_m_comb_outcome(
  dist = "Chi2",
  power,
  K,
  alpha = 0.05,
  beta1,
  beta2,
  varY1,
  varY2,
  rho01,
  rho02,
  rho1,
  rho2,
  r = 1
)
```

**Arguments**

dist	Specification of which distribution to base calculation on, either 'Chi2' for Chi-Squared or 'F' for F-Distribution.
power	Desired statistical power in decimal form; numeric.
K	Number of clusters in treatment arm, and control arm under equal allocation; numeric.
alpha	Type I error rate; numeric.
beta1	Effect size for the first outcome; numeric.
beta2	Effect size for the second outcome; numeric.
varY1	Total variance for the first outcome; numeric.
varY2	Total variance for the second outcome; numeric.
rho01	Correlation of the first outcome for two different individuals in the same cluster; numeric.
rho02	Correlation of the second outcome for two different individuals in the same cluster; numeric.
rho1	Correlation between the first and second outcomes for two individuals in the same cluster; numeric.
rho2	Correlation between the first and second outcomes for the same individual; numeric.
r	Treatment allocation ratio - $K2 = rK1$ where $K1$ is number of clusters in experimental group; numeric.

**Value**

A numerical value.

**Examples**

```
calc_m_comb_outcome(power = 0.8, K = 15, alpha = 0.05,
beta1 = 0.1, beta2 = 0.1, varY1 = 0.23, varY2 = 0.25,
rho01 = 0.025, rho02 = 0.025, rho1 = 0.01, rho2 = 0.05)
```

---

calc_m_conj_test	<i>Calculate cluster size for a cluster-randomized trial with co-primary endpoints using the conjunctive intersection-union test approach.</i>
------------------	--

---

**Description**

Allows user to calculate the cluster size of a cluster-randomized trial with two co-primary endpoints given a set of study design input values, including the number of clusters in each trial arm, and statistical power. Uses the conjunctive intersection-union test approach.

**Usage**

```
calc_m_conj_test(
  dist = "T",
  power,
  K,
  alpha = 0.05,
  beta1,
  beta2,
  varY1,
  varY2,
  rho01,
  rho02,
  rho1,
  rho2,
  r = 1,
  cv = 0,
  deltas = c(0, 0),
  two_sided = FALSE
)
```

**Arguments**

dist	Specification of which distribution to base calculation on, either 'T' for T-Distribution or 'MVN' for Multivariate Normal Distribution. Default is T-Distribution.
power	Desired statistical power in decimal form; numeric.
K	Number of clusters in treatment arm, and control arm under equal allocation; numeric.
alpha	Type I error rate; numeric.
beta1	Effect size for the first outcome; numeric.

beta2	Effect size for the second outcome; numeric.
varY1	Total variance for the first outcome; numeric.
varY2	Total variance for the second outcome; numeric.
rho01	Correlation of the first outcome for two different individuals in the same cluster; numeric.
rho02	Correlation of the second outcome for two different individuals in the same cluster; numeric.
rho1	Correlation between the first and second outcomes for two individuals in the same cluster; numeric.
rho2	Correlation between the first and second outcomes for the same individual; numeric.
r	Treatment allocation ratio - $K2 = rK1$ where $K1$ is number of clusters in experimental group; numeric.
cv	Cluster variation parameter, set to 0 if assuming all cluster sizes are equal; numeric.
deltas	Vector of non-inferiority margins, set to $\text{delta}_1 = \text{delta}_2 = 0$ ; numeric vector.
two_sided	Specification of whether to conduct two 2-sided tests, 'TRUE', or two 1-sided tests, 'FALSE', default is FALSE; boolean.

**Value**

A numerical value.

**Examples**

```
calc_m_conj_test(power = 0.8, K = 15, alpha = 0.05,
beta1 = 0.1, beta2 = 0.1, varY1 = 0.23, varY2 = 0.25,
rho01 = 0.025, rho02 = 0.025, rho1 = 0.01, rho2 = 0.05)
```

---

calc_m_disj_2dfctest	<i>Calculate cluster size for a cluster-randomized trial with co-primary endpoints using a disjunctive 2-DF test approach.</i>
----------------------	--

---

**Description**

Allows user to calculate the cluster size of a cluster-randomized trial with two co-primary outcomes given a set of study design input values, including the number of clusters in each trial arm, and statistical power. Uses the disjunctive 2-DF test approach.

**Usage**

```
calc_m_disj_2dftest(
  dist = "Chi2",
  power,
  K,
  alpha = 0.05,
  beta1,
  beta2,
  varY1,
  varY2,
  rho01,
  rho02,
  rho1,
  rho2,
  r = 1
)
```

**Arguments**

dist	Specification of which distribution to base calculation on, either 'Chi2' for Chi-Squared or 'F' for F-Distribution.
power	Desired statistical power in decimal form; numeric.
K	Number of clusters in treatment arm, and control arm under equal allocation; numeric.
alpha	Type I error rate; numeric.
beta1	Effect size for the first outcome; numeric.
beta2	Effect size for the second outcome; numeric.
varY1	Total variance for the first outcome; numeric.
varY2	Total variance for the second outcome; numeric.
rho01	Correlation of the first outcome for two different individuals in the same cluster; numeric.
rho02	Correlation of the second outcome for two different individuals in the same cluster; numeric.
rho1	Correlation between the first and second outcomes for two individuals in the same cluster; numeric.
rho2	Correlation between the first and second outcomes for the same individual; numeric.
r	Treatment allocation ratio - $K2 = rK1$ where $K1$ is number of clusters in experimental group; numeric.

**Value**

A numerical value.

**Examples**

```
calc_m_disj_2dfctest(power = 0.8, K = 15, alpha = 0.05,
beta1 = 0.1, beta2 = 0.1, varY1 = 0.23, varY2 = 0.25,
rho01 = 0.025, rho02 = 0.025, rho1 = 0.01, rho2 = 0.05)
```

---

calc_m_pval_adj	<i>Calculate cluster size for a cluster-randomized trial with co-primary endpoints using three common p-value adjustment methods</i>
-----------------	--

---

**Description**

#' @description Allows user to calculate the cluster size of a cluster-randomized trial with two co-primary endpoints given a set of study design input values, including the number of clusters in each trial arm, and statistical power. Uses three common p-value adjustment methods.

**Usage**

```
calc_m_pval_adj(
  dist = "Chi2",
  power,
  K,
  alpha = 0.05,
  beta1,
  beta2,
  varY1,
  varY2,
  rho01,
  rho02,
  rho2,
  r = 1
)
```

**Arguments**

dist	Specification of which distribution to base calculation on, either 'Chi2' for Chi-Squared or 'F' for F-Distribution.
power	Desired statistical power in decimal form; numeric.
K	Number of clusters in treatment arm, and control arm under equal allocation; numeric.
alpha	Type I error rate; numeric.
beta1	Effect size for the first outcome; numeric.
beta2	Effect size for the second outcome; numeric.
varY1	Total variance for the first outcome; numeric.
varY2	Total variance for the second outcome; numeric.

rho01	Correlation of the first outcome for two different individuals in the same cluster; numeric.
rho02	Correlation of the second outcome for two different individuals in the same cluster; numeric.
rho2	Correlation between the first and second outcomes for the same individual; numeric.
r	Treatment allocation ratio - $K2 = rK1$ where $K1$ is number of clusters in experimental group; numeric.

**Value**

A data frame of numerical values.

**Examples**

```
calc_m_pval_adj(power = 0.8, K = 15, alpha = 0.05,
beta1 = 0.1, beta2 = 0.1, varY1 = 0.23, varY2 = 0.25,
rho01 = 0.025, rho02 = 0.025, rho2 = 0.05)
```

---

calc\_m\_single\_1dftest *Calculate cluster size for a cluster-randomized trial with co-primary endpoints using the single 1-DF combined test approach.*

---

**Description**

Allows user to calculate the cluster size of a cluster-randomized trial with two co-primary endpoints given a set of study design input values, including the number of clusters in each trial arm, and statistical power. Uses the single 1-DF combined test approach for clustered data and two outcomes.

**Usage**

```
calc_m_single_1dftest(
  dist = "Chi2",
  power,
  K,
  alpha = 0.05,
  beta1,
  beta2,
  varY1,
  varY2,
  rho01,
  rho02,
  rho1,
  rho2,
  r = 1
)
```

**Arguments**

dist	Specification of which distribution to base calculation on, either 'Chi2' for Chi-Squared or 'F' for F-Distribution.
power	Desired statistical power in decimal form; numeric.
K	Number of clusters in treatment arm, and control arm under equal allocation; numeric.
alpha	Type I error rate; numeric.
beta1	Effect size for the first outcome; numeric.
beta2	Effect size for the second outcome; numeric.
varY1	Total variance for the first outcome; numeric.
varY2	Total variance for the second outcome; numeric.
rho01	Correlation of the first outcome for two different individuals in the same cluster; numeric.
rho02	Correlation of the second outcome for two different individuals in the same cluster; numeric.
rho1	Correlation between the first and second outcomes for two individuals in the same cluster; numeric.
rho2	Correlation between the first and second outcomes for the same individual; numeric.
r	Treatment allocation ratio - $K2 = rK1$ where $K1$ is number of clusters in experimental group; numeric.

**Value**

A numerical value.

**Examples**

```
calc_m_single_1dfctest(power = 0.8, K = 15, alpha = 0.05,
beta1 = 0.1, beta2 = 0.1, varY1 = 0.23, varY2 = 0.25,
rho01 = 0.025, rho02 = 0.025, rho1 = 0.01, rho2 = 0.05)
```

---

calc_ncp_chi2	<i>Find the non-centrality parameter corresponding to Type I error rate and statistical power</i>
---------------	---

---

**Description**

Allows user to find the corresponding non-centrality parameter for power analysis based on the Type I error rate, statistical power, and degrees of freedom.

**Usage**

```
calc_ncp_chi2(alpha, power, df = 1)
```



**Arguments**

alpha	Type I error rate; numeric.
power	Desired statistical power in decimal form; numeric.
df	Degrees of freedom; numeric.

**Value**

A number.

**Examples**

```
calc_ncp_chi2(alpha = 0.05, power = 0.8, df = 1)
```

---

calc\_pwr\_comb\_outcome *Calculate statistical power for a cluster-randomized trial with co-primary endpoints using a combined outcomes approach.*

---

**Description**

Allows user to calculate the statistical power of a cluster-randomized trial with two co-primary outcomes given a set of study design input values, including the number of clusters in each trial arm, and cluster size. Uses a combined outcomes approach where the two outcome effects are summed together.

**Usage**

```
calc_pwr_comb_outcome(  
  dist = "Chi2",  
  K,  
  m,  
  alpha = 0.05,  
  beta1,  
  beta2,  
  varY1,  
  varY2,  
  rho01,  
  rho02,  
  rho1,  
  rho2,  
  r = 1  
)
```

**Arguments**

dist	Specification of which distribution to base calculation on, either 'Chi2' for Chi-Squared or 'F' for F-Distribution.
K	Number of clusters in treatment arm, and control arm under equal allocation; numeric.
m	Individuals per cluster; numeric.
alpha	Type I error rate; numeric.
beta1	Effect size for the first outcome; numeric.
beta2	Effect size for the second outcome; numeric.
varY1	Total variance for the first outcome; numeric.
varY2	Total variance for the second outcome; numeric.
rho01	Correlation of the first outcome for two different individuals in the same cluster; numeric.
rho02	Correlation of the second outcome for two different individuals in the same cluster; numeric.
rho1	Correlation between the first and second outcomes for two individuals in the same cluster; numeric.
rho2	Correlation between the first and second outcomes for the same individual; numeric.
r	Treatment allocation ratio - $K2 = rK1$ where $K1$ is number of clusters in experimental group; numeric.

**Value**

A numerical value.

**Examples**

```
calc_pwr_comb_outcome(K = 15, m = 300, alpha = 0.05,
beta1 = 0.1, beta2 = 0.1, varY1 = 0.23, varY2 = 0.25,
rho01 = 0.025, rho02 = 0.025, rho1 = 0.01, rho2 = 0.05)
```

---

calc_pwr_conj_test	<i>Calculate statistical power for a cluster-randomized trial with co-primary endpoints using the conjunctive intersection-union test approach.</i>
--------------------	---

---

**Description**

Allows user to calculate the statistical power of a cluster-randomized trial with two co-primary outcomes given a set of study design input values, including the number of clusters in each trial arm, and cluster size. Uses the conjunctive intersection-union test approach. Code is adapted from "calPower\_ttestIU()" from [https://github.com/siyunyang/coprimary\\_CRT](https://github.com/siyunyang/coprimary_CRT) written by Siyun Yang.

**Usage**

```
calc_pwr_conj_test(
  dist = "T",
  K,
  m,
  alpha = 0.05,
  beta1,
  beta2,
  varY1,
  varY2,
  rho01,
  rho02,
  rho1,
  rho2,
  r = 1,
  cv = 0,
  deltas = c(0, 0),
  two_sided = FALSE
)
```

**Arguments**

dist	Specification of which distribution to base calculation on, either 'T' for T-Distribution or 'MVN' for Multivariate Normal Distribution. Default is T-Distribution.
K	Number of clusters in treatment arm, and control arm under equal allocation; numeric.
m	Individuals per cluster; numeric.
alpha	Type I error rate; numeric.
beta1	Effect size for the first outcome; numeric.
beta2	Effect size for the second outcome; numeric.
varY1	Total variance for the first outcome; numeric.
varY2	Total variance for the second outcome; numeric.
rho01	Correlation of the first outcome for two different individuals in the same cluster; numeric.
rho02	Correlation of the second outcome for two different individuals in the same cluster; numeric.
rho1	Correlation between the first and second outcomes for two individuals in the same cluster; numeric.
rho2	Correlation between the first and second outcomes for the same individual; numeric.
r	Treatment allocation ratio - $K2 = rK1$ where $K1$ is number of clusters in experimental group; numeric.
cv	Cluster variation parameter, set to 0 if assuming all cluster sizes are equal; numeric.

deltas	Vector of non-inferiority margins, set to $\text{delta}_1 = \text{delta}_2 = 0$ ; numeric vector.
two_sided	Specification of whether to conduct two 2-sided tests, 'TRUE', or two 1-sided tests, 'FALSE', default is FALSE; boolean.

**Value**

A numerical value.

**Examples**

```
calc_pwr_conj_test(K = 15, m = 300, alpha = 0.05,
  beta1 = 0.1, beta2 = 0.1, varY1 = 0.23, varY2 = 0.25,
  rho01 = 0.025, rho02 = 0.025, rho1 = 0.01, rho2 = 0.05)
```

---

calc\_pwr\_disj\_2dftest *Calculate statistical power for a cluster-randomized trial with co-primary endpoints using a disjunctive 2-DF test approach.*

---

**Description**

Allows user to calculate the statistical power of a cluster-randomized trial with two co-primary outcomes given a set of study design input values, including the number of clusters in each trial arm, and cluster size. Uses the disjunctive 2-DF test approach. Code is adapted from "calPower\_omnibus()" from [https://github.com/siyunyang/coprimary\\_CRT](https://github.com/siyunyang/coprimary_CRT) written by Siyun Yang.

**Usage**

```
calc_pwr_disj_2dftest(
  dist = "Chi2",
  K,
  m,
  alpha = 0.05,
  beta1,
  beta2,
  varY1,
  varY2,
  rho01,
  rho02,
  rho1,
  rho2,
  r = 1
)
```

**Arguments**

dist	Specification of which distribution to base calculation on, either 'Chi2' for Chi-Squared or 'F' for F-Distribution.
K	Number of clusters in treatment arm, and control arm under equal allocation; numeric.
m	Individuals per cluster; numeric.
alpha	Type I error rate; numeric.
beta1	Effect size for the first outcome; numeric.
beta2	Effect size for the second outcome; numeric.
varY1	Total variance for the first outcome; numeric.
varY2	Total variance for the second outcome; numeric.
rho01	Correlation of the first outcome for two different individuals in the same cluster; numeric.
rho02	Correlation of the second outcome for two different individuals in the same cluster; numeric.
rho1	Correlation between the first and second outcomes for two individuals in the same cluster; numeric.
rho2	Correlation between the first and second outcomes for the same individual; numeric.
r	Treatment allocation ratio - $K2 = rK1$ where $K1$ is number of clusters in experimental group; numeric.

**Value**

A numerical value.

**Examples**

```
calc_pwr_disj_2dftest(K = 15, m = 300, alpha = 0.05,
beta1 = 0.1, beta2 = 0.1, varY1 = 0.23, varY2 = 0.25,
rho01 = 0.025, rho02 = 0.025, rho1 = 0.01, rho2 = 0.05)
```

---

calc_pwr_pval_adj	<i>Calculate statistical power for a cluster-randomized trial with co-primary endpoints using three common p-value adjustment methods</i>
-------------------	---

---

**Description**

Allows user to calculate the statistical power of a cluster-randomized trial with two co-primary endpoints given a set of study design input values, including the number of clusters in each trial arm, and cluster size. Uses three common p-value adjustment methods.

**Usage**

```
calc_pwr_pval_adj(
  dist = "Chi2",
  K,
  m,
  alpha = 0.05,
  beta1,
  beta2,
  varY1,
  varY2,
  rho01,
  rho02,
  rho2,
  r = 1
)
```

**Arguments**

dist	Specification of which distribution to base calculation on, either 'Chi2' for Chi-Squared or 'F' for F-Distribution.
K	Number of clusters in treatment arm, and control arm under equal allocation; numeric.
m	Individuals per cluster; numeric.
alpha	Type I error rate; numeric.
beta1	Effect size for the first outcome; numeric.
beta2	Effect size for the second outcome; numeric.
varY1	Total variance for the first outcome; numeric.
varY2	Total variance for the second outcome; numeric.
rho01	Correlation of the first outcome for two different individuals in the same cluster; numeric.
rho02	Correlation of the second outcome for two different individuals in the same cluster; numeric.
rho2	Correlation between the first and second outcomes for the same individual; numeric.
r	Treatment allocation ratio - $K2 = rK1$ where $K1$ is number of clusters in experimental group; numeric.

**Value**

A data frame of numerical values.

**Examples**

```
calc_pwr_pval_adj(K = 15, m = 300, alpha = 0.05,
  beta1 = 0.1, beta2 = 0.1, varY1 = 0.23, varY2 = 0.25,
  rho01 = 0.025, rho02 = 0.025, rho2 = 0.05)
```

---

 calc\_pwr\_single\_1dftest

*Calculate statistical power for a cluster-randomized trial with co-primary endpoints using the single 1-DF combined test approach.*

---

### Description

Allows user to calculate the statistical power of a cluster-randomized trial with two co-primary endpoints given a set of study design input values, including the number of clusters in each trial arm, and cluster size. Uses the single 1-DF combined test approach for clustered data and two outcomes.

### Usage

```
calc_pwr_single_1dftest(
  dist = "Chi2",
  K,
  m,
  alpha = 0.05,
  beta1,
  beta2,
  varY1,
  varY2,
  rho01,
  rho02,
  rho1,
  rho2,
  r = 1
)
```

### Arguments

dist	Specification of which distribution to base calculation on, either 'Chi2' for Chi-Squared or 'F' for F-Distribution.
K	Number of clusters in treatment arm, and control arm under equal allocation; numeric.
m	Individuals per cluster; numeric.
alpha	Type I error rate; numeric.
beta1	Effect size for the first outcome; numeric.
beta2	Effect size for the second outcome; numeric.
varY1	Total variance for the first outcome; numeric.
varY2	Total variance for the second outcome; numeric.
rho01	Correlation of the first outcome for two different individuals in the same cluster; numeric.

rho02	Correlation of the second outcome for two different individuals in the same cluster; numeric.
rho1	Correlation between the first and second outcomes for two individuals in the same cluster; numeric.
rho2	Correlation between the first and second outcomes for the same individual; numeric.
r	Treatment allocation ratio - $K2 = rK1$ where $K1$ is number of clusters in experimental group; numeric.

**Value**

A numerical value.

**Examples**

```
calc_pwr_single_1dftest(K = 15, m = 300, alpha = 0.05,
beta1 = 0.1, beta2 = 0.1, varY1 = 0.23, varY2 = 0.25,
rho01 = 0.025, rho02 = 0.025, rho1 = 0.01, rho2 = 0.05)
```

---

run_crt2_design	<i>Find study design output specifications based on all five CRT co-primary design methods.</i>
-----------------	---

---

**Description**

Allows user to calculate either statistical power, number of clusters per treatment group ( $K$ ), or cluster size ( $m$ ), given a set of input values for all five study design approaches.

**Usage**

```
run_crt2_design(
  output,
  power = NA,
  K = NA,
  m = NA,
  alpha = 0.05,
  beta1,
  beta2,
  varY1,
  varY2,
  rho01,
  rho02,
  rho1,
  rho2,
  r = 1
)
```



**Arguments**

output	Parameter to calculate, either "power", "K", or "m"; character.
power	Desired statistical power; numeric.
K	Number of clusters in each arm; numeric.
m	Individuals per cluster; numeric.
alpha	Type I error rate; numeric.
beta1	Effect size for the first outcome; numeric.
beta2	Effect size for the second outcome; numeric.
varY1	Total variance for the first outcome; numeric.
varY2	Total variance for the second outcome; numeric.
rho01	Correlation of the first outcome for two different individuals in the same cluster; numeric.
rho02	Correlation of the second outcome for two different individuals in the same cluster; numeric.
rho1	Correlation between the first and second outcomes for two individuals in the same cluster; numeric.
rho2	Correlation between the first and second outcomes for the same individual; numeric.
r	Treatment allocation ratio - $K2 = rK1$ where $K1$ is number of clusters in experimental group; numeric.

**Value**

A data frame of numerical values.

**Examples**

```
run_crt2_design(output = "power", K = 15, m = 300, alpha = 0.05,  
beta1 = 0.1, beta2 = 0.1, varY1 = 0.23, varY2 = 0.25,  
rho01 = 0.025, rho02 = 0.025, rho1 = 0.01, rho2 = 0.05)
```

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