Package 'MultEq'

July 21, 2025

Type Package

Title Multiple Equivalence Tests and Simultaneous Confidence Intervals

Version 2.4

Date 2022-03-02

Author Mario Hasler

Maintainer Mario Hasler <hasler@email.uni-kiel.de>

Imports stats

Depends R (>= 2.10.0)

Suggests SimComp

Description Equivalence tests and related confidence intervals for the comparison of two treatments, simultaneously for one or many normally distributed, primary response variables (endpoints). The step-up procedure of Quan et al. (2001) is both applied for differences and extended to ratios of means. A related single-step procedure is also available.

License GPL

LazyLoad yes

NeedsCompilation no

Repository CRAN

Date/Publication 2022-03-01 15:30:04 UTC

Contents

MultEq-package 2
clinic 3
multeq.diff 3
multeq.rat 5
print.multeq.diff 7
print.multeq.rat 8
summary.multeq.diff 8
summary.multeq.rat 9

Index **10**

`MultEq-package` *Equivalence for multiple endpoints*

Description

The package provides tests and confidence intervals for comparing two treatments when there is more than one primary response variable (endpoint). The step-up procedure of Quan et al. (2001) is both applied for differences and extended to ratios of means of normally distributed data with equal group variances. A related single-step procedure is also available.

Details

Package:	MultEq
Type:	Package
Version:	2.4
Date:	2022-03-02
License:	GPL
LazyLoad:	yes

- multeq.diffEquivalence tests and related confidence intervals for differences of normal means of multiple endpoints
- multeq.ratEquivalence tests and related confidence intervals for ratios of normal means of multiple endpoints
- clinicData set of body measurements in a clinical study

Author(s)

Mario Hasler

Maintainer: Mario Hasler <hasler@email.uni-kiel.de>

References

Quan et al. (2001): Assessmant of equivalence on multiple endpoints, Statistics in Medicine 20, 3159-3173

Examples

```
data(clinic)

comp <- multeq.diff(data=clinic,grp="fact",method="step.up",margin.up=rep(0.6,5),
                    margin.lo=-rep(0.6,5))
summary(comp)
```

clinic *Body measurements in a clinical study*

Description

Measurements on six parts of patients' bodies in a clinical study for two competing treatments.

Usage

```
data(clinic)
```

Format

A data frame with 30 observations on the following 6 variables.

`fact` a factor with levels `1` `2`, specifying the treatment groups

`var1` numeric vectors containing measurements on a first part of patients' bodies

`var2` numeric vectors containing measurements on a second part of patients' bodies

`var3` numeric vectors containing measurements on a third part of patients' bodies

`var4` numeric vectors containing measurements on a fourth part of patients' bodies

`var5` numeric vectors containing measurements on a fifth part of patients' bodies

Source

L"auter, and Kropf, (1998): Exact stable multivariate tests for application in clinical research. Joint statistical meeting Dallas (USA), conference proceeedings, group 1

Examples

```
library(MultEq)

data(clinic)
plot(clinic[,-1])
```

multeq.diff *Equivalence for differences of means of multiple endpoints*

Description

Performs equivalence tests and related confidence intervals for differences of two normal means of multiple endpoints.

Usage

```
multeq.diff(data, grp, resp = NULL, base = 1, margin.lo = NULL, margin.up = NULL,
            method = "single.step", var.equal = FALSE, FWER = 0.05)
```

Arguments

data	a data frame containing response variables (endpoints) and the group variable as columns, the data must have exactly two treatment groups
grp	the name of the group variable in " "
resp	a vector of names of the response variables (endpoints) in " "
base	a single integer specifying the base/control group
margin.lo	a vector of absolute lower margins under the null hypotheses relating to the endpoints
margin.up	a vector of absolute upper margins under the null hypotheses relating to the endpoints
method	a character string: • "step.up": method of Quan et al. (2001), • "single.step": Bonferroni-adjusted single-step procedure
var.equal	a logical indicating homogeneous or heterogeneous variances of the data
FWER	a single numeric value specifying the familywise error rate to be controlled by the simultaneous confidence intervals

Details

The objective is to show equivalence for two treatment groups on multiple primary, normally distributed response variables (endpoints). If margin.up is not given, one-sided tests are applied for the alternative hypothesis that the differences (to the base group) of the means is larger than margin.lo. Analogously, same vice versa. Only if both margin.lo and margin.up are given, a two-sided equivalence test for differences is done. Bonferroni adjusted "two one-sided t-tests" (TOST) and related simultaneous confidence intervals are used for method "single.step"; the method of Quan et al. (2001) is applied for "step.up". Welch t-tests and related confidence intervals are used for var.equal=FALSE.

Value

An object of class multeq.diff containing:

estimate	a (named) vector of estimated differences
test.stat	a (named) vector of the calculated test statistics
degr.fr	either a single degree of freedom (var.equal=TRUE) or a (named) vector of degrees of freedom (var.equal=FALSE)
p.value	a (named) vector of p-values adjusted for multiplicity
lower	a (named) vector of lower confidence limits
upper	a (named) vector of upper confidence limits

Note

Because related to the TOST method, the two-sided confidence intervals for method="single.step" have simultaneous coverage probability (1-2alpha). The intervals for method="step.up" are stepwise adjusted and only applicable for test decisions, not for a simultaneous parameter estimation or comparing among each other.

Author(s)

Mario Hasler

References

Quan et al. (2001): Assessment of equivalence on multiple endpoints, Statistics in Medicine 20, 3159-3173

See Also

multeq.rat

Examples

```
data(clinic)

comp <- multeq.diff(data=clinic,grp="fact",method="step.up",margin.up=rep(0.6,5),
                    margin.lo=-rep(0.6,5))
summary(comp)
```

---

multeq.rat *Equivalence for ratios of means of multiple endpoints*

Description

Performs equivalence tests and related confidence intervals for ratios of two normal means of multiple endpoints.

Usage

```
multeq.rat(data, grp, resp = NULL, base = 1, margin.lo = NULL, margin.up = NULL,
           method = "single.step", var.equal = FALSE, FWER = 0.05)
```

Arguments

data	a data frame containing response variables (endpoints) and the group variable as columns, the data must have exactly two treatment groups
grp	the name of the group variable in " "
resp	a vector of names of the response variables (endpoints) in " "
base	a single integer specifying the base/control group
margin.lo	a vector of relative lower margins under the null hypotheses relating to the endpoints
margin.up	a vector of relative upper margins under the null hypotheses relating to the endpoints
method	a character string:

- "step.up": method of Quan et al. (2001),
- "single.step": Bonferroni-adjusted single-step procedure

`var.equal`	a logical indicating homogeneous or heterogeneous variances of the data
`FWER`	a single numeric value specifying the familywise error rate to be controlled by the simultaneous confidence intervals

Details

The objective is to show equivalence for two treatment groups on multiple primary, normally distributed response variables (endpoints). If margin.up is not given, one-sided tests are applied for the alternative hypothesis that the ratios (to the base group) of the means is larger than margin.lo. Analogously, same vice versa. Only if both margin.lo and margin.up are given, a two-sided equivalence tests for ratios is done. Bonferroni adjusted "two one-sided t-tests" (TOST) and related simultaneous confidence intervals are used for method "single.step"; an extended version of the method of Quan et al. (2001) is applied for "step.up". Welch t-tests and related confidence intervals are used for var.equal=FALSE.

Value

An object of class multeq.rat containing:

`estimate`	a (named) vector of estimated ratios
`test.stat`	a (named) vector of the calculated test statistics (var.equal=TRUE)
`test.stat.up`	a (named) vector of the calculated test statistics (up) (var.equal=FALSE)
`test.stat.do`	a (named) vector of the calculated test statistics (do) (var.equal=FALSE)
`degr.fr`	a single degree of freedom (var.equal=TRUE)
`degr.fr.up`	a (named) vector of degrees of freedom for test statistics (up) (var.equal=FALSE)
`degr.fr.do`	a (named) vector of degrees of freedom for test statistics (do) (var.equal=FALSE)
`degr.fr.ci`	a (named) vector of degrees of freedom used for the confidence intervals (var.equal=FALSE)
`p.value`	a (named) vector of p-values adjusted for multiplicity
`lower`	a (named) vector of lower confidence limits
`upper`	a (named) vector of upper confidence limits

Note

Because related to the TOST method, the two-sided confidence intervals for method="single.step" have simultaneous coverage probability (1-2alpha). The intervals for method="step.up" are stepwise adjusted and only applicable for test decisions, not for a simultaneous parameter estimation or comparing among each other.

Author(s)

Mario Hasler

References

Quan et al. (2001): Assessmant of equivalence on multiple endpoints, Statistics in Medicine 20, 3159-3173

See Also

multeq.diff

Examples

```
data(clinic)

comp <- multeq.rat(data=clinic,grp="fact",method="step.up",margin.up=rep(1.25,5),
                   margin.lo=1/rep(1.25,5))
summary(comp)
```

---

print.multeq.diff *Print out of the results of multeq.diff*

Description

A short print out of the results of multeq.diff.

Usage

```
## S3 method for class 'multeq.diff'
print(x, digits = 4, ...)
```

Arguments

x	an object of class "multeq.diff" as obtained by calling multeq.diff
digits	digits for rounding the results
...	arguments to be passed to print

Value

A print out containing the margins, estimates, confidence intervals, and p.values computed by multeq.diff.

Author(s)

Mario Hasler

See Also

print.multeq.rat

print.multeq.rat *Print out of the results of multeq.rat*

Description

A short print out of the results of multeq.rat.

Usage

```
## S3 method for class 'multeq.rat'
print(x, digits = 4, ...)
```

Arguments

x	an object of class "multeq.rat" as obtained by calling multeq.rat
digits	digits for rounding the results
...	arguments to be passed to print

Value

A print out containing the margins, estimates, confidence intervals, and p.values computed by multeq.rat.

Author(s)

Mario Hasler

See Also

print.multeq.diff

summary.multeq.diff *Summary function for multeq.diff*

Description

A detailed print out of the results of multeq.diff.

Usage

```
## S3 method for class 'multeq.diff'
summary(object, digits = 4, ...)
```

Arguments

object	an object of class "multeq.diff" as obtained by calling multeq.diff
digits	digits for rounding the results
...	arguments to be passed to print

Value

A print out containing the margins, degrees of freedom, estimates, test statistics, confidence intervals, and p.values computed by multeq.diff.

Author(s)

Mario Hasler

See Also

summary.multeq.rat

---

summary.multeq.rat *Summary function for multeq.rat*

Description

A detailed print out of the results of multeq.rat.

Usage

```
## S3 method for class 'multeq.rat'
summary(object, digits = 4, ...)
```

Arguments

object	an object of class "multeq.rat" as obtained by calling multeq.rat
digits	digits for rounding the results
...	arguments to be passed to print

Value

A print out containing the margins, degrees of freedom, estimates, test statistics, confidence intervals, and p.values computed by multeq.rat.

Author(s)

Mario Hasler

See Also

summary.multeq.diff

Index

∗ **datasets**
clinic, 3
∗ **htest**
multeq.diff, 3
multeq.rat, 5
∗ **package**
MultEq-package, 2
∗ **print**
print.multeq.diff, 7
print.multeq.rat, 8
summary.multeq.diff, 8
summary.multeq.rat, 9

clinic, 3

MultEq *(*MultEq-package*)*, 2
MultEq-package, 2
multeq.diff, 3, *7*
multeq.rat, *5*, 5

print.multeq.diff, 7, *8*
print.multeq.rat, *7*, 8

summary.multeq.diff, 8, *9*
summary.multeq.rat, *9*, 9