Package 'BHAI'

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Title Estimate the Burden of Healthcare-Associated Infections

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Description Provides an approach which is based on the methodology of the Burden of Communicable Diseases in Europe (BCoDE) and can be used for large and small samples such as individual countries. The Burden of Healthcare-Associated Infections (BHAI) is estimated in disability-adjusted life years, number of infections as well as number of deaths per year. Results can be visualized with various plotting functions and exported into tables.

Depends R (>= 3.6.0)

License GPL-3

LazyData true

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Imports prevtoinc, MCMCpack, plotrix, graphics, grDevices, stats, methods

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Description

The **BHAI** package

BHAI functions

bhai:

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bhai *Main function of the package to estimation of the burden of healthcare-associated infections*

Description

Estimation of the burden of healthcare-associated infections

Usage

```
bhai(pps, nsim = 1000, pop.sampling = TRUE,
  sample_distr = "rbetamix", estimate_loi_fun = bootstrap_mean_gren,
  stratified_sampling = FALSE, summarize_strata = TRUE,
  use_prior = TRUE)

## S4 method for signature 'PPS'
bhai(pps, nsim = 1000, pop.sampling = TRUE,
  sample_distr = "rbetamix", estimate_loi_fun = bootstrap_mean_gren,
  stratified_sampling = FALSE, summarize_strata = TRUE,
  use_prior = TRUE)
```

Arguments

pps	The PPS object containing the data.
nsim	Number of Monte Carlo simulations, default: 1000.
pop.sampling	Specifying whether parameters of the disease outcome trees should be sampled on population level, default: TRUE.
sample_distr	Distribution used for prevalence sampling, default: "rbetamix".
estimate_loi_fun	Function used for estimation of the length of infection, default: bootstrap_mean_gren (recommended!).
stratified_sampling	Specifying whether stratified sampling should be done.
summarize_strata	Specifying whether stratum-specific summary statistics should be computed.
use_prior	Specifying whether Prior distributions should be used for computations.

Value

A PPS class object.

See Also

PPS

Examples

```
data(german_pps_2011_repr)
german_pps_repr = PPS(num_hai_patients = num_hai_patients,
    num_hai_patients_by_stratum = num_hai_patients_by_stratum,
    num_hai_patients_by_stratum_prior = num_hai_patients_by_stratum_prior,
    num_survey_patients = num_survey_patients,
    length_of_stay = length_of_stay,
    loi_pps = loi_pps,
    mccabe_scores_distr = mccabe_scores_distr,
    mccabe_life_exp = mccabe_life_exp,
    hospital_discharges = hospital_discharges,
    population = population,
    country="Germany (representative sample)")
german_pps_repr

set.seed(3)
# The following example is run only for illustratory reasons
# Note that you should never run the function with only 10 Monte-Carlo simulations in practice!
bhai(german_pps_repr, nsim=10)
```

bhai.barplot *Barplot of cases, deaths and DALYs.*

Description

Barplot of cases, deaths and DALYs.

Usage

```
bhai.barplot(..., what, infections=NULL, cols1=NULL, cols2=NULL, ylab=NULL, ylim=NULL,
legend_labs=NULL, main="", names.inf=TRUE, cex.names=1, border=par("fg"), lwd.errors=2)
```

Arguments

...	Further plotting arguments
what	One of c("Cases", "Deaths", "DALY")
infections	If sepcified only a subset of infections in bhai_summary is plotted.
cols1	Color used to fill the bars.
cols2	Specifies colors of YLDs when plotting DALYs.
ylab	Y-axis labels.
ylim	Limits of y-axis.
legend_labs	Labels of legend.
main	Title of plot
names.inf	Specifying whether names of infections should be plotted.
cex.names	Font size of labels.
border	The color to be used for the border of the bars, default: par("fg").
lwd.errors	Line width of error bars.

See Also

PPS

Examples

```
data(german_pps_2011_repr)
german_pps_repr = PPS(num_hai_patients = num_hai_patients,
    num_hai_patients_by_stratum = num_hai_patients_by_stratum,
    num_hai_patients_by_stratum_prior = num_hai_patients_by_stratum_prior,
    num_survey_patients = num_survey_patients,
    length_of_stay = length_of_stay,
    loi_pps = loi_pps,
    mccabe_scores_distr = mccabe_scores_distr,
    mccabe_life_exp = mccabe_life_exp,
    hospital_discharges = hospital_discharges,
    population = population,
```

```
    country="Germany (representative sample)")
german_pps_repr

set.seed(3)
# The following example is run only for illustratory reasons
# Note that you should never run the function with only 10 Monte-Carlo simulations in practice!
result_ger = bhai(german_pps_repr, nsim=10)

bhai.barplot(result_ger, what="Cases")
```

`bhai.circleplot` *Summary plot of number of infections, deaths and DALYs*

Description

Summary plot of number of infections, deaths and DALYs

Usage

```
bhai.circleplot(pps, infections=NULL, main="", xlim=NULL, ylim=NULL)
```

Arguments

`pps`	The PPS object containing the data.
`infections`	Infections to be plotted.
`main`	Title of plot.
`xlim`	Limits of x-axis.
`ylim`	Limits of y-axis.

See Also

`PPS`

Examples

```
data(german_pps_2011_repr)
german_pps_repr = PPS(num_hai_patients = num_hai_patients,
    num_hai_patients_by_stratum = num_hai_patients_by_stratum,
    num_hai_patients_by_stratum_prior = num_hai_patients_by_stratum_prior,
    num_survey_patients = num_survey_patients,
    length_of_stay = length_of_stay,
    loi_pps = loi_pps,
    mccabe_scores_distr = mccabe_scores_distr,
    mccabe_life_exp = mccabe_life_exp,
    hospital_discharges = hospital_discharges,
    population = population,
    country="Germany (representative sample)")
```

```
german_pps_repr

set.seed(3)
# The following example is run only for illustratory reasons
# Note that you should never run the function with only 10 Monte-Carlo simulations in practice!
result = bhai(german_pps_repr, nsim=10)
bhai.circleplot(pps=result)
```

`bhai.prettyTable` *Create summary table*

Description

Create BHAI summary table

Usage

```
bhai.prettyTable(pps, pop_norm=FALSE, conf.int=TRUE)
```

Arguments

`pps`	The PPS object containing the data.
`pop_norm`	Indicating whether statistics should be computed per 100,000 population, default: TRUE.
`conf.int`	Specifying whether confidence intervals should be computed, default: TRUE.

Value

A data.frame containing the summarised results.

See Also

PPS

Examples

```
data(german_pps_2011_repr)
german_pps_repr = PPS(num_hai_patients = num_hai_patients,
    num_hai_patients_by_stratum = num_hai_patients_by_stratum,
    num_hai_patients_by_stratum_prior = num_hai_patients_by_stratum_prior,
    num_survey_patients = num_survey_patients,
    length_of_stay = length_of_stay,
    loi_pps = loi_pps,
    mccabe_scores_distr = mccabe_scores_distr,
    mccabe_life_exp = mccabe_life_exp,
    hospital_discharges = hospital_discharges,
    population = population,
    country="Germany (representative sample)")
```

```
german_pps_repr

set.seed(3)
# The following example is run only for illustratory reasons
# Note that you should never run the function with only 10 Monte-Carlo simulations in practice!
result = bhai(german_pps_repr, nsim=10)
bhai.prettyTable(result)
```

`bhai.strataplot` *Stratified barplot of cases, deaths and DALYs.*

Description

Stratified barplot of cases, deaths and DALYs.

Usage

```
bhai.strataplot(pps, infection, what, col=NULL, errors=TRUE, lwd.errors=2, xlab=NULL, ...)
```

Arguments

`pps`	The PPS object containing the data.
`infection`	Infection to be plotted.
`what`	One of c("Cases", "Deaths", "DALY")
`col`	Color used to fill the bars.
`errors`	Specifying whether error bars should be plotted, default: TRUE.
`lwd.errors`	Line width of error bars.
`xlab`	X-axis labels.
`...`	Further plotting arguments

See Also

PPS

Examples

```
data(german_pps_2011_repr)
german_pps_repr = PPS(num_hai_patients = num_hai_patients,
    num_hai_patients_by_stratum = num_hai_patients_by_stratum,
    num_hai_patients_by_stratum_prior = num_hai_patients_by_stratum_prior,
    num_survey_patients = num_survey_patients,
    length_of_stay = length_of_stay,
    loi_pps = loi_pps,
    mccabe_scores_distr = mccabe_scores_distr,
    mccabe_life_exp = mccabe_life_exp,
    hospital_discharges = hospital_discharges,
```

```
    population = population,
    country="Germany (representative sample)")
german_pps_repr

set.seed(3)
# The following example is run only for illustratory reasons
# Note that you should never run the function with only 10 Monte-Carlo simulations in practice!
result = bhai(german_pps_repr, nsim=10)
bhai.strataplot(pps=result, infection="HAP", what="Cases")
```

---

eu_pps *Aggregated data of the ECDC PPS 2010-2011.*

Description

Aggregated data of the ECDC PPS 2010-2011.

Usage

```
data(eu_pps_2011)
```

Format

A PPS object.

---

german_pps_conv *Aggregated data of the german PPS 2010-2011 (convenience sample).*

Description

Aggregated data of the german PPS 2010-2011 (convenience sample).

Usage

```
data(german_pps_2011_conv)
```

Format

A PPS object.

hospital_discharges *Hospital discharges in Germany (2011)*

Description

Hospital discharges in Germany (2011)

Usage

```
data(german_pps_2011_repr)
```

Format

A PPS object.

length_of_stay *Average length of stay of survey patients in german PPS 2011 (representative sample)*

Description

Average length of stay of survey patients in german PPS 2011 (representative sample)

Usage

```
data(german_pps_2011_repr)
```

Format

A PPS object.

loi_pps *A list containing length of infections from all patients in the german PPS 2011 representative sample.*

Description

A list containing length of infections from all patients in the german PPS 2011 representative sample.

Usage

```
data(german_pps_2011_repr)
```

Format

A PPS object.

`mccabe_life_exp` *Named list containing remaining life expectancies for each McCabe score (NONFATAL, ULTFATAL, RAPFATAL).*

Description

Named list containing remaining life expectancies for each McCabe score (NONFATAL, ULTFATAL, RAPFATAL).

Usage

```
data(german_pps_2011_repr)
```

Format

A PPS object.

`mccabe_scores_distr` *The observed McCabe scores (counts) for each infection, age and gender stratum from the ECDC PPS 2011-2012.*

Description

The observed McCabe scores (counts) for each infection, age and gender stratum from the ECDC PPS 2011-2012.

Usage

```
data(german_pps_2011_repr)
```

Format

A PPS object.

num_hai_patients *Number of cases for each infection in the german PPS 2011 (representative sample)*

Description

Number of cases for each infection in the german PPS 2011 (representative sample)

Usage

```
data(german_pps_2011_repr)
```

Format

A PPS object.

num_hai_patients_by_stratum *Stratified number of cases for each infection in the german PPS 2011 (representative sample)*

Description

Stratified number of cases for each infection in the german PPS 2011 (representative sample)

Usage

```
data(german_pps_2011_repr)
```

Format

A PPS object.

num_hai_patients_by_stratum_prior

Stratified number of cases for each infection in the german PPS 2011 (convenience sample). This distribution is used as a Prior for the representative sample.

Description

Stratified number of cases for each infection in the german PPS 2011 (convenience sample). This distribution is used as a Prior for the representative sample.

Usage

```
data(german_pps_2011_repr)
```

Format

A PPS object.

num_survey_patients

Number of survey patients in the german PPS 2011 (representative sample).

Description

Number of survey patients in the german PPS 2011 (representative sample).

Usage

```
data(german_pps_2011_repr)
```

Format

A PPS object.

population *Population size of Germany in 2011.*

Description

Population size of Germany in 2011.

Usage

```
data(german_pps_2011_repr)
```

Format

A PPS object.

PPS *Create a PPS object*

Description

This function creates a PPS object.

Usage

```
PPS(num_hai_patients = NULL, num_survey_patients = NULL,
  length_of_stay = NULL, loi_pps = NULL, hospital_discharges = NULL,
  num_hai_patients_by_stratum = NULL,
  num_hai_patients_by_stratum_prior = NULL, mccabe_scores_distr = NULL,
  mccabe_by_stratum_prior = NULL, mccabe_life_exp = NULL,
  num_survey_patients_by_stratum = NULL, population = NULL,
  country = "")
```

Arguments

num_hai_patients	Named numeric containing patients having healthcare-associated infections.
num_survey_patients	Number of patients in point prevalence survey.
length_of_stay	Length of stay of all patients in hospitals. This is need for the prevalence to incidence conversion with the Rhame-Sudderth formula.
loi_pps	A list containing length of infections from all patients in the PPS. The length of infection of all healthcare-associated infections. In PPS this is usually approximated as the time from infection onset until the date of the survey.
hospital_discharges	The number of hospital discharges.

num_hai_patients_by_stratum
: A list containing for each infection the number of patients in each age and gender stratum.

num_hai_patients_by_stratum_prior
: The prior weight (counts) for each infection, age and gender stratum. This is used for smooting the age and gender distribution when small numbers are observed.

mccabe_scores_distr
: The observed McCabe scores (counts) for each infection, age and gender stratum from the PPS.

mccabe_by_stratum_prior
: The prior weight (counts) for each infection, McCabe score, age and gender stratum. This is used for smooting the age and gender distribution when small numbers are observed.

mccabe_life_exp
: Named list containing remaining life expectancies for each McCabe score (NONFATAL, ULTFATAL, RAPFATAL).

num_survey_patients_by_stratum
: Number of survey patients stratified by infection, age and gender. If this parameter is provided the methodology described in Cassini et al. (2016) <doi:https://doi.org/10.1371/journal.pm is applied.

population
: Population size.

country
: Name of the country.

Value

A PPS class object.

See Also

PPS

Examples

```
data(german_pps_2011_repr)
german_pps_repr = PPS(num_hai_patients = num_hai_patients,
    num_hai_patients_by_stratum = num_hai_patients_by_stratum,
    num_hai_patients_by_stratum_prior = num_hai_patients_by_stratum_prior,
    num_survey_patients = num_survey_patients,
    length_of_stay = length_of_stay,
    loi_pps = loi_pps,
    mccabe_scores_distr = mccabe_scores_distr,
    mccabe_life_exp = mccabe_life_exp,
    hospital_discharges = hospital_discharges,
    population = population,
    country="Germany (representative sample)")
german_pps_repr
```

PPS-class *This class is a generic container for PPS data sets.*

Description

This class is a generic container for PPS data sets.

Slots

`infections` Character vector storing names of infections in PPS

`num_hai_patients` Named numeric containing patients having healthcare-associated infections.

`num_survey_patients` Number of patients in point prevalence survey.

`length_of_stay` Length of stay of all patients in hospitals. This is need for the prevalence to incidence conversion with the Rhame-Sudderth formula.

`loi_pps` A list containing length of infections from all patients in the PPS. In PPS this is usually calculated as the time from infection onset until the date of the survey.

`hospital_discharges` The number of hospital discharges.

`num_hai_patients_by_stratum` A list containing for each infection the number of patients in each age and gender stratum.

`num_hai_patients_by_stratum_prior` The prior weight (counts) for each infection, age and gender stratum. This is used for smooting the age and gender distribution when small numbers are observed.

`mccabe_scores_distr` The observed McCabe scores (counts) for each infection, age and gender stratum from the PPS.

`mccabe_by_stratum_prior` The prior weight (counts) for each infection, McCabe score, age and gender stratum. This is used for smooting the age and gender distribution when small numbers are observed.

`mccabe_life_exp` Named list containing remaining life expectancies for each McCabe score (NONFATAL, ULTFATAL, RAPFATAL).

`num_survey_patients_by_stratum` Number of survey patients stratified by infection, age and gender. If this parameter is provided the methodology described in Cassini et al. (2016) <doi:https://doi.org/10.1371/journal.pmed.1002150> is applied.

`population` Population size

`country` Name of the country in which PPS was conducted

`bhai_options` Options with which bhai was run. If bhai was not run yet, this is an empty list.

`bhai_summary` Summary statistics of bhai. If bhai was not run yet, this is an empty list.

sample.pps *Simulate PPS data*

Description

Simulate PPS data

Usage

```
sample.pps(pps_data, num_survey_patients)
```

Arguments

pps_data	The PPS object containing the data. Parameters for simulations are extracted from this data.
num_survey_patients	Numeric vector indicating sample sizes for simulations.

Value

A simulated PPS object.

See Also

PPS

Examples

```
# Specify the number of survey patients
sim_survey_patients = 10000
# Subsample data sets from european PPS
sim_pps = sample.pps(eu_pps, num_survey_patients = sim_survey_patients)
```

sim_pps *Simulated/subsampled data sets from european PPS*

Description

Simulated/subsampled data sets from european PPS

Usage

```
data(simulations)
```

Format

A PPS object.

sim_pps_bhai — *BHAI with default options was applied to simulated/subsampled data sets from european PPS*

Description

BHAI with default options was applied to simulated/subsampled data sets from european PPS

Usage

```
data(simulations)
```

Format

A PPS object.

sim_pps_bhai_prior — *BHAI with prior was applied to simulated/subsampled data sets from european PPS*

Description

BHAI with prior was applied to simulated/subsampled data sets from european PPS

Usage

```
data(simulations)
```

Format

A PPS object.

sim_pps_stratified — *BHAI with stratified sampling was applied to simulated/subsampled data sets from european PPS*

Description

BHAI with stratified sampling was applied to simulated/subsampled data sets from european PPS

Usage

```
data(simulations)
```

Format

A PPS object.

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