

# Package: BHAI (via r-universe)

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**Title** Estimate the Burden of Healthcare-Associated Infections

**Version** 0.99.2

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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

**RoxygenNote** 6.1.1

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

**NeedsCompilation** no

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BHAI

*BHAI:*

---

## Description

The **BHAI** package

## BHAI functions

[bhai:](#)

---

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**

<code>pps</code>	The PPS object containing the data.
<code>nsim</code>	Number of Monte Carlo simulations, default: 1000.
<code>pop.sampling</code>	Specifying whether parameters of the disease outcome trees should be sampled on population level, default: TRUE.
<code>sample_distr</code>	Distribution used for prevalence sampling, default: "rbetamix".
<code>estimate_loi_fun</code>	Function used for estimation of the length of infection, default: <code>bootstrap_mean_gren</code> (recommended!).
<code>stratified_sampling</code>	Specifying whether stratified sampling should be done.
<code>summarize_strata</code>	Specifying whether stratum-specific summary statistics should be computed.
<code>use_prior</code>	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	<i>Hospital discharges in Germany (2011)</i>
---------------------	--

---

**Description**

Hospital discharges in Germany (2011)

**Usage**

```
data(german_pps_2011_repr)
```

**Format**

A PPS object.

---

length_of_stay	<i>Average length of stay of survey patients in german PPS 2011 (representative sample)</i>
----------------	---

---

**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	<i>A list containing length of infections from all patients in the german PPS 2011 representative sample.</i>
---------	---

---

**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	<i>Named list containing remaining life expectancies for each McCabe score (NONFATAL, ULTFATAL, RAPFATAL).</i>
-----------------	--

---

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

---

**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	<i>Number of cases for each infection in the german PPS 2011 (representative sample)</i>
------------------	--

---

**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	<i>Number of survey patients in the german PPS 2011 (representative sample).</i>
---------------------	--

---

**Description**

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

**Usage**

```
data(german_pps_2011_repr)
```

**Format**

A PPS object.

---

population	<i>Population size of Germany in 2011.</i>
------------	--

---

**Description**

Population size of Germany in 2011.

**Usage**

```
data(german_pps_2011_repr)
```

**Format**

A PPS object.

---

PPS	<i>Create a PPS object</i>
-----	----------------------------

---

**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**

<code>num_hai_patients</code>	Named numeric containing patients having healthcare-associated infections.
<code>num_survey_patients</code>	Number of patients in point prevalence survey.
<code>length_of_stay</code>	Length of stay of all patients in hospitals. This is need for the prevalence to incidence conversion with the Rhame-Sudderth formula.
<code>loi_pps</code>	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.
<code>hospital_discharges</code>	The number of hospital discharges.
<code>num_hai_patients_by_stratum</code>	A list containing for each infection the number of patients in each age and gender stratum.
<code>num_hai_patients_by_stratum_prior</code>	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.
<code>mccabe_scores_distr</code>	The observed McCabe scores (counts) for each infection, age and gender stratum from the PPS.
<code>mccabe_by_stratum_prior</code>	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.
<code>mccabe_life_exp</code>	Named list containing remaining life expectancies for each McCabe score (NON-FATAL, ULTFATAL, RAPFATAL).
<code>num_survey_patients_by_stratum</code>	Number of survey patients stratified by infection, age and gender. If this parameter is provided the methodology described in Cassini et al. (2016) <doi: <a href="https://doi.org/10.1371/journal.pmi">https://doi.org/10.1371/journal.pmi</a> > is applied.
<code>population</code>	Population size.
<code>country</code>	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 Rhamme-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 (NON-FATAL, 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	<i>Simulated/subsampled data sets from european PPS</i>
---------	---

---

**Description**

Simulated/subsampled data sets from european PPS

**Usage**

data(simulations)

**Format**

A PPS object.

---

sim_pps_bhai	<i>BHAI with default options was applied to simulated/subsampled data sets from european PPS</i>
--------------	--

---

**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	<i>BHAI with prior was applied to simulated/subsampled data sets from european PPS</i>
--------------------	--

---

**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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