# Package ‘PHEindicatormethods’

**October 12, 2022**

**Type** Package  
**Version** 1.4.1  
**Title** Common Public Health Statistics and their Confidence Intervals  
**Description** Functions to calculate commonly used public health statistics and their confidence intervals using methods approved for use in the production of Public Health England indicators such as those presented via Fingertips (<http://fingertips.phe.org.uk/>). It provides functions for the generation of proportions, crude rates, means, directly standardised rates, indirectly standardised rates, standardised mortality ratios, slope and relative index of inequality and life expectancy.  
Statistical methods are referenced in the following publications.  
**BugReports** https://github.com/PublicHealthEngland/PHEindicatormethods/issues  
**Depends** R (&gt;= 3.1.0)  
**License** GPL-3  
**Encoding** UTF-8  
**LazyData** true  
**Imports** broom, dplyr (&gt;= 1.0.0), lifecycle (&gt;= 1.0.0), purrr, rlang (&gt;= 0.4.0), stats, tibble, tidyr  
**Suggests** knitr, readxl, rmarkdown, testthat, withr  
**RoxygenNote** 7.2.1  
**VignetteBuilder** knitr  
**NeedsCompilation** no
**assign_funnel_significance**

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**Repository** CRAN

**Date/Publication** 2022-08-08 11:40:17 UTC

**R topics documented:**

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assign_funnel_significance

Identifies whether each value in a dataset falls outside of 95 and/or 99.8 percent control limits based on the aggregated average value across the whole dataset as an indicator of statistically significant difference.

**Description**

This follows the funnel plot methodology published on the PHE Fingertips Technical Guidance page: https://fingertips.phe.org.uk/profile/guidance/supporting-information/PH-methods
assign_funnel_significance

Usage

assign_funnel_significance(
    data,
    numerator,
    denominator,
    rate,
    statistic = NULL,
    rate_type = NULL,
    multiplier = NULL
)

Arguments

data          a data.frame containing the data to assign significance for; unquoted string; no default
numerator     field name from data containing the observed numbers of cases in the sample meeting the required condition (the numerator or observed counts for the control limits); unquoted string; no default
denominator   field name from data containing the population(s) in the sample (the denominator or expected counts for the control limits); unquoted string; no default
rate          field name from data containing the rate data when creating funnels for a Crude or Directly Standardised Rate; unquoted string; no default
statistic     type of statistic to inform funnel calculations. Acceptable values are "proportion", "ratio" or "rate"; string; no default
rate_type     if statistic is "rate", specify either "dsr" or "crude"; string; no default
multiplier    the multiplier that the rate is normalised with (ie, per 100,000); only required when statistic = "rate"; numeric; no default

Value

returns the original data.frame with the significance level appended

Author(s)

Matthew Francis

See Also

Other PHEindicator package functions: calculate_ISRate(), calculate_ISRatio(), calculate_funnel_limits(), calculate_funnel_points(), phe_dsr(), phe_life_expectancy(), phe_mean(), phe_proportion(), phe_quantile(), phe_rate(), phe_sii()

Examples

library(dplyr)
df <- data.frame(
    Area = c("A", "B", "C", "D"),
byars_lower(numerator = c(10232, 12321, 15123, 13213),
  denominator = c(15232, 16123, 17932, 18475))

df %>%
  assign_funnel_significance(numerator, denominator,
                              statistic = "proportion", multiplier = 100)

byars_lower

byars_lower

Description

Calculates the lower confidence limits for observed numbers of events using Byar’s method (1).

Usage

byars_lower(x, confidence = 0.95)

Arguments

x the observed numbers of events; numeric vector; no default

confidence the required level of confidence expressed as a number between 0.9 and 1 or a
number between 90 and 100 or can be a vector of 0.95 and 0.998, for example, to output both 95 percent and 99.8 percent percent CIs; numeric; default 0.95

Value

Returns lower confidence limits for observed numbers of events using Byar’s method (1)

Notes

This is an internal package function that is appropriately called by exported 'phe_' prefixed functions within the PHEindicatormethods package.

byars_lower and byars_upper together return symmetric confidence intervals around counts, therefore for a specified confidence level, α, the probability that, by chance, the lower limit returned will be above the true underlying value, is α/2. If the confidence level is very close to 1 or the number of events is very small Byar’s method is inaccurate and may return a negative number - in these cases an error is returned.

References

byars_upper

Description

Calculates the upper confidence limits for observed numbers of events using Byar’s method (1).

Usage

byars_upper(x, confidence = 0.95)

Arguments

x  the observed numbers of events; numeric vector; no default

confidence the required level of confidence expressed as a number between 0.9 and 1 or a number between 90 and 100 or can be a vector of 0.95 and 0.998, for example, to output both 95 percent and 99.8 percent percent CIs; numeric; default 0.95

Value

Returns upper confidence limits for observed numbers of events using Byar’s method (1)

Notes

This is an internal package function that is appropriately called by exported 'phe_' prefixed functions within the PHEindicator methods package.

byars_lower and byars_upper together return symmetric confidence intervals around counts, therefore for a specified confidence level, $\alpha$, the probability that, by chance, the upper limit returned will be below the true underlying value, is $\alpha/2$.

References

calculate_funnel_limits

Calculate control limits for funnel plots

Description

Calculates control limits adopting a consistent method as per the PHE Fingertips Technical Guidance: https://fingertips.phe.org.uk/profile/guidance/supporting-information/PH-methods

Usage

```r
calculate_funnel_limits(
  data,
  numerator,
  denominator,
  rate,
  type = "full",
  multiplier = NULL,
  statistic = NULL,
  ratio_type = NULL,
  rate_type = NULL,
  years_of_data = NULL
)
```

Arguments

- **data**: a data.frame containing the data to calculate control limits for; unquoted string; no default
- **numerator**: field name from data containing the observed numbers of cases in the sample meeting the required condition (the numerator or observed counts for the control limits); unquoted string; no default
- **denominator**: field name from data containing the population(s) in the sample (the denominator or expected counts for the control limits); unquoted string; no default
- **rate**: field name from data containing the rate data when creating funnels for a Crude or Directly Standardised Rate; unquoted string; no default
- **type**: defines the data and metadata columns to be included in output; "standard" (for all data) or "full" (for all data and metadata); quoted string; default = "full"
- **multiplier**: the multiplier used to express the final values (eg 100 = percentage); numeric; no default
- **statistic**: type of statistic to inform funnel calculations. Acceptable values are "proportion", "ratio" or "rate"; string; no default
- **ratio_type**: if statistic is "ratio", specify either "count" or "isr" (indirectly standardised ratio); string; no default
- **rate_type**: if statistic is "rate", specify either "dsr" or "crude"; string; no default
- **years_of_data**: number of years the data represents; this is required for statistic = "rate"; numeric; no default
calculate_funnel_points

Value

returns the original data.frame with the following appended: lower 0.025 limit, upper 0.025 limit, lower 0.001 limit, upper 0.001 limit and baseline average

Author(s)

Matthew Francis

See Also

Other PHEindicatormethods package functions: assign_funnel_significance(), calculate_ISRate(), calculate_ISRatio(), calculate_funnel_points(), phe_dsr(), phe_life_expectancy(), phe_mean(), phe_proportion(), phe_quantile(), phe_rate(), phe_sii

Examples

library(dplyr)
set.seed(123)
df <- data.frame(obs = sample(200, 19 * 2 * 5 * 4, replace = TRUE),
                 pop = sample(10000:20000, 19 * 2 * 5 * 4, replace = TRUE))
df %>%
  calculate_funnel_limits(obs, pop, statistic = "proportion", multiplier = 100)

Description

For rate-based funnels: Derive rate and annual population values for charting based. Process removes rates where the rate type is dsr and the number of observed events are below 10.

Usage

calculate_funnel_points(
  data,
  numerator,
  denominator,
  rate,
  rate_type = NULL,
  years_of_data = NULL,
  multiplier = NULL
)
**Arguments**

- **data**: a data.frame containing the data to calculate control limits for; unquoted string; no default
- **numerator**: field name from data containing the observed numbers of cases in the sample meeting the required condition (the numerator or observed counts for the control limits); unquoted string; no default
- **denominator**: field name from data containing the population(s) in the sample (the denominator or expected counts for the control limits); unquoted string; no default
- **rate**: field name from data containing the rate data when creating funnels for a Crude or Directly Standardised Rate; unquoted string; no default
- **rate_type**: if statistic is "rate", specify either "dsr" or "crude"; string; no default
- **years_of_data**: number of years the data represents; this is required for statistic = "rate"; numeric; no default
- **multiplier**: the multiplier used to express the final values (e.g., 100 = percentage); numeric; no default

**Value**

returns the same table as provided with two additional fields. First will have the same name as the rate field, with the suffix "_chart", the second will be called denominator_derived

**Author(s)**

Sebastian Fox, <sebastian.fox@phe.gov.uk>

**See Also**

Other PHEindicatormethods package functions: assign_funnel_significance(), calculate_ISRate(), calculate_ISRatio(), calculate_funnel_limits(), phe_dsr(), phe_life_expectancy(), phe_mean(), phe_proportion(), phe_quantile(), phe_rate(), phe_sii()
calculate_ISRate

Usage

```
calculate_ISRate(
  data,
  x,
  n,
  x_ref,
  n_ref,
  refpoptype = "vector",
  type = "full",
  confidence = 0.95,
  multiplier = 1e+05
)
```

Arguments

data: data.frame containing the data to be standardised, pre-grouped if multiple ISRs
required; unquoted string; no default

x: field name from data containing the observed number of events for each standardisation
category (eg ageband) within each grouping set (eg area); unquoted string; no default

n: field name from data containing the populations for each standardisation category
(eg ageband) within each grouping set (eg area); unquoted string; no default

x_ref: the observed number of events in the reference population for each standardisation
category (eg age band); unquoted string referencing a numeric vector or field name from data depending
on value of refpoptype; no default

n_ref: the reference population for each standardisation category (eg age band); unquoted
string referencing a numeric vector or field name from data depending
on value of refpoptype; no default

refpoptype: whether x_ref and n_ref have been specified as vectors or a field name from
data; quoted string "field" or "vector"; default = "vector"

type: defines the data and metadata columns to be included in output; can be "value",
"lower", "upper", "standard" (for all data) or "full" (for all data and metadata);
quoted string; default = "full"

confidence: the required level of confidence expressed as a number between 0.9 and 1 or a
number between 90 and 100 or can be a vector of 0.95 and 0.998, for example,
to output both 95 percent and 99.8 percent CIs; numeric; default 0.95

multiplier: the multiplier used to express the final values (eg 100,000 = rate per 100,000);
numeric; default 100,000

Value

When type = "full", returns a tibble of observed events, expected events, indirectly standardised
rate, lower confidence limit, upper confidence limit, confidence level, statistic and method for each
grouping set
Notes

User MUST ensure that x, n, x_ref and n_ref vectors are all ordered by the same standardisation category values as records will be matched by position.

For numerators >= 10 Byar’s method (1) is applied using the byars_lower and byars_upper functions. For small numerators Byar’s method is less accurate and so an exact method (2) based on the Poisson distribution is used.

References


See Also

Other PHEindicators package functions: assign_funnel_significance(), calculate_ISRatio(), calculate_funnel_limits(), calculate_funnel_points(), phe_dsr(), phe_life_expectancy(), phe_mean(), phe_proportion(), phe_quantile(), phe_rate(), phe_sii()

Examples

library(dplyr)
df <- data.frame(indicatorid = rep(c(1234, 5678, 91011, 121314), each = 19 * 2 * 5),
  year = rep(2006:2010, each = 19 * 2),
  sex = rep(rep(c("Male", "Female"), each = 19), 5),
  ageband = rep(c(0,5,10,15,20,25,30,35,40,45,
    50,55,60,65,70,75,80,85,90), times = 10),
  obs = sample(200, 19 * 2 * 5 * 4, replace = TRUE),
  pop = sample(10000:20000, 19 * 2 * 5 * 4, replace = TRUE))

refdf <- data.frame(refcount = sample(200, 19, replace = TRUE),
  refpop = sample(10000:20000, 19, replace = TRUE))

## calculate multiple ISRs in single execution
df %>%
  group_by(indicatorid, year, sex) %>%
  calculate_ISRate(obs, pop, refdf$refcount, refdf$refpop)

## execute without outputting metadata fields
df %>%
  group_by(indicatorid, year, sex) %>%
  calculate_ISRate(obs, pop, refdf$refcount, refdf$refpop, type="standard", confidence=99.8)

## calculate 95% and 99.8% CIs in single execution
df %>%
  group_by(indicatorid, year, sex) %>%
  calculate_ISRate(obs, pop, refdf$refcount, refdf$refpop, confidence = c(0.95, 0.998))
Calculate Standardised Mortality Ratios using `calculate_ISRatio`

**Description**

Calculates standard mortality ratios (or indirectly standardised ratios) with confidence limits using Byar's (1) or exact (2) CI method.

**Usage**

```r
calculate_ISRatio(
    data,
    x,
    n,
    x_ref,
    n_ref,
    refpoptype = "vector",
    type = "full",
    confidence = 0.95,
    refvalue = 1
)
```

**Arguments**

- **data**: data.frame containing the data to be standardised, pre-grouped if multiple ISRs required; unquoted string; no default
- **x**: field name from data containing the observed number of events for each standardisation category (eg ageband) within each grouping set (eg area); unquoted string; no default
- **n**: field name from data containing the populations for each standardisation category (eg ageband) within each grouping set (eg area); unquoted string; no default
- **x_ref**: the observed number of events in the reference population for each standardisation category (eg age band); unquoted numeric vector or field name from data depending on value of refpoptype; no default
- **n_ref**: the reference population for each standardisation category (eg age band); unquoted numeric vector or field name from data depending on value of refpoptype; no default
- **refpoptype**: whether x_ref and n_ref have been specified as vectors or a field name from data; quoted string "field" or "vector"; default = "vector"
- **type**: defines the data and metadata columns to be included in output; can be "value", "lower", "upper", "standard" (for all data) or "full" (for all data and metadata); quoted string; default = "full"
calculate_ISRatio

confiden ce the required level of confidence expressed as a number between 0.9 and 1 or a number between 90 and 100 or can be a vector of 0.95 and 0.998, for example, to output both 95 percent and 99.8 percent CI s; numeric; default 0.95

refvalue the standardised reference ratio, numeric, default = 1

Value

When type = "full", returns a tibble of observed events, expected events, standardised mortality ratios, lower confidence limits, upper confidence limits, confidence level, statistic and method for each grouping set

Notes

User MUST ensure that x, n, x_ref and n_ref vectors are all ordered by the same standardisation category values as records will be matched by position.

For numerators >= 10 Byar’s method (1) is applied using the byars_lower and byars_upper functions. For small numerators Byar’s method is less accurate and so an exact method (2) based on the Poisson distribution is used.

References


See Also

Other PHEindicatormethods package functions: assign_funnel_significance(), calculate_ISRat e(), calculate_funnel_limits(), calculate_funnel_points(), phe_dsr(), phe_life_expectancy(), phe_mean(), phe_proportion(), phe_quantile(), phe_rate(), phe_sii()

Examples

library(dplyr)
df <- data.frame(indicatorid = rep(c(1234, 5678, 91011, 121314), each = 19 * 2 * 5),
year = rep(2006:2010, each = 19 * 2),
sex = rep(rep(c("Male", "Female"), each = 19), 5),
ageband = rep(c(0,5,10,15,20,25,30,35,40,45,
50,55,60,65,70,75,80,85,90), times = 10),
obs = sample(200, 19 * 2 * 5 * 4, replace = TRUE),
pop = sample(10000:20000, 19 * 2 * 5 * 4, replace = TRUE))

refdf <- data.frame(refcount = sample(200, 19, replace = TRUE),
refpop = sample(10000:20000, 19, replace = TRUE))

df %>%
DSR_data

```r
group_by(indicatorid, year, sex) %>%
calculate_ISRatio(obs, pop, refdf$refcount, refdf$refpop, type="standard")

# OR

df %>%
  group_by(indicatorid, year, sex) %>%
calculate_ISRatio(obs, pop, refdf$refcount, refdf$refpop, confidence=99.8, refvalue=100)
```

### Description
A data table of dummy Directly Standardised Rates by deprivation quintiles

### Usage
```r
data(DSR_data)
```

### Format
A data table

### Examples
```r
DSR_data
```

### esp2013

**European Standard Population 2013**

### Description
A numeric vector containing nineteen 5-year age band populations making up the 2013 European Standard Population ordered from age 0-4, 5-9, 10-14 ... to ... 85-89, 90+. Sorted by increasing age band.

### Usage
```r
esp2013
```

### Format
A numeric vector with 19 elements
### Value

5000 5500 5500 5500 6000 6000 6500 7000 7000 7000 6500 6000 5500 5000 4000 2500 1500 1000

### Notes

The 2013 European Standard Population is modelled and published by Eurostat (1) for use in the production of age-standardised rates. It uses the unweighted average 2010-based population projections of the European Union (x27) and European Free Trade Association (x4) countries for the period 2011-2030 broken down into 5-year age bands from age 0 - age 95+ with the 0-5 age band separated into age 0 and age 1-4. The version provided with this package combines the age 0 and age 1-4 populations into a single 0-4 age band and combines the 90-94 and 95+ populations into a single 90+ age band, giving 19 age bands in total.

### References


https://ec.europa.eu/eurostat/documents/3859598/5926869/KS-RA-13-028-EN.PDF/e713fa79-1add-44e8-b23d-5e8fa09b3f8f

### Examples

```r
esp2013
```

---

### Description

A data table of life expectancy data by area and deprivation decile

### Usage

```r
data(LE_data)
```

### Format

A data table

### Examples

```r
LE_data
```
PHEindicatormethods: A package for performing standard statistics for public health indicators

Description
A package for performing standard statistics for public health indicators.

phe_dsr
Calculate Directly Standardised Rates using phe_dsr

Description
Calculates directly standardised rates with confidence limits using Byar’s method (1) with Dobson method adjustment (2).

Usage
phe_dsr(
  data,
  x,
  n,
  stdpop = esp2013,
  stdpoptype = "vector",
  type = "full",
  confidence = 0.95,
  multiplier = 1e+05
)

Arguments
data       data.frame containing the data to be standardised, pre-grouped if multiple DSRs required; unquoted string; no default
x          field name from data containing the observed number of events for each standardisation category (eg ageband) within each grouping set (eg area); unquoted string; no default
n          field name from data containing the populations for each standardisation category (eg ageband) within each grouping set (eg area); unquoted string; no default
stdpop     the standard populations for each standardisation category (eg age band); unquoted string referencing a numeric vector or field name from data depending on value of stdpoptype; default = esp2013
stdpoptype whether the stdpop has been specified as a vector or a field name from data; quoted string "field" or "vector"; default = "vector"
type defines the data and metadata columns to be included in output; can be "value", "lower", "upper", "standard" (for all data) or "full" (for all data and metadata); quoted string; default = "full"

confidence the required level of confidence expressed as a number between 0.9 and 1 or a number between 90 and 100 or can be a vector of 0.95 and 0.998, for example, to output both 95 percent and 99.8 percent percent CIs; numeric; default 0.95

multiplier the multiplier used to express the final values (eg 100,000 = rate per 100,000); numeric; default 100,000

Value

When type = “full”, returns a tibble of total counts, total populations, directly standardised rates, lower confidence limits, upper confidence limits, confidence level, statistic and method for each grouping set

Notes

User MUST ensure that x, n and stdpop vectors are all ordered by the same standardisation category values as records will be matched by position.

For total counts >= 10 Byar’s method (1) is applied using the byars_lower and byars_upper functions. When the total count is < 10 DSRs are not reliable and will therefore not be calculated.

References


See Also

Other PHEindicatormethods package functions: assign_funnel_significance(), calculate_ISRate(), calculate_ISRatio(), calculate_funnel_limits(), calculate_funnel_points(), phe_life_expectancy(), phe_mean(), phe_proportion(), phe_quantile(), phe_rate(), phe_sii()

Examples

library(dplyr)
df <- data.frame(indicatorid = rep(c(1234, 5678, 91011, 121314), each = 19 * 2 * 5),
               year = rep(2006:2010, each = 19 * 2),
               sex = rep(rep(c("Male", "Female"), each = 19), 5),
               ageband = rep(c(0,5,10,15,20,25,30,35,40,45,
                               50,55,60,65,70,75,80,85,90), times = 10),
               obs = sample(200, 19 * 2 * 5 * 4, replace = TRUE),
               pop = sample(10000:20000, 19 * 2 * 5 * 4, replace = TRUE))
`phe_life_expectancy`  
Calculate Life Expectancy using `phe_life_expectancy`  

Description

Compute life expectancy for a given age, and its standard error

Usage

```r
phe_life_expectancy(
  data,  
deads,  
population,  
startage,  
age_contents = c(0L, 1L, 5L, 10L, 15L, 20L, 25L, 30L, 35L, 40L, 45L, 50L, 55L, 60L,  
                   65L, 70L, 75L, 80L, 85L, 90L),  
le_age = "all",  
type = "full",  
confidence = 0.95
)
```

Arguments

- `data`  
  data.frame or tbl containing the deaths and population data
- `deaths`  
  field name from data containing the number of deaths within age band; unquoted string; no default
- `population`  
  field name from data containing the population within age band; unquoted string; no default
- `startage`  
  field name from data containing the age band; no default
**phe_life_expectancy**

**age_contents**
vector; describes the contents of startage in the ascending order. This vector is used to check whether each group in data contains the complete set of age bands for the calculation to occur. It is also used to reorder the data based on the startage field.

**le_age**
the age band to return the life expectancy for. The default is "all", where the function returns the life expectancy values for all ages appended onto the input table. Any other value (or vector of values) must be age bands described by the age_contents input.

**type**
type of output; can be "standard" or "full" (full contains added details on the calculation within the dataframe); quoted string; default full.

**confidence**
the required level of confidence expressed as a number between 0.9 and 1 or a number between 90 and 100 or can be a vector of 0.95 and 0.998, for example, to output both 95 percent and 99.8 percent percent CIs; numeric; default 0.95

**Details**
This function aligns with the methodology in Public Health England’s Life Expectancy Calculator available on the Fingertips Technical Guidance web page.

The function is for an abridged life table using 5 year age intervals with a final age interval of 90+. The table has been completed using the methods described by Chiang.(1, 2) This age structure and methodology is used by The Office for National Statistics to produce life expectancy at national and local authority level.(3)

This function includes an adjustment to the method for calculating the variance of the life expectancy estimate to include a term for the variance associated with the final age interval. In the Chiang method the variance of the life expectancy is the weighted sum of the variance of the probability of survival across all the age intervals. For the final age interval the probability of survival is, Chiang argues, zero and has zero variance. However, Silcocks et al argue(4) that in the case of the final age interval the life expectancy is dependent not on the probability of survival but on the mean length of survival \( \frac{1}{M_{\omega}} \). Therefore the variance associated with the final age interval depends on the age-specific mortality rate \( M_{\omega} \).

Life expectancy cannot be calculated if the person-years in any given age interval is zero. It will also not be calculated if the total person-years is less than 5,000 as this is considered to be the minimum size for robust calculation of life expectancy.(5) Zero death counts are not a problem, except for the final age interval - there must be at least one death in the 90+ interval for the calculations to be possible.

Individual Life Expectancy values will be suppressed (although confidence intervals will be shown) when the 95% confidence interval is greater than 20 years.

The methodology used in this function, along with discussion of alternative options for life expectancy calculation for small areas, were described Eayres and Williams.(6)

**Value**
returns a data frame containing the life expectancies and confidence intervals for each le_age requested. When type = ‘full’ additionally returns the cumulative populations and deaths used in each LE calculation and metadata indicating parameters passed.
Author(s)

Sebastian Fox, <sebastian.fox@phe.gov.uk>

References


(2) Newell C. Methods and Models in Demography. Chichester, John Wiley & Sons, 1994:63-81


See Also

Other PHEindicatormethods package functions: assign_funnel_significance(), calculate_ISRatio(), calculate_funnel_limits(), calculate_funnel_points(), phe_dsr(), phe_mean(), phe_proportion(), phe_quantile(), phe_rate(), phe_sii()

Examples

library(dplyr)

## A simple example
df <- data.frame(startage = c(0L, 1L, 5L, 10L, 15L, 20L, 25L, 30L, 35L, 40L, 45L, 50L, 55L, 60L, 65L, 70L, 75L, 80L, 85L, 90L),
    deaths = c(17L, 9L, 4L, 2L, 2L, 2L, 3L, 4L, 10L, 16L, 22L, 5L, 1L, 0L, 1L, 7L, 2L, 8L, 2L, 1L, 0L, 0L))
phe_life_expectancy(df, deaths, pops, startage)

## or with multiple confidence limits
phe_life_expectancy(df, deaths, pops, startage, confidence = c(95, 99.8))
phe_life_expectancy(df, deaths, pops, startage = le_age = c(5, 25), type = "standard")

## Unordered age bands example
df <- data.frame(startage = c("0", "1-4", "5-9", "10 - 14", "15 - 19", "20 - 24", "25 - 29",
"30 - 34", "35 - 39", "40 - 44", "45 - 49", "50 - 54",
"55 - 59", "60 - 64", "65 - 69", "75 - 79", "80 - 84",
"85 - 89", "90 +", "70 - 74"),
pops = c(7060L, 35059L, 46974L, 48489L, 43219L, 38561L, 46009L, 57288L,
61435L, 55601L, 50209L, 56416L, 46411L, 39820L, 37978L,
23306L, 11936L, 11936L, 37978L, 33288L),
deads = c(17L, 9L, 8L, 20L, 15L, 24L, 33L, 50L, 71L, 100L, 163L,
phe_life_expectancy(df, deaths, pops, startage,
age_contents = c("0", "1-4", "5-9",
"10 - 14", "15 - 19",
"20 - 24", "25 - 29",
"30 - 34", "35 - 39",
"40 - 44", "45 - 49",
"50 - 54", "55 - 59",
"60 - 64", "65 - 69",
"70 - 74", "75 - 79",
"80 - 84", "85 - 89",
"90 +")))

df <- data.frame(area = c(rep("Area 1", 20), rep("Area 2", 20)),
startage = rep(c(0L, 1L, 5L, 10L, 15L, 20L, 25L, 30L, 35L, 40L, 45L, 50L, 55L,
60L, 65L, 70L, 75L, 80L, 85L, 90L), 2),
pops = rep(c(7060L, 35059L, 46974L, 48489L, 43219L, 38561L, 46009L, 57288L,
61435L, 55601L, 50209L, 56416L, 46411L, 39820L, 37978L,
23306L, 11936L, 11936L, 37978L, 33288L), 2),
deads = rep(c(17L, 9L, 8L, 20L, 15L, 24L, 33L, 50L, 71L, 100L, 163L,
df %>%
group_by(area) %>%
phe_life_expectancy(deaths, pops, startage)

### phe_mean

**Calculate Means using phe_mean**

**Description**

Calculates means with confidence limits using Student’s t-distribution method.

**Usage**

```r
phe_mean(data, x, type = "full", confidence = 0.95)
```
phe_mean

Arguments

data   a data.frame containing the data to calculate means for, pre-grouped if multiple means required; unquoted string; no default
x       field name from data containing the values to calculate the means for; unquoted string; no default
type    defines the data and metadata columns to be included in output; can be "value", "lower", "upper", "standard" (for all data) or "full" (for all data and metadata); quoted string; default = "full"
confidence the required level of confidence expressed as a number between 0.9 and 1 or a number between 90 and 100 or can be a vector of 0.95 and 0.998, for example, to output both 95 percent and 99.8 percent percent CIs; numeric; default 0.95

Value

When type = "full", returns a data.frame of value_sum, value_count, stdev, value, lowercl, uppercl, confidence, statistic and method for each grouping set

See Also

Other PHEindicatormethods package functions: assign_funnel_significance(), calculate_ISRate(), calculate_ISRatio(), calculate_funnel_limits(), calculate_funnel_points(), phe_dsr(), phe_life_expectancy(), phe_proportion(), phe_quantile(), phe_rate(), phe_sii()

Examples

library(dplyr)
df <- data.frame(values = c(30,40,50,60))

## default execution
phe_mean(df, values)

## calculate 95% and 99.8% CIs in single execution
phe_mean(df, values, confidence = c(0.95, 0.998))

## calculate multiple means in a single execution
df2 <- data.frame(area = rep(c("Area1", "Area2"),each=3),
                   values = c(20,30,40,200,300,400)) %>%
           group_by(area)
phe_mean(df2,values)
phe_mean(df2,values,type="standard", confidence=0.998)
phe_proportion  Calculate Proportions using phe_proportion

Description

Calculates proportions with confidence limits using Wilson Score method (1,2).

Usage

phe_proportion(data, x, n, type = "full", confidence = 0.95, multiplier = 1)

Arguments

data  a data.frame containing the data to calculate proportions for, pre-grouped if proportions required for group aggregates; unquoted string; no default  
x  field name from data containing the observed numbers of cases in the sample meeting the required condition (the numerator for the proportion); unquoted string; no default  
n  field name from data containing the number of cases in the sample (the denominator for the proportion); unquoted string; no default  
type  defines the data and metadata columns to be included in output; can be "value", "lower", "upper", "standard" (for all data) or "full" (for all data and metadata); quoted string; default = "full"  
confidence  the required level of confidence expressed as a number between 0.9 and 1 or a number between 90 and 100 or can be a vector of 0.95 and 0.998, for example, to output both 95 percent and 99.8 percent percent CIs; numeric; default 0.95  
multiplier  the multiplier used to express the final values (eg 100 = percentage); numeric; default 1

Value

When type = "full", returns the original data.frame with the following appended: proportion, lower confidence limit, upper confidence limit, confidence level, statistic and method

Notes

Wilson Score method (2) is applied using the wilson_lower and wilson_upper functions.

The percentage argument was deprecated in v1_1_0, please use multiplier argument instead

References

### phe_quantile

#### Assign Quantiles using phe_quantile

**Description**

Assigns data to quantiles based on numeric data rankings.

**Usage**

```r
phe_quantile(
  data,
  values,
  highergeog = NULL,
  nquantiles = 10L,
  invert = TRUE,
  inverttype = "logical",
  type = "full"
)
```

**Arguments**

- `data`  
  a data frame containing the quantitative data to be assigned to quantiles. If pre-grouped, separate sets of quantiles will be assigned for each grouping set; unquoted string; no default

### Examples

```r
# ungrouped data frame
df <- data.frame(area = rep(c("Area1","Area2","Area3","Area4"), each=3),
                 numerator = c(NA,82,9,48, 6500,8200,10000,10000,8,7,750,900),
                 denominator = rep(c(100,10000,10000,10000), each=3))

phe_proportion(df, numerator, denominator)
phe_proportion(df, numerator, denominator, confidence=99.8)
phe_proportion(df, numerator, denominator, type="standard")
phe_proportion(df, numerator, denominator, confidence = c(0.95, 0.998))

# grouped data frame
library(dplyr)
dfg <- df %>% group_by(area)
phe_proportion(dfg, numerator, denominator, multiplier=100)
```
values  field name from data containing the numeric values to rank data by and assign quantiles from; unquoted string; no default

highergeo  deprecated - functionality replaced by pre-grouping the input data frame

nquantiles  the number of quantiles to separate each grouping set into; numeric; default=10L

invert  whether the quantiles should be directly (FALSE) or inversely (TRUE) related to the numerical value order; logical (to apply same value to all grouping sets) OR unquoted string referencing field name from data that stores logical values for each grouping set; default = TRUE (ie highest values assigned to quantile 1)

inverttype  whether the invert argument has been specified as a logical value or a field name from data; quoted string "field" or "logical"; default = "logical"

type  defines whether to include metadata columns in output to reference the arguments passed; can be "standard" or "full"; quoted string; default = "full"

Value

When type = "full", returns the original data.frame with quantile (quantile value), nquantiles (number of quantiles requested), groupvars (grouping sets quantiles assigned within) and invert (indicating direction of quantile assignment) fields appended.

Notes

See PHE Technical Guide - Assigning Deprivation Quintiles for methodology. In particular, note that this function strictly applies the algorithm defined but some manual review, and potentially adjustment, is advised in some cases where multiple small areas with equal rank fall across a natural quantile boundary.

See Also

Other PHEindictormethods package functions: assign_funnel_significance(), calculate_ISRate(), calculate_ISRatio(), calculate_funnel_limits(), calculate_funnel_points(), phe_dsr(), phe_life_expectancy(), phe_mean(), phe_proportion(), phe_rate(), phe_sii()

Examples

df <- data.frame(region = as.character(rep(c("Region1","Region2","Region3","Region4"), each=250)), smallarea = as.character(paste0("Area",seq_along(1:1000))), vals = as.numeric(sample(200, 1000, replace = TRUE)), stringsAsFactors=FALSE)

# assign small areas to deciles across whole data frame
phe_quantile(df, vals)

# assign small area to deciles within regions by pre-grouping the input data frame
library(dplyr)
df_grp <- df %>% group_by(region)
phe_quantile(df_grp, vals)

# assign small areas to quintiles, where highest value = highest quantile
**Description**

Calculates rates with confidence limits using Byar's (1) or exact (2) CI method.

**Usage**

```r
phe_rate(data, x, n, type = "full", confidence = 0.95, multiplier = 1e+05)
```

**Arguments**

- `data`: the data.frame containing the data to calculate rates for, pre-grouped if proportions required for group aggregates; unquoted string; no default
- `x`: field name from data containing the rate numerators (eg observed number of events); unquoted string; no default
- `n`: field name from data containing the rate denominators (eg populations); unquoted string; no default
- `type`: defines the data and metadata columns to be included in output; can be "value", "lower", "upper", "standard" (for all data) or "full" (for all data and metadata); quoted string; default = "full"
- `confidence`: the required level of confidence expressed as a number between 0.9 and 1 or a number between 90 and 100 or can be a vector of 0.95 and 0.998, for example, to output both 95 percent and 99.8 percent CIs; numeric; default 0.95
- `multiplier`: the multiplier used to express the final values (eg 100,000 = rate per 100,000); numeric; default 100,000

**Value**

When `type` = "full", returns the original data.frame with the following appended: rate, lower confidence limit, upper confidence limit, confidence level, statistic and method

**Notes**

For numerators >= 10 Byar's method (1) is applied using the `byars_lower` and `byars_upper` functions. For small numerators Byar's method is less accurate and so an exact method (2) based on the Poisson distribution is used.
References


See Also

Other PHEindicator methods package functions: assign_funnel_significance(), calculate_ISRate(), calculate_ISRatio(), calculate_funnel_limits(), calculate_funnel_points(), phe_dsr(), phe_life_expectancy(), phe_mean(), phe_proportion(), phe_quantile(), phe_sii()

Examples

# ungrouped data frame
df <- data.frame(area = rep(c("Area1","Area2","Area3","Area4"), each=3),
obs = c(NA,82,9,48,6500,8200,10000,10000,8,7,750,900),
pop = rep(c(100,10000,10000,10000), each=3))

phe_rate(df, obs, pop)
phe_rate(df, obs, pop, type="standard")
phe_rate(df, obs, pop, confidence=99.8, multiplier=100)

# grouped data frame
library(dplyr)
dfg <- df %>% group_by(area)
phe_rate(dfg, obs, pop)

---

**phe_sii**

*Calculate Slope Index of Inequality using phe_sii*

**Description**

phe_sii() returns the slope index of inequality (SII) statistic for each subgroup of the inputted dataframe, with lower and upper confidence limits based on the specified confidence.

**Usage**

phe_sii(
  data,
  quantile,
  population,
  x = NULL,
  value = NULL,
  value_type = 0,
  lower_cl = NULL,
)
Arguments

data  data.frame containing the required input fields, pre-grouped if an SII is required for each subgroup; unquoted string; no default

quantile  field name within data that contains the quantile label (e.g. decile). The number of quantiles should be between 5 and 100; unquoted string; no default

population  field name within data that contains the quantile populations (i.e., denominator). Non-zero populations are required for all quantiles to calculate SII for an area; unquoted string; no default

x  (for indicators that are proportions) field name within data that contains the members of the population with the attribute of interest (i.e., numerator). This will be divided by population to calculate a proportion as the indicator value (if value field is not provided); unquoted string; no default

value  field name within data that contains the indicator value (this does not need to be supplied for proportions if count and population are given); unquoted string; no default

value_type  indicates the indicator type (1 = rate, 2 = proportion, 0 = other); integer; default 0

lower_cl  field name within data that contains 95 percent lower confidence limit of indicator value (to calculate standard error of indicator value). This field is needed if the se field is not supplied; unquoted string; no default

upper_cl  field name within data that contains 95 percent upper confidence limit of indicator value (to calculate standard error of indicator value). This field is needed if the se field is not supplied; unquoted string; no default

se  field name within data that contains the standard error of the indicator value. If not supplied, this will be calculated from the 95 percent lower and upper confidence limits (i.e. one or the other of these fields must be supplied); unquoted string; no default

multiplier  factor to multiply the SII and SII confidence limits by (e.g., set to 100 to return prevalences on a percentage scale between 0 and 100). If the multiplier is negative, the inverse of the RII is taken to account for the change in polarity; numeric; default 1

repetitions  number of random samples to perform to return confidence interval of SII (and RII). Minimum is 1000, no maximum (though the more repetitions, the longer the run time); numeric; default 100,000
**confidence**

confidence level used to calculate the lower and upper confidence limits of SII, expressed as a number between 0.9 and 1, or 90 and 100. It can be a vector of 0.95 and 0.998, for example, to output both 95 percent and 99.8 percent CIs; numeric; default 0.95

**rii**

option to return the Relative Index of Inequality (RII) with associated confidence limits as well as the SII; logical; default FALSE

**reliability_stat**

option to carry out the SII confidence interval simulation 10 times instead of once and return the Mean Average Difference between the first and subsequent samples (as a measure of the amount of variation). Warning: this will significantly increase run time of the function and should first be tested on a small number of repetitions; logical; default FALSE

**type**

"full" output includes columns in the output dataset specifying the parameters the user has input to the function (value_type, multiplier, CI_confidence, CI_method); character string either "full" or "standard"; default "full"

### Details

The Relative Index of Inequality (RII) can also be returned via an optional argument.

The SII and RII are two measures of health inequality. They show the relation between the level of health or frequency of a health problem in different population groups and the ranking of these groups on the social scale.

The input dataframe should be grouped before passing to the function if an SII/RII for each subgroup is required, and quantiles ordered from least to most advantaged.

### Value

The SII with lower and upper confidence limits for each subgroup of the inputted data.frame.

### Calculation

The SII is calculated using linear regression (1). To allow for differences in population size between quantiles (e.g. deprivation deciles), each is given a rank score (or relative rank) based on the midpoint of its range in the cumulative distribution of the total area population. The quantiles are first ordered (e.g from 1 most deprived to 10 least deprived for deprivation deciles). If quantile 1 then contains 12 percent of the total population, its relative rank is 0.12/2=0.6. If quantile 2 includes 10 percent of the population, its relative rank is 0.12+(0.10/2)=0.17. A square root transformation is applied to the regression to account for heteroskedasticity (the tendency for the variances of the quantile values to be related to the size of the values, i.e larger values will tend to have larger variances). A regression model is fitted to the transformed data: \(Y = \sqrt{a} = \sqrt{a} + b \cdot \sqrt{a}\), where \(Y\) is the value of the indicator for the quantile, \(a\) is the proportion of the total population in the quantile and \(b\) is the relative rank. The SII is the gradient of the resulting fitted line, and could be positive or negative according to the indicator polarity. Since the relative ranks, by definition, range from 0 to 1, the SII is the difference between the fitted value at \(x=1\) and \(x=0\). The RII is the ratio of the fitted value at \(x=1\), \(Y1\) and the fitted value at \(x=0\), \(Y0\). which can be calculated as: \(RII = (Y0 + SII) / Y0\)
Function arguments

The indicator type can be specified via the value_type parameter. Transformations can be applied to the indicator value and its confidence limits before calculating the standard error in cases where the confidence interval around the indicator value is likely to be non-symmetric. This is a log transformation for rates, and logit for proportions. If the standard error is supplied directly to the function from the input dataset, this is used instead of calculating one from the indicator confidence limits.

Warning

The SII calculation assumes a linear relationship between indicator value and quantile, and small populations within quantiles can make it unstable. This function does not include checks for linearity or stability; it is the user’s responsibility to ensure the input data is suitable for the SII calculation.

Notes

This function is using nest and unnest functions from tidyr version 1.0.0.

References


See Also

Other PHEindicatormethods package functions: assign_funnel_significance(), calculate_ISRate(), calculate_ISRatio(), calculate_funnel_limits(), calculate_funnel_points(), phe_dsr(), phe_life_expectancy(), phe_mean(), phe_proportion(), phe_quantile(), phe_rate()

Examples

library(dplyr)

data <- data.frame(area = c(rep("Area1", 10), rep("Area2", 10)),
decile = c(1:10, 1:10),
population = c(7291, 7997, 6105, 7666, 6934, 5918, 5974, 7147, 7534, 21675,
            20065, 19750, 24713, 20112, 19618, 22408, 19752, 18939, 19312),
value = c(75.9, 78.3, 83.8, 83.6, 80.5, 81.1, 81.7, 84.2, 80.6, 86.3,
          70.5, 71.6, 72.5, 73.5, 73.1, 76.2, 78.7, 80.6, 80.9, 80),
lowerCL = c(72.7,75.3,80.9,80.2,77.1,78.7,79.4,75.8,83.2,
           70.1,71.1,72.1,73.1,72.7,75.7,78.2,80.1,80.4,79.5),
upperCL = c(79.1,81.4,86.8,87.1,83.8,84.2,84.4,86.9,85.4,
           89.4,71.2,71.2,73.2,73.7,75.8,78.8,79.8,81.2,81.3,80.9),
StandardError = c(1.64,1.58,1.51,1.78,1.7,1.56,1.37,1.4,2.43,
                  1.57,0.23,0.26,0.3,0.16,0.79,0.78,0.4,0.28,0.23,0.35)
}


# Run SII function on the two areas in the data
phe_sii(group_by(data, area),
       decile,
       population,
       value_type = 0, # default normal distribution
       value = value,
       lower_cl = lowerCL,
       upper_cl = upperCL,
       confidence = 0.95,
       rii = TRUE,
       type = "standard")

# Supplying the standard error instead of the indicator 95 percent confidence limits
# gives the same result
phe_sii(group_by(data, area),
       decile,
       population,
       value_type = 0,
       value = value,
       se = StandardError,
       confidence = 0.95,
       rii = TRUE,
       type = "standard")

# multiple confidence intervals
phe_sii(group_by(data, area),
       decile,
       population,
       value_type = 0,
       value = value,
       se = StandardError,
       confidence = c(0.95, 0.998),
       repetitions = 10000,
       rii = TRUE,
       type = "standard")

---

**prevalence_data**

**SII test datasets - Prevalence**

**Description**

A data table of example prevalence data by area and deprivation decile

**Usage**

```r
data(prevalence_data)
```

**Format**

A data table
Examples
   prevalence_data

Description
Calculates lower confidence limits for observed numbers of events using the Wilson Score method (1,2).

Usage
   wilson_lower(x, n, confidence = 0.95)

Arguments
   x the observed numbers of cases in the samples meeting the required condition; numeric vector; no default
   n the numbers of cases in the samples; numeric vector; no default
   confidence the required level of confidence expressed as a number between 0.9 and 1 or a number between 90 and 100 or can be a vector of 0.95 and 0.998, for example, to output both 95 percent and 99.8 percent percent CIs; numeric; default 0.95

Value
Returns lower confidence limits for observed numbers of events using the Wilson Score method (1,2)

Notes
This is an internal package function that is appropriately called by exported 'phe_' prefixed functions within the PHEindicatormethods package.

wilson_lower and wilson_upper together return symmetric confidence intervals, therefore for a specified confidence level, \( \alpha \), the probability that, by chance, the lower limit returned will be above the true underlying value, is \( \alpha/2.\#' 

References
Description

Calculates upper confidence limits for observed numbers of events using the Wilson Score method (1,2).

Usage

wilson_upper(x, n, confidence = 0.95)

Arguments

x
the observed numbers of cases in the samples meeting the required condition; numeric vector; no default

n
the numbers of cases in the samples; numeric vector; no default

confidence
the required level of confidence expressed as a number between 0.9 and 1 or a number between 90 and 100 or can be a vector of 0.95 and 0.998, for example, to output both 95 percent and 99.8 percent percent CIs; numeric; default 0.95

Value

Returns upper confidence limits for observed numbers of events using the Wilson Score method (1,2)

Notes

This is an internal package function that is appropriately called by exported 'phe_' prefixed functions within the PHEindicatormethods package.

wilson_lower and wilson_upper together return symmetric confidence intervals, therefore for a specified confidence level, \( \alpha \), the probability that, by chance, the upper limit returned will be below the true underlying value, is \( \alpha/2.\#'\)

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