Package 'covidprobability'

February 11, 2021

Title Estimate the Unit-Wide Probability of COVID-19

Version 0.1.0

Description We propose a method to estimate the probability of an undetected case of COVID-19 in a defined setting, when a given number of people have been exposed, with a given pretest probability of having COVID-19 as a result of that exposure. Since we are interested in undetected COVID-19, we assume no person has developed symptoms (which would warrant further investigation) and that everyone was tested on a given day, and all tested negative.

URL https://github.com/eebrown/covidprobability

BugReports https://github.com/eebrown/covidprobability/issues

License GPL-3

Encoding UTF-8

LazyData true

RoxygenNote 7.1.1

Imports stats, utils

Depends R (>= 2.10)

Suggests knitr, rmarkdown, testthat (>= 3.0.0)

VignetteBuilder knitr

Config/testthat/edition 3

NeedsCompilation no

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Repository CRAN

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R topics documented:

`adjust_pretest` *Calculate pretest probability change over time*

Description

Calculates the pretest probability over time, assuming the individual does not develop symptoms, by taking into account the distribution of incubation periods (defined as the time from exposure to symptom onset).

Usage

```
adjust_pretest(pre0, asympt, days = 14, mu = 1.63, sigma = 0.5)
```

Arguments

`pre0`	Initial pretest probability (on day of exposure)
`asympt`	The proportion of positive patients who would be expected not to ever develop symptoms (true asymptomatic patients).
`days`	Days since exposure for calculation range
`mu`	The mean of a lognormal distribution that approximates the incubation period for COVID-19. E.g. 1.63 (see reference).
`sigma`	The standard deviation of a lognormal distribution that approximates the incubation period for COVID-19. E.g. 0.5 (see reference).

Value

pretest probability by day (time series)

References

See McAloon et al. https://bmjopen.bmj.com/content/10/8/e039652/

`calc_postest_prob` *Calculate posttest probability from pretest probability and test characteristics*

Description

Calculate posttest probability from pretest probability and test characteristics

Usage

```
calc_postest_prob(pretest_prob, sens, spec)
```

Arguments

`pretest_prob`	Pretest probability
`sens`	Test sensitivity
`spec`	Test specificity

Value

posttest probability

`individual_probability` *Calculate a time series of probability for an individual following exposure*

Description

The probability that an individual has COVID-19 will change over time as new information is gleaned. The initial probability is the pretest probability (pre0) associated with the nature of the interaction/exposure. This probability will decrease with each passing day that the individual does not develop symptoms. When a test is done, the probability is the posttest probability; this reduces the probability based on the test characteristics at the time of testing. Subsequently, the probability will continue to decrease with each passing day that no symptoms develop. This function returns a time series including those 3 phases.

Usage

```
individual_probability(test_day, pre0, sens, spec, asympt, days, mu, sigma)
```

Arguments

test_day	Day of PCR test (days since exposure)
pre0	Pre-test probability of person on day of exposure
sens	A vector of sensitivities by day since exposure
spec	The specificity of the PCR test
asympt	The proportion of infected patients expected to remain asymptomatic throughout the course of infection
days	Days since exposure for calculation range
mu	The mean of a lognormal distribution that approximates the incubation period for COVID-19. E.g. 1.63 (see reference).
sigma	The standard deviation of a lognormal distribution that approximates the incubation period for COVID-19. E.g. 0.5 (see reference).

Value

A time series of probabilities

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posttest_series *Calculate post-test probability if testing occurred on each day in a series*

Description

Given an initial pretest probability, and assuming symptoms never arise, with each passing day the pretest probability will be lower, given the person did not experience symptoms. This returns a vector of posttest probabilities which takes all of the above into account, assuming a negative test on each day. Note this is not a time series, and does not reflect if serial testing were done each day and assumes testing was only done once.

Usage

```
posttest_series(pre0, asympt, days = 14, mu = 1.63, sigma = 0.5, sens, spec)
```

Arguments

pre0	The pretest probability on day 0 (at exposure)
asympt	The proportion of infected patients expected to remain asymptomatic throughout the course of infection
days	Days since exposure for calculation range
mu	The mean of a lognormal distribution that approximates the incubation period for COVID-19. E.g. 1.63 (see reference).
sigma	The standard deviation of a lognormal distribution that approximates the incubation period for COVID-19. E.g. 0.5 (see reference).
sens	A vector of sensitivities by day since exposure
spec	The test specificity

Value

A vector of posttest probabilities

`probability_any` *Find the probability of any (at least one) event happening*

Description

For an event that occurs with probability p, this function returns the probability of an occurrence given n repetitions. p is numeric and can be a vector.

Usage

```
probability_any(n, p)
```

Arguments

`n`	The number of times to repeat the event (independent)
`p`	The individual probability of the event happening

Details

The probability that any event p occurs with n repetitions is equal to the reciprocal of the probability that p never occurs. The probability that p never occurs with n repetitions is `(1 -p) ^ n`. Thus, the probability that any event p occurs after n repetitions is `1 -( (1 -p) ^ n )`.

Value

The probability of an event with the specified probability, after n repetitions

Examples

```
probability_any(1, 0.5)
probability_any(2, 0.5)
probability_any(2, c(0.5, 1/3, 0.25))
```

prop_remaining *The remaining individuals who would not be expected to show symptoms yet*

Description

Every day, a certain number of people are expected to show symptoms, based on the incubation period. This would typically lead to further investigation and ongoing suspicion of an outbreak. This function calculates the proportion of individuals on a given day that would not be expected to have developed symptoms yet. So if no one has developed symptoms, this proportion of people could still have undetected COVID-19.

Usage

```
prop_remaining(t, asympt, mu = 1.63, sigma = 0.5)
```

Arguments

t	day
asympt	The proportion of positive patients who would be expected not to ever develop symptoms (true asymptomatic patients).
mu	The mean of a lognormal distribution that approximates the incubation period for COVID-19. E.g. 1.63 (see reference).
sigma	The standard deviation of a lognormal distribution that approximates the incubation period for COVID-19. E.g. 0.5 (see reference).

Value

Proportion who would not be expected to show symptoms yet

References

See McAloon et al. https://bmjopen.bmj.com/content/10/8/e039652/

sens *COVID-19 PCR sensitivity by days since exposure*

Description

COVID-19 PCR sensitivity by days since exposure

Usage

```
sens
```

Format

A data frame with 21 rows and 3 variables:

point point estimate of sensitivity

lower lower 95% confidence interval of sensitivity

upper upper 95% confidence interval of sensitivity

Source

https://github.com/HopkinsIDD/covidRTPCR

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unit_probability *Calculate a time series of unit-wide probability following exposure*

Description

To calculate the probability that any asymptomatic person has COVID-19, this function treats each person/exposure as independent events and calculates the probability time series using the individuals time series from `individual_probability()`.

Usage

```
unit_probability(test_day, pre0, sens, spec, asympt, days, mu, sigma, n)
```

Arguments

`test_day`	Day of PCR test (days since exposure)
`pre0`	Pre-test probability of person on day of exposure
`sens`	A vector of sensitivities by day since exposure
`spec`	The specificity of the PCR test
`asympt`	The proportion of infected patients expected to remain asymptomatic throughout the course of infection
`days`	Days since exposure for calculation range
`mu`	The mean of a lognormal distribution that approximates the incubation period for COVID-19. E.g. 1.63 (see reference).
`sigma`	The standard deviation of a lognormal distribution that approximates the incubation period for COVID-19. E.g. 0.5 (see reference).
`n`	Number of exposed individuals

Value

The probability of an event with the specified probability, after n repetitions

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