Package ‘nephro’

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Type Package

Title Utilities for Nephrology

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Author Cristian Pattaro, Ryosuke Fujii

Maintainer Cristian Pattaro <cristian.pattaro@eurac.edu>

Description Set of functions to estimate kidney function and other phenotypes of interest in nephrology based on different biomechimal traits. MDRD, CKD-EPI, and Virga equations are compared in Pattaro (2013) <doi:10.1159/000351043>, where the respective references are given. In addition, the software includes Stevens (2008) <doi:10.1053/j.ajkd.2007.11.018> and Cockcroft (1976) <doi:10.1159/000180580> formulas. The race-free CKD-EPI equations (2021) <doi:10.1056/NEJMoa2102953> are also implemented from ver.1.3.

License GPL (>= 3)

NeedsCompilation no

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Description

This package contains a set of tools for the estimation of kidney function. Kidney function is assessed by means of the Glomerular Filtration Rate (GFR), which can be estimated using different biomarkers. The most commonly used ones are serum or plasma creatinine and cystatin C. Included in this package are the following GFR estimating functions: the Modification of Diet in Renal Disease (MDRD) study equation based on four (MDRD4) or six (MDRD6) parameters (see Levey 1999, 2006); the CKD-Epi equations for creatinine (CKDEpi.creat, CKDEpi.creat.rf), cystatin C (CKDEpi.cys), and a combination of creatinine and cystatin C (CKDEpi.creat.cys, CKDEpi.creat.cys.rf) (see Inker 2012 & Inker 2021); the three equations proposed by Stevens 2008 based on cystatin C only (Stevens.cys1), age- and sex-weighted cystatin C (Stevens.cys2), and a combination of cystatin C and creatinine (Stevens.creat.cys); the classic Cockroft and Gault 1976 equation for creatinine clearance estimation (CG); and the recent equation by Virga (2007) (Virga). A comparative description of several functions included in the package can be found in Pattaro (2013). An extensive literature does exist that compares the methods described.

Details

Package: nephro
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Author(s)

Cristian Pattaro <cristian.pattaro@eurac.edu>, Ryosuke Fujii <ryosuke.fujii@eurac.edu>

Acknowledgements: Max Plischke (contributed examples and bug reporting)

References

Citing this package:

Formulas:
- Cockroft DW, Gault MH. Prediction of creatinine clearance from serum creatinine. Nephron 1976;
16: 31-41.

On IDMS calibration:

Examples

```r
# Comparison between different equations

creat <- c(0.8, 0.9, 1.0, 1.1, 1.2, 1.3)
cyst <- c(1.1, 0.95, 1.1, 1.0, 1.3, 1.2)
sex <- c(1, 1, 1, 0, 0, 0)
age <- c(60, 65, 43, 82, 71, 55)
ethn <- round(runif(6))
wt <- c(70, 80, 60, 55, 87, 71)

eGFR <- data.frame(creat, cyst)
eGFR$MDRD4 <- MDRD4(creat, sex, age, ethn, 'IDMS')
eGFR$CKDEpi.creat <- CKDEpi.creat(creat, sex, age, ethn)
eGFR$CKDEpi.creat.rf <- CKDEpi.creat.rf(creat, sex, age)
eGFR$CKDEpi.cys <- CKDEpi.cys(cyst, sex, age)
eGFR$CKDEpi.creat.cys <- CKDEpi.creat.cys(creat, cyst, sex, age)
eGFR$Stevens.cys1 <- Stevens.cys1(cyst)
eGFR$Stevens.cys2 <- Stevens.cys2(cyst, sex, age, ethn)
eGFR$Stevens.creat.cys <- Stevens.creat.cys(creat, cyst, sex, age, ethn)
eGFR$cg <- CG(creat, sex, age, wt)
eGFR$virga <- Virga(creat, sex, age, wt)
```
pairs(eGFR[3:13])

# For use with non-IDMS calibrated creatinine
# several authors (see references) suggested
# a 5% creatinine adjustment

creat <- c(0.8, 0.9, 1.0, 1.1, 1.2, 1.3)
sex <- c(1, 1, 1, 0, 0, 0)
age <- c(60, 65, 43, 82, 71, 55)
ethn <- round(runif(6))
gfr <- CKDEpi.creat(0.95*creat, sex, age, ethn)

CG

Cockroft and Gault equation

Description
Creatinine clearance is estimated with the Cockroft and Gault formula.

Usage
CG(creatinine, sex, age, wt)

Arguments
creatinine  Numeric vector with serum or plasma creatinine values in mg/dl
sex  Numeric vector with 0 for females and 1 for males
age  Numeric vector with age in years
wt  Numeric vector with weight in kg

Value
A numeric vector with eGFR values in ml/min/1.73 m².

Author(s)
Cristian Pattaro

References

See Also
CKDEpi.creat, MDRD4, Virga
CKDEpi.creat

CKDEpi.creat  CKD-EPI equation for serum creatinine

Description

GFR is estimated with the CKD-EPI Study equation based on IDMS serum or plasma creatinine.

Usage

CKDEpi.creat(creatinine, sex, age, ethnicity)

Arguments

creatinine  Numeric vector with serum or plasma creatinine values in mg/dl
sex  Numeric vector with 0 for females and 1 for males
age  Numeric vector with age in years
ethnicity  Numeric vector with 0 for non-Black and 1 for Black individuals

Value

A numeric vector with eGFR values in ml/min/1.73 m$^2$.

Author(s)

Cristian Pattaro

References


See Also

CKDEpi.creat.cys, CKDEpi.cys, CKDEpi.creat.rf, CKDEpi.creat.cys.rf
CKDEpi.creat.cys

CKD-EPI equation for creatinine and cystatin C

Description

CKD-EPI equation to estimate GFR based on a combination of creatinine and cystatin C

Usage

CKDEpi.creat.cys(creatinine, cystatin, sex, age, ethnicity)

Arguments

creatinine Numeric vector with serum or plasma creatinine values in mg/dl
cystatin Numeric vector with serum or plasma cystatin C values in mg/dl
sex Numeric vector with 0 for females and 1 for males
age Numeric vector with age in years
ethnicity Numeric vector with 0 for non-Black and 1 for Black individuals

Value

A numeric vector with eGFR values in ml/min/1.73 m².

Author(s)

Cristian Pattaro

References


See Also

CKDEpi.creat, CKDEpi.cys, CKDEpi.creat.rf, CKDEpi.creat.cys.rf
Description

CKD-EPI equation to estimate GFR based on a combination of creatinine and cystatin C without race coefficient.

Usage

CKDEpi.creat.cys.rf(creatinine, cystatin, sex, age)

Arguments

creatinine Numeric vector with serum or plasma creatinine values in mg/dl
cystatin Numeric vector with serum or plasma cystatin C values in mg/l
sex Numeric vector with 0 for females and 1 for males
age Numeric vector with age in years

Value

A numeric vector with eGFR values in ml/min/1.73 m².

Author(s)

Ryosuke Fujii

References


See Also

CKDEpi.creat, CKDEpi.creat.cys, CKDEpi.cys, CKDEpi.creat.rf
CKDEpi.creat.rf  CKD-EPI equation for serum creatinine without race coefficient

Description
GFR is estimated with the CKD-EPI Study equation based on serum creatinine without race coefficient.

Usage
CKDEpi.creat.rf(creatinine, sex, age)

Arguments
creatinine  Numeric vector with serum or plasma creatinine values in mg/dl
sex  Numeric vector with 0 for females and 1 for males
age  Numeric vector with age in years

Value
A numeric vector with eGFR values in ml/min/1.73 m².

Author(s)
Ryosuke Fujii

References

See Also
CKDEpi.creat, CKDEpi.creat.cys, CKDEpi.cys, CKDEpi.creat.cys.rf

CKDEpi.cys  CKD-EPI equation for cystatin C

Description
GFR is estimated with the CKD-EPI equation for cystatin C proposed by Inker et al., N Engl J Med 2012

Usage
CKDEpi.cys(cystatin, sex, age)
**MDRD4**

**Arguments**
- **cystatin**: Numeric vector with serum or plasma cystatin C values in mg/l
- **sex**: Numeric vector with 0 for females and 1 for males
- **age**: Numeric vector with age in years

**Value**
The function returns a numeric vector with eGFR values in ml/min/1.73 m².

**Author(s)**
Cristian Pattaro

**References**

**See Also**
- CKDEpi.creat, CKDEpi.creat.cys, CKDEpi.creat.rf, CKDEpi.creat.cys.rf

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**MDRD4** *Four-parameter MDRD study equation*

**Description**
GFR is estimated with the 4-parameter Modification of Diet in Renal Disease (MDRD) study equation.

**Usage**

```
MDRD4(creatinine, sex, age, ethnicity, method = "IDMS")
```

**Arguments**
- **creatinine**: Numeric vector with serum or plasma creatinine values in mg/dl
- **sex**: Numeric vector with 0 for females and 1 for males
- **age**: Numeric vector with age in years
- **ethnicity**: Numeric vector with 0 for non-Black and 1 for Black individuals
- **method**: Defaults is 'IDMS' for IDMS-traceable creatinine; write 'other' if not IDMS

**Value**
A numeric vector with eGFR values in ml/min/1.73 m².
Author(s)
Cristian Pattaro

References

See Also
CKDEpi.creat, MDRD6, CG

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**MDRD6**

*Six-parameter MDRD study equation*

**Description**
GFR is estimated with the 6-parameter Modification of Diet in Renal Disease (MDRD) study equation.

**Usage**

```r
MDRD6(creatinine, sex, age, albumin, BUN, ethnicity, method = 'IDMS')
```

**Arguments**
- **creatinine** Numeric vector with serum or plasma creatinine values in mg/dl
- **sex** Numeric vector with 0 for females and 1 for males
- **age** Numeric vector with age in years
- **albumin** Numeric vector with serum or plasma albumin in g/dl
- **BUN** Numeric vector with blood urea nitrogen levels in mg/dl
- **ethnicity** Numeric vector with 0 for non-Black and 1 for Black individuals
- **method** Defaults is 'IDMS' for IDMS-traceable creatinine; write 'other' if not IDMS

**Value**
A numeric vector with eGFR values in ml/min/1.73 m².

**Author(s)**
Cristian Pattaro
Stevens.creat.cys

References

See Also
MDRD4

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<th>Stevens.creat.cys</th>
<th>Stevens’ formula for a combination of serum creatinine and cystatin C</th>
</tr>
</thead>
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Description
GFR estimation using the 3rd formula proposed by Stevens et al. (Am J Kidney Dis 2008), which combines creatinine and cystatin C

Usage

Stevens.creat.cys(creatinine, cystatin, sex, age, ethnicity)

Arguments

- creatinine: Numeric vector with serum or plasma creatinine values in mg/dl
- cystatin: Numeric vector with serum or plasma cystatin C values in mg/l
- sex: Numeric vector with 0 for females and 1 for males
- age: Numeric vector with age in years
- ethnicity: Numeric vector with 0 for non-Black and 1 for Black individuals

Value
The function returns a numeric vector with eGFR values in ml/min/1.73 $m^2$.

Author(s)
Cristian Pattaro

References

See Also
CKDEpi.creat.cys
Stevens.cys1  

**GFR estimation using serum cystatin C**

**Description**

GFR is estimated with the 1st formula proposed by Stevens et al. (Am J Kidney Dis 2008), i.e.: as a simple transformation of cystatin C, without using any other information.

**Usage**

Stevens.cys1(cystatin)

**Arguments**

cystatin  
Numeric vector with serum or plasma cystatin C values in mg/l.

**Value**

A numeric vector with eGFR values in ml/min/1.73 m².

**Author(s)**

Cristian Pattaro

**References**


**See Also**

Stevens.cys2, Stevens.creat.cys, CKDEpi.cys

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Stevens.cys2  

**Stevens' formula for serum cystatin C, age, and sex**

**Description**

GFR is estimated with the 2nd formula proposed by Stevens et al. (Am J Kidney Dis 2008), where cystatin C is weighted by sex and age.

**Usage**

Stevens.cys2(cystatin, sex, age, ethnicity)
Virga

Arguments

cystatin  Numeric vector with serum or plasma cystatin C values in mg/l
sex       Numeric vector with 0 for females and 1 for males
age       Numeric vector with age in years
ethnicity Numeric vector with 0 for non-Black and 1 for Black individuals

Value
A numeric vector with eGFR values in ml/min/1.73 m^2.

Author(s)
Cristian Pattaro

References

See Also
Stevens.cys1, Stevens.creat.cys, CKDEpi.cys

Virga

Virga's formula

Description
Virga's formula is based on serum creatinine, sex, age, and body weight.

Usage
Virga(creatinine, sex, age, wt)

Arguments
creatinine  Numeric vector with serum or plasma creatinine values in mg/dl
sex        Numeric 0/1 vector: 0 for females, 1 for males
age        Numeric vector with age in years
wt          Numeric vector with weight in kg

Value
A numeric vector with eGFR values in ml/min/1.73 m^2
Author(s)
Cristian Pattaro

References

See Also
CG, MDRD4
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