## Package ‘nephro’

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**Title** Utilities for Nephrology  
**Version** 1.2  
**Date** 2017-05-05  
**Author** Cristian Pattaro  
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**Description** Set of functions to estimate renal 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.  
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**NeedsCompilation** no  
**Repository** CRAN  
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Description

This package contains a set of tools for the estimation of renal function. Renal 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 (\texttt{MDRD4}) or six (\texttt{MDRD6}) parameters (see Levey 1999, 2006); the CKD-Epi equations for creatinine (\texttt{CKDEpi.creat}), cystatin C (\texttt{CKDEpi.cys}), and a combination of creatinine and cystatin C (\texttt{CKDEpi.creat.cys}) (see Inker 2012); the three equations proposed by Stevens 2008 based on cystatin C only (\texttt{Stevens.cys1}), age- and sex-weighted cystatin C (\texttt{Stevens.cys2}), and a combination of cystatin C and creatinine (\texttt{Stevens.creat.cys}); the classic Cockroft and Gault 1976 equation for creatinine clearance estimation (\texttt{CG}); and the recent equation by Virga (2007) (\texttt{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

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Author(s)

Cristian Pattaro <cristian.pattaro@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. \textit{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, 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$CKDEpi.cys <- CKDEpi.cys(cyst, sex, age)
eGFR$CKDEpi.creat.cys <- CKDEpi.creat.cys(creat, cyst, sex, age, ethn)
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[,3:11])
```
# 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, 0, 0, 0)
age <- c(60, 65, 43, 82, 71, 55)
ethn <- round(runif(6))
gfr <- CKDEpi.creat(0.95*creat, sex, age, ethn)

---

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  

**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**

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>creatinine</td>
<td>Numeric vector with serum or plasma creatinine values in mg/dl</td>
</tr>
<tr>
<td>sex</td>
<td>Numeric vector with 0 for females and 1 for males</td>
</tr>
<tr>
<td>age</td>
<td>Numeric vector with age in years</td>
</tr>
<tr>
<td>ethnicity</td>
<td>Numeric vector with 0 for non-Black and 1 for Black individuals</td>
</tr>
</tbody>
</table>

**Value**

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

**Author(s)**

Cristian Pattaro

**References**


**See Also**

CKDEpi.creat.cys, CKDEpi.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
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)

Arguments
- **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

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

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**

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

References


See Also

MDRD4

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

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>creatinine</td>
<td>Numeric vector with serum or plasma creatinine values in mg/dl</td>
</tr>
<tr>
<td>cystatin</td>
<td>Numeric vector with serum or plasma cystatin C values in mg/dl</td>
</tr>
<tr>
<td>sex</td>
<td>Numeric vector with 0 for females and 1 for males</td>
</tr>
<tr>
<td>age</td>
<td>Numeric vector with age in years</td>
</tr>
<tr>
<td>ethnicity</td>
<td>Numeric vector with 0 for non-Black and 1 for Black individuals</td>
</tr>
</tbody>
</table>

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`

### 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

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>cystatin</td>
<td>Numeric vector with serum or plasma cystatin C values in mg/dl</td>
</tr>
</tbody>
</table>

Value

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

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)`

**Arguments**

- **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**

*Stevens.cys1, Stevens.creat.cys, CKDEpi.cys*
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 \text{ml/min/1.73 m}^2$

Author(s)

Cristian Pattaro

References


See Also

CG, MDRD4
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