



## **Comparative Assessment of Glomerular Filtration Rate (GFR) Google APPs and CKD Prepare GFR India Google App**

**P. B. Shah<sup>1\*</sup>, L. Jeyaseelan<sup>2</sup>, P. Soundararajan<sup>3</sup> and B. W. C. Sathiyasekaran<sup>1</sup>**

<sup>1</sup>Department of Community Medicine, SRMC & RI, SRIHER, Chennai, India.

<sup>2</sup>Department of Bio-statistics, CMC, Vellore, India.

<sup>3</sup>Department of Nephrology, SRMC & RI, SRIHER, Consultant, Apollo Hospital, Hyderabad, India.

### **Authors' contributions**

*This work was carried out in collaboration among all authors. Author PBS construction of the idea, scientific writing, collecting data, statistics and revision of the final manuscript. Authors LG, PS and BWCS scientific writing and revision of the final manuscript. All authors read and approved the final manuscript.*

### **Article Information**

DOI: 10.9734/JPRI/2021/v33i231148

#### **Editor(s):**

(1) Dr. Giuseppe Murdaca, University of Genoa, Italy.

#### **Reviewers:**

(1) Flavia Silva de Souza, Universidade Federal do Rio de Janeiro-UFRJ, Brasil.

(2) Pablo Amair-Miani, Hospital de Clínicas Caracas, Venezuela.

(3) Jacobo Villalobos, Central University of Venezuela, Venezuela.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/65744>

**Original Research Article**

**Received 05 December 2020**

**Accepted 11 February 2021**

**Published 19 February 2021**

### **ABSTRACT**

**Aim:** Glomerular filtration rate (GFR) estimation is an important parameter for assessment of kidney function and management of the patient with suspected kidney function. These mobile applications hence change the way better patient care is managed. In the research project, there is an attempt to perform comparative assessment of GFR Google APPs and CKD PREPARE GFR India Google APP.

**Methods:** Google app store was searched to identify all the applications which may help in estimation of GFR. All the application were compared except general medical calculators and non-English applications. All important parameters were identified with the guidance of delphi group and comparison chart was made.

**Results:** The search of Google play store led to 35 mobile applications related to GFR estimation. The majority of the applications were by IT company developers and few were by associations or

\*Corresponding author: E-mail: [drpankajbshah@gmail.com](mailto:drpankajbshah@gmail.com);

individuals. There are few companies who have developed multiple mobile applications with different formulas. Many of these aspects of the mobile applications which are considered had important parameters. Few of the applications have multiple page interfaces which may lead to multiple clicks before reaching to GFR estimation which may be at times may be difficult in case of large amounts of use.

**Conclusion:** All the GFR estimation applications are comparable. Single user interface applications have advantages over others where all the data can be entered and results are available in a single view. The disclaimer of using calculators under medical guidance of a qualified physicians is always required.

*Keywords: Kidney function tests; glomerular filtration rate (GFR); creatinine, mobile applications.*

## 1. INTRODUCTION

Glomerular filtration rate (GFR) estimation is an important parameter for assessment of kidney function and management of the patient with suspected kidney function. Since there is difficulty in estimating GFR directly, various indirect methods are used [1-4]. One of the most important methods is estimating the same on the basis of estimation equations which are time tested equations over many decades [1-4]. There are many equations evolved on the various evidence available at different time points and for different populations. The commonest among are Cockcroft-Gault formula (CG), Modification of Diet in Renal Disease (MDRD) Study equation and Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) formulas [1-4]. The various equations performs well in certain stages of chronic kidney disease and hence usually clinicians prefer all calculations at one place instead of sticking to one formula. The GFR estimating equations are as follows [1-4]:

a) Estimated creatinine clearance rate (eCCr) using Cockcroft-Gault formula:

$$eC Cr = \frac{(140 - \text{Age}) \times \text{Weight (in kilograms)}}{72 \times \text{Serum Creatinine (in mg/dL)}} \times \begin{cases} 1 & \text{Male} \\ 0.85 & \text{Female} \end{cases}$$

b) For creatinine in mg/dl (MDRD2):

$$eGFR = 186 \times \text{Serum Creatinine}^{-1.154} \times \text{Age}^{-0.203} \times \begin{cases} 1 & \text{White} \\ 1.212 & \text{Black} \end{cases} \times \begin{cases} 1 & \text{Male} \\ 0.742 & \text{Female} \end{cases}$$

c) Estimated GFR (eGFR) using the CKD-EPI formula

$$eGFR = 141 \times \min(\text{SCR}/k, 1) \times \max(\text{SCR}/k, 1)^{-1.209} \times 0.993^{\text{Age}} \times \begin{cases} 1 & \text{White} \\ 1.018 & \text{Black} \end{cases} \times \begin{cases} 1 & \text{Male} \\ 0.917 & \text{Female} \end{cases}$$

where SCr is serum creatinine (mg/dL), k is 0.7 for females and 0.9 for males, a is -0.329 for females and -0.411 for males, min indicates the

minimum of SCr/k or 1, and max indicates the maximum of SCr/k or 1.

Currently the CKD-EPI formula, which is internationally accepted to calculate the GFR.

With the advent of information technology (computer or mobile based system for design, development, use) and it is available as a mobile application on finger tips. Mobile applications can be prepared using the technology which can use calculations in their background system required similar to calculators depending on the parameters entered in the mobile applications information system or data entry points. These mobile applications hence change the way better patient care is managed [5-9]. If the formula is added properly in the programming system, there is no way error in calculation can occur in the calculations like our daily calculators. The mobile application thus can become an easy tool for managing better patient care by calculating GFR at bedside with the help of these standard formula mobile applications. There is limited literature available for mobile application in CKD and specially with respect to GFR estimation [10-18]. There are few countries where GFR estimation is mandatory as part of the blood test reporting system [19-25]. With the evolving technology, microsoft store, android google play store and Iphone app store are the prominent application stores for downloading and installing the same. In the arena of mobile technology, the android mobile software system is more commonly used [26-29]. Hence google play store application is one of the easy ways for any developer to inform the users about their applications and suggest them for installation in their mobile phone and use them. These applications are of two types. General medical calculating applications and specific calculating applications. General medical applications have many formulas which healthcare professionals may use while specific calculating applications

have only those specific equation estimations as required. In the research project, there is an attempt to perform comparative assessment of GFR Google APPs and CKD PREPARE GFR India Google APP.

## 2. METHODS

A search using the term GFR was used in Google app play store to identify all the GFR applications available. A Delphi group was created to assess the important parameters which included health care professionals as well as IT professionals. Various rounds of the discussion led to identifications of the few important parameters from the large list of parameters identified in the initial stages. The comparative assessment tool was created using various parameters identified for usefulness of the application. The various aspects of the tools are as follows:

1. Name of the application
2. Developer details
3. User rating given in Google play store
4. Last updates done
5. Size of the application
6. Approximate download or installation information available
7. Version of the mobile app
8. Level of android system required
9. Which are the GFR formulas calculations available- Creatinine based or cystine based
10. Single page interactions or multiple page interaction or clicking required
11. Free or paid application
12. Any association/society application

In addition to the above aspects, there is also a need to find if applications are available by Indian developers or Indian health care professionals. There were few parameters which were decided to be excluded at present were calculating various levels of GFR using various applications, using the review posted by users and number of downloads of the mobile applications. Since GFR calculations are based on specific formulas, many of the IT professionals suggested that once formulas are properly fed using the proper programming language then unlikely there can be errors. Reviews posted were not considered at present as few users usually post their reviews and it may not be a true representation of all the users. Though the number of downloads of each application is considered, the comparative

assessment is not considered as an important parameter for value comparison as all users who have downloaded, installed and later uninstalled cannot be captured properly. Also there are many marketing agencies which are being hired by IT companies for marketing of their mobile applications. Though size of the application was an important aspect a few years back for any mobile applications but now due to newer generation of mobiles with large amounts of internal storage, it is decided to not to consider the size of the application as an most important parameter. Disclaimer with respect to consultation with healthcare professionals for any of the GFR values calculated is considered an important aspect in the application details provided by the developer. It was decided to exclude general medical calculators as well as non-english calculators in the present comparative assessment. It is always better to have a single application with various estimation equations of the GFR, it was decided to note if individuals or IT companies have made available multiple applications with different combinations of the formulas which are actually not required. This was identified using the same developer name in the application page.

## 3. RESULTS AND DISCUSSION

The search of Google play store led to 35 mobile applications related to GFR estimation in the month of January 2021. Five applications were excluded as either they were also having general calculator features or non english applications. Two applications were paid in nature and one application had the feature of GFR estimation using cystine values. The details of the remaining 27 mobile applications for GFR estimation is shown in the following table. The majority of the applications were by IT company developers and few were by associations or individuals. Only one application i.e GFR India developed by the authors of the study is from India. There are few companies who have developed multiple mobile applications with different formulas. Many of these applications were developed or updated in the same year and they could have been a single application instead of multiple applications. The advantage of the single application is that it gives comparison of various estimating equations at a single glance. Few applications had disclaimer about the consultations with health care professionals is an important aspect. Some of the applications had also given various details of

stages of chronic kidney disease. The authors have developed GFR India and had many of these aspects of the mobile applications which are considered as important parameters. Few of the applications have multiple page interfaces which may lead to multiple clicks before reaching to GFR estimation which may be at times may be difficult in case of large amounts of use.

Table 1 shows the list of the GFR applications.

Table 2. Shows the Applications with multiple interfaces and pages which may be tedious and time consuming.

Table 3. GFR estimation applications with all available calculations is a single interface and page.

**Table 1. GFR app**

No	Name	App by
1	CKD-EPI y MDRD UdelaR Uruguay	Aberto
2	Easy eGFR	AV Tech solutions
3	eGFR Calculator	Blue rock
4	CCr calculator(Cockcroft-Gault equation)	Blue rock
5	Kinetic GFR Calculator	Eoin
6	GFR India	GFR Ind
7	ANHAES eGFR calculator	gtrab
8	Estimated Glomerular Filtration Rate (EGFR)	Gumption multimedia
9	eGFR Calculator	Gumption multimedia
10	Cockcroft-Gault calculator	Gumption multimedia
11	GFR Calculator: Kidney Health & CKD Stage	iMedical Apps
12	eGFR Calculators Pro: Renal or Kidney Function	iMedical Apps
13	GFR Calculator	Individual
14	GFR Calculator	Intelligent solutions
15	GFR Calculator Pro	Intelligent solutions
16	eGFR Calculator	KS soft app
17	GFR Easycalc	Louis Janssens
18	GFR & BSA Calculator	Medcomis Ltd
19	eGFR Calc - GFR calculator and tracker	Meditis
20	eGFR Calc	Medmobile.eu
22	eGFR Calculators	National Kidney Foundation
23	Estimated Glomerular Filtration Rate	Prof. Dr. Erdem
24	eGFR	ScyMed
25	eGFR CKD EPI Calculator App	Shigeto Takagi
26	yourGFR - Calculate your eGFR	Tommy
27	Xiga eGFR Calculator	Virtual software house

**Table 2. Applications with multiple interfaces and pages**

Name	CG	MDRD	CKD-EPI	Indian	any other equation
Easy eGFR	N	Y	Y	N	Y
eGFR Calculator	N	Y	Y	N	N
GFR Calculator: Kidney Health & CKD Stage	Y	Y	Y	N	Y
eGFR Calculators Pro: Renal or Kidney Function	Y	Y	Y	N	N
GFR Calculator	Y	Y	Y	N	Y
eGFR Calculators	Y	Y	Y	N	Y
eGFR CKD EPI Calculator App	N	N	Y	N	N
eGFR Calculator	Y	Y	Y	N	Y

Y- Yes, N- no

**Table 3. Application with all available calculations is a single interface and page**

<b>Name</b>	<b>CG</b>	<b>MDRD</b>	<b>CKD-EPI</b>	<b>Indian</b>	<b>any other equation</b>
CKD-EPI y MDRD Udela R Uruguay	N	Y	Y	N	N
CCr calculator(Cockcroft-Gault equation)	y	N	N	N	N
Kinetic GFR Calculator	N	Y	N	N	N
GFR India	Y	Y	Y	N	Y
ANHAES eGFR calculator	N	N	Y	N	N
Estimated Glomerular Filtration Rate (EGFR)	Y	Y	Y	N	Y
eGFR Calculator	Y	Y	Y	N	Y
Cockcroft-Gault calculator	Y	N	N	N	N
GFR Calculator	Y	Y	Y	N	
GFR Calculator Pro	Y	Y	Y	N	Y
eGFR Calculator	Y	Y	Y	N	Y
GFR Easycalc	N	Y	Y	N	N
GFR & BSA Calculator	Y	N	N	N	N
eGFR Calc - GFR calculator and tracker	Y	Y	Y	N	Y
eGFR Calc	Y	Y	Y	N	Y
Estimated Glomerular Filtration Rate	N	Y	Y	N	N
eGFR	Y	Y	Y	N	Y
yourGFR - Calculate your eGFR	Y	Y	Y	N	Y
Xiga eGFR Calculator	Y	Y	Y	N	Y
GFR Calculator	Y	Y	Y	N	Y

Y-Yes, N- no

Overall all the mobile applications have been downloaded by the larger number of the users. It is always to have a single user interface so that once information is entered, all possible GFR estimating equations calculations will be displayed. The mobile application will assist clinicians, patients and caregiver an opportunity for better patient care [10,26-29]. The individual calculations accuracy is not assessed in the present comparison. Users of these application must know the importance of the results obtain, which can be used for medical diagnose, clinical or treatment follow up as well and it is always required to have medical guidance from a qualified physician. Further research is required about user friendly aspects and feedback from various stakeholders and integrating these systems with patients lab reporting systems.

#### 4. CONCLUSIONS

All the GFR estimation applications are comparable. Single user interface applications have advantages over others where all the data can be entered and results are available in a single view. The disclaimer of using calculators under medical guidance of a qualified physicians is always required.

#### DISCLAIMER

The authors are owner and involved in the development of GFR IND app which is self funded project of the authors. There is absolutely no conflict of interest between the authors and producers of the products other then GFR Ind because we do intend to use this comparison only as the advancement of knowledge. Also, the research was not funded by any software producing company rather it was funded by personal efforts of the authors.

#### CONSENT

It is not applicable.

#### ETHICAL APPROVAL

It is not applicable.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

#### REFERENCES

1. Stevens LA, Coresh J, Greene T, Levey AS. Assessing kidney function — measured and estimated glomerular filtration rate. *N Engl J Med.* 2006;354:2473-83.
2. Levey AS, Stevens LA, Schmid CH, et al. A new equation to estimate glomerular filtration rate. *Ann Intern Med* 2009;150:604-12.
3. Levey AS, Bosch JP, Lewis JB, Greene T, Rogers N, Roth D. A more accurate method to estimate glomerular filtration rate from serum creatinine: A new prediction equation. Modification of Diet in renal disease study group. *Ann Intern Med.* 1999;130:461-70
4. Inker LA, Eckfeldt J, Levey AS, et al. Expressing the CKD-EPI (Chronic Kidney Disease Epidemiology Collaboration) cystatin C equations for estimating GFR with standardized serum cystatin C values. *Am J Kidney Dis.* 2011;58:682-4.
5. Chavez S, Fedele D, Guo Y, Bernier A, Smith M, Warnick J, Modave F. Mobile apps for the management of diabetes. *Diabetes Care.* 2017;40(10):e145-6.
6. Wang K, Varma DS, Prosperi M. A systematic review of the effectiveness of mobile apps for monitoring and management of mental health symptoms or disorders. *Journal of psychiatric research.* 2018;107:73-8.
7. Ming LC, Untong N, Aliudin NA, Osili N, Kifli N, Tan CS et al. Mobile health apps on COVID-19 launched in the early days of the pandemic: Content analysis and review. *JMIR mHealth and uHealth.* 2020; 8(9):e19796.
8. Thurnheer SE, Gravestock I, Pichierri G, Steurer J, Burgstaller JM. Benefits of mobile apps in pain management: Systematic review. *JMIR mHealth and uHealth.* 2018;6(10):e11231.
9. Tinschert P, Jakob R, Barata F, Kramer JN, Kowatsch T. The potential of mobile apps for improving asthma self-management: A review of publicly available and well-adopted asthma apps. *JMIR mHealth and uHealth.* 2017;5(8):e113.
10. Sobrinho A, da Silva LD, Perkusich A, Pinheiro ME, Cunha P. Design and evaluation of a mobile application to assist the self-monitoring of the chronic kidney disease in developing countries. *BMC Medical Informatics and Decision Making.* 2018;18(1):1-4.

11. Singh K, Diamantidis CJ, Ramani S, Bhavsar NA, Mara P, Warner J et al. Patients' and nephrologists' evaluation of patient-facing smartphone apps for CKD. *Clinical Journal of the American Society of Nephrology*. 2019 ;14(4):523-9.
12. Kosa SD, Monize J, D'Souza M, Joshi A, Philip K, Reza S et al. Nutritional mobile applications for CKD patients: Systematic review. *Kidney international reports*. 2019; 4(3):399-407.
13. Lee YL, Cui YY, Tu MH, Chen YC, Chang P. Mobile health to maintain continuity of patient-centered care for chronic kidney disease: Content analysis of apps. *JMIR mHealth and uHealth*. 2018;6(4):e10173.
14. Topf JM, Hiremath S. Got CKD? There's an app for that!. *CJASN*. 2019;14(4):491-492;
15. Klein J. Utilization of mobile nutrition applications by patients with chronic kidney disease. *Journal of Renal Nutrition*. 2019; 29(1):e5-7.
16. Lewis RA, Lunney M, Chong C, Tonelli M. Identifying mobile applications aimed at self-management in people with chronic kidney disease. *Canadian journal of Kidney Health and Disease*. 2019;6: 2054358119834283.
17. Scott IA, Scuffham P, Gupta D, Harch TM, Borch J, Richards B. Going digital: A narrative overview of the effects, quality and utility of mobile apps in chronic disease self-management. *Australian Health Review*. 2018;44(1):62-82.
18. Alhodaib HI, Antza C, Chandan JS, Hanif W, Sankaranarayanan S, Paul S et al. Mobile clinical decision support system for the management of diabetic patients with kidney complications in UK primary care settings: Mixed methods feasibility study. *JMIR diabetes*. 2020;5(4):e19650.
19. Miller WG, Jones GR. Estimated glomerular filtration rate; laboratory implementation and current global status. *Advances in Chronic Kidney Disease*. 2018;25(1):7-13.
20. Biljak VR, Honovic L, Matica J, Kresic B, Vojak SS. The role of laboratory testing in detection and classification of chronic kidney disease: national recommendations. *Biochem Med*. 2017;27(1):153-176.
21. Johnson DW, Jones GR, Mathew TH, et al. Australasian creatinine consensus working group. Chronic kidney disease and automatic reporting of estimated glomerular filtration rate: New developments and revised recommendations. *Med J Aust*. 2012;197(4):224-225.
22. Abuşoglu S, Aydın I, Bakar F, et al. A short guideline on chronic kidney disease for medical laboratory practice. *Turk J Biochem*. 2016;41:292-301.
23. NICE Clinical Guideline 182. Chronic kidney disease. Early identification and management of chronic kidney disease in adults in primary and secondary care. Available: <https://www.nice.org.uk/guidance/cg182>. Accessed: April 27, 2017.
24. Kilpatrick ES, Verrill H. A national audit of estimated glomerular filtration rate and proteinuria reporting in the UK. *Ann Clin Biochem*. 2011;48(6):558-561.
25. Bello AK, Levin A, Tonelli M, et al. Assessment of Global Kidney Health Care Status. *JAMA*. 2017;317(18):1864-1881.
26. Arora S, Ter Hofstede F, Mahajan V. The implications of offering free versions for the performance of paid mobile apps. *Journal of Marketing*. 2017;81(6):62-78.
27. Gan SK, Koshy C, Nguyen PV, Haw YX. An overview of clinically and healthcare related apps in Google and Apple app stores: Connecting patients, drugs and clinicians. *Scientific phone apps and mobile devices*. 2016 ;2(1):8.
28. Gan SK, Poon JK. The world of biomedical apps: their uses, limitations, and potential. *Scientific Phone Apps and Mobile Devices*. 2016;2(1):6.
29. Gan SKE. The history and future of scientific phone apps and mobile devices. *Sci Phone Appl Mob Devices*. 2018;4(2). Available: <https://doi.org/10.1186/s41070-018-0022-8>.

© 2021 Shah et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

*Peer-review history:*  
The peer review history for this paper can be accessed here:  
<http://www.sdiarticle4.com/review-history/65744>