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

P. B. Shah¹, L. Jeyaseelan², P. Soundararajan³ and B. W. C. Sathiyasekaran¹

¹Department of Community Medicine, SRMC & RI, SRIHER, Chennai, India. ²Department of Bio-statistics, CMC, Vellore, India. ³Department 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.

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;
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 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:

\[
e\text{C Cr} = (140-\text{Age}) \times \text{Weigh (in kilograms)} \times 0.85 \text{ if Female}
\]

\[\frac{[1.212 \text{ if Black} \times [0.742 \text{ if Female}]}{[0.993 \text{Age} \times [1.018 \text{if Female}] \times [1.159 \text{if Black}]}
\]

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 inter nationally 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    |
| 21 | eGFR Calculators                              | National Kidney Foundation|
| 22 | Estimated Glomerular Filtration Rate           | Prof. Dr. Erdem|
| 23 | eGFR                                          | ScyMed          |
| 24 | eGFR CKD EPI Calculator App                    | Shigeto Takagi  |
| 25 | yourGFR - Calculate your eGFR                 | Tommy           |
| 26 | 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

| Name                                         | CG | MDRD | CKD-EPI | Indian | any other equation |
|----------------------------------------------|----|------|---------|--------|-------------------|
| 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      | 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      | Y                 |
| 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.

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