

## A content analysis of 'Water Apps' and prevention of urological diseases: Do apps really help?

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**Introduction** Maintaining hydration reduces incidence of kidney stone disease (KSD), chronic kidney disease (CKD) and urinary tract infections (UTIs). Mobile applications (apps) measuring hydration are gaining in usage, allowing users to monitor intake whilst also taking into account the signs and symptoms of dehydration. Our study looked at the water apps in the management and/or prevention of urological disease.

**Material and methods** The original android app store (Google Play Store), and the Apple App Store (iOS App Store) were searched using the term 'hydration', 'fluid' and 'water'. All apps from each distribution platform, with a minimum of 100 reviews, were then selected and analysed.

**Results** After identification of 51 applications (13 from Apple App Store, and 38 from Google Play Store), 45 were free to download and 6 were paid (cost range: \$2.19–\$7.97). While none of the apps facilitated measurement of urine output and colour, 12 mentioned signs and symptoms of dehydration. Furthermore, when calculating required fluid intake, the level of activity was considered by 31 apps. With regards to information provision, only one of the apps included advice or education about urological conditions associated with poor hydration. None of the apps gave advice on hydration related to CKD and UTI.

**Conclusions** Mobile phone apps are a well-established tool for measuring fluid intake. However, they provide little information regarding the importance of hydration, and don't utilise other measures such as level of activity, urine output or colour. Considering the increasing popularity of fitness and hydration apps in our daily lives, the developers need to make them more comprehensive and informative.

**Key Words:** hydration ↔ water ↔ fluid ↔ apps ↔ applications ↔ kidney stone  
↔ urinary tract infection ↔ chronic kidney disease

## INTRODUCTION

Regular and adequate intake of water has been shown to be beneficial in a range of urological diseases [1–4]. Increased water intake can prevent both the onset and progression of chronic kidney disease (CKD) as well as the development of polycystic kidney disease (PKD) [1]. Rat models have further shown a link between vasopressin and V2 receptor

signalling and the pathogenesis of polycystic kidney disease [2], thus indicating the possible need for hydration to mitigate these effects. There is also a well-documented link between lack of hydration and the development of urinary tract infection (UTI) [3, 4], as well as positive hydration status aiding treatment of such infections [3]. Hydration can be assessed by measuring total fluid intake and urine output, and can be affected by physical activity, the hydration

index of consumed fluids, climate, gender and physiological state.

The incidence of kidney-related diseases is also rising. The incidence of both chronic kidney disease and kidney stone disease (KSD) are steadily increasing [5, 6]. It is estimated that 12% of the world population is now affected by KSD, thereby further increasing the risk of CKD and end-stage renal failure [6]. Incidence of UTIs is also increasing, which showed one of the sharpest rises in emergency presentations in the UK within the last decade [7]. Furthermore, UTIs are a large cause of antibiotic use in the older population, with an estimated 29–66% [8] of all antibiotic prescriptions in care homes relating to such infections. Thus, not only are UTIs a large cause of morbidity in the elderly, but also place a large burden on primary care services.

Mobile applications (apps) are constantly increasing in popularity and usage, as well as gaining an ever-expanding reach globally. Within this, the use of health-related apps is benefiting in popularity. Across the two leading platforms of apps (iOS and Android) in 2014, the number of health apps published exceeded 100,000 [9]. Within this review of such health-related apps, behavioural change (typically self-monitoring behaviour) was observed in tandem with usage [9]. Apps have also been used as a platform for providing self-management information in those patients with long-term health conditions [10]. These have shown some potential in improving health outcomes in this cohort of patients. From a patient's perspective, health apps can improve patient's experience and increase their access to health information relevant to their conditions [11]. The benefit of health apps in patients with chronic conditions has already been shown by enhancement of self-management in patients with diabetes [12].

There is limited evidence on the efficacy and usefulness of hydration apps, specifically within the context of prevention of urological diseases. 'Kidney Stones' – an app aiming to promote increased compliance with kidney stone metaphylaxis has shown some use in promoting compliance and thus reducing incidence of kidney stone disease [13]. Part of the app's measure of metaphylaxis was monitoring patient's drinking behaviours and thus hydration levels through a subjective questionnaire [13]. In light of the increasing incidence of urological diseases, as well as increasing prevalence of health-promoting mobile phone applications, this paper will review the current cohort of apps promoting water and hydration, and assess their efficacy in promoting both good urological health and advising users about the documented links between poor hydration and urological diseases.

## Objectives

The aim of this study was to determine the role of water related mobile applications in the monitoring and subsequent prevention of urological conditions.

## MATERIAL AND METHODS

A search was performed using the Android App Store and iOS App store between 26/09/2019 – 31/12/2019.

### Selection criteria

The search term 'hydration', 'fluid' and 'water' was used to identify all relevant apps between 26/09/2019 – 31/12/2019.

### Inclusion criteria

1. Apps found in either the Android App Store (Google Play Store) or Apple App store (iOS App Store).
2. Basic and upgraded versions of the same app were considered as separate entities if their content differed.
3. Apps found in both the Android App Store and iOS App Store were both collected and individually analysed.

### Exclusion criteria

1. Apps with less than 100 reviews were discarded.
  2. Apps no longer in use or discontinued.
- Download data could not be used to quantify the use of apps as this data was not released by Apple for the apps in the iOS App Store. The apps were categorised by the two platforms under 'Health and Fitness' or 'Medical' or 'Tools'.

### Data collection

Data was collected in two broad categories: parameters assessing level of hydration and associated activity and parameters assessing signs and symptoms of urological diseases.

Data collected assessing hydration included: type of fluid intake, level of activity, motivational cues associated with data collection, sharing capabilities, competitiveness with peers and reminders or prompts.

Data collected assessing signs and symptoms included: urine colour, urine volume, signs and symptoms of dehydration, kidney stone disease-specific advice, chronic kidney disease-specific advice and urinary tract infection-specific advice.

The following operational definitions were used to collect and analyse the data:

- Cost – either ‘free’ (there was no cost to download the app) or ‘paid’ (the user was charged to download the app)
- Category – the categorical classification of the app in either the Apple App Store or Android App Store
- Reminders – either ‘yes’ (users were given notified reminders on their smartphone to record their hydration status) or ‘no’ (users were given no reminders on their smartphone to record their hydration status)
- Competition – either ‘yes’ (users were incentivised to achieve a certain level of hydration for an in-app reward/recognition of achievement) or ‘no’ (there was no reward/recognition of user’s hydration level)
- Sharing – either ‘yes’ (users were able to share the app with other people) or ‘no’ (there was no sharing facility)
- Motivational cues – either ‘yes’ (the app contained encouraging messages to incentivise users to measure their hydration status) or ‘no’ (there were no such encouraging messages)
- Level of activity measurement – either ‘yes’ (the level of user’s physical activity was measured and accounted for alongside measurement of hydration level) or ‘no’ (there was no measurement of physical exercise level)
- Consideration of type of fluid – either ‘water’ (the app only measures intake of water alone) or ‘many’ (the app accounts for many different types of fluids)
- Measure of urine colour – either ‘yes’ (the app measures the colour of user’s urine) or ‘no’ (the app doesn’t measure the colour of urine)
- Measure of urine volume – either ‘yes’ (the app measures the total volume of user’s urine) or ‘no’ (the app doesn’t measure the total volume of user’s urine).
- Signs of symptoms of dehydration – either ‘yes’ (the app provides information about the signs and symptoms of dehydration) or ‘no’ (the app does not provide information about the signs and symptoms of dehydration)
- Kidney stone disease (KSD) specific advice – either ‘yes’ (the app contains information about kidney stone disease) or ‘no’ (the app does not contain information about kidney stone disease)
- Chronic kidney disease (CKD) specific advice – either ‘yes’ (the app contains information about chronic kidney disease) or ‘no’ (the app does not contain information about chronic kidney disease)
- Urinary tract infection (UTI) specific advice – either ‘yes’ (the app contains information about urinary tract infection) or ‘no’ (the app does not contain information about urinary tract infection)

## Data analysis

The data was collected and analysed by three authors – YPM, EJ and HBMZ. Initially 107 apps were identified and after those with less than 100 reviews were removed, 51 apps remained in the final study.

## RESULTS

The final number of included apps in our sample was 51 [Table 1], of which 38 were Android apps and 13 were iOS apps. Of these, 45 were found to be unique, with 3 spanning both platforms. As for the cost, 45 were free to download and 6 were paid (Cost range: \$2.19–\$7.97). The final iOS sample was small compared to the number of Android apps. Thus, we have presented the data for each platform separately, as well as looking at the overall implication.

The majority of the apps were free to download across both platforms, with free apps making up 88% of the total. Also, most of the apps fell into the ‘Health and Fitness’ category (94%) across both platforms. There were also two apps from iOS which were defined as ‘Medical’ and one app from Android defined as ‘Tools’.

## Hydration specific data

The large majority of apps (98%) gave users notifiable reminders regarding their hydration level (Table 2), with only one app not having a reminder facility. There was a competitiveness facility in 31% of all apps. The majority of apps (61%) facilitated sharing of the app with other and new users. A proportion (71%) also contained motivational cues for users to increase their level of hydration.

**Table 1.** General information about hydration applications on Android and iOS Platforms

	iOS	Android	Total
Number of apps	13	38	51
Cost of apps	Free – 11 Paid – 2	Free – 34 Paid – 4	Free – 45 (88%) Paid – 6 (12%)
Category of apps	Health & Fitness – 11 Medical – 2	Health & Fitness – 37 Tools – 1	Health & Fitness – 48 (94%) Medical – 2 (4%) Tools – 1 (2%)

**Table 2.** Hydration specific data from Android and iOS Apps

	iOS (app)	Android (app)	Total
Reminders or prompts	Yes – 12 No – 1	Yes – 38 No – 0	Yes – 50 (98%) No – 1 (2%)
Competitiveness with peers	Yes – 6 No – 7	Yes – 10 No – 28	Yes – 16 (31%) No – 35 (69%)
Sharing	Yes – 6 No – 7	Yes – 25 No – 13	Yes – 31 (61%) No – 20 (39%)
Motivational cues	Yes – 5 No – 8	Yes – 31 No – 7	Yes – 36 (71%) No – 15 (29%)
Level of activity measurement	Yes – 6 No – 7	Yes – 25 No – 13	Yes – 31 (61%) No – 20 (39%)
Consideration of type of fluid	Water – 6 Many – 7	Water – 20 Many – 18	Yes – 26 (51%) No – 25 (49%)

**Table 3.** Urine parameters and disease-specific data from Android and iOS Apps

	iOS	Android	Total
Measure of urine colour	Yes – 0 No – 13	Yes – 0 No – 38	Yes – 0 (0%) No – 51 (100%)
Measure of urine volume	Yes – 0 No – 13	Yes – 0 No – 38	Yes – 0 (0%) No – 51 (100%)
Signs and symptoms of dehydration	Yes – 0 No – 13	Yes – 12 No – 26	Yes – 12 (24%) No – 39 (76%)
Kidney stone disease (KSD) – specific advice	Yes – 1 No – 12	Yes – 0 No – 38	Yes – 1 (2%) No – 50 (98%)
Chronic kidney disease (CKD) – specific advice	Yes – 0 No – 13	Yes – 0 No – 38	Yes – 0 (0%) No – 51 (100%)
Urinary tract infection (UTI) – specific advice	Yes – 0 No – 13	Yes – 0 No – 38	Yes – 0 (0%) No – 51 (100%)

The majority of apps (61%) considered the user's level of physical activity when measuring their level of hydration. A smaller majority (51%) also considered the type of fluid consumed, rather than assuming it will be solely water.

### Data regarding signs and symptoms

None of the apps across both platforms asked the users to measure their urine colour or their urine volume (Table 3). However, 24% of apps provide information and guidance on the signs and symptoms of dehydration. While only one app provided information about kidney stone disease (2%), none of the apps provided information about CKD or UTI.

## DISCUSSION

The overall aim of our study was to assess whether hydration-promoting mobile phone apps provides users with information on urological diseases, namely

kidney stone disease, chronic kidney disease and urinary tract infections, which have all been shown to reduce incidence with increased fluid intake [1, 3, 4]. Overall, the apps provided a useful platform for users to monitor their fluid intake, with majority providing users with reminders, sharing facilities and motivational cues relating to their drinking behaviours. They also largely accounted for level of activity and type of fluid consumption, both factors integral to levels of hydration. Crucially however, the apps provided very little disease-specific information, and thus poorly bridging the link between hydration and renal disease. The lack of disease specific information means that users will not understand the relationship between regular and adequate hydration and good kidney health. As incidence of urological diseases increase [5, 6], it is important for users to maintain their hydration regularly.

Thus, to decrease the incidence of urological diseases, apps must clearly illustrate this relationship between hydration, well-being and being healthy. As shown in a previously published app for patients suffering from kidney stone disease, users found the information provided by an app more suitable than traditional information brochures [13]. Thus, mobile phone apps are clearly a useful platform for patients and management of their conditions moving forward in the future.

The apps reviewed in the study appeared to have a good user interface and allowed for good connectivity between users. This was shown through many apps facilitating reminders, sharing and motivational cues. Therefore, they showed promise in being able to convey useful information regarding urological diseases in a way which can be user-friendly and accessible to lay users with little medical knowledge. Some apps (24%) have also provided information on the signs and symptoms of dehydration. Although not many, this shows that there may be some effort to promote good health through hydration. This also represents a useful starting point for apps, providing users with increasing amounts of health-promoting information.

### Limitations of the study

Although we focused on a large sample size of apps, we selected apps in the Apple Store or Android Store with over 100 reviews, creating a total sample of 51 apps. The apps in our sample were also skewed more towards the Android platform, with 38 of the 51 (75%) coming from the Android store. It is possible that apps with lower number of reviews might have provided more disease-specific information. However, given that we have selected the apps with

over 100 reviews, we have reviewed the most popular apps in the category and thus are focusing on the majority of users of hydration apps.

Our study has investigated the app information between urological disease and hydration specifically for kidney stone disease, chronic kidney disease and urinary tract infections. Although currently most apps were poor on this, mobile phone apps could also play a useful role in the prevention of these and many more diseases [14, 15]. They could also look at levels of fluid intake and hydration [16, 17].

### Recommendations for future research

Our study included a large number of hydration apps across both mobile phone platforms. It may be useful to repeat the research on a larger scale including all such apps. This could also provide an opportunity for a follow-up study to investigate the change in app content over a certain time-frame and assess if there has been any change in the disease-promoting facilities of hydration apps.

Despite all the benefit of promoting hydration purported, it is also important to advise the possible dangers of hydration in particular patient groups. This would include those on dialysis or with severe decompensated heart failure. It would therefore be important to consider the inclusion of such disclaimers in future research and app design. Currently, none of the apps provided this information.

This study has illustrated a substantial lack of information provided by hydration-promoting apps related to urological diseases. Consequently, it is possible that a hydration app can be designed to both promote the importance of regular and sufficient hydration, provide information about diseases and signify the link between the two. Urine colour and volume are good indicators of hydration and perhaps apps should highlight the importance of this, and future updates or applications should consider incorporating this.

### CONCLUSIONS

Mobile phone apps are a well-established tool for measuring fluid intake. However, they provide little information regarding the importance of hydration for urological diseases, and don't utilise other measures of hydration, such as level of activity, urine output or colour. Considering the increasing popularity of fitness and hydration apps in our daily lives, the developers need to make them more comprehensive and informative.

### CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest from any of the co-authors.

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### ETHICAL APPROVAL

As this is a review, no formal ethical approval was necessary.

### References

- Clark WF, Sontrop JM, Huang SH, Moist L, Bouby N, Bankir L. Hydration and chronic kidney disease progression: a critical review of the evidence. *Am J Nephrol.* 2016; 43: 281-292.
- Hopp K, Wang X, Ye H, et al. Effects of hydration in rats and mice with polycystic kidney disease. *Am J Physiol Renal Physiol.* 2015; 308: 261-266.
- Manz F. Hydration and disease. *Journal of the Am Coll Nutr.* 2007; 26 (5 Suppl): 535S-541S.
- Stauffer CM, Donadini R, Ramelli GP, Marchand S, Bianchetti MG. Family history and behavioural abnormalities in girls with recurrent urinary tract infections: a controlled study. *J Urol.* 2004; 171: 1663-1665.
- Luo S, Grams ME. Epidemiology research to foster improvement in chronic kidney disease care. *Kidney Int.* 2020; 97: 477-486.
- Wright AE, Rukin NJ, Somani BK. Ureterscopy and stones: Current status and future expectations. *World J Nephrol.* 2014; 3: 243-248.
- Bardsley M, Blunt I, Davies S, et al. Is secondary preventive care improving? Observational study of 10-year trends in emergency admissions for conditions amenable to ambulatory care. *BMJ Open.* 2013; 3: p.e002007.
- Ahmed H, Farewell D, Jones HM, Francis NA, Paranjothy S, Butler CC. Incidence and antibiotic prescribing for clinically diagnosed urinary tract infection in older adults in UK primary care, 2004-2014. *PLoS One.* 2018; 13: e0190521.
- Zhao J, Freeman B, Li M. Can mobile phone apps influence people's health behavior change? An evidence review. *J Med Internet Res.* 2016; 18: p.e287.
- Whitehead L, Seaton P. The effectiveness of self-management mobile phone and tablet apps in long-term condition management: a systematic review. *J Med Internet Res.* 2016; 18: p.e97.
- Lu C, Hu Y, Xie J, et al. The use of mobile health applications to improve patient experience: cross-sectional study in Chinese public hospitals. *JMIR mHealth and uHealth.* 2018; 6: e126.
- Anderson K, Burford O, Emmerton L. Mobile health apps to facilitate self-care: a qualitative study of user experiences. *PLoS One.* 2016; 11: p.e0156164.
- Becker B, Gadzhiev N, Popiolek M, Gross AJ, Netsch C. A mobile app for patients suffering from kidney stones. *Urologe A.* 2018; 57: 577-582.
- Jamnadas E, Aboumarzouk O, Kallidonis P, et al. The role of social media and internet search engines in information provision and dissemination to patients with kidney stone disease: A systematic review from

- European association of young academic urologists. *J Endourol.* 2018; 32: 673-184.
15. Vaggers S, Puri S, Wagenlehner F, et al. A content analysis of mobile phone applications for the diagnosis, treatment, and prevention of urinary tract infections, and their compliance with European association of urology guidelines on urological infections. *Eur Urol Focus.* 2020; S2405-4569(20)30057-2. doi: 10.1016/j.euf.2020.02.002. Online ahead of print.
16. Sulaiman SK, Enakshee J, Traxer O, et al. Which type of water is recommended for patients with stone disease (hard or soft water, tap or bottled water): Evidence from a systematic review over the last 3 decades. *Curr Urol Rep.* 2020; 21: 6.
17. Gamage KN, Jamnadass E, Sulaiman SK, et al. The role of fluid intake in the prevention of kidney stone disease: A systematic review over the last two decades. *Turk J Urol.* 2020. doi: 10.5152/tud.2020.20155. Online ahead of print. ■