

# A Critical Appraisal of Fertility and Menstrual Tracking Apps for the iPhone



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## Abstract

**Objective:** This study sought to review and appraise Apple Store applications (apps) designed for menstrual cycle tracking, ovulation prediction, and other topics related to fertility or the management of infertility.

**Methods:** The Apple Store was systematically searched using the keywords "period tracker," "menstrual tracker," "fertility," "ovulation," "IVF," and "in vitro fertilization." Apps were downloaded after being screened against pre-defined inclusion criteria. Included apps were independently reviewed by two authors. Data were extracted, and an app quality score (AQS) was calculated according to a premade rubric. Apps were assessed on the basis of their general features, menstrual cycle tracking and prediction features, infertility-related features, and usability.

**Results:** A total of 140 apps were included in the final analysis, of which 90 (64.3%) were free. The average AQS was 32.5%. There was no significant difference in AQS between free and paid apps (31.5% vs. 34.2%;  $P = 0.491$ ). A total of 62 (44.3%) apps made dynamic cycle predictions on the basis of cumulatively input data. Thirty-one apps (22.1%) contained serious inaccuracies in content, tools, or both. Only 25 apps (17.9%) contained information or functions specifically related to infertility or its management.

**Key Words:** mHealth, mobile health, smartphone apps, medical apps, menstrual cycle tracking

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**Conclusion:** Some high-quality menstrual cycle tracking apps are available; however, many more are of low quality, and users should be wary of relying on their predictions to avoid pregnancy or to maximize chances of conception. Few apps specifically address the needs of patients struggling with infertility.

## Résumé

**Objectif :** Cette étude avait pour but d'examiner et d'évaluer les applications de l'App Store d'Apple conçues pour suivre les menstruations, prédire l'ovulation et traiter d'autres sujets relatifs à la fertilité ou au traitement de l'infertilité.

**Méthodologie :** Une recherche systématique a été effectuée dans l'App Store au moyen des mots-clés *period tracker*, *menstrual tracker*, *fertility*, *ovulation*, *IVF* et *in vitro fertilization*. Les applications ont été téléchargées après un contrôle en fonction de critères d'inclusion prédéfinis. Les applications retenues ont été évaluées indépendamment par deux des auteurs. Les données ont été extraites, et un indice de qualité de l'application (IQA) a été calculé selon une grille préétablie. Les applications ont été évaluées en fonction de leurs caractéristiques générales, des fonctionnalités de suivi et de prédiction des menstruations, des fonctionnalités relatives à l'infertilité et de la convivialité.

**Résultats :** Un total de 140 applications, dont 90 applications (64,3 %) gratuites, ont été retenues pour l'analyse. L'IQA moyen était de 32,5 %. Aucune différence significative n'a été observée entre les IQA des applications gratuites et payantes (31,5 % par rapport à 34,2 %;  $P = 0,491$ ). Un total de 62 applications (44,3 %) comportaient des fonctionnalités de prédiction dynamique des cycles fondée sur le cumul des données saisies. D'importantes inexactitudes dans le contenu, les outils ou les deux ont été trouvées dans 31 applications (22,1 %). Seulement 25 applications (17,9 %) comprenaient de l'information ou des fonctionnalités spécifiques à l'infertilité ou au traitement de l'infertilité.

**Conclusion :** Certaines applications de suivi menstruel de haute qualité sont offertes. Toutefois, on recense beaucoup plus d'applications de mauvaise qualité. Ainsi, les utilisatrices ne devraient pas se fier aux prédictions de ces applications pour prévenir la grossesse ou pour maximiser leurs chances de

concevoir. Peu d'applications répondent spécifiquement aux besoins des patientes qui éprouvent des problèmes d'infertilité.

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## INTRODUCTION

Smartphones and smartphone applications (apps) have changed many aspects of our lives, including how we track and monitor our health. In 2017, over 150 000 health-related apps were available in the Apple store alone.<sup>1</sup> Smartphone apps are not regulated like medical devices and are therefore plagued with concerns around reliability, effectiveness, privacy, and accountability.<sup>2</sup>

Many health apps address the topic of reproductive health. Despite their popularity, few of these apps have been rigorously evaluated, and their methods to predict events such as future ovulation days or fertile windows are often unknown. Previous studies reviewing apps in women's health have raised serious concerns regarding information accuracy, comprehensiveness, and safety.<sup>3–5</sup> App users and their health care providers would benefit from knowing more about the quality of information and advice provided by these apps. Misleading or inaccurate apps have the potential to cause harm, including unwanted pregnancies or delays in conception. Conversely, high-quality apps can serve as a useful tools and adjuncts to traditional medical care.

The objective of this study was to systematically evaluate and critically appraise iPhone apps designed for menstrual cycle tracking, ovulation prediction, and other topics related to fertility and/or the management of infertility.

## METHODS

Using an iPhone, we searched the Canadian Apple App Store between January and March 2016 for iOS apps using each of the following key words: “period tracker,” “menstrual tracker,” “fertility,” “ovulation,” “IVF,” and “in vitro fertilization.” We listed all search results. We then excluded apps that were in a non-English language, intended for use only by health care professionals (rather than consumers), intended for use only in pregnancy, intended for use only by men, designed specifically for patients of a fertility clinic or physician based outside of Canada or the United States, not updated since before January 1, 2014, and not relevant.

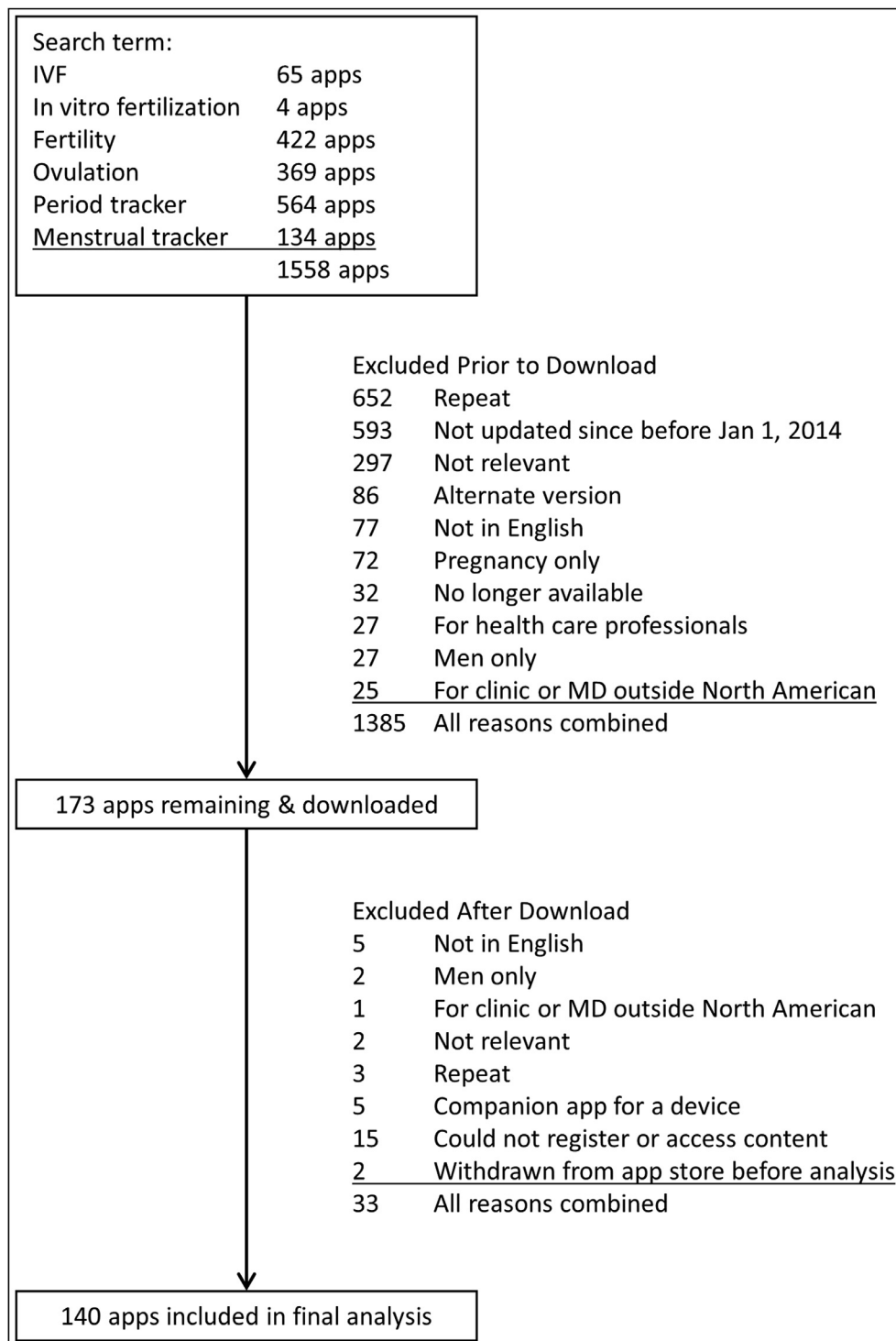
Apps were included regardless of App Store category classification. Repeats and alternate versions of the same app were also excluded, keeping the version with the most functionality or features, regardless of price. The remaining apps were downloaded between January and March 2017 onto both an iPhone 5 and an iPod Touch using a purpose-made iTunes account. All apps were then re-screened against the aforementioned exclusion criteria. Apps that were intended solely as a companion to a physical device, no longer available at the time of data analysis, or non-functional were also excluded. The app selection flow chart is shown in [Figure 1](#).

All included apps were reviewed independently by authors R.Z. and M.C. Disagreements were settled by consensus or by author C.J., when necessary. In-app content was purchased whenever necessary to evaluate the app fully. The following information was collected from included apps: category; cost (including any necessary in-app purchases and/or subscriptions); Apple App Store rating (average value and number of ratings); presence or absence of a privacy policy; presence or absence of a clinical disclaimer; presence or absence of advertisements; stated affiliations with any institutions, physicians, clinics, organizations or corporations; and references for information provided in the app and/or for any claims made by the app. We noted the presence or absence of general app features: the need for registration, password protection, data export functionality, data back-up functionality, links to social media or a message board, ability to sync with devices or wearables, generation of reports, and generation of reminders. We also noted the presence or absence of features specifically related to fertility, ovulation, and natural conception: information provision, cycle tracker, temperature tracker, intercourse tracker, weight and other symptom trackers, note-taking functionality, appointment tracker, medication tracker, ovulation predictor, fertile window predictor, next day 1 predictor, and due date calculator. Finally, we noted the presence or absence of features related to infertility and assisted reproductive technologies (ART): ART-specific information provision, cycle tracker, appointment tracker, medication tracker, ability to connect to health care providers, and ability to connect with peers.

A scoring rubric was created after reviewing scoring systems used in other reviews of smartphone apps for health care,<sup>6–8</sup> as well as a thorough review of the literature around best-practice methodologies for evaluating health-related smartphone apps.<sup>9</sup> This rubric was used to calculate an app quality score (AQS) for each app. The AQS rubric is shown in [Table 1](#). Each reviewer independently calculated an AQS, and the two scores were averaged to

**Figure 1. App selection flow chart.**

IVF: in vitro fertilization.



calculate the final AQS for each app. The final AQS was converted into a percentage to allow for comparison across apps because not all raw scores had the same denominator. For example, some apps had no content to assess, and rather than scoring them zero on content, that part of the

score was omitted altogether. In this way, apps were not penalized for having a narrower scope.

A secondary score, referred to as the app usability score (AUS), was calculated from three of the AQS criteria:

**Table 1. App quality score rubric**

Domain	0	1	2	3	Overall 0
Subjective usability	Very difficult to navigate through app, input data, change settings, etc.	Generally difficult to navigate through app, input data, change settings, etc.	Generally easy to navigate through app, input data, change settings, etc.	Very easy to navigate through app, input data, change settings, etc.	—
Advertisements	Present	Absent	—	—	—
Clinical disclaimer and privacy policy	Both absent	One present	Both present		—
References for content	Absent	Mostly missing and/or incorrect	Some missing and/or incorrect	Present and correct	—
Accuracy and comprehensiveness of content	Information untruthful or mostly untruthful	Information mostly truthful but at least somewhat biased or not at all evidence based or lacking important components	Information entirely or almost entirely truthful and unbiased AND at least somewhat evidence based and thorough	Information entirely or almost entirely truthful, evidence based, thorough, unbiased	Information untruthful with the potential to cause harm regardless of the degree of bias, evidence base, or comprehensiveness
Accuracy of tools	Tools mostly or always inaccurate	Some tools accurate or tools accurate under certain conditions only	Most tools accurate or tools accurate under standard conditions only	All tools found to be accurate under all testing conditions	Tools mostly or always inaccurate with errors having the potential to cause harm
General features	0/8 features	1–2/8 features	3–5/8 features	6–8/8 features	—
Specific features – natural conception	0/14 features	1–4/14 features	5–9/14 features	10–14/14 features	—
Specific features – assisted conception	0/6 features	1–2/6 features	3–4/6 features	5–6/6 features	—

subjective usability, accuracy and comprehensiveness of content, and accuracy of tools. Because the AUS was a subset of the AQS, it was calculated in the same manner.

Descriptive statistics were used to analyze the apps. In addition, *t* tests were used to compare the average scores and features between free and paid apps. A chi-squared test was used to test for an association between app price and whether app predictions were dynamic. Intraclass correlation was used to calculate the inter-rater agreement for AQS and AUS scores. Statistical analysis was performed using R software version 3.4 (R Foundation, Vienna, Austria). This study was exempt from Research Ethics Board approval because it did not involve human subjects.

## RESULTS

The initial search revealed 1558 apps. As shown in [Figure 1](#), after applying exclusion criteria, 140 apps were included in the final analysis: 90 free (64.3%), 46 paid (32.9%), and four paid by subscription (2.9%). Paid apps ranged in price from \$0.99 to \$39.99, with a mean price of \$4.66 and a median price of \$2.79. The subscription-based apps ranged in price from \$1.39 to \$13.99 per month.

The frequency of general, fertility-, and infertility-related features is shown in [Table 2](#). Paid apps were significantly less likely have to advertisements and significantly more likely to have a clinical disclaimer. There were no other

**Table 2. Frequency of features in free and paid apps**

Feature	Free (n = 90)	Paid (n = 50)	P value
Privacy policy	40 (44.4)	23 (46.0)	1.000
No advertisements	70 (77.8)	49 (98.0)	0.003
Clinical disclaimer	33 (36.7)	28 (56.0)	0.042
References or attributions for content	9 (10.0)	6 (12.0)	0.935
Can use without registering	70 (77.8)	43 (86.0)	0.338
Password protection option	51 (56.7)	25 (50.0)	0.561
Data export function	28 (31.1)	22 (44.0)	0.180
Backup function	31 (34.4)	18 (36.0)	1.000
Social media or message board component	17 (18.9)	7 (14.0)	0.616
Syncs with external devices	22 (23.9)	7 (14.0)	0.214
Generates reports	40 (44.9)	30 (60.0)	0.127
Generates reminders	53 (58.9)	27 (54.0)	0.703
Provides general information about menstrual cycles or fertility	32 (36.0)	19 (38.0)	0.955
Menstrual cycle tracker	76 (84.4)	39 (78)	0.469
Basal body temperature tracker	50 (55.6)	26 (52.0)	0.820
Intercourse tracker	52 (57.8)	32 (64.0)	0.589
Cervical mucous tracker	30 (33.3)	23 (46.0)	0.194
Ovulation stick tracker	24 (26.7)	17 (34.0)	0.472
Medical appointment tracker	7 (7.8)	5 (10.0)	0.893
General medication tracker	35 (38.9)	16 (32.0)	0.530
Ovulation prediction calculator	54 (60.0)	33 (66.0)	0.603
Fertile window calculator	77 (85.6)	36 (72.0)	0.085
Expected next menstrual cycle start calculator	70 (77.8)	35 (70.0)	0.415
Estimated due date calculator	14 (15.6)	11 (22.0)	0.469
Provides information about infertility or infertility treatment	8 (8.9)	7 (14.0)	0.515
Infertility treatment specific menstrual cycle calendar	3 (3.3)	2 (4.0)	1.000
Infertility treatment specific appointment tracker	5 (5.6)	3 (6.0)	1.000
Fertility medication tracker	6 (6.7)	5 (10.0)	0.708
Real-time interaction with fertility health care professionals	0	0	NA
Real-time interaction with other fertility patients	6 (6.7)	4 (8.0)	1.000

Values are n (%) or P.

**Table 3. Top scoring apps by overall app quality score**

App name	App quality score (%)	Price
Glow Ovulation, Period Tracker	85.4	\$9.99/month
Fertility Friend FF App	79.2	\$13.99/month
Clue: Health & Period Tracker	77.1	Free
iPeriod Period Tracker Ultimate / Menstrual Calendar	64.3	\$2.79
Kindara: Fertility Tracker	62.5	Free
Ovia Fertility Period Tracker	62.5	Free
CycleProGo	61.9	Free
Lily - Fertility Calculator	60.4	\$8.49
Maya - My Period Tracker (previously LoveCycles)	59.5	Free
My Cycles Period Tracker	59.5	Free
Period Tracker Period Calendar	59.5	Free
Ovagraph - TCOYF Fertility & Ovulation Tracker	59.5	Free
Life Pro: Period Tracker, Period and Ovulation App	59.5	\$5.49

TCOYF: Taking Charge of Your Fertility.

statistically significant differences in features between the free and paid apps (Table 2).

Among paid apps, after excluding one app that was an outlier with respect to cost (with a cost of \$39.99), there was a significant correlation between app price and the likelihood of making dynamic compared with static cycle predictions ( $P = 0.002$ ).

A total of 31 of 140 apps (22.1%) received an AQS of zero because of overwhelming inaccuracies of content (eight apps), tools (21 apps), or both (two apps). At least 15 of these 31 apps had information or tools related to “gender prediction,” most often advising intercourse on certain days of the fertile window to increase the chance of having a baby of a specific sex.

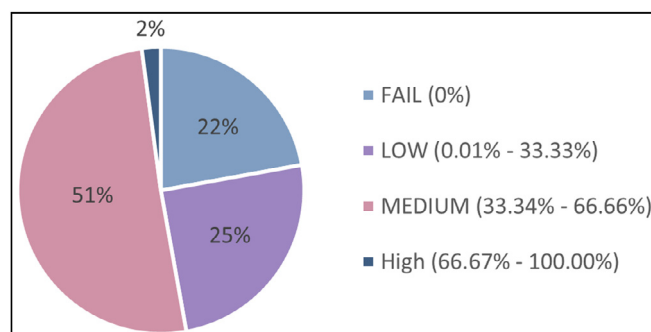
The mean AQS was 32.5%, with a median of 35.4% and a range of 0% to 85.4%. Excluding the 31 of 140 apps with

a score of zero, the average AQS was 41.7%, with a median of 42.9% and a range of 14.3% to 85.4%. The intraclass correlation for the AQS was 0.96 (95% confidence interval 0.95–0.97), and it was 0.59 (95% confidence interval 0.47–0.69) for the AUS.

There was no significant difference between the mean AQS of free and paid apps (31.5% vs. 34.2%;  $P = 0.491$ ). Table 3 lists the top apps by AQS along with their prices. Figure 2 shows the percentage of apps with fail, low, medium, and high AQS.

Twenty-five of 140 apps (17.9%), of which 14 were free and 11 were paid, included at least one feature related to infertility or ART. Fifteen included information related to ART, five included an ART cycle calendar, eight included an ART appointment tracker, 11 included an ART medication tracker, and 10 included the ability to engage with peers. None included the ability to interact with ART professionals. Seven apps included at least three of these features and are listed in Table 4 along with their price, AQS, and AUS.

A list of all 140 apps along with their features and scores can be found in the online Appendix.

**Figure 2. Percentage of apps with app quality scores in the fail, low, medium, and high ranges.**

## DISCUSSION

This study comprehensively reviewed 140 apps related to menstrual cycle tracking and fertility and found that there was extreme variability among apps, with an overall quality that was low. There was no difference in the overall app quality score between free and paid apps. Many apps were overly simplistic in their predictions, with only 44.3% of



**Table 4. Apps with most features related to infertility or assisted reproductive technology**

App name	Number of infertility features	Price	App quality score (%)	App usability score (%)
Glow Ovulation, Period Tracker	5	\$9.99/month	85.4	72.2
Fertility App	4	Free	41.7	27.8
Fertility Friend FF App	4	\$13.99/month	79.2	61.1
Fertility View - Fertility & IVF support	4	Free	50.0	44.4
Fertility Tracker App	3	Free	47.2	22.2
My Cycles Period Tracker	3	Free	59.5	33.3
Ovagraph - TCOYF Fertility & Ovulation Tracker	3	Free	59.5	27.8

IVF: in vitro fertilization; TCOYF: Taking Charge of Your Fertility.

assessed apps predicting future fertile windows and ovulation dates according to cumulatively input data. Nearly all apps assumed ovulatory cycles regardless of average cycle length or between-cycle variability; this has the potential to mislead or falsely reassure users with highly irregular and potentially anovulatory cycles, who should be seeking medical care.

Twenty-two percent of apps were found to contain incorrect information or inaccurate tools, and they could put users at risk of either inadvertent pregnancy or delayed conception. Most notably, some apps suggest intercourse on certain days of the cycle increase the chance of conceiving a fetus of a specific sex. As a result of these suggestions, users may be advised to have intercourse only outside of the fertile window, advice that itself can lead to a failure to conceive. Other apps falsely claim to function as effective contraceptive tools, which could potentially lead to unintended pregnancies.

The majority of included apps appeared to be published by independent app developers or technology companies, and they were not developed or sponsored by health care professionals. This finding is consistent with a larger study that found that only 32% of medical apps were developed by traditional health care players.<sup>1</sup> In many cases it was difficult to determine the exact nature of the app developer. This lack of transparency adds to the challenges faced by users when trying to find a trustworthy product to use.

Only 17.9% of apps contained at least one feature related to infertility or fertility treatment, and even fewer had the ability to track in vitro fertilization treatment calendars, appointments, or fertility medications. The absence of infertility-related information and features from most cycle tracking apps can leave users with the impression that their failure to conceive is related only to timing of intercourse, when in fact it is well known that infertility has numerous underlying

causes. The lack of infertility content is also a missed opportunity; one study found that 12% of fertility tracking app users were using their apps to “inform fertility treatment.”<sup>10</sup>

A number of other studies have reviewed smartphone apps related to menstrual cycle tracking. Setton et al. compared the predicted fertile window of the 20 most popular free websites and apps against the “gold standard” of Wilcox et al.<sup>11</sup> and found high rates of inaccuracies, including many apps with a suggested fertile window that extended beyond the predicted date of ovulation.<sup>12</sup> Our current study replicates these findings, and others, but with a much broader and more representative sample of apps. Moglia et al. also evaluated menstrual cycle tracking apps available in the U.S. Apple store.<sup>3</sup> These investigators found rates of inaccurate information (19% of apps) in their initial search results that were similar to those found in the present study. In contrast to this study, however, they excluded paid apps, apps that they deemed inaccurate, and apps that made predictions on the basis of static data from their full content analysis. Ultimately, these investigators found 20 of 225 apps that met these criteria, many of which are included here.

Mangone et al. performed a thorough review of apps for the prevention of unintended pregnancy, including 72 fertility tracking apps.<sup>5</sup> Troublingly, they found that many apps lacked comprehensive content and did not focus or even include information on evidence-based best practices related to contraception. Furthermore, consistent with the current study, they did not find a correlation between price and quality.

One of the challenges in reviewing health-related smartphone apps is the lack of standardized methodologies for evaluation, although a number have recently been proposed.<sup>2,13–15</sup> The present study applied systematic review methodologies wherever possible to achieve the most rigorous and inclusive results. Our search strategy within the Apple store was thorough and comprehensive. Each

included app was downloaded—including all paid features—and independently assessed by two individuals using a pre-defined rubric. The present study is in full compliance with the eight-item checklist for quality and risk of bias for studies reviewing smartphone apps as set out by BinDhim et al.<sup>9</sup>

One limitation of this study is that it does not reflect apps that were updated or released after our review period. We also included only apps that were available for the iPhone; therefore, not all apps included in this study are available for Android users, and any menstrual tracking or fertility apps available only on an Android were not assessed. Additionally, apps were assessed by two of the authors, both of whom have extensive medical training in obstetrics and gynaecology and are therefore not representative of the average app user. Despite using an objective scoring rubric, it is possible that this experience introduced bias into our assessments.

This study provides high-quality data on a large number of apps that are practical and relevant to both health care providers and patients alike. Finding usable and trustworthy apps within the App Store is extremely challenging both because of the nature of the search function itself and because of the overwhelming selection.<sup>16</sup> Clinicians should be equipped with the language to discuss mobile apps with their patients and, importantly, to guide patients away from commonly encountered harms and towards the best-performing apps in their field. In gynaecology and fertility, that means steering patients away from apps that, for example, claim to predict fetal sex according to day of conception or make unsubstantiated claims about contraceptive efficacy and towards those that dynamically predict ovulation in line with established calendar methods, provide a wide range of features, and allow for the generation and sharing of reports between users and health care providers.

## CONCLUSION

Despite the vast number of apps in this space, there remains a paucity of well-designed apps to support and assist individuals undergoing treatment for infertility. App developers are encouraged to work with patients, clinicians, and all relevant stakeholders to address this gap mindfully.

## Acknowledgements

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## SUPPLEMENTARY DATA

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.jogc.2019.09.023>.

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