Case Report

Feasibility Assessment of Smartphone Camera–Based Atrial Fibrillation Detection Compared With Portable Electrocardiogram: Single-Patient Case Study

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Abstract

Background: Atrial fibrillation (AF) affects more than 33 million people globally, with many cases remaining undiagnosed due to the paroxysmal nature of the condition. Current portable AF detection devices require additional hardware, and their cost may limit their accessibility in community screening programs. Facial camera–based remote photoplethysmography (rPPG) is a novel alternative to conventional fingertip-based photoplethysmography (PPG) that enables contact-free cardiac rhythm assessment.

Objective: This study aimed to assess the technical feasibility of a novel smartphone camera–based facial rPPG AF detection system by comparing its performance with that of a portable electrocardiogram (ECG) device under real-world home monitoring conditions.

Methods: We conducted a prospective, single-patient volunteer case study involving a patient with diagnosed paroxysmal AF and atrial flutter with variable block over 12 consecutive days. Simultaneous 60-second recordings were scheduled 3 times daily using the electronRx smartphone app and a Kardia portable ECG device to obtain a total of 36 paired recordings. The primary outcome was device agreement in rhythm classification between the 2 systems. Secondary outcomes included assessment of the effect of signal quality on device agreement and analysis of discordant recordings to identify technical limitations.

Results: Of the 36 scheduled recording sessions, 35 were attempted, yielding 24 successful simultaneous recordings. Of these, 23 paired recordings met the quality criteria, and device agreement was achieved in 21 (91.3%) recordings. The smartphone system detected 4 of the 5 episodes classified as AF by the Kardia device and agreed with 17 of the 18 recordings classified as normal sinus rhythm. A total of 2 discordant cases were identified: 1 false negative associated with atrial flutter presenting as a fixed 3:1 atrioventricular block and 1 false positive related to poor signal quality due to suboptimal lighting conditions. Signal quality significantly affected performance, with 94.7% agreement in recordings of good quality compared with 75% in recordings of poor quality.

Conclusions: This case study demonstrates the technical feasibility of using a smartphone facial camera–based rPPG rhythm analysis for AF detection. The approach shows promise as an accessible screening tool. However, the single-patient design, data attrition resulting from synchronization and signal quality issues, and the identified technical limitations highlight the need for larger validation studies before clinical application can be considered.

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KEYWORDS

atrial fibrillation; smartphone; photoplethysmography; heart rate variability; mobile health; digital biomarkers

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Introduction

Atrial fibrillation (AF) is the most common sustained cardiac arrhythmia, affecting an estimated 33.5 million individuals worldwide, and its prevalence continues to rise due to population aging and an increase in cardiovascular risk factors [1,2]. However, the clinical significance of AF extends beyond its symptoms, as the condition increases stroke risk approximately 5-fold and contributes substantially to health care costs through emergency admissions and long-term complications [3]. Despite these serious implications, a significant proportion of AF cases remain undiagnosed, particularly cases involving paroxysmal episodes that may be asymptomatic or occur infrequently [4].

The challenge of AF detection arises primarily from its episodic nature, with many patients experiencing irregular episodes separated by periods of normal sinus rhythm. Traditional methods of detecting AF involve either continuous cardiac monitoring in a hospital setting or periodic electrocardiogram (ECG) recordings during clinical encounters, both of which may miss paroxysmal episodes occurring outside these monitoring windows [5]. This diagnostic gap has led to increased interest in ambulatory monitoring technologies that can capture AF episodes in a patient's home environment over extended periods of time.

Recent technological advances have led to the introduction of portable ECG devices designed for consumer use, such as the Kardia (AliveCor Inc) system, which has already received regulatory approval for the detection of AF [6]. These devices represent a significant improvement in accessibility compared with traditional hospital-based monitoring because they enable patients to record single-lead ECGs during symptomatic episodes or as part of routine screening protocols. However, these systems still require additional hardware, typically costing between £120 and £300, and necessitate direct skin contact with electrodes, which may limit their utility in certain populations and settings [7].

The widespread availability of smartphones, with more than 7.1 billion users globally, presents an opportunity to develop AF detection capabilities using existing and ubiquitous technology platforms [8]. Smartphone-based photoplethysmography (PPG), which uses the device's camera and flashlight to detect cardiovascular signals through fingertip contact or facial measurements, is already showing promise in various cardiac monitoring applications [9,10]. The technique relies on detecting subtle changes in light absorption caused by pulsatile blood flow, from which heart rate variability parameters can be derived and analyzed for rhythm irregularities characteristic of AF [11].

The advantages of smartphone-based AF detection include the elimination of the need for additional hardware, the potential for unlimited monitoring episodes without per-recording costs, and improved accessibility across diverse populations [12-14]. However, the clinical validation of such systems remains limited, with few studies comparing smartphone-based approaches directly with established portable ECG devices under real-world monitoring conditions.

This case study aimed to assess the technical feasibility of a novel smartphone camera–based AF detection system that detects changes in blood flow using facial imaging through comparison with an established portable ECG device over an extended monitoring period in a patient with documented AF. The primary objective was to evaluate device agreement in rhythm classification between the 2 systems, whereas the secondary objectives included assessing the impact of signal quality on classification agreement and characterizing discordant cases to identify technical limitations that may require further development.

Methods

Study Design

We conducted a prospective, single-patient volunteer case study to assess the technical performance of smartphone camera–based AF detection by comparing it with a portable ECG device. The data were collected from May 20, 2025, to May 31, 2025, over 12 consecutive days, with recordings scheduled 3 times daily for a total of 36 recording sessions. The single-patient study design was used to evaluate the impact of signal quality and identify sources of discordance rather than to estimate diagnostic accuracy. These findings were intended to provide essential proof-of-concept information, which can be used to inform subsequent, larger validation studies.

There were several differences between the original data collection protocol and the final study. Among these, the planned monitoring period increased from 10 days to 12 days, resulting in 36 recording sessions rather than the planned 30. There was also a difference in the software name: the software was referred to as purpleDx 6.1.0 in the protocol and as the electronRx (electronRx Ltd) smartphone app in the final study. The study objectives were also refined to include an assessment of the effect of signal quality on device agreement and a characterization of discordant recordings to identify technical limitations.

Ethical Considerations

The participant volunteered to take part in the study and was informed by the clinical team about their rights and the protections offered under Good Clinical Practice (GCP) guidelines of the International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use (ICH), particularly with respect to safety and withdrawal. The study was conducted in accordance with the principles of the Declaration of Helsinki and applicable GCP guidelines. Written informed consent was obtained from the participant before enrolment and covered participation in the study, data collection, analysis, and the anonymized publication of the study findings. Participant data were anonymized before analysis and publication, and all identifiable information was handled confidentially in accordance with applicable data protection regulations. The study was not prospectively registered in a public clinical study registry.

Participant Recruitment and Demographics

A single male participant aged 50 to 70 years was recruited from a general practitioner (GP) surgery following identification

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by the GP. More specific demographic details have been withheld to maintain participant anonymity in accordance with research ethics requirements. To be eligible for inclusion in the study, the participant was required to have a diagnosis of paroxysmal AF and atrial flutter with variable block documented on a 12-lead ECG. From a technical and compliance perspective, the participant was also required to demonstrate the ability to operate both the smartphone and portable ECG devices independently and a willingness to comply with the 3-times-daily recording protocol for 12 consecutive days.

Technology Specifications

Comparator Technology: Kardia Portable ECG Device

The comparison device was the Kardia 6-lead portable ECG system, which has received regulatory clearance as a Class II medical device for AF detection. The device consists of a small hardware unit that connects to a smartphone app and enables the recording of 6-lead ECGs through direct skin contact using the integrated electrodes. Previously published validation studies using the Kardia system have demonstrated high sensitivity and specificity for AF detection compared with physician-interpreted 12-lead ECGs [15-19]. The device was configured to record 60-second tracings with automatic rhythm classification using the manufacturer's proprietary algorithm. For this case study, the Kardia device was used as a comparator rather than as a reference standard for AF diagnosis; consequently, its classifications were used to assess device concordance rather than to provide diagnostic accuracy.

Test Technology: electronRx Smartphone App

The investigational technology used in this study comprised a smartphone app (electronRx) that uses the front-facing camera for noncontact facial remote photoplethysmography (rPPG)–based cardiac rhythm analysis. The system uses the smartphone's front-facing camera to detect cardiovascular signals through facial blood flow, with real-time signal processing algorithms analyzing heart rate variability patterns to identify potential AF episodes [20]. The primary classification parameter used was the root mean square of successive differences (rMSSD) in R-R intervals, and a threshold of 250 milliseconds was used to distinguish between AF and normal sinus rhythm based on heart rate variability characteristics. The app was installed on an iPhone 12 (Apple Inc) and configured to record for 60 seconds while performing simultaneous heart rate variability analysis.

Data Collection Procedure

Participant Training and Instructions

Before commencing data collection, the study participant provided written informed consent and received standardized instructions on how to operate both the electronRx smartphone app and the Kardia 6-lead portable ECG device. The participant was also asked to familiarize themselves with both systems before the start of the study. Instructions included performing recordings in a well-lit room, sitting on a comfortable chair away from direct sunlight, and placing the smartphone on a stable surface. During the recordings, the participant was instructed to remain as still as possible, initiate the electronRx app first, and immediately place 2 fingers from each hand on the Kardia leads to ensure near-simultaneous recording. The participant was also instructed to keep notes on factors that could affect signal quality, specifically lighting, the color and pattern of clothing, and any movement during the recording. The participant performed all recordings independently in the home environment without investigator supervision.

Recording Schedule and Conditions

For both devices, recordings were scheduled 3 times daily (morning, afternoon, and evening) for 12 consecutive days, totaling 36 recording sessions. Each session involved the simultaneous operation of both devices to ensure temporal concordance in rhythm detection. The recordings were performed in the participant's home environment under standardized conditions, including adequate ambient lighting, a stable seating position, and minimal physical movement during the recording period. To enable simultaneous recordings, the Kardia device was operated using an iPad (Apple Inc), whereas the smartphone app was operated using an iPhone.

Synchronization Protocol

To ensure accurate temporal comparison between the devices, the following synchronization protocol was implemented: the smartphone app was initiated first, followed immediately by the placement of the participant's fingers on the Kardia electrodes to begin the ECG recording. Both devices were then confirmed to be actively recording before the participant remained stationary for the 60-second measurement period. Any sessions in which synchronization could not be achieved were excluded from analysis and repeated where possible. The study protocol is provided in Multimedia Appendix 1.

Quality Control Measures

Signal quality was assessed for both devices during each recording session. For the smartphone system, signal quality was evaluated based on the consistency of the PPG waveform and the absence of motion artifacts. For the Kardia system, signal quality was assessed using the device's integrated quality indicators and by visual inspection of the ECG tracing. Recordings were categorized as either good quality (clear, consistent signal with minimal artifacts) or poor quality (significant noise, motion artifacts, or signal interruption). As this was a single-patient feasibility study involving simultaneous recordings, no formal blinding to the device outputs was performed. Discordant cases were reviewed by a clinician. However, measurement bias was reduced through simultaneous device operation and standardized conditions, while attrition bias was addressed by reporting all recording outcomes.

Outcome Measures

The primary outcome measure was device agreement in rhythm classification, defined as concordance between the smartphone app and the Kardia device in identifying recordings as either AF or normal sinus rhythm. This was assessed by comparing the rhythm classification assigned by each system for each paired recording and was expressed as the percentage of recordings with concordant classifications. Given the single-patient study design, statistical testing was deemed

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inappropriate, and results are presented as descriptive statistics and percentage agreement.

Secondary outcome measures included assessing the effect of signal quality on device agreement and analyzing discordant cases in detail to identify technical factors contributing to disagreement. For the electronRx smartphone app, signal quality was assessed according to predefined criteria, whereas Kardia signal quality was assessed through the device's built-in quality indicators. Paired recordings were categorized as good or poor quality, and agreement rates were compared descriptively between these categories. To assess discordant cases, recordings in which the electronRx smartphone app and Kardia system provided different rhythm classifications were individually reviewed to identify potential causes of disagreement.

Data Analysis

Data analysis was performed using standard Python (version 3.11; Python Software Foundation) data analysis and statistical tools, including *NumPy* and *SciPy*. The analysis focused on a descriptive assessment of device performance without statistical testing due to the single-patient design of the study. Agreement rates were calculated as simple percentages, and factors potentially influencing concordance were examined. Recordings that were not simultaneous or did not meet the quality criteria were excluded from the final analysis. Each discordant case underwent detailed individual analysis to identify technical or clinical factors that may have contributed to disagreement between the devices.

Results

Data Collection Summary

Over the 12-day monitoring period, 35 of the 36 planned recordings were completed; however, some recordings were excluded due to technical issues, mainly synchronization failures, and 1 recording was deemed unclassified by the Kardia device. This resulted in 24 successful simultaneous recordings using both devices. In total, 23 paired recordings met the quality criteria for inclusion in the final analysis (Table 1). No adverse events occurred during the study.

Table 1. Recording outcomes for the 12-day monitoring period, including the total number of attempted recordings, successful simultaneous recordings, recordings excluded for technical reasons, and final analyzed pairs obtained using the Kardia 6-lead portable electrocardiogram device and the electronRx smartphone app.

Outcome categories	Recordings, n (%)
Scheduled recordings	36 (N/A[a])
Total attempted recordings	35 (100)
Recordings excluded due to technical issues	11 (31.4)
Successful simultaneous recordings	24 (68.6)
Recordings excluded due to failure to meet quality criteria	1 (2.8)
Final analyzed pairs	23 (63.9)

[a]N/A: not applicable.

Device Agreement Analysis

Analysis of the 23 paired recordings revealed device agreement in 21 cases, representing an overall concordance rate of 91.3%. The Kardia device classified 5 recordings as showing AF and 18 as showing normal sinus rhythm, whereas the smartphone app classified 5 recordings as AF and 18 as normal sinus rhythm. Representative heart rate plots obtained using the electronRx smartphone app, showing normal sinus rhythm and AF, are shown in Figures 1A and 1B, respectively. Direct comparison revealed that 4 recordings were classified as AF by both devices and 17 were classified as normal sinus rhythm by both devices (Table 2). Two example Poincaré plots demonstrating agreement between the 2 devices are shown in Figures 2A and 2B.

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Figure 1. Representative heart rate (HR) plot obtained using the electronRx smartphone app showing (A) normal sinus rhythm and (B) atrial fibrillation.

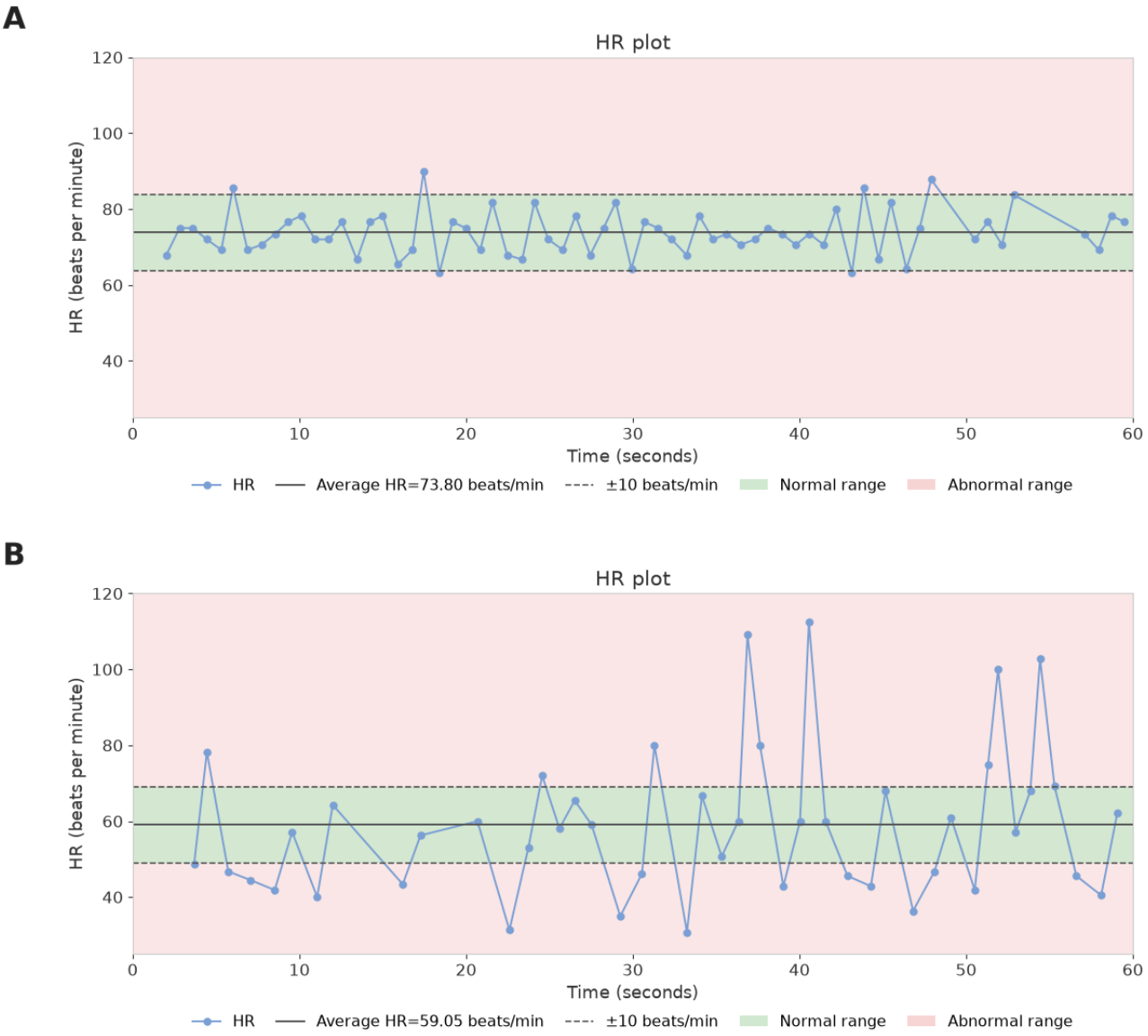
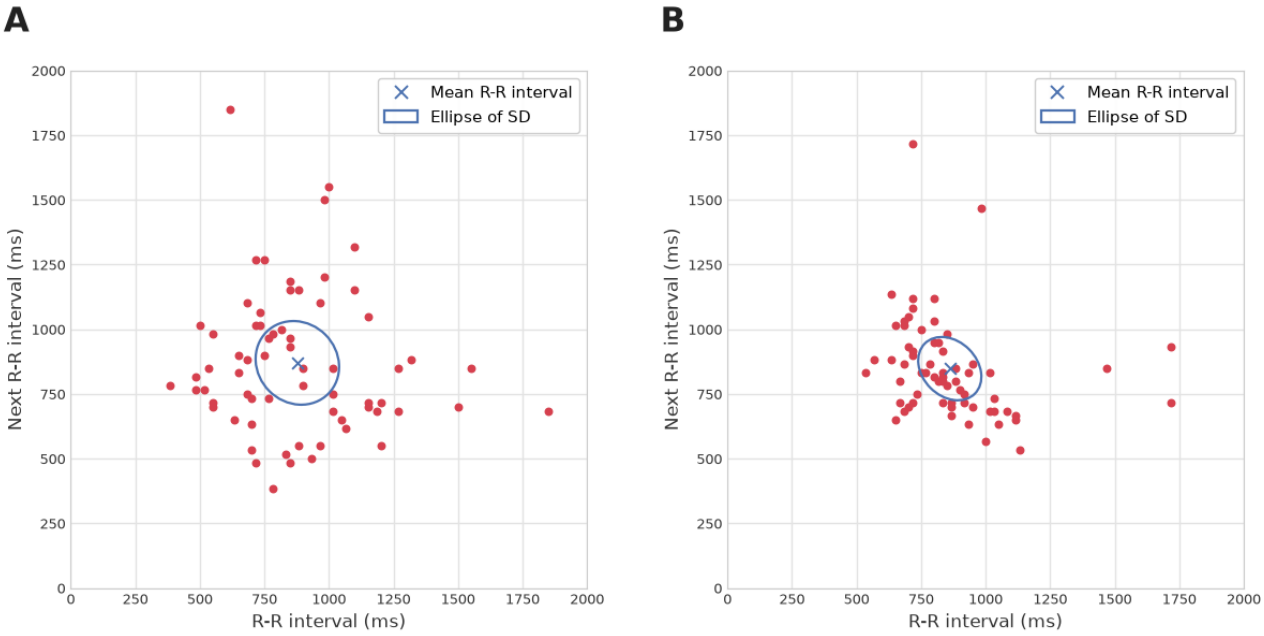


Table 2. Confusion matrix showing rhythm classification by the electronRx (eRx) smartphone app compared with the Kardia 6-lead electrocardiogram device (N=23).

Kardia device classification	eRx: atrial fibrillation (positive), n (%)	eRx: normal sinus rhythm (negative), n (%)
Atrial fibrillation (positive)	4 (80)	1 (20)
Normal sinus rhythm (negative)	1 (5.6)	17 (94.4)

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Figure 2. Poincaré plots demonstrating 2 cases of agreement between the devices: (A) classified as atrial fibrillation by both the smartphone app and the Kardia device and (B) classified as normal sinus rhythm by both the smartphone app and the Kardia device.

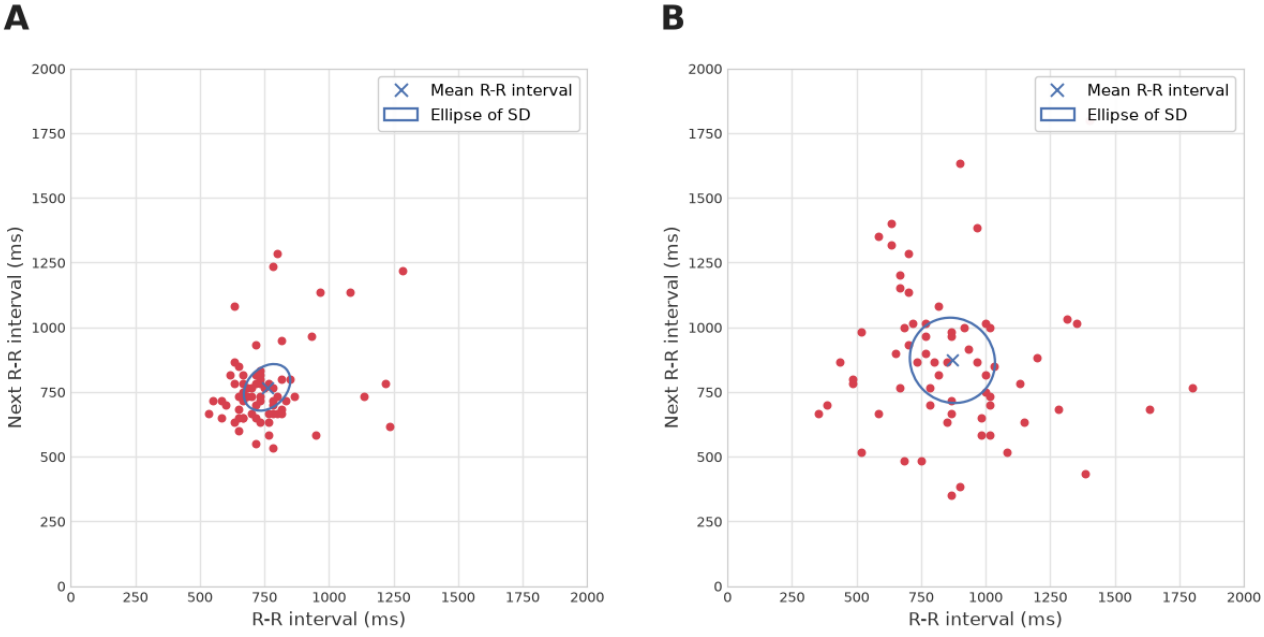


When examining agreement by rhythm type, the smartphone system agreed with the Kardia device in 4 (80%) of 5 recordings classified as AF and 17 (94.4%) of 18 recordings classified as normal sinus rhythm (Table 2). The higher agreement rate for normal sinus rhythm than for AF reflects the technical challenges associated with detecting irregular rhythms using heart rate variability analysis.

Analysis of Discordant Cases

Two discordant recordings were identified, each reflecting distinct technical challenges in rhythm classification. Poincaré plots showing these 2 discordant cases, including a smartphone false positive for AF and a smartphone false negative, are shown in Figures 3A and 3B, respectively.

Figure 3. Poincaré plots showing the 2 discordant cases: (A) classified as atrial fibrillation (AF) by the smartphone app but as normal sinus rhythm by the Kardia device (false positive) and (B) classified as normal sinus rhythm by the smartphone app but as AF by the Kardia device (false negative).



False Negative Case

One recording was classified as normal sinus rhythm by the smartphone app but as AF by the Kardia device (Figure 3B). A clinical review of this case revealed that the participant was experiencing atrial flutter with a fixed 3:1 atrioventricular block at the time of the recording. The regular ventricular response pattern created consistent R-R intervals, resulting in an rMSSD value of 235 milliseconds, which fell below the 250-millisecond threshold used by the smartphone algorithm for AF detection.

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The Kardia device classified this recording as "possible atrial fibrillation," although subsequent clinical consultation confirmed atrial flutter rather than true AF. This case highlights the technical challenges of distinguishing between different atrial arrhythmias, particularly when the ventricular response remains regular.

False Positive Case

One recording was classified as AF by the smartphone app but as normal sinus rhythm by the Kardia device (Figure 3A). Further analysis revealed that this recording was obtained during an evening session when lighting conditions were suboptimal, resulting in poor signal quality with apparent double-peak detection in the PPG waveform. The signal processing artifacts created artificially elevated heart rate variability, producing an rMSSD value of 287 milliseconds and triggering the AF classification algorithm. The Kardia ECG tracing for this session showed a clear normal sinus rhythm, with regular P waves and QRS complexes. This case demonstrates the importance of signal quality control when using smartphone-based cardiac monitoring apps.

Signal Quality Assessment

An assessment of the impact of signal quality revealed a clear relationship between recording quality and device agreement rates. Device agreement was higher for recordings classified as good quality than for those classified as poor quality, highlighting the importance of signal quality for accurate rhythm classification (Table 3).

Table 3. Signal quality analysis of paired recordings obtained during the 12-day monitoring period using the Kardia 6-lead portable electrocardiogram device and the electronRx smartphone app, showing device agreement and detection rates by recording quality (N=23).

Signal quality impact	Good quality recordings (n=19), n/N (%)	Poor quality recordings (n=4), n/N (%)
Device agreement	18/19 (94.7)	3/4 (75)
Atrial fibrillation detection rate	4/4 (100)	0/1 (0)
Normal sinus rhythm detection rate	14/15 (93.3)	3/3 (100)

The main factors affecting signal quality included ambient lighting conditions, participant movement during recording, and smartphone position stability. Furthermore, evening recordings were particularly likely to experience poor signal quality due to inadequate lighting for the camera-based PPG system. Motion artifacts, particularly facial motion during smartphone recordings, also created signal disturbances that affected heart rate variability calculations. Additionally, unstable smartphone positioning on uneven surfaces led to intermittent signal loss during recording sessions.

Discussion

Principal Findings

To our knowledge, this case study provides the first direct comparison between a smartphone camera–based facial rPPG AF detection system and an established portable ECG device in a real-world home monitoring setting. The high rate of device agreement demonstrates the technical feasibility of PPG-based rhythm analysis for identifying AF episodes. The successful detection of AF episodes by the smartphone system suggests that camera-based heart rate variability analysis can be used to identify the irregular rhythm patterns characteristic of AF [12,13,21]. However, the technical challenges revealed by the discordant cases highlight important technical limitations that require further development before any clinical application can be considered. These technical challenges were compounded by the need to operate 2 devices simultaneously to obtain temporally aligned recordings.

Several practical observations emerged from this study regarding the usability and technical performance of both systems. The smartphone-based approach required careful attention to lighting conditions and facial positioning to achieve optimal signal quality. However, the contact-free nature of smartphone recording may offer advantages over the more obvious electrode-based monitoring required by the Kardia device, although usability was not formally assessed in this study and should be evaluated in future research.

Furthermore, the 60-second recording duration was generally well tolerated with both systems. The simultaneous operation of both devices required coordination but was feasible after the study participant became familiar with the protocol.

The analysis of discordant cases revealed fundamental challenges in rhythm classification that affect both smartphone-based and portable ECG approaches. The false negative case involving atrial flutter with a regular ventricular response demonstrates that heart rate variability–based detection algorithms may miss certain atrial arrhythmias when atrioventricular conduction produces regular ventricular responses. This limitation is not unique to smartphone-based systems, as evidenced by the Kardia device's classification of this episode as "possible" rather than definite AF.

The false positive case associated with poor signal quality highlights the importance of signal processing and quality control in smartphone-based cardiac monitoring. These limitations are currently being addressed through continued algorithm development and improved signal quality assessment.

Comparison With Prior Work

Unlike the electronRx smartphone app, which uses facial rPPG for AF detection, many other commercially available systems use fingertip PPG. Examples of these systems include the FibriCheck, CORAI, and Preventicus Heartbeats apps. Several of these systems have received approval from the Food and Drug Administration (FDA) or *Conformité Européenne* (CE; European Conformity) marking, and previous studies have shown that they have achieved high diagnostic accuracy for rhythm classification, with sensitivities and specificities exceeding 90% [12-14,17,21]. However, this approach requires

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users to deliberately place their finger on the camera flash, making it unsuitable for passive monitoring. The accuracy of the results is affected by finger motion and the amount of pressure exerted on the camera lens.

Several portable ECG systems also exist, such as the Kardia device, which was used as a comparator in this study. These systems provide high-quality rhythm assessment but require dedicated hardware and electrode contact [18,19]. In contrast, the system evaluated in this study derives pulse waveforms from facial video using rPPG. This study did not evaluate the sensitivity and specificity of this approach for AF detection. Although this approach is contact-free and eliminates the need for users to purchase additional hardware, our findings suggest that it is also particularly sensitive to environmental factors, especially lighting conditions and motion artifacts.

Although this study was not designed to establish diagnostic accuracy, it provides evidence to support the feasibility of facial camera–based rPPG for AF detection. The influence of signal quality on rhythm classification observed in this study is consistent with findings from other studies evaluating smartphone-based PPG technologies [12,13,21].

Implications

These findings add to the growing body of evidence supporting optical rhythm monitoring and suggest that this technology could offer an accessible and scalable means of screening for or monitoring AF. However, existing clinical guidelines recommend ECG confirmation before a diagnosis of AF can be confirmed; consequently, positive results from smartphone-based monitoring will still require subsequent confirmation by ECG [22,23]. However, an accessible and scalable approach to AF screening and monitoring could have several practical implications. For patients, earlier detection can provide reassurance and ensure more timely management. For providers, it could help support earlier diagnosis and enable more efficient use of health care resources. This study provides preliminary evidence for the feasibility of this approach and a basis for further validation studies of facial camera–based AF detection systems.

Limitations

The main limitation of this case study is the single-patient study design, which limits the generalizability of the results. Although this design was appropriate for an initial case study, further evaluation of device performance will require assessment in broader patient populations. The study participant also had a diagnosis of paroxysmal AF and atrial flutter with variable block, which, although relatively common, may not be representative of all AF presentations. Additionally, the study was conducted using a single smartphone in the home environment; consequently, the influence of different smartphones, camera specifications, and environmental conditions was not evaluated. The assessment of signal quality was also subjective in nature and involved only a single reviewer. Although predefined criteria were used to categorize the quality of the recording as either good or poor, this may have introduced some subjectivity into the results. Future studies should include independent assessments of signal quality to evaluate interrater reliability.

Although the device demonstrated good agreement in rhythm classification, approximately one-third of all attempted recordings could not be analyzed because of synchronization or signal quality issues. Consequently, the reported agreement reflects only those recordings that were analyzed rather than all attempted measurements, which could overestimate the performance of the device. Future work will focus on improving recording synchronization to better assess device performance. A further limitation of this study is that rhythm classification was performed using the Kardia device as a comparator rather than a gold standard, such as a clinician-reviewed 12-lead ECG or Holter ECG recording.

Conclusions

This case study demonstrates the feasibility of smartphone camera–based AF detection using PPG. Its high level of agreement with the Kardia portable ECG device supports its potential use as a low-cost, accessible screening approach for AF. However, smartphone app performance was influenced by multiple factors, including lighting and motion, and the algorithm showed limitations in distinguishing atrial flutter and sinus rhythm. The exclusion of recordings because of synchronization and signal quality issues highlights the importance of robust data acquisition for accurate rhythm classification. Further larger-scale validation studies are needed to optimize signal processing algorithms, confirm the app's accuracy, and assess its suitability for community screening applications.

Acknowledgments

The authors declare the use of generative AI (GenAI) in the research and writing process. According to the Generative Artificial Intelligence Delegation Taxonomy (2025), the following tasks were delegated to GenAI tools under full human supervision: code generation, code optimization, process automation, algorithm creation for data analysis, and data analysis. The GenAI tools used were Gemini (version 3.6; Alphabet Inc) and Claude Code Sonnet (version 5.5; Anthropic PBC). All AI-generated outputs were reviewed and verified by the authors, who retain full responsibility for the final manuscript. GenAI tools are not listed as authors and do not bear responsibility for the final outcomes.

Data Availability

The datasets generated or analyzed during this study are not publicly available due to restrictions related to privacy and confidentiality but are available from the corresponding author upon reasonable request.

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Authors' Contributions

Conceptualization: BP, DB
Formal analysis: LM
Investigation: DB
Methodology: LM
Project administration: CG, DB
Resources: DB
Supervision: BP, DB
Visualization: BP, CG
Writing—original draft: BP
Writing—review and editing: BP, DB, GC, CG, LM

Conflicts of Interest

BP, CG, and LM are employees of electronRx Ltd, a deeptech company focused on developing digital technologies for respiratory monitoring, and DB and GC are advisors to electronRx Ltd, which currently holds several patents related to smartphone-based monitoring of cardiac and respiratory parameters.

Multimedia Appendix 1

Study protocol.
[DOCX File , 1784 KB-Multimedia Appendix 1]

References

1. Chugh SS, Havmoeller R, Narayanan K, Singh D, Rienstra M, Benjamin EJ, et al. Worldwide epidemiology of atrial fibrillation: a Global Burden of Disease 2010 Study. Circulation. Feb 25, 2014;129(8):837-847. [FREE Full text] [doi: 10.1161/CIRCULATIONAHA.113.005119] [Medline: 24345399]
2. Patel NJ, Atti V, Mitrani RD, Viles-Gonzalez JF, Goldberger JJ. Global rising trends of atrial fibrillation: a major public health concern. Heart. Dec 2018;104(24):1989-1990. [doi: 10.1136/heartjnl-2018-313350] [Medline: 29907645]
3. Hindricks G, Potpara T, Dagres N, Arbelo E, Bax JJ, Blomström-Lundqvist C, et al. 2020 ESC guidelines for the diagnosis and management of atrial fibrillation developed in collaboration with the European Association for Cardio-Thoracic Surgery (EACTS): the task force for the diagnosis and management of atrial fibrillation of the European Society of Cardiology (ESC) developed with the special contribution of the European Heart Rhythm Association (EHRA) of the ESC. Eur Heart J. Feb 01, 2021;42(5):373-498. [FREE Full text] [doi: 10.1093/eurheartj/ehaa612] [Medline: 32860505]
4. Turakhia MP, Guo JD, Keshishian A, Delinger R, Sun X, Ferri M, et al. Contemporary prevalence estimates of undiagnosed and diagnosed atrial fibrillation in the United States. Clin Cardiol. May 2023;46(5):484-493. [FREE Full text] [doi: 10.1002/clc.23983] [Medline: 36855960]
5. Abdelrazik A, Eldesouky M, Antoun I, Lau EY, Koya A, Vali Z, et al. Wearable devices for arrhythmia detection: advancements and clinical implications. Sensors (Basel). Apr 30, 2025;25(9):2848. [FREE Full text] [doi: 10.3390/s25092848] [Medline: 40363284]
6. KardiaMobile for detecting atrial fibrillation. National Institute for Health and Care Excellence. 2022. URL: https://www.nice.org.uk/guidance/mtg64 [accessed 2025-08-12]
7. Zepeda-Echavarria A, van de Leur RR, van Sleuwen M, Hassink RJ, Wildbergh TX, Doevendans PA, et al. Electrocardiogram devices for home use: technological and clinical scoping review. JMIR Cardio. Jul 07, 2023;7:e44003. [FREE Full text] [doi: 10.2196/44003] [Medline: 37418308]
8. Forecast number of mobile users worldwide from 2020 to 2025 (in billions). Statista. Apr 07, 2021. URL: https://www.statista.com/statistics/218984/number-of-global-mobile-users-since-2010/#:~:text=In%202021%2C%20the%20number%20of,projected%20to%20reach%207.49%20billion [accessed 2025-08-12]
9. Gruwez H, Ezzat D, Van Puyvelde T, Dhont S, Meekers E, Bruckers L, et al. Real-world validation of smartphone-based photoplethysmography for rate and rhythm monitoring in atrial fibrillation. Europace. Mar 30, 2024;26(4):euae065. [FREE Full text] [doi: 10.1093/europace/euae065] [Medline: 38630867]
10. De Ridder B, Van Rompaey B, Kampen JK, Haine S, Dilles T. Smartphone apps using photoplethysmography for heart rate monitoring: meta-analysis. JMIR Cardio. Feb 27, 2018;2(1):e4. [FREE Full text] [doi: 10.2196/cardio.8802] [Medline: 31758768]
11. Allen J. Photoplethysmography and its application in clinical physiological measurement. Physiol Meas. Mar 2007;28(3):R1-39. [doi: 10.1088/0967-3334/28/3/R01] [Medline: 17322588]

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12. Brasier N, Raichle CJ, Dörr M, Becke A, Nohturfft V, Weber S, et al. Detection of atrial fibrillation with a smartphone camera: first prospective, international, two-centre, clinical validation study (DETECT AF PRO). Europace. Jan 01, 2019;21(1):41-47. [FREE Full text] [doi: 10.1093/europace/euy176] [Medline: 30085018]
13. Proesmans T, Mortelmans C, Van Haelst R, Verbrugge F, Vandervoort P, Vaes B. Mobile phone-based use of the photoplethysmography technique to detect atrial fibrillation in primary care: diagnostic accuracy study of the FibriCheck app. JMIR Mhealth Uhealth. Mar 27, 2019;7(3):e12284. [FREE Full text] [doi: 10.2196/12284] [Medline: 30916656]
14. Gruwez H, Van Herendael H, Maris S, Dhont S, Meekers E, Bruckers L, et al. Effectiveness of photoplethysmography-based rhythm monitoring after atrial fibrillation ablation using a smartphone application: DIGITOTAL study. Heart Rhythm. Oct 2025;22(10):2570-2578. [FREE Full text] [doi: 10.1016/j.hrthm.2024.11.026] [Medline: 39579949]
15. William AD, Kanbour M, Callahan T, Bhargava M, Varma N, Rickard J, et al. Assessing the accuracy of an automated atrial fibrillation detection algorithm using smartphone technology: the iREAD study. Heart Rhythm. Oct 2018;15(10):1561-1565. [doi: 10.1016/j.hrthm.2018.06.037] [Medline: 30143448]
16. Azram M, Ahmed N, Leese L, Brigham M, Bowes R, Wheatcroft SB, et al. Clinical validation and evaluation of a novel six-lead handheld electrocardiogram recorder compared to the 12-lead electrocardiogram in unselected cardiology patients (EVALECG Cardio). Eur Heart J Digit Health. Sep 28, 2021;2(4):643-648. [FREE Full text] [doi: 10.1093/ehjdh/ztab083] [Medline: 36713105]
17. Wouters F, Gruwez H, Smeets C, Pijalovic A, Wilms W, Vranken J, et al. Comparative evaluation of consumer wearable devices for atrial fibrillation detection: validation study. JMIR Form Res. Jan 09, 2025;9:e65139. [FREE Full text] [doi: 10.2196/65139] [Medline: 39791483]
18. Bumgarner JM, Lambert CT, Hussein AA, Cantillon DJ, Baranowski B, Wolski K, et al. Smartwatch algorithm for automated detection of atrial fibrillation. J Am Coll Cardiol. May 29, 2018;71(21):2381-2388. [FREE Full text] [doi: 10.1016/j.jacc.2018.03.003] [Medline: 29535065]
19. Wegner FK, Kochhäuser S, Ellermann C, Lange PS, Frommeyer G, Leitz P, et al. Prospective blinded evaluation of the smartphone-based AliveCor Kardia ECG monitor for atrial fibrillation detection: the PEAK-AF study. Eur J Intern Med. Mar 2020;73:72-75. [doi: 10.1016/j.ejim.2019.11.018] [Medline: 31806411]
20. Verkruysse W, Svaasand LO, Nelson JS. Remote plethysmographic imaging using ambient light. Opt Express. Dec 22, 2008;16(26):21434-21445. [FREE Full text] [doi: 10.1364/oe.16.021434] [Medline: 19104573]
21. Fernstad J, Svennberg E, Åberg P, Kemp Gudmundsdottir K, Jansson A, Engdahl J. Validation of a novel smartphone-based photoplethysmographic method for ambulatory heart rhythm diagnostics: the SMARTBEATS study. Europace. Mar 30, 2024;26(4):euae079. [FREE Full text] [doi: 10.1093/europace/euae079] [Medline: 38533836]
22. Van Gelder IC, Rienstra M, Bunting KV, Casado-Arroyo R, Caso V, Crijns HJ, et al. 2024 ESC guidelines for the management of atrial fibrillation developed in collaboration with the European Association for Cardio-Thoracic Surgery (EACTS). Eur Heart J. Sep 29, 2024;45(36):3314-3414. [FREE Full text] [doi: 10.1093/eurheartj/ehae176] [Medline: 39210723]
23. Atrial fibrillation: diagnosis and management. National Institute for Health and Care Excellence. Apr 27, 2021. URL: https://www.nice.org.uk/guidance/ng196 [accessed 2026-07-22]

Abbreviations

AF: atrial fibrillation
CE: Conformité Européenne
ECG: electrocardiogram
FDA: Food and Drug Administration
GCP: Good Clinical Practice
GP: general practitioner
ICH: International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use
PPG: photoplethysmography
rMSSD: root mean square of successive differences
rPPG: remote photoplethysmography

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