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Wrist-worn wearables for atrial fibrillation detection: diagnostic performance of PPG versus single-lead ECG – a review

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Abstract

Background: Atrial fibrillation (AF) is the most common sustained cardiac arrhythmia and an important cause of stroke and reduced quality of life. Standard methods such as 12-lead electrocardiography and Holter monitoring cover only limited periods and are not ideal for repeated screening. Wrist-worn devices, including smartwatches and fitness bands, are now part of a healthy lifestyle and are widely used by athletes and physically active individuals. Many record photoplethysmography (PPG), single-lead electrocardiography (ECG), or both, but their diagnostic value in AF detection is still not fully established.

Aim: To compare the diagnostic performance of wrist-worn devices using PPG and single-lead ECG for AF detection in adults.

Material and methods: A systematic PubMed search was performed using smartwatch- and AF-related terms. The search was limited to the last five years, English language, human studies, and free full-text articles. Of 44 records, 13 original studies were included after screening.

Results: In controlled cohorts with good signal quality, PPG-based algorithms usually showed sensitivity and specificity around 94–95% or higher. In real-world settings, especially in older post-stroke patients, sensitivity of irregular rhythm notifications was much lower, around one third, although

specificity reached 100%. Single-lead ECG smartwatches and ambulatory ECG recorders usually achieved sensitivity and specificity above 90%. Physician interpretation of smartwatch ECG recordings improved diagnostic accuracy.

Conclusions: Both PPG- and ECG-based wrist-worn devices can detect AF with high accuracy in selected settings. In routine practice, ECG-based devices seem more reliable, while PPG results are more dependent on signal quality and algorithm design. Positive findings should still be confirmed by standard ECG.

Keywords: Atrial fibrillation, Electrocardiography, Photoplethysmography, Wearable Electronic Devices, Screening

1. Introduction

1.1 Atrial fibrillation as a diagnostic challenge

Atrial fibrillation (AF) is the most common sustained cardiac arrhythmia in adults. Its prevalence increases markedly with age and is expected to rise even further due to population ageing and improved survival of patients with cardiovascular disease. AF is associated with a higher risk of ischaemic stroke, heart failure, cognitive decline, and reduced quality of life. Many AF episodes are asymptomatic or present only with non-specific symptoms such as fatigue, dyspnoea, or palpitations, which means that the arrhythmia may remain undiagnosed for a long time. Earlier detection of AF creates an opportunity to initiate oral anticoagulation and rate- or rhythm-control therapy, potentially preventing serious complications.

The diagnostic gold standard for AF remains the surface electrocardiogram (ECG). In everyday clinical practice, this usually means a short 12-lead ECG recorded during a consultation or 24-hour Holter monitoring. Although these methods are well established, they cover only limited time periods and are not very practical for repeated screening in large populations. They also require specialised equipment and trained personnel.

1.2. Wrist-worn devices and technologies for atrial fibrillation detection

In the last decade, wrist-worn devices such as smartwatches and fitness bands have become widely used. Many people already use them for step counting or tracking sports activity. A considerable number of these devices can record heart rhythm by means of photoplethysmography (PPG) or single-lead ECG, and some newer models combine both signals or use artificial intelligence (AI) for data interpretation (Avram et al., 2021; Mannhart et al., 2023).

PPG is an optical method based on detecting changes in blood volume within the microcirculation by using green or infrared light. (Castaneda et al., 2018). It is inexpensive, allows continuous heart rate monitoring, and in principle does not require any active involvement from the user. However, PPG is sensitive to motion artefacts and other factors affecting signal quality, including ambient light, and it does not directly reflect atrial electrical activity but rather peripheral blood volume changes (Merino-Monge et al., 2023; Tamura, 2019). A smartwatch-derived single-lead ECG is closer to a conventional diagnostic ECG and allows the physician to visually confirm atrial fibrillation, but the user must actively initiate a 30-second recording and remain still, so the monitoring is more intermittent in nature (Ford et al., 2022).

1.3. Current evidence and aim of the review

Several validation studies have assessed the ability of wrist-worn devices to detect atrial fibrillation, but they differ considerably in terms of study design, population, and outcome definitions (Liao et al., 2022; Selder et al., 2020, 2023). Some focus on purely PPG-based algorithms, others on smartwatch-derived ECG, and a few on combined PPG–ECG strategies triggered by irregular pulse notifications(Avram et al., 2021). Because these devices are being promoted very intensively, both clinicians and patients increasingly ask which technology performs better in detecting atrial fibrillation and how reliable such results are in comparison with standard ECG.

The aim of this review is to summarise the current evidence on the diagnostic performance of wrist-worn devices using PPG and single-lead ECG for atrial fibrillation detection in adults, with particular attention to sensitivity, specificity, and selected clinical settings in which each of these technologies may be useful.

2. Results

2.1. Overview of the populations in included core studies

The final core evidence base consisted of validation studies performed in several clinically different populations. These included ambulatory adults with or without increased AF risk monitored in free-living conditions(Avram et al., 2021; Chang et al., 2022), Chinese adults undergoing AF screening (Fu & Li, 2021), cardiology outpatients undergoing rhythm assessment or with already diagnosed AF or other arrythmia (Ford et al., 2022; Mannhart et al., 2023; Selder et al., 2023) with and without prior smartphone or smartwatch usage experience (Wouters et al., 2025), older stroke patients (Meza et al., 2023), patients evaluated around cardioversion or during ablation procedures (Liao et al., 2022; Selder et al., 2023), elderly users with paired PPG–ECG recordings (Selder et al., 2020), patients after heart valve surgery (Müller et al., 2024), adults with AF and other supraventricular arrhythmias (Liao et al., 2022) and adults with non-permanent AF monitored with implantable cardiac devices (Wasserlauf et al., 2023). Across all selected studies, wearable-derived AF detection was compared with an ECG-based reference standard, most commonly 12-lead ECG, 24-hour Holter ECG, continuous telemetry, patch ECG, or an implanted monitor.

2.2. PPG-only wrist-worn devices

Among studies evaluating PPG-only wrist-worn systems, diagnostic performance was generally high in semi-controlled or controlled settings, but less consistent in real-life or high-risk populations.

In ambulatory adults monitored over 24 hours in free-living conditions, a Garmin-based smartwatch PPG algorithm detected AF with 97.3% sensitivity and 88.6% specificity at the participant level when compared with simultaneous 24-hour Holter ECG (Chang et al., 2022). At the 5-minute segment level, sensitivity and specificity were 97.1% and 86.8%, respectively (Chang et al., 2022). The study included 200 participants, of whom 112 had Holter-documented AF and 88 did not. The study was performed in ambulatory rather than strictly controlled conditions. However, only PPG segments of sufficient quality were included in the final analysis after exclusion of motion-related and noisy recordings. The authors also noted that rapid ventricular rate contributed to false-negative results, whereas premature beats were a common source of false positives (Chang et al., 2022).

Very good results were also observed in a study of standalone PPG algorithms applied to commercial wristbands and smartwatches. In a semi-controlled clinical setting before and after cardioversion, Selder et al. evaluated the FibriCheck algorithm on two different PPG devices: a Biostrap wristband and a Fitbit smartwatch. Against 12-lead ECG interpreted by cardiologists, diagnostic performance reached 98% sensitivity and 96% specificity for Biostrap, and 97% sensitivity and 100% specificity for Fitbit. The study included two separate cohorts, comprising 78 patients in the Biostrap-FibriCheck group and 73 patients in the Fitbit-FibriCheck group. These findings suggest that a standalone PPG algorithm may maintain high diagnostic accuracy across different consumer wrist-worn devices in a semi-controlled clinical setting (Selder et al., 2023).

Liao et al. examined methodological aspects of smartwatch-based photoplethysmography for atrial fibrillation detection in 116 adults undergoing catheter ablation or electrical cardioversion, using simultaneous continuous ECG rhythm classification as the ECG-based reference standard. In the between-patient analysis, the 25-beat PPG model achieved 96.0% sensitivity and 92.5% specificity, whereas in the within-subject analysis these values were 97.0% and 94.0%, respectively. The authors also demonstrated that longer PPG recording windows improved AF detection, while shorter segments reduced diagnostic performance. In addition, they assessed the effect of premature ventricular contractions (PVCs) and premature atrial contractions (PACs), showing that these ectopic beats could negatively influence algorithm accuracy. When segments containing PVCs and PACs were included, the final adjusted 25-beat model reached 94.1% sensitivity and 93.4% specificity (Liao et al., 2022).

Among the PPG-only studies included in this review, the lowest sensitivity was observed in stroke patients. In a subgroup of 33 older patients treated on a stroke unit, of whom 29 had AF during 4-hour monitoring, Meza et al. evaluated the Fitbit Charge 5 irregular rhythm notification feature against continuous bedside ECG monitoring as the ECG-based reference standard. Sensitivity was only 34.5%, whereas specificity remained 100%. These findings indicate that the device generated very few false-positive alerts, but failed to detect a substantial proportion of true AF cases in this post-stroke population (Meza et al., 2023).

Wasserlauf et al. assessed the Apple Watch Irregular Rhythm Notification function, a passive photoplethysmography-based feature rather than a smartwatch ECG tool, in 30 patients with

nonpermanent atrial fibrillation who were simultaneously monitored using either an insertable cardiac monitor or a cardiac implanted electronic device as the ECG-based reference standard. In this multicenter study, subject-level sensitivity reached 72%, while specificity was 100%. During periods of active watch wear, episode-level sensitivity was lower, at 60%. These results indicate that passive PPG-based alerts may support opportunistic identification of AF, but their value appears more limited when more detailed evaluation of AF episodes or burden is required. (Wasserlauf et al., 2023).

Overall, studies of PPG-only wrist-worn devices showed considerable diagnostic potential, although performance was clearly influenced by recording conditions, signal quality, and the clinical profile of the monitored population. In semi-controlled settings or in analyses restricted to interpretable PPG segments, sensitivity often exceeded 90% and specificity remained high, in some studies approaching 100%. By contrast, under more demanding real-world conditions, particularly in post-stroke cohorts or when passive notification-based systems were used, sensitivity declined to 34.5–72% despite preserved or near-preserved specificity. Taken together, these findings suggest that PPG-based wearables may perform well as screening tools, but their diagnostic accuracy appears less stable outside selected settings and remains more vulnerable to signal-related limitations than would be expected from controlled validation studies alone (Chang et al., 2022; Liao et al., 2022; Meza et al., 2023; Selder et al., 2023; Wasserlauf et al., 2023).

2.3. ECG-only wrist-worn devices

Studies based on single-lead ECG generally showed good, although sometimes variable, diagnostic performance, depending on the device, the embedded algorithm, and the extent of clinician over-reading.

In the BASEL Wearable Study, Mannhart et al. compared five direct-to-consumer ECG-capable devices in 201 consecutive cardiology patients, including 62 with AF and 139 without AF, using physician-interpreted 12-lead ECG as the reference standard. Device-level performance varied considerably: Apple Watch 6 and Samsung Galaxy Watch 3 both achieved 85% sensitivity and 75% specificity; Withings ScanWatch reached 58% sensitivity and 75% specificity; Fitbit Sense showed 66% sensitivity and 79% specificity; and AliveCor KardiaMobile achieved 79% sensitivity and 69% specificity. An important practical limitation was the high proportion of inconclusive tracings, ranging from 17% to

26%, which reduced the clinical usefulness of these consumer devices in routine cardiology settings (Mannhart et al., 2023).

More favourable results were reported in postoperative monitoring after valve procedures. Müller et al. studied 105 patients after surgical or transcatheter heart valve intervention, of whom 93 completed the study protocol. Patients recorded Apple Watch single-lead ECG at least three times daily, and the results were compared both with continuous 2–4-day telemetry and with a 12-lead ECG on postoperative day three. Against telemetry, smartwatch ECG achieved 91% sensitivity and 96% specificity, with an overall accuracy of 95%. When compared with the single 12-lead ECG obtained on day three, sensitivity and specificity were 71% and 92%, respectively. These findings indicate that repeated smartwatch ECG recordings may have additional value in postoperative rhythm surveillance beyond a single short conventional ECG recording (Müller et al., 2024).

In the HUAMI Heart Study, Fu and Li evaluated a wrist-worn dynamic ECG recorder with an AI-based AF detection algorithm in 114 Chinese adults, including 61 with sinus rhythm and 53 with AF, using standard 12-lead ECG as the reference method. Specificity remained 100% in all tested body positions, whereas sensitivity varied according to posture: 88.68% in the supine position, 94.34% in the upright position, and 94.34% after exercise. These data suggest that dynamic ECG wearables can maintain very high specificity across different recording conditions, with only limited variation in sensitivity (Fu & Li, 2021).

A direct comparison between two ECG-based smartwatch algorithms was provided by the SMART WARS study. In 125 elderly outpatients who underwent simultaneous Apple Watch Series 4, KardiaBand, and 12-lead ECG recordings, Ford et al. showed clear differences according to device and interpretation strategy. In the automated analysis, after exclusion of inconclusive tracings, Apple Watch reached 50% sensitivity and 100% specificity, whereas KardiaBand achieved 96% sensitivity and 93% specificity. When a hybrid strategy combining device output with clinician review was applied, Apple Watch improved to 68% sensitivity and 93% specificity, while KardiaBand reached 94% sensitivity and 90% specificity. These findings indicate that ECG-based smartwatch algorithms are not directly interchangeable and that clinician interpretation may substantially improve diagnostic performance, particularly when automated classification is less reliable (Ford et al., 2022).

Overall, ECG-based wearables showed consistently high diagnostic potential when validated against ECG-based reference standards, especially when recordings were interpretable and clinical review was available. However, their performance was still influenced by device-specific algorithms, the proportion of inconclusive tracings, and the context in which the recordings were obtained.

2.4. Devices combining PPG and ECG, and mixed comparative studies

One of the most comprehensive hybrid strategies was presented by Avram et al. in 204 adults at risk of AF who underwent 28-day monitoring under free-living conditions. The device combined continuous PPG surveillance with on-demand confirmatory ECG recording, while the reference standard consisted of patch ECG with adjudicated rhythm assessment. The combined algorithm achieved 96.9% sensitivity and 99.3% specificity. The authors also reported modality-specific results: the PPG-only algorithm reached 87.8% sensitivity and 97.4% specificity, whereas the ECG-only algorithm achieved 98.9% sensitivity and 99.3% specificity. These findings suggest that a PPG-triggered ECG strategy may offer a practical compromise between near-continuous monitoring and high diagnostic certainty (Avram et al., 2021).

Another mixed validation study was conducted by Wouters et al. in 122 adults recruited from a cardiology outpatient clinic, including 30 with AF and 92 with sinus rhythm, all assessed against simultaneous 12-lead ECG as the reference standard. Under supervised, clinic-like conditions, all tested devices achieved 100% sensitivity for AF detection. Specificity for sinus rhythm was 96.4% for KardiaMobile 6L, 97.8% for Apple Watch, 98.9% for FibriCheck, and 97.8% for Preventicus. These findings indicate that both ECG-based and PPG-based consumer solutions may achieve very high diagnostic performance under standardized conditions, with only minor differences in specificity across the tested devices (Wouters et al., 2025).

In a separate comparative study, Selder et al. evaluated both a research PPG wristband with an offline algorithm and a one-lead ECG wristband in a mixed cohort of 60 elderly users, generating 180 paired PPG–ECG recordings. Using ECG-based rhythm labeling as the reference standard, the PPG wristband achieved 100% sensitivity and 96% specificity at the user level, while the one-lead ECG wristband reached 100% sensitivity and 98% specificity. The authors also observed that the PPG-based device produced a higher proportion of unclassifiable recordings than the ECG-based wristband, although repeated measurements substantially reduced this limitation. This study is particularly valuable because

it provided a direct comparison of wrist-worn PPG and single-lead ECG under the same experimental conditions (Selder et al., 2020).

2.5. Summary of performance patterns across the selected studies

Across the selected studies, PPG-only wrist-worn devices showed substantial diagnostic potential, although their performance was clearly shaped by signal quality, recording conditions, and the clinical profile of the monitored population. In semi-controlled settings, or when the analysis was restricted to interpretable PPG recordings, sensitivity was generally high and in several studies exceeded 90%, while specificity also remained favorable. By contrast, under more demanding real-world conditions, particularly in post-stroke populations or when passive notification-based systems were used, sensitivity declined markedly despite preserved or near-preserved specificity (Chang et al., 2022; Liao et al., 2022; Meza et al., 2023; Selder et al., 2023; Wasserlauf et al., 2023).

Overall, single-lead ECG-based wearables appeared to provide more stable diagnostic results, with several studies reporting sensitivity and specificity above 90%. when validated against ECG-based reference standards such as 12-lead ECG, telemetry, or adjudicated ECG recordings. Particularly favorable results were reported for KardiaBand in SMART WARS, Apple Watch ECG in postoperative valve monitoring, and the dynamic ECG recorder evaluated in the HUAMI Heart Study. At the same time, ECG-based performance still depended on device-specific algorithms and on the proportion of inconclusive recordings, which was especially evident in the BASEL Wearable Study (Ford et al., 2022; Fu & Li, 2021; Mannhart et al., 2023; Müller et al., 2024).

Devices combining PPG and ECG, as well as mixed comparative studies, suggest that a hybrid approach may offer a useful balance between broader rhythm surveillance and higher diagnostic confidence. In Avram et al., continuous PPG monitoring combined with on-demand ECG confirmation achieved very high specificity, while Wouters et al. showed that both ECG-based and PPG-based consumer tools can perform very well in a supervised outpatient setting when validated against simultaneous 12-lead ECG. Comparative data from Selder et al. also indicate that both modalities may reach high accuracy under standardized conditions, although PPG-based recordings appeared more prone to unclassifiable segments (Avram et al., 2021; Selder et al., 2020; Wouters et al., 2025).

3 Discussion

3.1. Main findings

The present review indicates that both PPG-based and ECG-based wrist-worn devices may detect atrial fibrillation with high diagnostic accuracy, but their performance was not equally stable across settings. In several semi-controlled validation studies, both technologies reached favorable sensitivity and specificity, often above 90% when compared with ECG-based reference standards. However, the overall pattern of results suggests that ECG-based devices provided more consistent performance, whereas PPG-based systems were more dependent on artefacts such as recording quality, signal artefacts, and the clinical profile of the monitored population. (Chang et al., 2022; Ford et al., 2022; Fu & Li, 2021; Liao et al., 2022; Mannhart et al., 2023; Meza et al., 2023; Müller et al., 2024; Selder et al., 2023).

This difference became more visible outside controlled conditions. PPG-based systems performed very well when signal quality was good or when only interpretable recordings were included in the analysis, but their sensitivity dropped in more difficult settings, such as passive irregular rhythm notification or post-stroke monitoring. ECG-based devices also had limitations, especially inconclusive tracings and variability between proprietary algorithms, but their results appeared more stable overall (Ford et al., 2022; Mannhart et al., 2023).

Another important finding is that combined or hybrid strategies may currently offer the most balanced solution. In particular, the study by Avram et al. suggests that continuous PPG surveillance combined with confirmatory ECG recording may reduce some weaknesses of each method used alone (Avram et al., 2021).

3.2. Comparison between PPG and ECG

PPG has clear practical advantages. It allows passive and potentially long-term rhythm surveillance without requiring the user to actively start a recording. This may help detect asymptomatic or short AF episodes that could be missed by occasional ECG measurements. This is especially relevant in everyday

life, because many people wear smartwatches or fitness bands continuously as part of a healthy lifestyle or sports routine. At the same time, the studies included in this review show that PPG-based performance depends strongly on signal quality. Motion artefacts which could interfere a lot, ectopic beats, shorter recording windows, and less controlled real-world conditions may all reduce accuracy, even if specificity remains high (Chang et al., 2022; Liao et al., 2022; Meza et al., 2023; Wasserlauf et al., 2023). For this reason, PPG seems to be potentially useful as a screening tool, but less reliable as a stand-alone diagnostic method.

Single-lead ECG-based devices have a different profile. Their main advantage is that they provide a tracing directly related to the electrical activity of the heart, which makes clinical interpretation easier and more reliable. This was clearly demonstrated in the SMART WARS study, where physician over-reading improved performance beyond automated classification alone (Ford et al., 2022). On the other hand, ECG-based devices usually require active user involvement which can be difficult with patients without prior smartphone or smartwatch usage experience, because the recording must be initiated manually and is often limited to short time intervals.

Based on the findings of the reviewed studies, ECG-based wearable devices currently seem more suitable for direct rhythm diagnosis, whereas PPG-based systems may be better suited for broader rhythm surveillance and early identification of possible AF. In practical terms, PPG offers the advantage of wider and more continuous monitoring, while ECG appears more useful when a more reliable confirmation of the rhythm is needed.

3.3. Clinical implications

From a clinical perspective, wrist-worn devices should not be regarded as a substitute for standard ECG. Based on the studies included in this review, they should rather be considered, at least for now, as supportive tools for screening, early detection, or rhythm monitoring. Positive findings obtained from wrist-worn devices should still be confirmed by standard ECG-based methods, especially before therapeutic decisions are made, such as initiation of anticoagulant therapy or invasive rhythm management.

The potential role of these technologies may differ across clinical groups. In patients after valve interventions or in individuals undergoing rhythm follow-up after cardioversion or ablation, smartwatch ECG may provide additional value by increasing the chance of capturing intermittent AF episodes between conventional assessments especially when continuous standard ECG monitoring is not available. (Liao et al., 2022; Müller et al., 2024). In contrast, passive PPG-based notifications may be more suitable for broad, low-threshold monitoring, but their limitations should be clearly understood, particularly in more vulnerable groups such as post-stroke patients (Meza et al., 2023; Wasserlauf et al., 2023).

This issue is also relevant to sports medicine and to physically active individuals. Smartwatches and fitness bands are widely used not only by professional athletes, but also by people who simply try to maintain a healthy lifestyle. In these groups, wearable devices may be helpful in identifying symptomatic arrhythmias or rhythm irregularities that might otherwise remain unnoticed or undocumented. This may be particularly valuable in apparently healthy individuals, especially if device-generated alerts encourage them to seek medical advice and undergo further evaluation. At the same time, exercise-related motion, sweating, and variable peripheral perfusion may reduce signal quality, particularly in PPG-based systems. For this reason, alerts generated by wearable devices should be interpreted with caution and, whenever possible, in an appropriate clinical context.

3.4. Limitations of the available evidence

Several important limitations of the currently available evidence need to be considered. First, many of the included studies were based on relatively small and selected clinical groups rather than broad, community-based populations. In several datasets, the proportion of patients with atrial fibrillation was much higher than would usually be expected in a real screening population, which clearly limits the generalizability of these findings.

Second, the studies differed quite substantially in both design and methodology. Although all reference methods were ECG-based, they were not the same across studies and included 12-lead ECG, Holter ECG, telemetry, patch ECG, and implantable rhythm monitoring. Results were also reported at different analytical levels, such as subject level, segment level, or episode level, which makes direct comparison less straightforward. In several PPG-based studies, noisy or uninterpretable recordings were excluded

from the final analysis, which may have led to somewhat better performance estimates than would be expected in everyday use.

Another major issue is the rapid pace of technological development. New smartwatch models, sensors, and proprietary algorithms are introduced very quickly, often faster than validation studies can be completed, published, and then interpreted. Because of this, some of the studies included in this review may already refer to earlier generations of devices or older software versions and therefore may not fully reflect the performance of technologies currently available on the commercial market.

Finally, the number of direct comparative studies evaluating PPG-based, ECG-based, and hybrid strategies under similar conditions remains limited. For this reason, the current conclusions should still be interpreted with caution, especially when they are applied to general screening populations or to the newest wearable technologies.

3.5. Future directions and practical perspective

Further research is clearly needed. Future studies should help identify which patient groups are most likely to benefit from wearable-based AF detection, because the current evidence still comes mainly from selected clinical cohorts. Another important issue is possible overdiagnosis. Wider rhythm monitoring may detect very short or low-burden AF episodes, and the clinical value of such findings is not always straightforward. This is particularly relevant because the benefit-risk balance of starting anticoagulation in device-detected or subclinical AF is still not fully settled, so broader detection does not automatically mean better treatment for every patient.

A useful next step may be better integration of wearable data into routine care. It could be helpful if patients were able to share a summary of alerts from the previous weeks or months with their general practitioner, or if smartwatch ECG tracings could be uploaded in a form that is easy for primary care physicians to review. This would allow doctors to look not only at single alerts, but also at rhythm patterns over time. Hybrid systems combining continuous PPG surveillance with ECG confirmation also seem particularly attractive, because they may join broader monitoring with stronger rhythm verification. Such an approach may be especially valuable in postoperative follow-up, since

postoperative AF remains one of the most common complications after cardiac surgery. If wearable monitoring proves reliable in this setting, it could simplify rhythm surveillance after transfer from monitored units or after discharge, and help detect AF earlier without prolonged use of large monitoring systems. Overall, these points support the need for further well-designed studies in this field.

4. Conclusion

Wrist-worn devices are becoming an important tool for atrial fibrillation detection. The studies included in this review suggest that both PPG-based and single-lead ECG-based technologies may achieve good diagnostic accuracy, especially in selected patient groups and under more controlled conditions. However, ECG-based devices seem to provide more stable and clinically reliable results, whereas PPG-based systems are more dependent on signal quality and recording conditions.

At present, the most promising option seems to be the combination of both technologies, in which broader PPG monitoring is supported by ECG confirmation. Still, wearable devices should not replace standard ECG-based diagnostics. Positive findings require physician interpretation and confirmation with a conventional ECG-based gold standard before treatment decisions are made. Further well-designed research is needed to determine how these technologies should be used in routine clinical practice and which patient groups may benefit the most.

Disclosure

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In preparing this work, the authors used Google Gemini for the purpose of summarizing articles, constructing sentences, enhancing English level. After using this tool, the authors have reviewed and edited the content as needed and accept full responsibility for the substantive content of the publication.

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