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Comparative Evaluation of Digital Consumer Devices for Atrial Fibrillation Detection: a Validation Study

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Background
Consumer-oriented digital devices, such as smartphones and smartwatches, have gained prominence for their ability to conduct heart rhythm analysis, specifically in detecting atrial fibrillation (AF) through proprietary algorithms using electrocardiography (ECG) and/or photoplethysmography (PPG)-based digital recordings. Despite numerous individual validation studies, a direct inter-device comparison of their performance remains elusive.

Objective
To evaluate and compare the ability of digital consumer devices to discriminate between sinus rhythm and AF.

Methods
Patients exhibiting sinus rhythm or AF were consecutively enrolled from the cardiology outpatient clinic. They were instructed to perform heart rhythm measurements, using a handheld six-lead ECG device, a smartwatch-derived single-lead ECG, and two PPG-based smartphone applications in a random sequence, with continuous gold standard 12-lead ECG reference monitoring. Only one confirmed measurement per patient for each digital device was included in the analysis.

Results
Overall, 122 patients were included (age 69 [61 - 77] years, 63.9% male, 25% with AF). The sensitivity, specificity, accuracy, Cramer's V, and AUROC of the used devices, compared with a reference 12-lead ECG, were comparable and are presented in Table 1. Cohen's kappa demonstrated a near-perfect intra-device algorithm agreement between the first and second measurements with sufficient quality. Remarkably, smartphone PPG app (A) yielded significantly fewer inconclusive tracings compared to the other digital devices ($p = .002$). Nevertheless, participants preferred the use of a smartwatch form factor to monitor their heart rhythm.

Conclusion
The discrimination between sinus rhythm and AF using digital consumer devices based on ECG or PPG was highly accurate, with no discernible variations across the examined devices.

Table 1. Performance of the digital heart rhythm devices in comparison to a reference 12-lead ECG.

	Six-lead handheld ECG	Smartwatch ECG	Smartphone PPG (A)	Smartphone PPG (B)
Sensitivity	100%	100%	100%	100%
Specificity	96.3%	97.7%	100%	100%
Accuracy	97.3%	98.2%	100%	100%
Cramer's V	0.933	0.954	1.000	1.000
AUROC	0.982	0.988	1.000	1.000
Cohen's kappa*	0.913	0.864	0.916	0.922
Insufficient quality or inconclusive tracings**	13.7%	13.5%	6.2%	15.4%
Patient preference ***	9.9%	54.6%	35.5%	

*AUROC, area under the receiver operating characteristic curve; *The intra-device algorithm agreement was assessed between the first and second measurement of sufficient quality. **Measurements with insufficient quality or inconclusive tracings were excluded from the other analyses; ***Out of 121 patients. One patient had no preference.*