

Mobile health technology for Atrial Fibrillation Application screening using smart devices-based PPG

The HUAWEI Heart Study

(Pre-MAFA Study)

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On behalf of the MAFA II Study Investigators
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Declaration of interest

- I have nothing to declare



Background

- Low detection and nonadherence in AF management
- Photoplethysmography (PPG) and mobile health (mHealth) technology may enable a screening approach combined with intervention.

Limit data on AF screening integration with clinical AF care

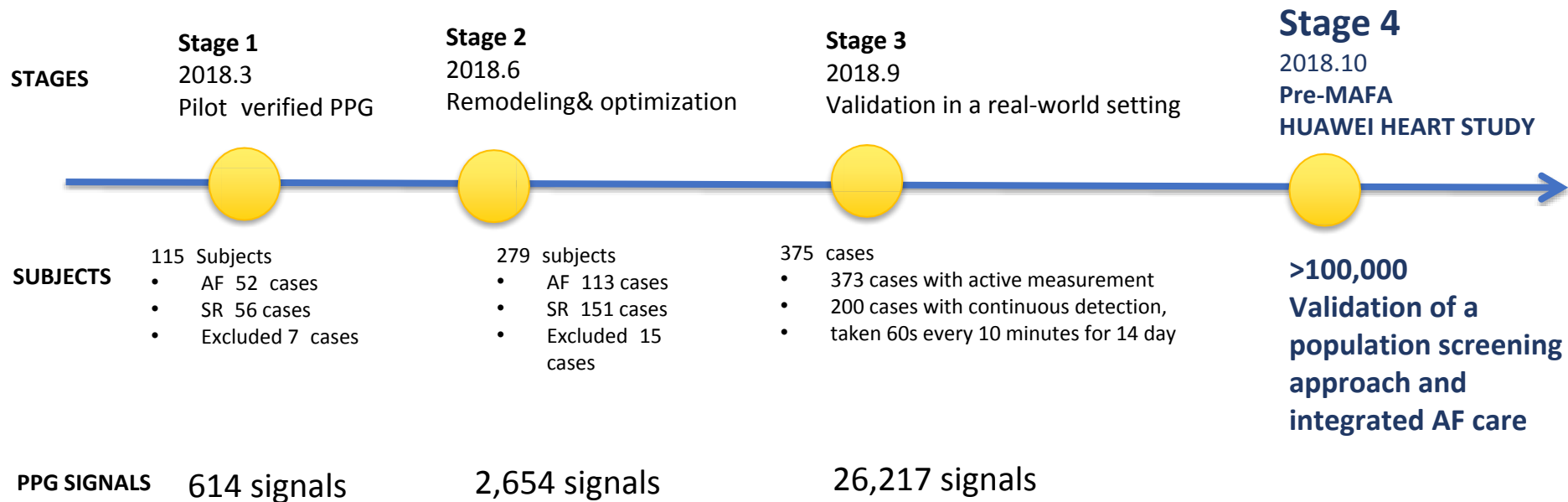
Objective

To investigate the effectiveness of AF screening in a large population-based cohort using smart device based photoplethysmography (PPG) technology, combined with a clinical care AF management pathway using a mHealth approach

- **Primary outcome:** the incidence of AF identified
- **Secondary outcome:** the anticoagulant use

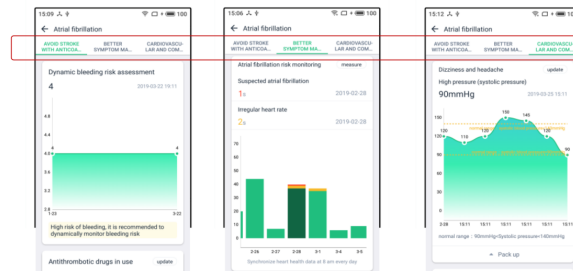
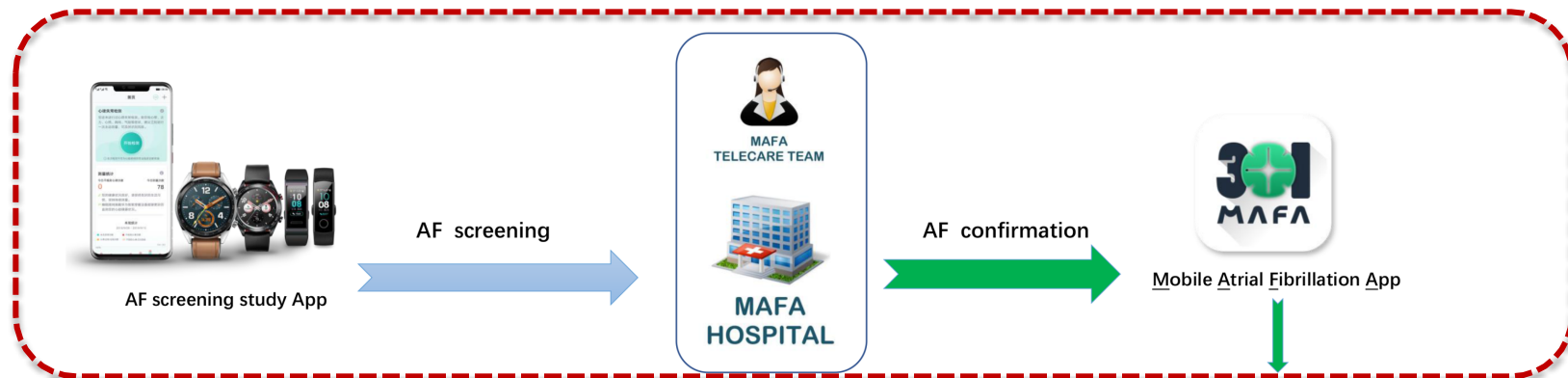
Independent academic study

PPG algorithm and smart devices have been validated before into HUAWEI HEART STUDY



*Subjects were excluded if they had a pacemaker or implantable defibrillator, or they were unable to use smart wearable devices.

AF screening flow diagram



AF integrated care ABC

Individuals with “suspected” AF
by PPG algorithm

MAFA Telecare team

Check and follow up at **24** hour

Can't contact

Follow up on **First** week

Can't contact

Follow up on **Second** week

Can't contact

Follow up on **Fourth** week

Can't contact

Follow up on **Sixth** week

Can't contact

Follow up on **Eighth** week

Can't contact

Loss of follow-up

MAFA doctors

AF confirmed by
clinical evaluation,
ECG, 24 h Holter

MAFA II cluster
randomized clinical trial
Follow up for 12 months

**The confirmation and follow-up of
individuals with “suspected” AF**

Inclusion

Adult ≥ 18 years

Huawei phone (Android 5.0 or higher)

Smart devices:

Huawei Watch GT (Version 1.0.3.52 or higher)

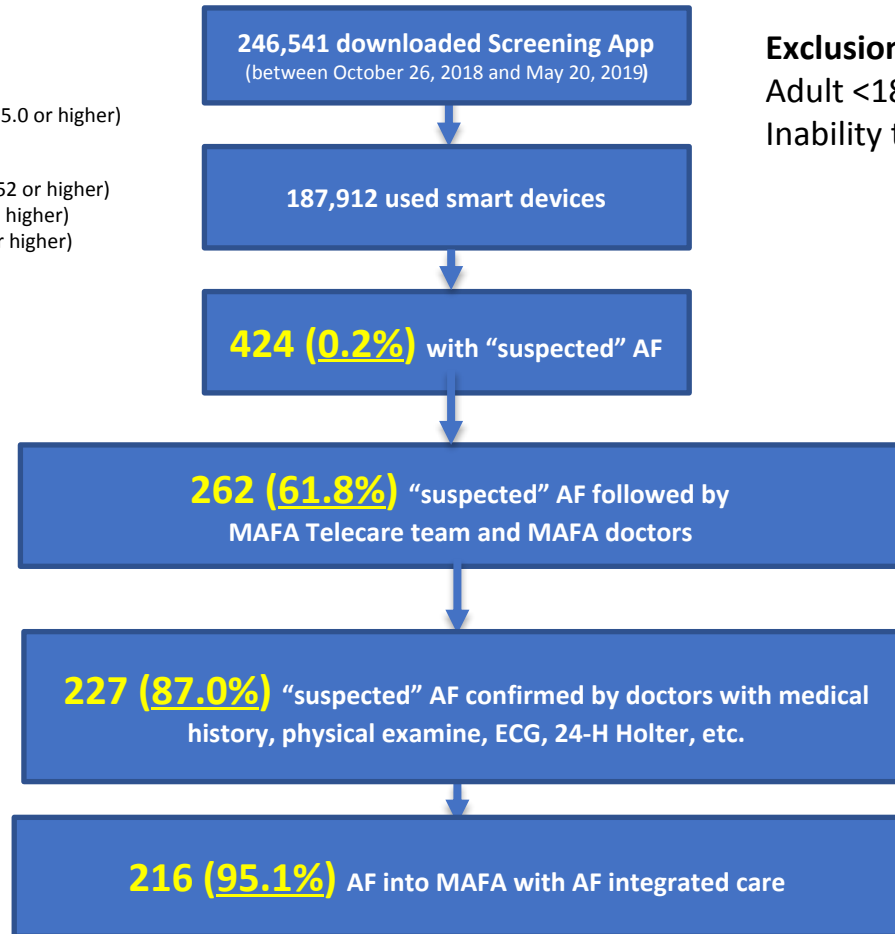
Honor Watch (Version 1.0.3.52 or higher)

Honor Band 4 (Version 1.0.0.86 or higher)

Exclusion

Adult < 18 years

Inability to use smart phone or devices

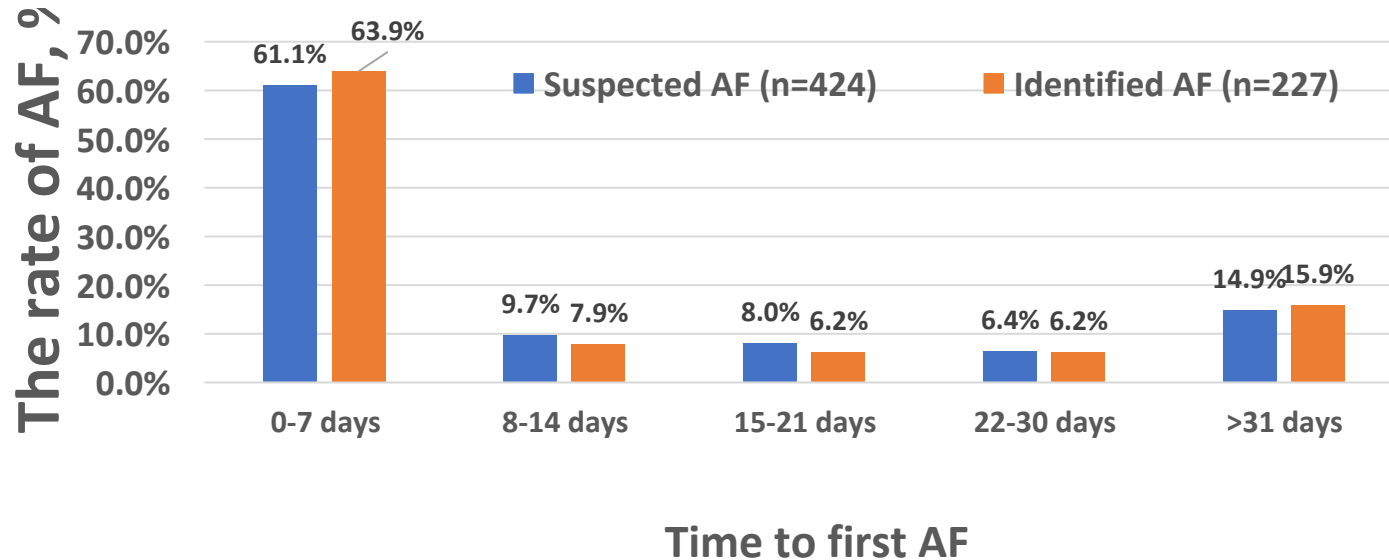


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Baseline characteristics

	Overall Cohort (n=187,912)	Notification (n=424)	Individuals with clinical evaluation (n=262)	Identified AF (n=227)
Suspected AF episodes, n	265,139	265,139	203,985	186,956
Female, n (%)	24938 (13.3)	55(13.0)	43(16.4)	42(18.5)
Age, mean (SD)	34.7(11.5)	54.1(14.3)	54.9(14.0)	56.1(13.7)
≥65, n (%)	3419 (1.8)	95(22.4)	62(23.7)	58(25.5)
55-64, n (%)	7491 (4.0)	112(26.4)	71(27.1)	69(30.4)
40-54, n (%)	44432 (23.6)	136(32.1)	82(31.3)	64(28.2)
20-39, n (%)	132570 (70.5)	81 (19.1)	47(17.9)	36(15.9)

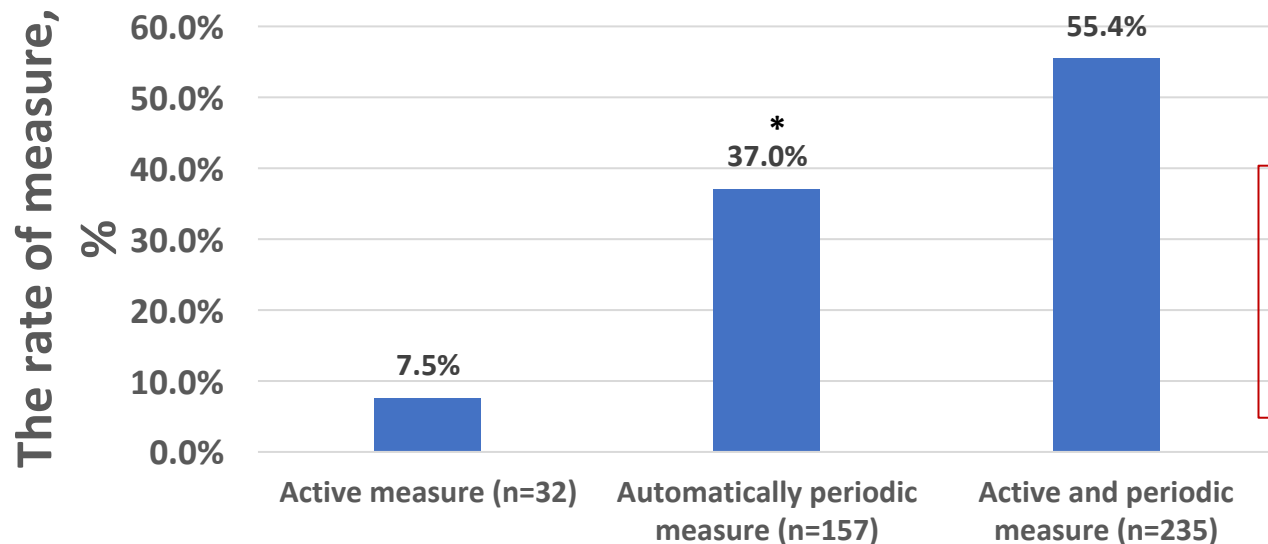
Results: 71% of AF episodes were found within 14 days, but nearly one third of AF episodes were recorded after two weeks



About **one third** of AF episodes were recorded after two weeks

Monitoring time to first detected AF episode

Results: The automatic periodical measurements were much likely to detect “suspected” AF episodes



Monitoring method for first “suspected” AF

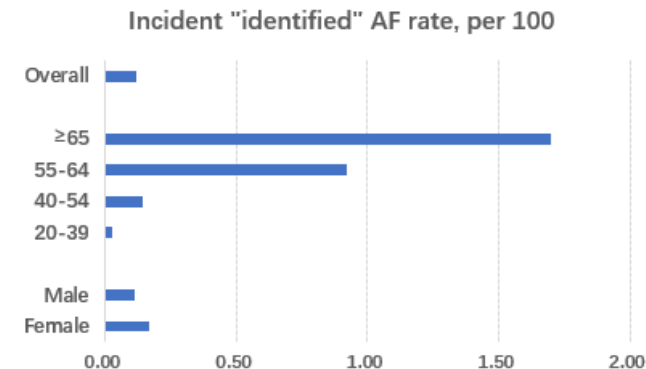
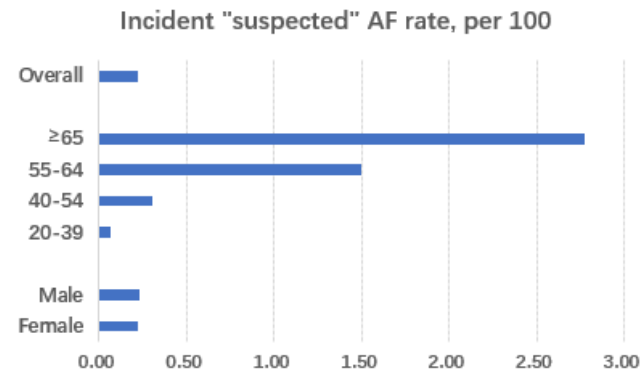
*Compared to active measure, $p < 0.001$, ** Compared to automatically periodic measure, $p < 0.001$.

Results: The highest proportion of AF episodes was among the elderly aged over 65 years, and there was a consistent increases of incident 'suspected AF' and 'identified' AF over age

Positive PPG signals	Total PPG signals	PPV of PPG signals (95% CI)
186,956	203,985	91.6% (91.5%-91.8%)
Number of cases with identified AF	Number of cases with suspected AF	Proportion of positive AF (95% CI)
227	262	86.6% (82.0%-90.2%)

	Suspected AF	Total	%	95%CI
Overall	424	187912	0.23	(0.21-0.25)
≥65	95	3419	2.78	(2.28-3.38)
55-64	112	7491	1.50	(1.24-1.80)
40-54	136	44432	0.31	(0.26-0.36)
18-39	81	132570	0.06	(0.05-0.08)
Male	369	162972	0.23	(0.20-0.25)
Female	55	24938	0.22	(0.17-0.29)

	Identified AF	Total	%	95%CI
Overall	227	187912	0.12	0.11-0.14
≥65	58	3419	1.70	(1.31-2.19)
55-64	69	7491	0.92	(0.73-1.16)
40-54	64	44432	0.14	(0.11-0.18)
18-39	36	132570	0.03	(0.02-0.04)
Male	185	162972	0.11	(0.10-0.13)
Female	42	24938	0.17	(0.12-0.23)



Results **80%** of patients at high-risk were anticoagulated

Oral anticoagulant use in AF patients

	Low risk	Intermediate risk	High risk
N (%)	91 (42.1)	71(32.9)	54 (25.0)
Anticoagulant use at baseline, n%	5 (5.49)	9 (12.68)	43 (79.63)
Anticoagulant use at 3 months, n%	3 (3.30)	29 (40.85)	42 (77.78)
p	0.372	<0.001	0.673

* Low risk: CHA₂DS₂-VASC of 0 in males, or 1 in females; Intermediate risk: CHA₂DS₂-VASC of 2 in female, 1 in male; High risk: CHA₂DS₂-VASC ≥3 in females, ≥2 in males. McNemar's test was used for testing the difference.

The reasons for patients with or without oral anticoagulants (OACs) on baseline:

Low risk patients with OACs at baseline: 2 patients undergoing AF ablation, with OAC used after discharge, 2 patients with current onset acute AF episodes, and 1 patient with rheumatic valvular heart disease.

High risk patients without OACs at baseline: six patients who were unwilling to accept anticoagulants, four patients with antiplatelets (aspirin or clopidogrel), and one patient anticoagulated with traditional Chinese medicine.

2007-2009 year
1034 Patients with AF
OACs: **14%**

(Guo Y, et al. Int Card J. 2013)

Limitations

- Although we had strict follow-up procedures for 'suspected AF', there were 38% of individuals with 'suspected AF' who could not be effectively followed up, which would decrease the proportion of identified AF.
- For the PPV calculation with PPG signals, we did not have real-time 12-lead ECG data synchronized with PPG-based smart devices.
- Incident AF detection in present study might be impacted by the availability of smart phones and devices.

Comparison with Apple Heart study

Main Aspects		Huawei Heart Study	Apple Heart Study
Algorithm accuracy	PPG Detecting PPV	91.6%	71.3%
Measurement	Period measurement	Based on PPG, Periodic measurement results are given, the proportion of irregular rhythms is analyzed	Based on PPG, Periodic measurement results are not given
	Period measurement frequency	Every 10 minutes	Every 2h for baseline mode, an irregular tachogram initiates a cascade of more frequent mode (every 16 minutes)
Follow up and confirmation	Follow-up mode	Follow-up by doctor, combined with a clinical care AF management	Follow-up with video visit online
	Confirmation mode	Confirmed with medical history, physical examination, ECG or 24-Holter by doctors	Confirmed with ePatch
	Follow-up rate	62% with MAFA telecare and doctors	44% first study visit * effectively followed up with ePatch returned and analyzed: 21%
	Proportion of confirmed AF by doctors or ePatch	87%	34%

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Summary



AF screening in
186,956 population



0.2 % received
the notification of
suspected AF



**MAFA
HOSPITAL**

87% confirmed
AF by doctors



Mobile Atrial Fibrillation App

95% with MAFA for
AF integrated care ABC



80% of high-risk patients
were successfully
anticoagulated.

Clinical application

Continuous home-monitoring with smart device-based PPG technology is a feasible approach for screening and early detection of AF in a large population.

This could help our efforts at screening and detection of AF, as well as early interventions to reduce stroke and other AF-related complications.

Acknowledgments

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THANK YOU

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Mobile Health Technology for Atrial Fibrillation Screening Using Photoplethysmography-Based Smart Devices: The HUAWEI Heart study

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ABSTRACT

BACKGROUND Low detection and nonadherence are major problems in current management approaches for patients with suspected atrial fibrillation (AF). Mobile health (mHealth) devices may enable earlier AF detection, and improved AF management.

OBJECTIVES To investigate the effectiveness of AF screening in a large population-based cohort using smart device based photoplethysmography (PPG) technology, combined with a clinical care AF management pathway using a mHealth approach.

METHODS AF screening was performed with smart devices using PPG technology (Huawei Technologies Co., Ltd., Shenzhen, China) which were made available for the population aged over 18 years across China. Monitoring for at least 14 days with a wristband (HONOR BAND 4) or wristwatch (HUAWEI WATCH GT, HONOR WATCH), was allowed. The patients with 'possible AF' episodes using the PPG algorithm were further confirmed by health providers among the MAFA (mobile AF App) Telecare center and network hospitals, with clinical evaluation, electrocardiogram (ECG), or 24-h Holter.

RESULTS There were 246,541 individuals who downloaded the PPG screening App, and 187,912 individuals used smart devices to monitor their pulse rhythm between October 26, 2018 and May 20, 2019. Among those with PPG monitoring (mean age 35 years, 86.7% male), 424 (mean age 54 years, 87.0% male) received a 'suspected AF' notification (424/187,912, 0.23%). Of those effectively followed up, 227 individuals (227/262, 87.0%) were confirmed as having AF, with the positive predictive value (PPV) of PPG signals being 91.6% (95% confidential interval (CI) 91.5%-91.8%). Both 'suspected AF' and 'identified AF' markedly increased with age (p for trend <0.001), and individuals in Northeast China had the highest proportion of detected AF of 0.28% (95%CI 0.20-0.39). Of the individuals with identified AF, 216 (216/227, 95.1%) subsequently entered a programme of integrated AF management using a mobile AF application (mAFApp); approximately 80% of 'high risk' patients were successfully anticoagulated.

CONCLUSIONS Based on the present study, continuous home-monitoring with smart device based PPG technology could be a feasible approach for AF screening. This would help efforts at screening and detection of AF, as well as early interventions to reduce stroke and other AF-related complications. (J Am Coll Cardiol 2019;1:1)

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User reported adverse events

	Overall cohort
Total	186
Any device connection and data synchronization issues	123
Login and experience issues (any)	63
Skin irritation, anxiety, pressure	0