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EHRA SURVEY

Reimbursement practices for use of digital devices in atrial fibrillation and other arrhythmias: a European Heart Rhythm Association survey

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Abstract

Since digital devices are increasingly used in cardiology for assessing cardiac rhythm and detecting arrhythmias, especially atrial fibrillation (AF), our aim was to evaluate the expectations and opinions of healthcare professionals in Europe on reimbursement policies for the use of digital devices (including wearables) in AF and other arrhythmias. An anonymous survey was proposed through announcements on the European Heart Rhythm Association website, social media channels, and mail newsletter. Two hundred and seventeen healthcare professionals participated in the survey: 32.7%, reported regular use of digital devices, 45.2% reported that they sometimes use these tools, 18.6% that they do not use but would like to. Only a minority (3.5%) reported a lack of trust in digital devices. The survey highlighted a general propensity to provide medical consultation for suspected AF or other arrhythmias detected by a consumer-initiated use of digital devices, even if time constraints and reimbursement availability emerged as important elements. More than 85% of respondents agreed that reimbursement should be applied for clinical use of digital devices, also in different settings such as post-stroke, post-cardioversion, post-ablation, and in patients with palpitations or syncope. Finally, 73.6% of respondents confirmed a lack of reimbursement fees in their country for physicians' consultations (tracings interpretation) related to digital devices. Digital devices, including wearables, are increasingly and widely used for assessing cardiac rhythm and detecting AF, but a definition of reimbursement policies for physicians' consultations is needed.

Keywords Atrial fibrillation • Digital medicine • Health technology assessment • Reimbursement • Screening • Wearables • mHealth • EHRA survey

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What's new?

- Digital devices, including wearables, are increasingly used for assessing cardiac rhythm and for detecting atrial fibrillation (AF).
- A survey performed across Europe, which involved 217 healthcare professionals, highlighted a general propensity to provide medical consultation for suspected AF or for other arrhythmias detected by a consumer-initiated use of digital devices, even if time constraints and reimbursement availability emerged as important elements.
- More than 85% of respondents agreed that reimbursement should be applied for clinical use of digital devices for AF screening, as well as for use of digital tools in other settings, such as post-stroke, post-cardioversion, post-ablation, and in patients with palpitations or syncope.
- A definition of reimbursement policies for physicians' consultations is needed.

Introduction

In the last years, the field of cardiology was consistently modified by the availability of direct-to-consumer wearable devices and apps. Such opportunities were responsible for a paradigm shift in which detection of abnormalities in heart rate and heart rhythm is no longer under the exclusive control of the physicians.[1–4]

Indeed, a large number of devices and apps, only in part designed and validated for medical use, became available to consumers with the possibility to measure a series of parameters, specifically heart rate and heart rhythm abnormalities, with a particular focus on atrial fibrillation (AF).[5–7]

In this scenario, physicians are often requested to provide interpretation and medical advice on cardiac recordings related to rhythm assessment through photopletismogram (PPG) or electrocardiogram (ECG) techniques. A recent European Heart Rhythm Association (EHRA) position paper provided practical guidance and a full picture of digital technologies and of the specific problems of using digital devices, including wearables and apps, also considering the legal implications of data processing.[6]

However, it remains undefined what are the expectations and opinions of healthcare professionals on reimbursement policies, which cover an important role in the organization of care and health technology assessment.[8] To approach this complex topic, EHRA promoted a survey establishing a collaboration between members of the EHRA board involved in the field of health economics, digital media, e-health, and scientific activities.

Methods

An anonymous survey was proposed to healthcare professionals through announcements on the EHRA website, social media channels, and mail newsletters sent to EHRA members. A total of 2300 invitations were sent in January 2022, with a solicit in February 2022. The survey was based on 19 questions with multiple choices. The full questionnaire is available in the Supplementary Appendix.

The survey was conducted in compliance with the European General Data Protection Regulation. In this report, we will present the results of the survey questions.

Results

Two hundred and seventeen healthcare professionals from the European Society of Cardiology (ESC) member countries participated in the survey. Among respondents, the proportion of males was 78.6% and over one-third of respondents were below the age of 40, a quarter between the age of 40 and 49, less than one-fifth between 50 and 59 as well as between 60 and 69 and only 1.6% above 70. Most respondents were senior physicians (77.2%), while 15.0% were physicians in training and 4% were technicians or nurses. The reported fields of activity were cardiac electrophysiology in 71.4%, clinical cardiology in 24.6%, heart failure in 3.2%, and other fields in 0.8%. The place of work was an academic hospital in around half of the respondents, a general hospital in 42.5%, and only a small proportion worked in primary care or other settings.

Respondents replied to the question of whether digital devices (including wearables) are used in their practice for risk stratification or arrhythmia search as follows: about one-third reported that they use these tools regularly, 45.2% reported that they sometimes use these tools, 18.6% that they do not use but would like to. Only a minority reported a lack of trust in digital tools/wearables for a cardiology practice.

As shown in *Figure 1*, the current use of digital devices among respondents was homogeneously distributed between replies corresponding to 'never used' and 'very often used', with 43.2% of respondents reporting that they often use these tools.

The availability of physicians for medical consultations related to suspected AF or other arrhythmias detected by patient-initiated use of digital tools/wearables was tested in the questions shown in *Figure 2*. The two questions were provided to stratify patients at risk (top panel) from subjects not at potential risk of AF (age <45 years). As shown, there was a general propensity to provide medical consultation, even if time constraints and reimbursement availability emerged as important elements. It is noteworthy that more than one-third of respondents declared complete availability to be involved in this task for patients at risk, even independently of other considerations.

The opinion of respondents on statements related to reimbursement policies according to different patterns of using digital devices for AF screening, specifically physician-initiated (top panel), patient-initiated (middle panel), or consumer-initiated when the subject is not at potential risk (bottom panel). As shown, the survey highlighted a wide agreement on the need to establish a reimbursement tariff, especially when digital devices are used for AF screening in patients at risk, such as patients aged ≥65 years (*Figure 3*).

As known, digital devices may directly provide an ECG recording, or be based on PPG recordings, or other sensors that require subsequent confirmation with an electrocardiographic method. As shown in *Figure 4*, the survey showed a general agreement that reimbursement should be provided for both types of devices, even if the devices with electrocardiographic recordings achieved a higher rate of favourable assessments.

Regarding potential reimbursement practices for physician consultations (tracings interpretation) related to digital devices, most respondents reported that reimbursement should be provided separately from both rentals of hardware or software and fees for

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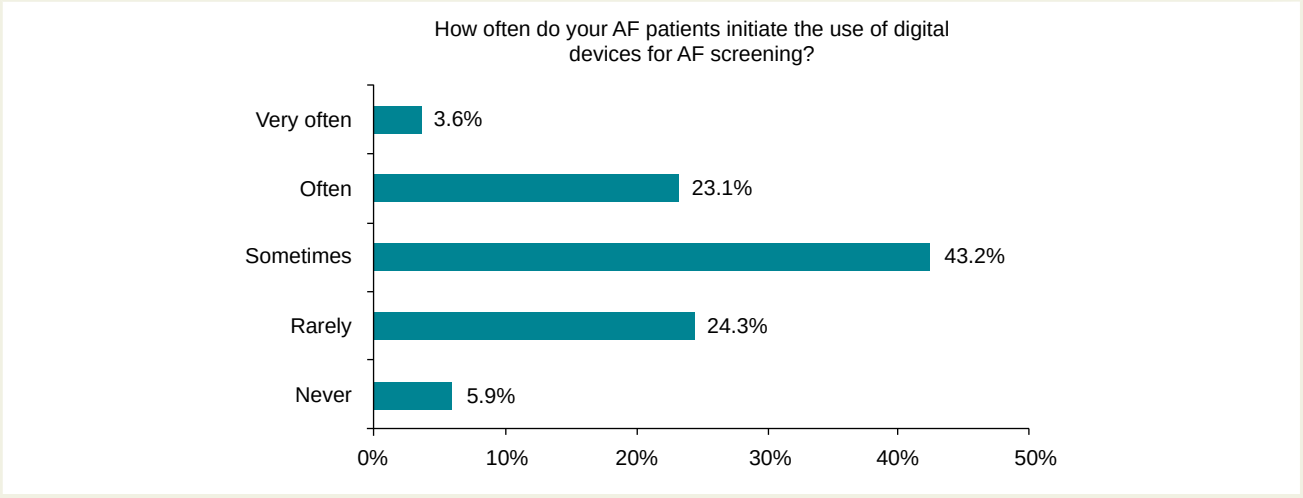

Figure 1 Frequency of use of digital devices among respondents to the survey.

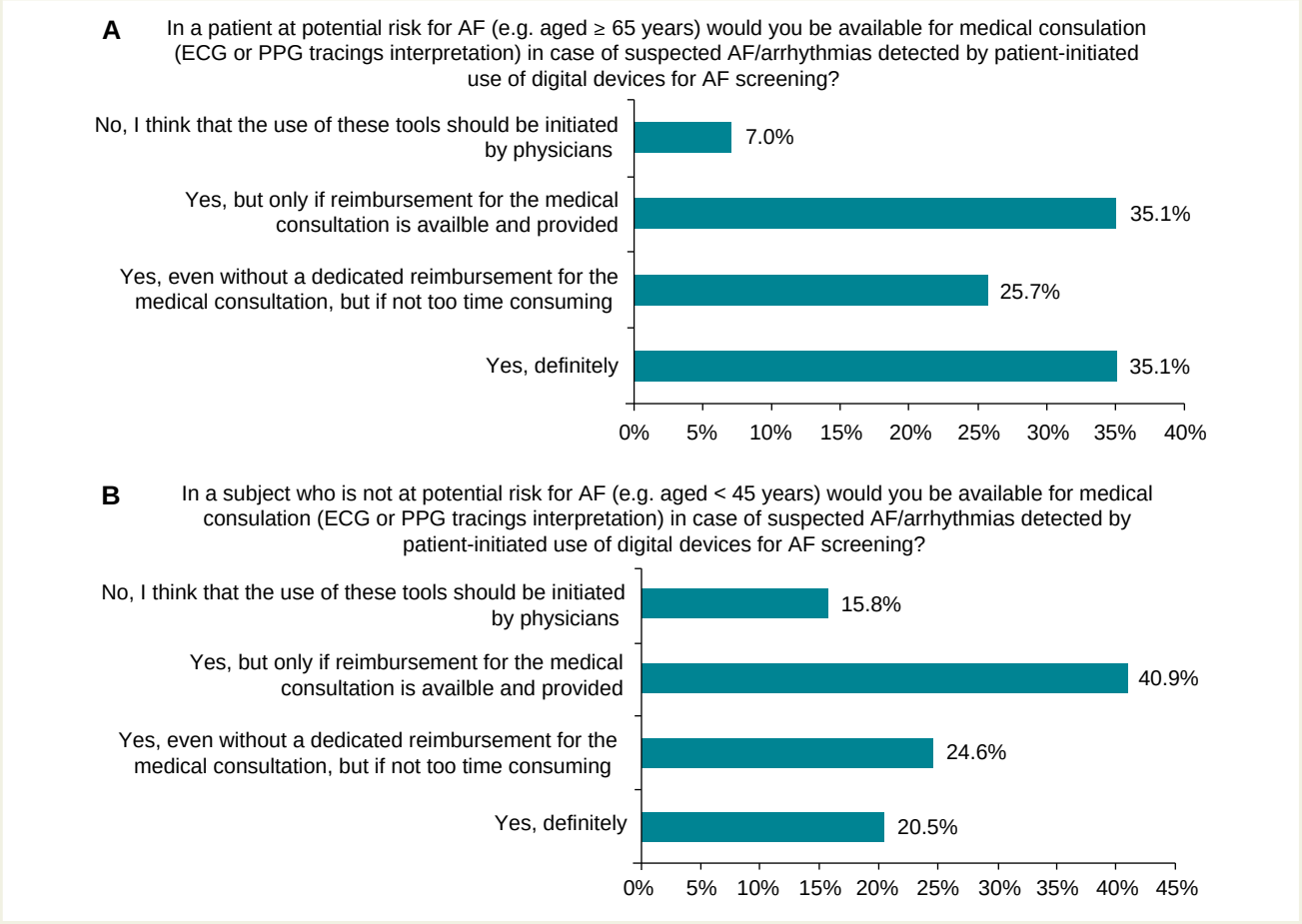

Figure 2 Availability for medical consultations related to patient-initiated or consumer-initiated use of digital devices.

other clinical activities (clinical examinations or teleconsultations) (*Figure 5*).

The survey also explored agreement on reimbursement for clinical use of digital devices in settings different from the screening of AF. As shown in *Figure 6*, more than 85% of respondents agreed that reimbursement should be applied for the search of AF post-stroke for secondary prevention (top panel), for assessing the presence or absence of AF recurrences after cardioversion and/or during antiarrhythmic treatment (middle panel), or to search for AF post-ablation of AF (e.g. during follow-up to help in some clinical decisions).

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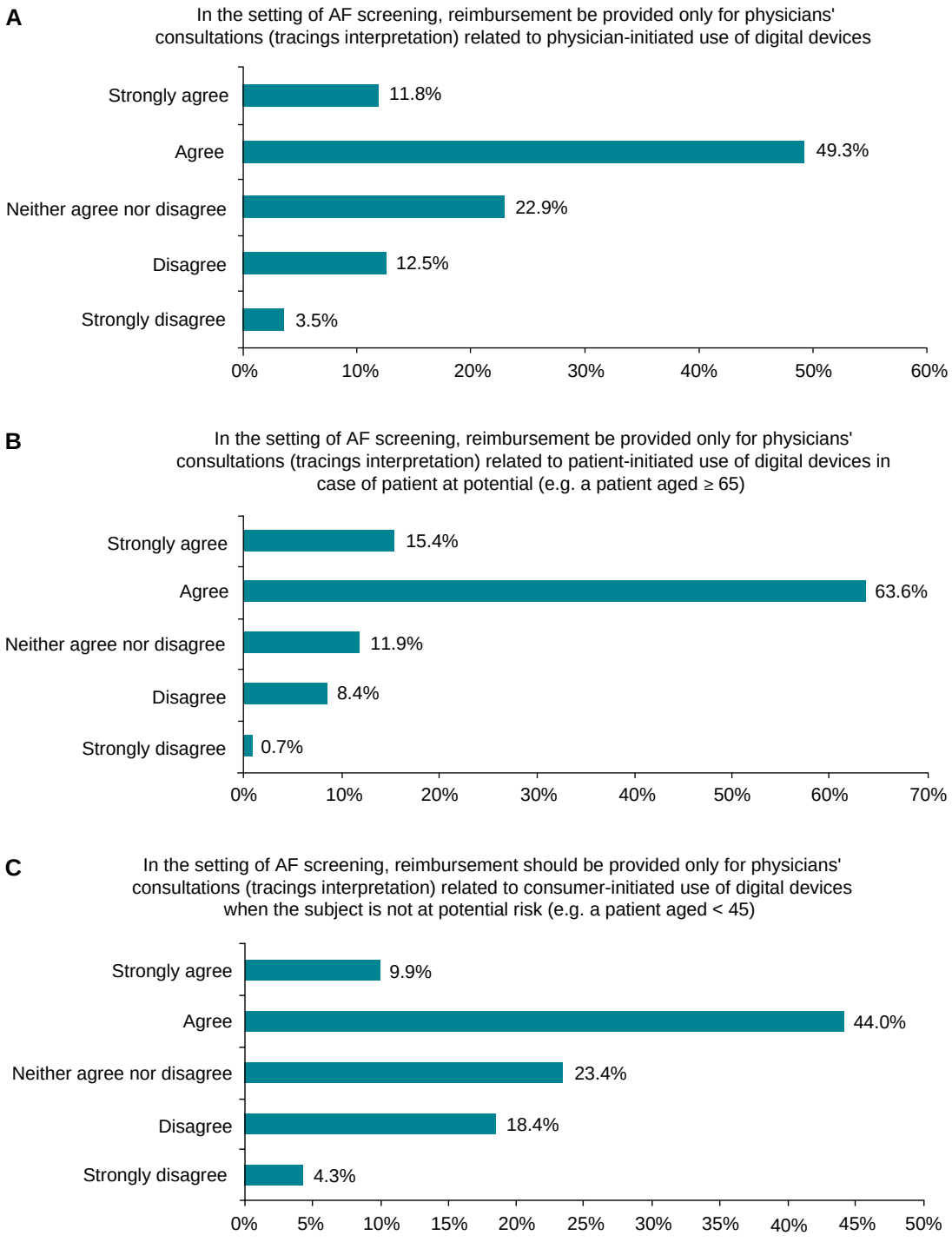

Figure 3 Agreement of respondents with statements on reimbursement policies according to different patterns of using digital devices for AF screening, specifically physician-initiated (top panel), patient-initiated (middle panel), or consumer-initiated when the subject is not at potential risk (bottom panel).

As shown in *Figure 7*, the survey also explored agreement on the use of digital devices in symptomatic patients, with palpitations (top panel) or with syncope or pre-syncope (bottom panel). More than 85% of respondents agreed on the provision of reimbursement for this potential use.

Finally, the survey assessed if some reimbursement exists for physicians' consultations (tracings interpretation) related to digital devices. As shown in *Figure 8* (top panel) almost three-quarters of respondents reported that no reimbursement fee was available in their country or region. More than 60% of respondents who

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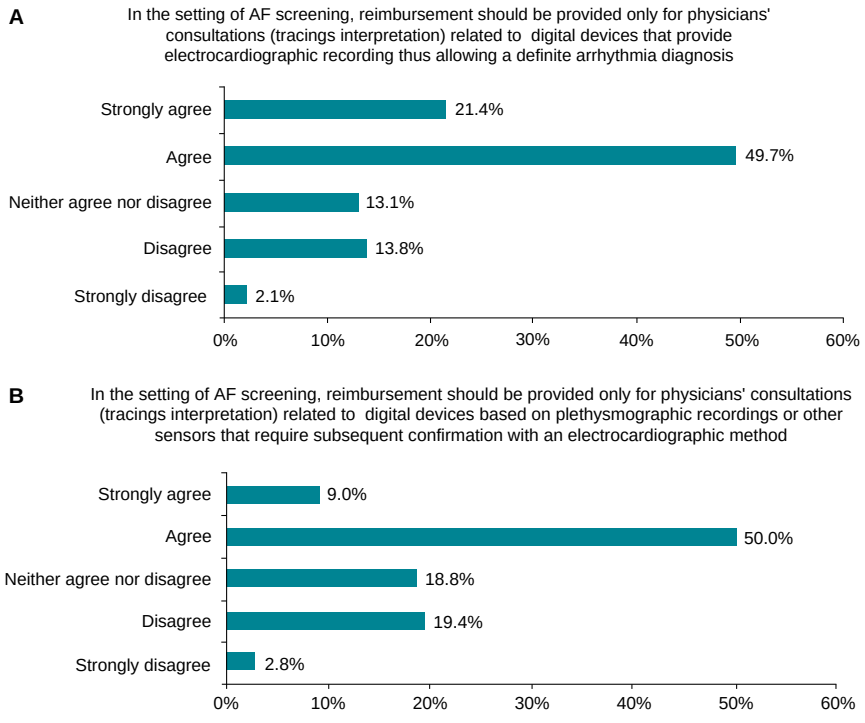

Figure 4 Agreement of respondents with statements on reimbursement policies according to different types of digital devices, specifically devices providing electrocardiographic recording (top panel) or devices based on photoplethysmographic recordings or other sensors that require subsequent confirmation with an electrocardiographic method (bottom panel).

Figure 5 Agreement of respondents with statements on reimbursement policies and potential relationship with rental of hardware or software for digital devices (top panel) or other clinical activities (e.g. clinical examination—teleconsultation) (bottom panel).

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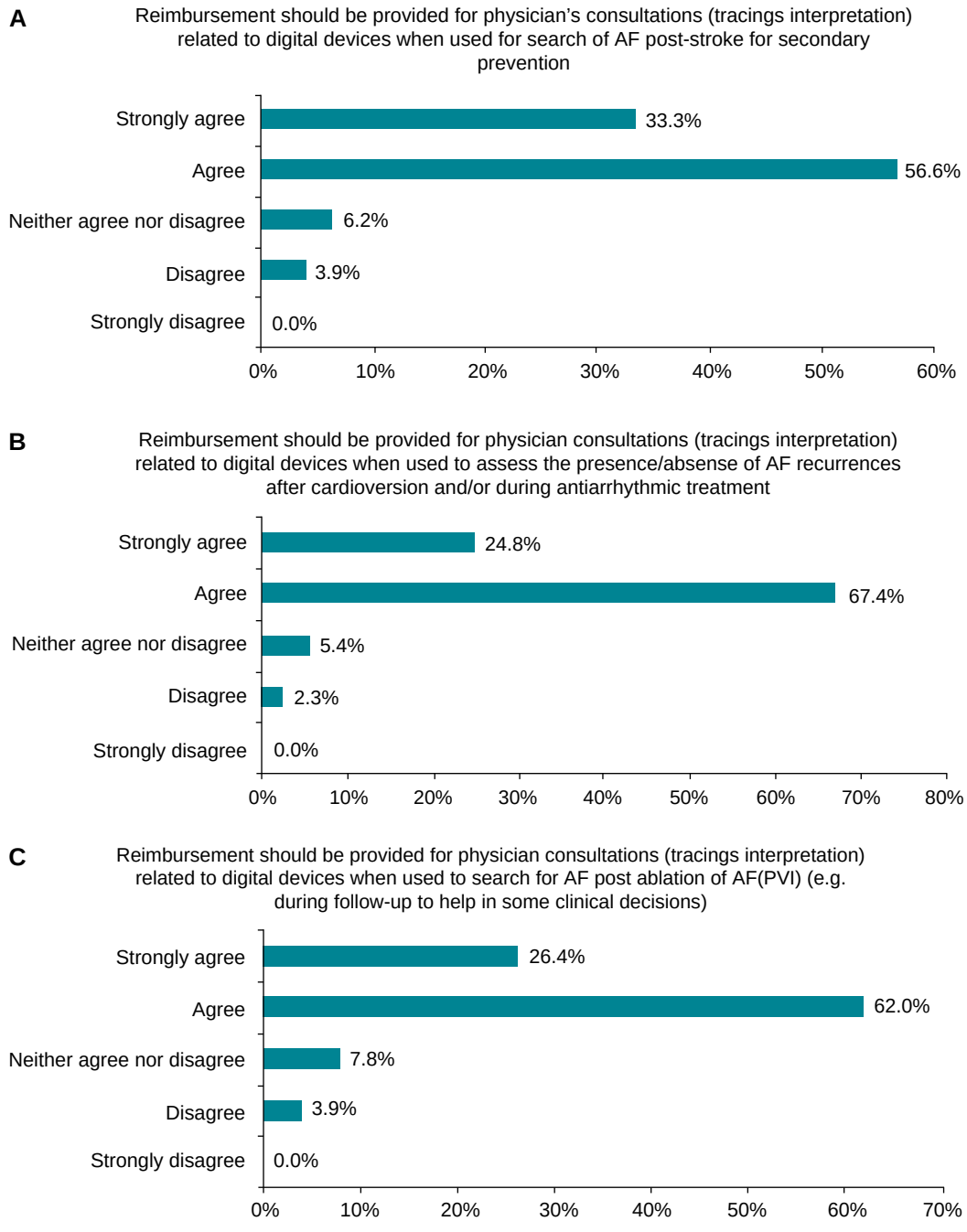

Figure 6 Agreement of respondents with statements on reimbursement policies for clinical use of digital devices in settings different from the screening of AF, specifically for the search of AF post-stroke for secondary prevention (top panel), for assessing the presence or absence of AF recurrences after cardioversion and/or during antiarrhythmic treatment (middle panel), or to search for AF post-ablation of AF (e.g. during follow-up to help in some clinical decisions).

declared that a reimbursement fee was available, indicated that they were not aware if the reimbursement was provided by the national or regional public healthcare system, by private insurance companies only or both (middle panel). Concerning the possibility of making digital devices freely available for patients within the healthcare system for an integrated mHealth programme, this possibility was envisioned by almost half of respondents as not feasible, with a relatively high proportion of respondents having no opinion on this (bottom panel).

Discussion

Reimbursement practices are an important component of the healthcare process and a lack of reimbursement or inadequate tariffs

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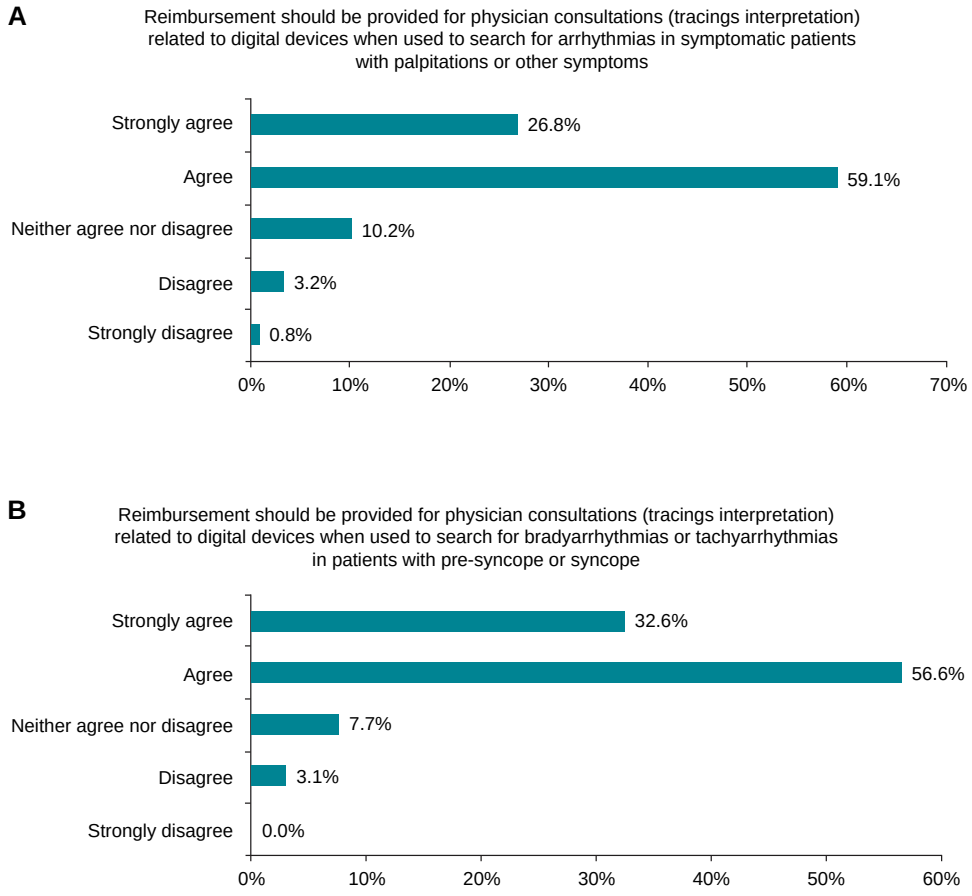

Figure 7 Agreement of respondents with statements on reimbursement policies for clinical use of digital devices in settings different from the screening of AF, specifically in symptomatic patients, in patients with palpitations or other symptoms (top panel) or with syncope or presyncope (bottom panel).

may constitute a barrier to the widespread clinical use of specific technologies, for diagnostic or therapeutic purposes.[8–11]

As widely reported in the literature, the COVID-19 pandemic fuelled an important implementation of telemedicine and digital tools for remote connection between physicians and patients and remote patient monitoring in all fields of medicine, including cardiology and arrhythmia management.[12–20] However, a series of barriers and unresolved issues remain, mainly linked to the lack of digital literacy in some elderly patient groups[21] and a series of organizational aspects.[22,23]

Digital devices for cardiac rhythm monitoring have the peculiar characteristic of being used by patients and consumers even independently of physician's advice, thus creating a novel scenario in medical activities, particularly in the field of arrhythmia detection and screening for AF.[3,4,6,24,25]

In this new scenario, each country will have to face challenges and opportunities to integrate an increasing number of well-developed digital technologies, as well as to respond to changes in evaluation and licencing. New protocols focused on the quality of life (with or without mortality benefits) will have to be adopted in a short period to evaluate these technologies from a health technology assessment perspective.[26]

Within this complex scenario, the issue of the work of physicians, very frequently involved in consultations by consumers and patients, becomes of topical interest and this survey highlights many important aspects that deserve attention by regulatory bodies and policymakers.

Our survey highlights that digital devices are frequently used in physicians' practice for risk stratification or arrhythmia search, with around one-third of respondents using these tools regularly and only a very small proportion (3.5%) of healthcare professionals reporting a lack of trust in these devices.

The survey also illustrates a general propensity among respondents to provide medical consultation about the use of digital tools/wearables by consumers or patients, even if time and availability of reimbursement emerged as important elements. It is noteworthy that more than one-third of respondents declared complete availability to be involved in this task for patients at risk, even independently of other considerations. These results need to be interpreted by considering a certain degree of bias related to the respondents' interest in this topic inherent to voluntary participation in this survey.

Digital devices for cardiac rhythm monitoring, and particularly wearables, may be employed by consumers and/or patients in different settings but it is clear that screening for AF in patients at risk is of

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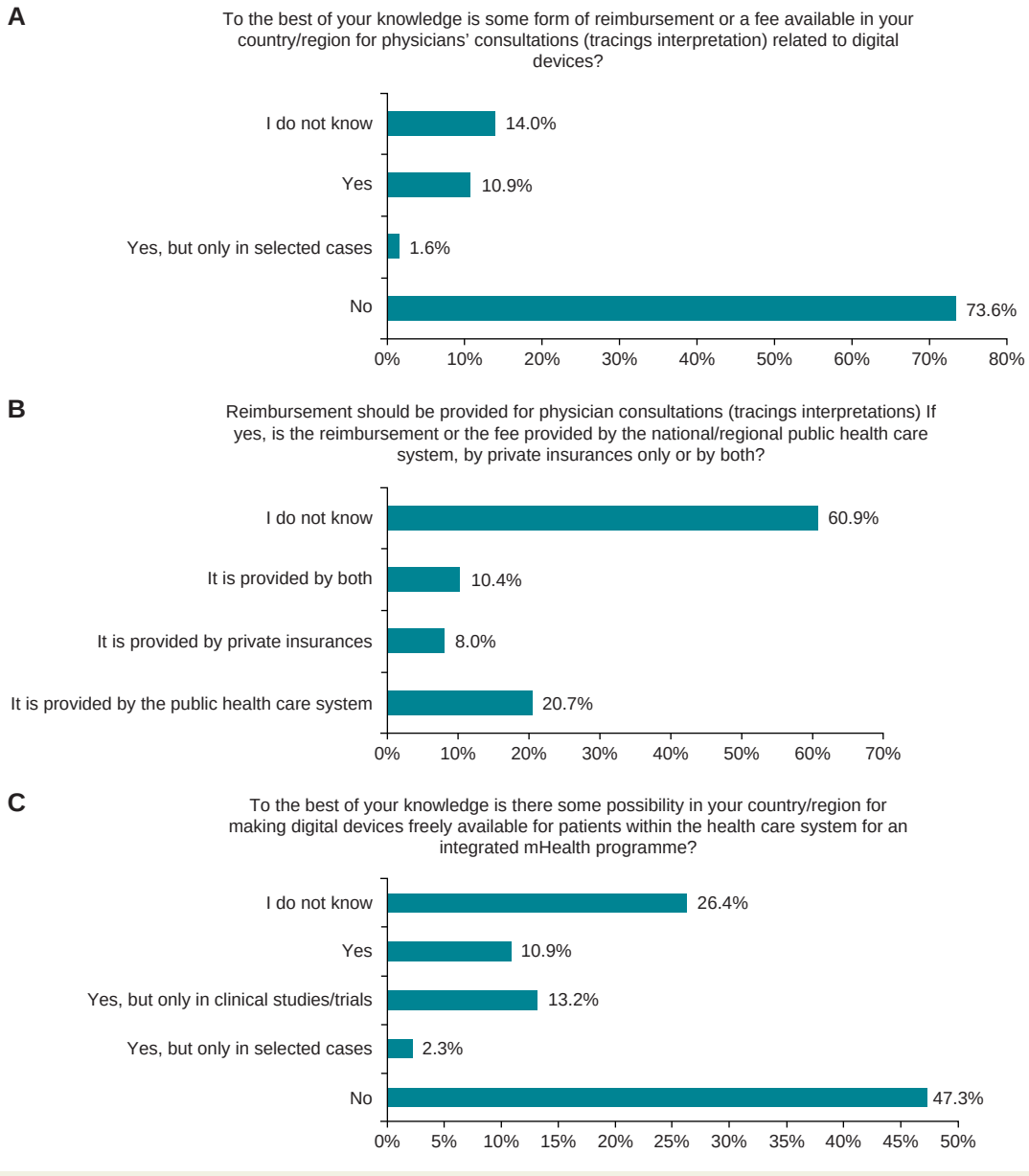

Figure 8 Characteristics of reimbursement for digital devices and the possibility of making digital devices freely available for patients.

primary interest and has been the object of several studies with various technologies, both for opportunistic or systematic screening.[27–31] Screening for AF in subjects aged more than 65 years is recommended by the ESC guidelines on AF management[32] and even below 65 years in case of additional risk factors by the current EHRA practical guide.[6] Appropriate targeting of the candidates for AF screening is crucial since the obvious consequence of AF detection in the case of screening is the prescription of oral anticoagulation in patients with a high risk of stroke. However, the potential asymmetry between diffusion of wearables and risk of AF[33,34] may lead to consultation requests for patients who are not appropriate candidates for AF screening. Our survey indicates that healthcare providers want to be available for consultations, even if they request the institution of an appropriate reimbursement also in these cases.

Up to now, the literature on AF screening was mainly focused on the results in terms of the AF detection rate, confirmed by an ECG, but many organizational and practical aspects, including the cost-effectiveness, are strictly linked to the type of device used for AF search, the way how it becomes available to patients/customers and the organizational pathways for clinical evaluation.[35,36]

The survey illustrates a general agreement of participating physicians on instituting reimbursement for appropriate use of digital devices in settings different from the screening of AF, specifically for the search of AF post-stroke for secondary prevention, for assessing the presence or absence of AF recurrences after cardioversion and/or during antiarrhythmic treatment or to search for AF post-ablation of AF (e.g. during follow-up to help in some clinical decisions), for evaluating patients with palpitations, or with presyncope/syncope. The clinical use of

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wearables/digital tools in these settings is in line with many consensus documents and guidelines, as well as with current practice.[6,37–39]

Finally, the survey highlights that a gap exists in the implementation of strategies for stroke prevention and arrhythmia management that may have a great potential value[6,37,40,41] but require appropriate integration into the healthcare system and specific organization of care pathways for a referral. Physicians and healthcare professionals appear to be unaware of the administrative and regulatory aspects that involve the use of digital devices, and this constitutes a field of action where scientific associations should be active partners of regulatory institutions, in line with the virtuous circle of health technology assessment.[8,42] Finally, a strict collaboration between patient associations and scientific associations should lead to the delivery of guidance documents for the appropriate use of digital devices in the setting of AF and arrhythmia.

Conclusions

According to a survey promoted by EHRA, digital devices, including wearables, are increasingly and widely used for assessing cardiac rhythm and detecting AF, but a definition of reimbursement policies for physicians' consultations is needed, also when the use of these tools is consumer-initiated. A strict collaboration is needed between policymakers, scientific associations, and patient associations for guiding the appropriate use of digital devices and the organization of care pathways for a referral.

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Data availability

Since the research is based on a survey, no sharing of data is predicted.

References

1. Boriani G, Schnabel RB, Healey JS, Lopes RD, Verbiest-van Gurp N, Lobban T *et al.* Consumer-led screening for atrial fibrillation using consumer-facing wearables, devices and apps: a survey of health care professionals by AF-SCREEN international collaboration. *Eur J Intern Med* 2020;**82**:97–104.
2. Ding EY, Svennberg E, Wurster C, Duncker D, Manninger M, Lubitz SA *et al.* Survey of current perspectives on consumer-available digital health devices for detecting atrial fibrillation. *Cardiovasc Digit Heal J* 2020;**1**:21–9.
3. Manninger M, Kosiuk J, Zweiker D, Njeim M, Antolic B, Kircanski B *et al.* Role of wearable rhythm recordings in clinical decision making-the wEHRAbles project. *Clin Cardiol* 2020;**43**:1032–9.
4. Manninger M, Zweiker D, Svennberg E, Chatzikyriakou S, Pavlovic N, Zaman JAB *et al.* Current perspectives on wearable rhythm recordings for clinical decision-making: the wEHRAbles 2 survey. *Europace* 2021;**23**:1106–13.
5. Perales CR L, Van Spall HGC, Maeda S, Jimenez A, Lațcu DC, Milman A *et al.* Mobile health applications for the detection of atrial fibrillation: a systematic review. *Europace* 2021;**23**:11–28.
6. Svennberg E, Tjong F, Goette A, Akoum A L, Bordachar P *et al.* How to use digital devices to detect and manage arrhythmias: an EHRA practical guide. *Europace* 2022;**24**:979–1005.
7. Bonini N, Vitolo M, Imberti JF, Proietti M, Romiti GF, Boriani G *et al.* Mobile health technology in atrial fibrillation. *Expert Rev Med Devices* 2022;**19**:327–40.
8. Boriani G, Maniadakis N, Auricchio A, Müller-Riemenschneider F, Fattore G, Leyva F *et al.* Health technology assessment in interventional electrophysiology and device therapy: a position paper of the European Heart Rhythm Association. *Eur Heart J* 2013;**34**:1869–74.
9. Kuck K-H, Bordachar P, Borggrefe M, Burri H, Leyva F, Schauerte P *et al.* New devices in heart failure: an European Heart Rhythm Association report. *Europace* 2014;**16**:109–28.
10. Boriani G, Burri H, Mantovani LG, Maniadakis N, Leyva F, Kautzner J *et al.* Device therapy and hospital reimbursement practices across European countries: a heterogeneous scenario. *Europace* 2011;**13**:ii59–ii65.
11. Maniadakis N, Vardas P, Mantovani LG, Fattore G, Boriani G. Economic evaluation in cardiology. *Europace* 2011;**13**:ii3–ii8.
12. Molinari G, Brunetti ND, Nodari S, Molinari M, Spagna G, Ioakim M *et al.* Impact of 2020 SARS-CoV-2 outbreak on telemedicine management of cardiovascular disease in Italy. *Intern Emerg Med* 2021;**16**:1191–6.
13. Maines M, Palmisano P, Del Greco M, Melissano D, De Bonis S, Baccillieri S *et al.* Impact of COVID-19 pandemic on remote monitoring of cardiac implantable electronic devices in Italy: results of a survey promoted by AIAC (Italian association of arrhythmology and cardiac pacing). *J Clin Med* 2021;**10**:4086.
14. Boriani G, Palmisano P, Guerra F, Bertini M, Zanotto G, Lavalle C *et al.* Impact of COVID-19 pandemic on the clinical activities related to arrhythmias and electrophysiology in Italy: results of a survey promoted by AIAC (Italian Association of Arrhythmology and Cardiac pacing). *Intern Emerg Med* 2020;**15**:1445–56.
15. Mattioli AV, Cossarizza A, Boriani G. COVID-19 pandemic: usefulness of telemedicine in management of arrhythmias in elderly people. *J Geriatr Cardiol* 2020;**17**:593–6.
16. Schuuring MJ, Kauw D, Bouma BJ. COVID-19 pandemic: practical considerations on rapid initiation of remote care in chronic cardiac patients. *Eur Heart J Digit Health* 2020;**1**:8–9.
17. Gawałko M, Duncker D, Manninger M, van der Velden RMJ, Hermans ANL, Verhaert DVM *et al.* The European TeleCheck-AF project on remote app-based management of atrial fibrillation during the COVID-19 pandemic: centre and patient experiences. *Europace* 2021;**23**:1003–15.
18. Diemberger I, Vicentini A, Cattafi G, Ziacchi M, Iacopino S, Morani G *et al.* The impact of COVID-19 pandemic and lockdown restrictions on cardiac implantable device recipients with remote monitoring. *J Clin Med* 2021;**10**:5626.
19. Venturelli A, Vitolo M, Albini A, Imberti JF, Venturelli A, Menozzi M *et al.* How did COVID-19 affect medical and cardiology journals? A pandemic in literature. *J Cardiovasc Med (Hagerstown)* 2021;**22**:840–7.
20. Simovic S, Providencia R, Barra S, Kircanski B, Guerra JM, Conte G *et al.* The use of remote monitoring of cardiac implantable devices during the COVID-19 pandemic: an EHRA physician survey. *Europace* 2022;**24**:473–80.
21. Boriani G, Maisano A, Bonini N, Albini A, Imberti JF, Venturelli A *et al.* Digital literacy as a potential barrier to implementation of cardiology tele-visits after COVID-19 pandemic: the INFO-COVID survey. *J Geriatr Cardiol* 2021;**18**:739–47.
22. Garattini L, Badinella Martini M, Mannucci PM. Improving primary care in Europe beyond COVID-19: from telemedicine to organizational reforms. *Intern Emerg Med* 2021;**16**:255–8.
23. Linz D, Garcia R, Guerra F, Kommata V, Bollmann A, Duncker D. Twitter for professional use in electrophysiology: practical guide for #EPeeps. *Europace* 2021;**23**:1192–9.
24. Boriani G, Vitolo M, Diemberger I, Proietti M, Valenti AC, Malavasi VL *et al.* Optimizing indices of atrial fibrillation susceptibility and burden to evaluate atrial fibrillation severity, risk and outcomes. *Cardiovasc Res* 2021;**117**:1–21.
25. Ding EY, Marcus GM, McManus DD. Emerging technologies for identifying atrial fibrillation. *Circ Res* 2020;**127**:128–42.
26. Anderson M, Drummond M, Taylor D, McGuire A, Carter P, Mossialos E. Promoting innovation while controlling cost: the UK's approach to health technology assessment. *Health Policy* 2022;**126**:224–33.
27. Lowres N, Olivier J, Chao TF, Chen SA, Chen Y, Diederichsen A *et al.* Estimated stroke risk, yield, and number needed to screen for atrial fibrillation detected through single time screening: a multicountry patient-level meta-analysis of 141,220 screened individuals. *PLoS Med* 2019;**16**:e1002903.
28. Guo Y, Guo J, Shi X, Yao Y, Sun Y, Xia Y *et al.* Mobile health technology-supported atrial fibrillation screening and integrated care: a report from the mAFA-II trial long-term extension cohort. *Eur J Intern Med* 2020;**82**:105–11.

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29. Svennberg E, Friberg L, Frykman V, Al-Khalili F, Engdahl J, Rosenqvist M. Clinical outcomes in systematic screening for atrial fibrillation (STROKESTOP): a multicentre, parallel group, unmasked, randomised controlled trial. *Lancet* 2021;**398**:1498–506.
30. Boriani G, Palmisano P, Malavasi VL, Fantecchi E, Vitolo M, Bonini N *et al.* Clinical factors associated with atrial fibrillation detection on single-time point screening using a hand-held single-lead ECG device. *J Clin Med* 2021;**10**:729.
31. Uittenbogaart SB, Verbiest-van Gurp N, Lucassen WAM, Winkens B, Nielen M, Erkens PMG *et al.* Opportunistic screening versus usual care for detection of atrial fibrillation in primary care: cluster randomised controlled trial. *BMJ* 2020;**370**: m3208.
32. 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). *Eur Heart J* 2021;**42**:373–498.
33. Perez M V, Mahaffey KW, Hedlin H, Rumsfeld JS, Garcia A, Ferris T, *et al.* Large-scale assessment of a smartwatch to identify atrial fibrillation. *N Engl J Med* 2019;**381**: 1909–17.
34. Cheung CC, Gin KG, Andrade JG. Watch out: the many limitations in smartwatch-driven AF detection. *JACC Clin Electrophysiol* 2019;**5**:525–6.
35. Mairesse GH, Moran P, Van Gelder IC, Elsner C, Rosenqvist M, Mant J *et al.* Screening for atrial fibrillation: a European Heart Rhythm Association (EHRA) consensus document endorsed by the Heart Rhythm Society (HRS), Asia Pacific Heart Rhythm Society (APHRS), and Sociedad Latinoamericana de Estimulación Cardíaca y Electrofisiología (SOLAECE). *Europace* 2017;**19**:1589–623.
36. Khurshid S, Chen W, Singer DE, Atlas SJ, Ashburner JM, Choi JC *et al.* Comparative clinical effectiveness of population-based atrial fibrillation screening using contemporary modalities: a decision-analytic model. *J Am Heart Assoc* 2021;**10**:e020330.
37. Schnabel RB, Haeusler KG, Healey JS, Freedman B, Boriani G, Brachmann J *et al.* Searching for atrial fibrillation poststroke: a white paper of the AF-SCREEN international collaboration. *Circulation* 2019;**140**:1834–50.
38. Tarakji KG, Silva J, Chen LY, Turakhia MP, Perez M, Attia ZI *et al.* Digital health and the care of the patient with arrhythmia: what every electrophysiologist needs to know. *Circ Arrhythm Electrophysiol* 2020;**13**:e007953.
39. Hillmann HAK, Soltani S, Mueller-Leisse J, Hohmann S, Duncker D. Cardiac rhythm monitoring using wearables for clinical guidance before and after catheter ablation. *J Clin Med* 2022;**11**:2428.
40. Bufalino VJ, Bleser WK, Singletary EA, Granger BB, O'Brien EC, Elkind MSV *et al.* Frontiers of upstream stroke prevention and reduced stroke inequity through predicting, preventing, and managing hypertension and atrial fibrillation: a call to action from the value in healthcare initiative's predict & prevent learning collaborative. *Circ Cardiovasc Qual Outcomes* 2020;**13**:e006780.
41. Proietti M, Boriani G. Screening for atrial fibrillation in relation to stroke and mortality risk. *Thromb Haemost* 2022;**122**:171–5.
42. Brönneke JB, Müller J, Mouratis K, Hagen J, Stern AD. Regulatory, legal, and market aspects of smart wearables for cardiac monitoring. *Sensors (Basel)* 2021;**21**:4937.

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