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Arrhythmia burden, symptoms and quality of life in female and male endurance athletes with paroxysmal atrial fibrillation: a multicentre cohort study in Norway, Australia and Belgium

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ABSTRACT

Objectives To assess atrial fibrillation (AF) burden, symptoms and quality of life (QoL) in endurance athletes with paroxysmal AF.

Design Prospective cohort study.

Setting and participants Otherwise healthy endurance athletes with paroxysmal AF in Norway, Australia and Belgium. The current study presents baseline measurements collected before the intervention of a randomised controlled trial on effects of individually tailored training adaptation.

Methods AF burden (percentage time in AF) was measured by insertable cardiac monitors (Confirm Rx, Abbott). AF-related symptoms and QoL were assessed using the Atrial Fibrillation Effect on QualiTy-of-Life Questionnaire (AFEQT) with any score <80 defined as clinically relevant.

Results 43 athletes (age 57±10 (mean±SD), range 33–75 years, 3 women) were included. The athletes were monitored for 50±18 days. Median AF burden was 0.18% (IQR 0%–2.6%). Out of 29 athletes with at least one AF episode, 21 (72%) had AF episodes >60 min. 13 athletes (30%) had AFEQT overall score <80, indicating reduced QoL, and 23 athletes (53%) had significant symptoms. AF burden above median, and episodes >60 min were associated with reduced QoL (mean AFEQT score 78 vs 90, p=0.001 and 78 vs 90, p=0.001, respectively). There were large individual variations between the athletes concerning AF burden, symptoms and QoL.

Conclusions Although most athletes were still competing, more than half had troublesome symptoms. One-third had reduced QoL, which was associated with higher AF burden and longer duration of AF episodes. Variations between the athletes highlight the need for individually tailored AF management in athletes with paroxysmal AF.

Trial registration number NCT04991337.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The main strength is the use of insertable cardiac monitors for continuous monitoring of atrial fibrillation burden in endurance athletes with paroxysmal atrial fibrillation.
⇒ The well-defined cohort of athletes without other cardiovascular risk factors suggests the study has captured the exercise-associated atrial fibrillation phenotype.
⇒ The main limitation is the small sample size, which may influence the statistical findings with large variations between the athletes.
⇒ Despite efforts to recruit female athletes, women remained under-represented.

INTRODUCTION

Vigorous endurance exercise promotes atrial fibrillation (AF), the most common cardiac arrhythmia in athletes.[1 2] Previous studies have reported a prevalence of AF of between 13% and 29% in middle-aged and older male competitive endurance athletes with prolonged exposure to endurance exercise.[3–5] Although under-represented in most prior studies, female athletes seem to have a lower prevalence of AF compared with males.[6 7] The pathophysiology of AF in athletes is only partly understood but may include exercise-related electrical and structural atrial remodelling.[1 8] Compared with the general AF population, athletes more often present with paroxysmal AF and fewer comorbidities.[9–12] AF management in endurance athletes is often challenging due to intolerance to rate-controlling medications and concerns about

the proarrhythmic effects of antiarrhythmic drugs. Recurrent arrhythmias after AF ablation remain an issue,[13–16] leaving athletes with unsatisfactory symptom control and reduced health-related quality of life (QoL).[15–18]

Knowledge about how AF burden may affect symptoms and QoL is warranted to improve the management of AF in athletes, but few studies have addressed the clinical characteristics of this subgroup of AF patients. The aim of this study was to assess AF burden by continuous monitoring using insertable cardiac monitor (ICM), AF-related symptoms and QoL in female and male non-elite endurance athletes with prolonged exposure to endurance sports with clinical paroxysmal AF.

METHODS

Study design

The current study is a prospective cohort study including athletes recruited to participate in a randomised controlled trial (RCT), the Effect of Detraining in Endurance Athletes with Atrial Fibrillation (NEXAF Detraining) trial, clinical trial registration number NCT04991337.[19] The current study presents baseline measurements collected up until randomisation and before the intervention of the RCT began. Participants were enrolled between 5 January 2022 and 22 May 2024 at one of the five medical research facilities in the trial: Bærum Hospital, Bærum, Norway, St. Olavs Hospital, Trondheim, Norway, Baker Heart and Diabetes Institute, Melbourne, Australia, Jessa Hospital, Hasselt, Belgium and Leuven University Hospital, Leuven, Belgium. The participants were recruited among individuals who approached the study group using a weblink on the study webpage or were referred to one of the study centres (online supplemental figure 1).

Study population

Eligible athletes were female and male non-elite and veteran endurance athletes aged ≥18 years diagnosed with paroxysmal AF documented by ECG. To be included, the athletes had to report a minimum of two previous episodes of AF, including at least one during the past 6 months. Athletes with recurrent AF after AF ablation therapy were also included. Athletes were included if they were currently engaged in endurance sports such as running, swimming and rowing for a minimum of 5 hours/week or cycling and cross-country skiing for a minimum of 8 hours/week, or combinations of these sports or other comparable endurance sports.[20] Individuals with cardiovascular risk factors or other comorbid conditions were excluded. All inclusion and exclusion criteria are listed in online supplemental table 1.[19–23] The methods of the RCT NEXAF Detraining have been previously published.[19]

Assessments of AF burden and AF episodes

We continuously monitored AF using a wireless ICM (Confirm RxTM, Abbott, Sylmar, California, USA)

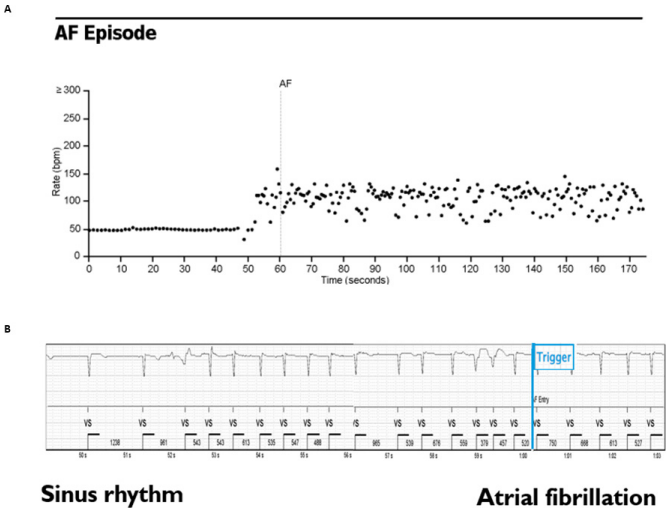

Figure 1 Insertable cardiac monitor (ICM) report from an endurance athlete in the study, demonstrating detection of an atrial fibrillation (AF) episode. (A) Time in seconds (x-axis) and heart rate in beats per minute (bpm) (y-axis). The report shows an initial regular heart rate of ~50 bpm, followed by a sudden change to complete irregular rhythm. (B) The corresponding EGM demonstrating initial sinus rhythm, followed by irregular rhythm that triggers the ICM to recognise the rhythm as AF.

programmed to detect and record AF episodes lasting ≥30 s (Graphical abstract).[5 14] The device connected via Bluetooth to a smartphone application. Summarised reports of data from the ICM were generated in the Abbott software Merlin.net. Experienced cardiologists (TA, GC, RW and ALG) adjudicated EGMs of episodes recognised as AF by the ICM (figure 1). We defined AF burden as the cumulative duration of AF episodes as a percentage of the total duration of monitoring.[14 24] The total number of AF episodes, numbers of episodes lasting >6 min, >60 min and >24 hours, and days with and without AF within the study period were also recorded. The current analyses were based on a minimum of 5 weeks of monitoring from ICM implantation up until the date of randomisation.

AF symptoms and QoL

The Atrial Fibrillation Effect on QualiTy-of-Life (AFEQT) Questionnaire was presented to all participants at the start of the baseline visit, before the physical testing and randomisation. AFEQT has a recall period of symptoms and QoL of 4 weeks.[25] It produces an overall score based on 18 items, providing a comprehensive picture of the patient's AF-related QoL, and subscale scores of symptoms (palpitations, irregular heartbeat, pause in heart activity, light-headedness or dizziness), daily activities (ability to practise recreational exercise and sports, hobbies and difficulties performing physical activities due to fatigue or shortness of breath), and treatment concerns (that AF may start any time or worsen the medical condition in the long run, worries about side effects of treatments). AFEQT consists of a 7-point horizontal response scale, with a '1' indicating 'not at all

bothered' and a '7' indicating 'extremely bothered'. The scores are calculated through specific formulas, with sum scores ranging from 0 to 100.[25] While a score of 0 corresponds to complete AF-related disability, a score of 100 corresponds to no AF-related disability. Based on previous literature, in the main analysis, we defined any score <80 as clinically relevant, and any score <60 as more severe AF-related impact on QoL and the subscale domains.[25 26] Given the high baseline fitness and health status of the study cohort, suggesting that smaller deviations might be clinically meaningful, we also performed analyses using an alternative AFEQT score cut-off <90.

Participants were classified according to the clinician-allocated semiquantitative modified European Heart Rhythm Association (mEHRA) classification.[14 27] A mEHRA class 1 corresponds to no symptoms, class 2a mild, class 2b moderate, class 3 severe and class 4 disabling symptoms.

Other variables

During the baseline visit, height and weight were measured and body mass index calculated as kg/m^2. We asked participants to complete a questionnaire containing the following questions: 'What is your primary endurance sport/activity?', 'In total, how many years have you practised regular endurance training?' (<10, 10–19, 20–29, 30–39 or 40 years or more), 'Do you participate in competitive endurance sports or activities?', 'During an average week in the past 6 months: How many hours of endurance exercise did you complete?'. These questions have previously been used in studies of endurance athletes with and without AF.[4 28] We obtained self-reports about medication and previous or planned AF ablation therapy. Cardiopulmonary exercise testing was performed using predefined continuous ramp bicycle protocols to determine maximal oxygen consumption (VO_2max).[19]

Statistical analyses

We analysed AF burden, number and duration of AF episodes, and associations with AFEQT scores using the statistical software R V.4.4.1 (R Foundation for Statistical Computing, Vienna, Austria). Continuous variables are presented as means±SD for normally distributed variables, medians (IQR) for non-normally distributed variables, and categorical variables as frequencies and percentages (%). We report mean AFEQT scores by categories of AF burden applying thresholds used in previous studies; >6 min, >60 min, >24 hours, by percent AF (0%, 0,1%–1% and >1%),[29 30] and in categories dichotomised by median AF burden. We assessed differences in AFEQT across subgroups using analysis of variance and/or covariance. For AF burden, time in AF and number of AF episodes, a Mann-Whitney U test was used to compare differences across dichotomised groups due to non-normal distribution of these measures. While the main analyses were performed for the entire cohort, we also report the results of sensitivity analyses after excluding participants without AF episodes during the study period.

A multiple regression model was also fitted with AFEQT as the outcome and AF burden as the predictor of interest, adjusting for the potentially confounding covariates age, sex, fitness level and weekly training hours. We considered a two-tailed p<0.05 statistically significant.

Patient and public involvement

The user group of the NEXAF Detraining study consists of two members from a user panel, two study participants included at Bærum Hospital, and a representative from the Norwegian Health Association.

RESULTS

Participants' characteristics

Table 1 shows the characteristics of the 43 athletes included.

The athletes were currently practising 7 hours per week of endurance exercise. 27 (63%) had performed regular endurance exercise for ≥30 years. 32 (74%) were still involved in regular competition. The female athletes reported ≥30 years of regular endurance and demonstrated outstanding fitness with absolute numbers of VO_2max comparable to the males. Most athletes (93%) were classified as mild to moderately symptomatic (mEHRA class 2a or 2b). None of the participants used rate or rhythm controlling drugs on a daily basis. Six athletes (14%) were previously treated with AF ablation, 2 of them twice and 10 athletes were on an AF ablation waiting list.

AF burden

The athletes were monitored with ICM for an average of 50±18 days and experienced a median of 3 (IQR 0–21) episodes of AF, ranging from 0 to 387. The median AF burden was 0.18% (IQR 0–2.6%). A total of 29 athletes (67%) experienced at least one AF episode, of whom three athletes had only short episodes with a duration ≤6 min. 21 (72% of those with any AF) experienced at least one AF episode with duration >60 min. Compared with athletes with only shorter episodes, athletes with episodes >60 min had significantly higher median AF burden 2.62% (IQR 1.09–4.45) vs 0% (IQR 0–0.01), p<0.001 and higher median number of AF episodes 21 (IQR 9–49) vs 0 (IQR 0–1), p<0.001 (online supplemental table 2). One athlete had an AF episode lasting >24 hours (~34 hours). The median number of days with and without AF episodes was 5 (IQR 1–16) and 35 (IQR 29–54), respectively.

Only one female athlete had AF during the study period (mean AF burden for female athletes 2.98%, median 0, ICR 0–4.47).

Symptoms and QoL

The mean AFEQT overall score was 84±13 (table 2).

13 athletes (30%) had an AFEQT overall score <80, suggesting reduced QoL, of whom 5 scored

Table 1 Characteristics of female and male endurance athletes with paroxysmal AF (n=43) participating in the study

Characteristics	All (n=43) Mean±SD	Female (n=3) Mean±SD	Male (n=40) Mean±SD
Age, years	57±10	63±7	57±10
Body height, cm	182±8	171±4	182±7
Body mass index, kg/m^2	24.1±2.4	21.1±0.3	24.4±2.3
Systolic blood pressure, mm Hg Diastolic blood pressure, mm Hg	129±12 76±9	139±11 85±9	128±12 76±9
Resting heart rate, beats per minute	52±8	50±10	52±8
Current training load, hours/week*	6.8±2.2	6.3±1.2	6.8±2.3
VO_2max, mL/kg/min	44.1±7.5	40.9±5.3	44.1±5
VO_2max of predicted values,† %	152±23	192±12	149±21
	n (%)	**n (%)**	**n (%)**
mEHRA class			
1–No symptoms	3 (7)	0 (0)	3 (8)
2a–Mild symptoms	15 (35)	1 (33)	14 (35)
2b–Moderate symptoms	25 (58)	2 (67)	23 (58)
3–Severe symptoms	0 (0)	0 (0)	0 (0)
4–Disabling symptoms	0 (0)	0 (0)	0 (0)
Primary sport‡			
Cycling	16 (37)	0 (0)	16 (40)
Cross-country skiing	12 (28)	1 (33)	11 (28)
Running	10 (23)	2 (67)	8 (20)
Other	5 (12)	0 (0)	5 (12)
Participating in competitive sports	32 (74)	1 (33)	31 (78)
Cumulative training load (years)‡			
<10	5 (12)	0 (0)	5 (13)
10–19	8 (19)	0 (0)	8 (20)
20–29	3 (7)	0 (0)	3 (8)
30–39	11 (26)	1 (33)	10 (25)
>40	16 (37)	2 (67)	14 (35)
AF ablation			
Previous AF ablation§	6 (14)	0 (0)	6 (15)
On waiting list for AF ablation	10 (23)	0 (0)	10 (25)

*Self-reported weekly endurance exercise past 6 months.
†Predicted values based on age, sex, body height and weight (Wasserman/Hansen formula).[35]
‡Self-reported.
§Two participants were AF ablated twice.
AF, atrial fibrillation; mEHRA, Modified European Heart Rhythm Association; VO_2max, maximal oxygen consumption.

<60, indicating more severely reduced QoL. The mean AFEQT symptom score was 78, and 23 athletes (53%) scored <80, indicating clinically relevant AF symptoms. 10 athletes (23%) scored <60, suggesting severely symptomatic AF. Daily activities were affected in 12 athletes (28%), and 9 athletes (21%) had significant treatment concerns.

In a sensitivity analysis including only the 29 athletes with at least one AF episode during the study period, the mean AFEQT overall and symptom scores were 81 and 74, respectively, and thus comparable to the main analysis. The numbers (proportions) with scores <80 were 12 (41%) for the AFEQT overall score and 18 (62%) for the symptom score.

Using AFEQT-scores <90 as alternative cut-off to define clinically relevant deviations, 25 (58%) had reduced QoL, 29 (67%) experienced clinically relevant symptoms, with 18 (42%) and 25 (58%) having affection of daily activities and treatment concerns, respectively.

Table 2 Means and categories of the Atrial Fibrillation Effect on QualiTy-of-Life (AFEQT) Questionnaire overall and subscale scores in endurance athletes with clinical paroxysmal atrial fibrillation (n=43)

AFEQT Scores	Mean±SD	Score ≥80 n (%)	Score 79–60 n (%)	Score <60 n (%)
Overall score	84±13	30 (67.7)	8 (18.6)	5 (11.6)
Subscale scores				
Symptom	78±18	20 (46.5)	13 (30.2)	10 (23.3)
Daily activities	86±18	31 (72.1)	7 (16.3)	5 (11.6)
Treatment concerns	86±12	34 (79.1)	6 (13.9)	3 (7.0)

Scores <80 were defined as clinically relevant, scores <60 were defined as more severely reduced quality of life/more severe symptoms.

The mean AFEQT overall and subscale scores for the female participants were >90 (online supplemental table 3).

Relationship between AF, symptoms and QoL

Including athletes without AF episodes, athletes with AF burden above compared with below the median had a lower mean AFEQT overall score (77.9 vs 90.3, beta 12.5, 95% CI 5 to 19.5, p=0.001, model R^2=0.21). Figure 2 shows mean AFEQT overall scores across categories of AF burden, indicating a significantly lower QoL with increasing AF burden, with 13.1 points lower AFEQT overall score for AF burden >1% compared with no AF (95% CI 4.2 to 22.0, p=0.006). This difference remained significant in a multiple regression model adjusting for age, sex, VO_2max, previous ablation and weekly training hours (beta 12.5, 95% CI 1.7 to 23.4, p=0.03) (online supplemental table 4).

AFEQT scores did not differ between athletes with number of AF episodes below vs above the median (mean scores 81.5 vs 86.9, beta 5.4 95% CI −2.5 to 13.3, p=0.19, model R^2=0.02). Athletes with any AF episode lasting >60 min had a significantly lower AFEQT overall score compared with athletes with only episodes ≤60 min, with mean scores of 78 vs 90 (beta −12.4, 95% CI −19.5 to −5.3, p=0.001, model R^2=0.20) (figure 3). This difference was still significant after adjustment for time in AF and number of AF episodes (beta −18.2, 95% CI −28.4 to −8.0, p=0.001, model R^2=0.21), indicating that episode duration >60 min may be associated with reduced QoL.

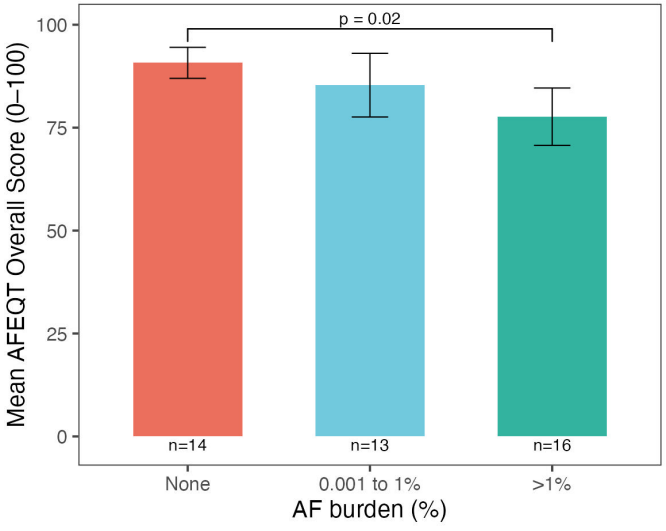

Figure 2 Mean Atrial Fibrillation Effect on QualiTy-of-Life Questionnaire (AFEQT) overall scores (0–100) across three categories of atrial fibrillation (AF) burden (percent of time in AF) in endurance athletes with paroxysmal AF; (0% (n=14), 0.001%–1% (n=13) and >1% (n=16).

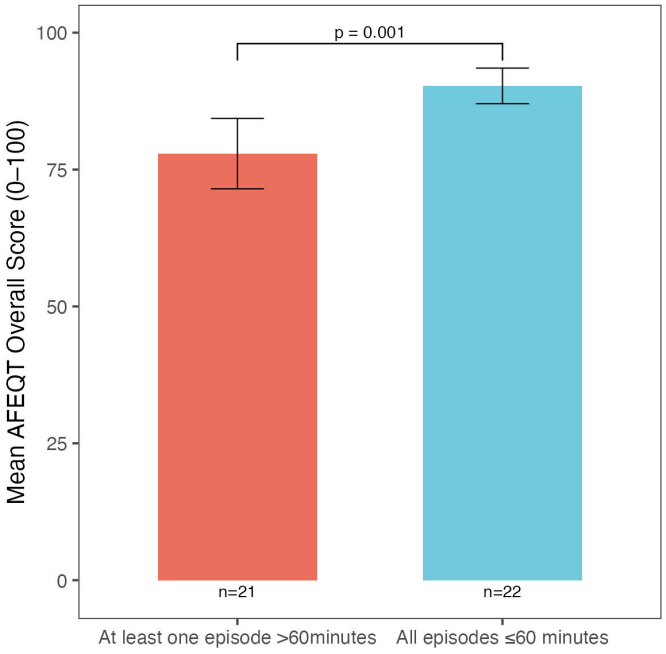

Figure 3 Mean Atrial Fibrillation Effect on QualiTy-of-Life Questionnaire (AFEQT) overall scores (0–100) in endurance athletes with paroxysmal atrial fibrillation (AF) (n=43) across categories of at least one AF episode lasting >60 min (n=21) or all episodes with duration ≤60 min (n=22).

In the sensitivity analysis excluding athletes without any AF episodes, the AFEQT overall score did not differ significantly between athletes with AF burden above versus below the median (beta 4.9, 95% CI −5.7 to 15.5, p=0.37) or between those with number of episodes above or below the median (beta 3.6, 95% CI −7.1 to 14.3, p=0.51).

Days with AF were not associated with AF-related QoL (data not shown). There was no significant association between AFEQT symptom subscale score and AF burden, AF episode duration or number of episodes (online supplemental table 2 and figure 2), or between ablated versus non-ablated athletes in terms of symptoms or QoL.

Individual data on ICM-detected AF burden and AFEQT overall scores for each of the 43 athletes are shown in figure 4. Both AF burden, symptoms and QoL varied largely between the studied athletes.

DISCUSSION

To our knowledge, this is the first study to report symptoms, QoL and continuously monitored AF burden using

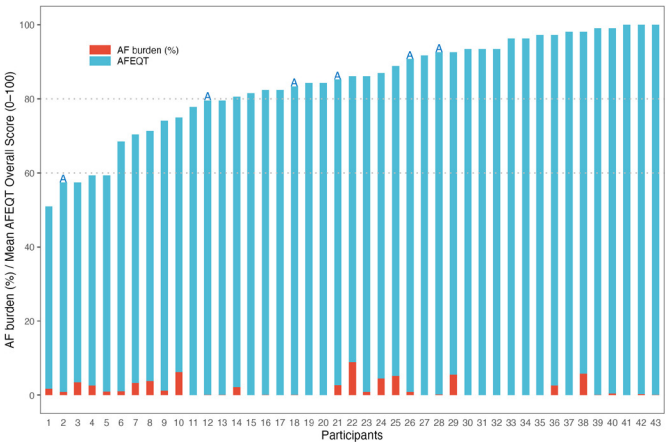

Figure 4 Atrial fibrillation (AF) burden in % (red columns), Atrial Fibrillation Effect on QualiTy-of-Life Questionnaire (AFEQT) overall scores range 0–100 (blue columns) and history of previous AF ablation (marked with an 'A') for each of the 43 endurance athletes participating in the study.

ICMs in endurance athletes diagnosed with AF. Due to strict eligibility criteria, none of the athletes had other AF-related risk factors, providing a description of symptoms and QoL in relation to the athletes' arrhythmia without the confound of comorbidities. Despite a relatively low median AF burden of 0.18%, one-third of the athletes experienced reduced AF-related QoL, and a majority had clinically relevant symptoms (AFEQT-score<80), with one out of four being more severely symptomatic (AFEQT-score <60).

The extraordinarily high fitness and health status of the athletes studied might suggest that even smaller deviations from an optimal AFEQT score of 100 are clinically meaningful. Explorative analysis using AFEQT-scores <90 as alternative cut-off indicates that more than half had reduced AF-related QoL and two out of three had clinically relevant symptoms.

A higher AF burden and a duration of AF episodes of more than 60 min were associated with lower overall AFEQT scores. Although the relatively small sample size prevents conclusions about causality, this may indicate a larger impact on QoL compared with those with a lower AF burden and shorter AF episodes. These results correspond well with a study by Andrade *et al*, including non-athletic patients treated with AF ablation, in which healthcare utilisation and QoL were associated with higher AF burden and duration of AF episodes.[29] On the other hand, while some athletes experienced symptoms and reduced QoL despite a very low AF burden, others were less affected despite a higher AF burden (figure 4), underlining the importance of including symptoms and QoL as additional endpoints of interest in studies measuring device-monitored AF burden.

There was a marked variability in the degree of AF symptoms ranging from more classical symptoms, such as palpitations, light-headedness or dizziness, to impairment in performing tasks of daily living and reduced QoL. Some athletes were also concerned about the implications of treatments on their long-term health. In line with the results of our study, in a previous study among 80 male veteran skiers with AF, the majority experienced symptoms such as palpitations and one out of five experienced poor health related to their AF.[12]

Endurance exercise is associated with an increased risk of developing AF, in particular occurring in middle-aged and older veteran endurance athletes,[1 3 4] probably because of cardiac adaptations to a high training load over time. A common limitation of previous studies is the inability to rule out other causes of AF, such as hypertension and other cardiovascular risk factors. Furthermore, in many studies, AF diagnosis was based on self-reports. As different phenotypes of AF may need different management strategies, including different recommendations regarding exercise, the thorough phenotyping of the athletes is a main advantage of this study. The athletic lifestyle and participation in competitive sports may contribute to our findings that a majority experienced AF-related physical and psychological limitations independent of their AF burden. Present AF guidelines give divergent exercise recommendations for athletes with AF, which may lead to wrestling internal conflicts on whether the continuation of vigorous exercise might worsen their arrhythmia.

Clinical implications

This study revealed large variations in terms of both AF burden, symptoms, QoL and level of activity after an AF diagnosis, advocating for individually tailored AF management in athletes with paroxysmal AF. The study provides indicative data on the impact of AF burden and duration of AF episodes on symptoms and QoL, suggesting that AF burden monitoring may be useful in athletes with AF. Moreover, AF burden is associated with downstream events, including stroke and heart failure.[31] Due to side effects such as lethargy and the negative impact on exercise capacity, rate-controlling drugs are often poorly tolerated in athletes.[20] Rate-controlling and rhythm-controlling drugs were only used occasionally in some athletes as pill-in-the-pocket. Recently published guidelines suggest early rhythm control with pulmonary vein isolation as a reasonable first-line treatment in symptomatic AF athletes without structural heart disease.[13 24] In our study, >50% of the athletes were classified mEHRA Class 2b, which has been suggested as an appropriate threshold for considering interventions such as AF ablation.[27] Studies have shown that AF recurrence-free rate after a first AF ablation for paroxysmal AF is similar for athletes and non-athletes, with 1-year freedom from AF of approximately 75%, but 3-year freedom somewhat lower.[15 17 18 30] Six of the athletes in our study had recurrent AF after previous AF ablation therapy, and two of them had been ablated twice. Athletes with recurrent AF after previous AF ablation did not differ from non-ablated athletes concerning AF burden, symptoms or QoL, but the small numbers limit the ability to draw conclusions about subgroup differences. The current study demonstrates

that recurrent AF after ablation therapy is a clinical challenge in some athletes and highlights the need to explore alternative strategies to manage AF in athletes. The ongoing RCT NEXAF might provide data on the impact of training adaptation as a viable non-invasive option to reduce AF burden or improve QoL in this group.[19]

More than one out of four athletes experienced reduced ability to perform daily activities related to their arrhythmia. Our clinical experience is that some athletes are forced to reduce their training, but due to the inclusion criteria of the study, all athletes were still performing endurance exercise for several hours per week. Exercise is highlighted as a pillar of modern AF management, but guidelines lack specific exercise recommendations for athletes with AF.[5 24] Traditionally, many clinicians advocate 'detraining' for athletes diagnosed with AF. Tensions related to balancing the desire to continue training after a diagnosis of AF were identified as a common complaint in recently published interview-based qualitative study including 10 middle-aged male endurance athletes with paroxysmal AF.[32 33] Hopefully, data from RCTs and prospective studies could aid the development of more specific exercise recommendations in athletes with AF.[19]

The main strength of the study is the use of ICMs for continuous AF monitoring. Moreover, the study included a well-defined cohort of high-performing athletes without other cardiovascular risk factors, suggesting the study has truly captured the exercise-associated AF phenotype. The multicentre design, and the inclusion of male and female athletes practising a variety of sports, suggest that the results may be generalised to other endurance athletes with clinical paroxysmal AF.

Limitations

The main limitation is the relatively small sample size which limits the ability to conclude about causality and subgroup differences. Participants were self-selected via online outreach or referral, which might have favoured motivated or symptomatic people, affecting QoL and symptom reporting. Furthermore, the 4-week recall period of AFEQT is a limitation since athletes typically present with short and rare AF episodes. Thus, symptom and QoL ascertainment may not accurately capture recent AF episodes. Under-representation of female athletes is another important limitation of the study. Very few studies have addressed AF in female athletes, but previous studies have demonstrated that inclusion of female athletes diagnosed with AF is challenging.[6 7] We believe that the lower prevalence of AF in female compared with male athletes is the main explanation and argue that publication of even small numbers of female phenotypes and outcomes is important to improve knowledge and to enable future meta-analyses.[34] Female athletes were encouraged to participate through recruitment campaigns; however, only 13 women approached the study group with interest to participate, of whom 3 were eligible. Females included had concerns about not being fit enough for the study, suggesting female athletes may have lower self-confidence than men regarding their physical fitness and, therefore, are reluctant to participate in exercise studies. Under-representation of female athletes in sports cardiology leads to inferior knowledge which may affect the base to inform clinical management. Future studies should systematically assess reasons for females to refrain from participation, to gain more knowledge about the obstacles. The increasing female participation in endurance sports events may help achieve a more balanced representation in future studies. Additionally, the use of sport event participation lists, athlete networks or athlete federations may be effective recruitment strategies. Finally, the homogeneity of a high-performing sports cohort without comorbidities improves internal validity but restricts external validity and application to other AF groups like female athletes and individuals with cardiovascular comorbidities.

CONCLUSIONS

Despite a relatively low AF burden, most athletes experienced clinically relevant AF-related symptoms and one-third had reduced AF-related QoL. A higher AF burden and duration of AF episodes >60 min were associated with more reduced QoL. Symptoms and QoL varied largely between the athletes studied, highlighting the importance of clinicians recognising the athletic lifestyle of these otherwise healthy AF patients, and the need for individually tailored AF management.

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