Atrial fibrillation in athletes and general population
A systematic review and meta-analysis

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Abstract
Background: Atrial fibrillation (AF) is the most common type of heart arrhythmia, but the impact of long-term, high-intensity endurance exercise on the risk of AF remains uncertain.

Methods: PubMed, EMBASE, and Cochrane library databases were searched till Nov 2017 to retrieve the articles. The included studies were summarized, pooled odds ratio (OR) and its 95% confidence interval (CI) were calculated. Both fixed and random effects models were used to combine the data. Stratified and logistic meta-regression analyses were performed to explore the sources of heterogeneity across studies.

Results: Nine studies including 2308 athletes and 6593 controls were eligible. Our results showed that the risk of AF was significantly higher in athletes than in general population (OR = 2.34, 95% CI = 1.04–5.28, $P_{\text{heterogeneity}}<0.01$, $I^2 = 92.3\%$). Subgroup analysis based on gender and mean age demonstrated a significantly increased risk in men (OR = 4.03, 95% CI = 1.73–9.42, $P_{\text{heterogeneity}}<0.01$, $I^2 = 82.7\%$) and participants with mean age < 60 (OR = 3.24, 95% CI = 1.23–8.55, $P_{\text{heterogeneity}}<0.01$, $I^2 = 84.3\%$). Furthermore, subgroup analysis based on type of athletes demonstrated a significantly increased risk of AF in participants with single type of sport (OR = 3.97, 95% CI = 1.16–13.62, $P_{\text{heterogeneity}}=0.018$, $I^2 = 70.4\%$). Results remained unchanged after performing sensitivity analysis. Meta-regression showed that gender, age, type of study, sample size, and sports mode were unrelated to heterogeneity.

Conclusion: Our study confirmed that the risk of AF was significantly higher in athletes than in general population, especially among men and participants aged < 60.

Abbreviations: AF = atrial fibrillation, CI = confidence interval, OR = odds ratio, STROBE = Strengthening the Reporting of Observational Studies in Epidemiology.

Keywords: atrial fibrillation, general population, meta-analysis, systematic review

1. Introduction
Atrial fibrillation (AF) is the most commonly encountered type of heart arrhythmia in clinical practice, and its prevalence increases with advancing age.\textsuperscript{[1,2]} In general population, the average prevalence of AF was 0.5% in subjects aged 45 to 54 years, about 1% in 54 to 64 years, and 4% in 65 to 74 years.\textsuperscript{[2]} The Framingham Heart Study and other studies have identified male sex, advancing age, diabetes mellitus, hypertension, heart failure, obesity, myocardial infarction (MI), valve disease, and alcohol consumption as main risk factors for AF.\textsuperscript{[3–6]}

Growing evidence strongly supports the cardiac risk factor modification, which includes increasing cardio-pulmonary fitness (such as traditional modificable cardiac risk factors, weight loss, and exercise) for the management of AF.\textsuperscript{[7–10]} It was speculated that long-term endurance exercise practice may promote changes in the cardiac structure, increase vagal tone, bradycardia, inducing AF.\textsuperscript{[11–14]} The grading benefits of exercise on cardiovascular health and mortality have been demonstrated in several observational and cohort studies.\textsuperscript{[15–18]} However, there is considerable uncertainty about the impact of long-term, high-intensity endurance exercise on the risk of AF. Therefore, we conducted this systematic review and meta-analysis to quantitatively assess the risk of AF in athletes and general population.

2. Materials and methods
The present meta-analysis was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines.\textsuperscript{[19]}

2.1. Search Strategy
An extensive searching through PubMed, Embase, Cochrane Library Databases (most recently updated in 2017 November),
using the search terms “AF”, “athletes”, and “endurance exercise” was done. Two reviewers independently performed the search and any disagreements regarding the eligibility were resolved through discussion. There were no search limitations concerning publication language and study design but limited to observational studies. We tried to identify potentially relevant studies from the whole reference lists by orderly reviewing title, abstract and full text.

### 2.2. Selection criteria

The inclusion criteria were as follows:

1. Case-control or cohort studies that focused on the association of endurance exercise and AF;
2. Comparison of athletes group with non-athletes group (control);

Studies were excluded for the following reasons:

1. unpublished papers, reviews, and duplication of publications;
2. data unavailable for AF;
3. no control population. If more than 1 article was published using the same case series, we selected the study with the largest sample size.

### 2.3. Data extraction and quality assessment

All the available data were extracted from each study by 2 investigators independently according to the inclusion criteria listed above. For each study, we recorded the first author, year of publication, country of origin, gender, mean age, study design, sports mode, follow-up time, the number of cases and controls, and outcomes. Any disagreement was resolved by discussing with the third expert. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations were followed on the methodological evaluation of what should be included in an accurate and complete report of observational studies. The STROBE statement is a checklist of 22 items that are essential for good reporting of observational studies (Table 2). These items relate to the article’s title and abstract (item 1), the introduction (items 2 and 3), methods (items 4–12), results (items 13–17), discussion sections (items 18–21), and other information (item 22 on funding).

### 2.4. Statistical analysis

The pooled odds ratio (OR) with corresponding 95% confidence interval (CI) was estimated. Heterogeneity of the studies was assessed using the Cochran Q test and was quantified by I² statistic (considered high heterogeneity for I² >50%). Preliminary analysis was performed using a fixed effects model (Mantel–Haenszel method) and using a random effects model (Der Simomian and Laird) if there is high heterogeneity. To explore the sources of heterogeneity across studies, we did stratified and logistic meta-regression analyses. Relative influence of each study on the pooled estimate was assessed by omitting 1 study at a time for sensitivity analysis. Publication bias was evaluated by visual inspection of symmetry of funnel plot and assessment of Begg and Egger test. Statistical analyses were done using STATA software, version 12.0 (STATA Corp., College Station, TX). P < .05 were considered as representative of statistical significance and all tests were 2-sided.

### Table 1

Characteristics of the studies included in this meta-analysis.

| Authors/year of publication | Country | Male (%) | Mean age | Study design | Sports mode | Follow-up time | Atrial fibrillation/athletes (N) | Atrial fibrillation/general population (N) | Outcomes |
|----------------------------|---------|----------|----------|--------------|-------------|----------------|----------------------------------|---------------------------------------------|----------|
| Karjalainen/1998           | Finland | 100      | 49.6 ± 5.3Y | Case-control | Top-level orienteers (runners) | NA             | 12/228                          | 2/212                                       | Prevalence of AF |
| Ellosa/2006                | Spain   | 100      | 43.2 ± 11.9Y | Case-control | Mixed, mainly aerobic cyclist | NA             | 16/31                           | 3/129                                       | Prevalence of AF |
| Heidbuchel/2006            | Belgium | 83       | 53 ± 9.0Y  | Cohort       | Mixed sports | 2.5Y           | 25/31                           | 51/106                                      | Prevalence of AF |
| Balnesberger/2008          | Switzerland | 100    | 66 ± 6Y   | Case-control | Former Swiss elite cyclists | 30–50Y         | 6/62                           | 0/62                                        | Prevalence of AF |
| Molina/2008                | Spain   | 100      | 66 ± 7Y   | Cohort       | Marathon runners | 11.6Y         | 9/183                          | 2/290                                       | Prevalence of AF |
| Mont/2008                  | Spain   | 100      | 47.8 ± 10.9Y | Case-control | Mixed sports | NA             | 83/120                         | 24/96                                       | Prevalence of AF |
| Mozaffarian /2008          | USA     | 42       | 72.8 ± 5.6Y | Cohort       | Mixed sports | NA             | 121Y                           | 127/477                                     | Prevalence of AF |
| Myrstad/2014               | Norway  | 100      | 68.9Y     | Cross-sectional study | Cross-country ski racing | NA              | 66/509                         | 183/1807                                 | Prevalence of AF |
| Sun/2015                   | China   | 46       | 53.8Y     | Cross-sectional study | Mixed sports | NA             | 6/639                          | 75/3354                                    | Prevalence of AF |

AF = atrial fibrillation, NA = not available, USA = United States of America, Y = years.
Table 2
Methodological quality of included studies (STROBE criteria).

| Variables                  | Karjalainen/1998 | Elosua/2006 | Heidbchel/2006 | Baldesberger/2008 | Molina/2008 | Mont/2008 | Mozaffarian/2008 | Myrstad/2014 | Sun/2015 |
|---------------------------|------------------|-------------|----------------|-------------------|-------------|-----------|-----------------|--------------|----------|
| Title/abstract            | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Introduction              | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Background/rationale      | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Objectives                | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Methods                   | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Study design              | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Setting                   | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Participants              | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Variables                 | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Data sources/Measurement  | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Bias                      | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Study size                | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Quantitative variables    | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Statistical methods       | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Results                   | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Participants              | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Descriptive data          | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Outcome data              | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Main results              | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Other analyses            | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Discussion                | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Key results               | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Limitations               | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Interpretation            | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Generalizability          | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |
| Funding information       | ★★               | ★★          | ★★             | ★★                | ★★          | ★★        | ★★              | ★★           | ★★       |

3. Results

3.1. Study selection

From our electronic search, we identified a total of 356 studies (Fig. 1). We found an additional 3 studies by hand searching from the reference lists of other review articles. Of these, 323 studies were excluded after removing the duplicates. Two hundred and 72 irrelevant records were excluded by screening the titles and abstracts. Of the remaining 51 papers, 30 articles were excluded due to letters, reviews, and meta-analysis. Twenty-one titles and abstracts. Of the remaining 51 papers, 30 articles were excluded, 7 are without control and 5 presented unusable data. Finally, 9 observational studies with 8901 participants according to the inclusion criteria were included in our study.

3.2. Characteristics of the studies

Nine studies assessed 8901 participants, including 2308 athletes and 6593 controls. Study characteristics are summarized in Table 1. The included studies were published between 1998 and 2015. The number of participants per study ranged from 124 to 3993. The mean age of the patients in each study varied between 39 and 72.8. Methodological quality of observational studies included in the meta-analysis was shown in Table 2. In the 9 observational studies, 8 studies presented statistical methods, 7 studies adequately described their study limitations in the discussion, and 8 presented their funding sources.

3.3. Quantitative synthesis

Overall, the risk of AF was significantly higher in the athletes group than in controls (OR = 2.34, 95% CI = 1.04 to 5.28, \(P_{\text{heterogeneity}} < .001, I^2 = 92.3\%\), Fig. 2).

3.4. Evaluation of heterogeneity

Subgroup analysis based on gender demonstrated a significantly increased risk in men (OR = 4.03, 95% CI = 1.73 to 9.42, \(P_{\text{heterogeneity}} < .001, I^2 = 82.7\%\), Fig. 3A). Based on the mean age, significant result was obtained for the mean age group of <60 (OR = 3.24, 95% CI = 1.23–8.55, \(P_{\text{heterogeneity}} < .001, I^2 = 84.3\%\), Fig. 3B). In the subgroup analysis based on study type, a significant risk was found in the case-control group (OR = 5.30, 95% CI = 3.07–8.46, \(P_{\text{heterogeneity}} = .343, I^2 = 10\%\), Fig. 3C). Based on the sample sizes, the group with sample sizes <300 demonstrated significant results (OR = 4.91, 95% CI = 3.08–7.84, \(P_{\text{heterogeneity}} = .341, I^2 = 10.4\%\), Fig. 3D). In the subgroup analysis based on sports mode, a significantly increased risk was found in the group with single type (OR = 3.97, 95% CI = 1.16–13.62, \(P_{\text{heterogeneity}} = .018, I^2 = 70.4\%\), Fig. 3E). There was heterogeneity among studies in overall comparisons and also subgroup analyses. To explore the sources of heterogeneity across studies, we assessed mean age and sample size by logistic meta-regression analysis. Meta-regression analyses revealed that age (\(P = .131\), Fig. 4A) did not explain the heterogeneity across studies, but sample size (\(P = .044\), Fig. 4B) was partly associated with heterogeneity among the studies.

3.5. Sensitive analysis

Sensitivity analyses were performed to assess the influence of individual study on the pooled ORs by sequential removing each eligible study. As seen in Figure 5, omission of any single study showed no change in the overall statistical significance, indicating that our results are statistically robust.
3.6. Publication bias
Begg funnel plot and Egger test were performed to assess publication bias among the literature. As shown in Figure 6, there was no evidence of publication bias (Begg test \( P = .754 \); Egger test \( P = .144 \)).

4. Discussion
To the best of our knowledge, this is the largest study reported so far that analyzed data from 9 trials with 8901 participants and evaluated whether the risk of AF was higher in athletes compared to general population. Our results showed that the risk of AF was significantly higher in athletes than in general population. A consideration is that the average age of our study population ranged from 39 to 72.8 years, where the age range was larger compared to the studies that demonstrated an increased AF risk with exercise. One study that reported an increased risk of lone AF with vigorous exercise also demonstrated that the increased risk disappeared among participants >50 years of age.\[16\] Subgroup analysis based on mean age showed significant result only for the Mean age group of <60 in this systematic review and meta-analysis. Furthermore, a recent study\[17\] demonstrated that in patients >75 years, AF was more likely to be asymptomatic. Early studies of athletes with arrhythmias showed that most athletes were young, male, and competitive in the elite level.\[12,33\] About 25 percent of these arrhythmias were AF. Some case-control studies examined lone AF patients clinically\[25,34\] or in emergency department.\[28\] In these studies, ORs of AF in patients who performed vigorous exercise ranged from 3.13 to 15.11. Again, most of the patients were male. This systematic review and meta-analysis have included general population and athletes, and have examined both men and women, with mean age ranging between 39 and 72.8 years old.

The risk of AF in athletes and general population has been investigated by previous meta-analysis studies. Recently, Abdulla et al\[15\] conducted a systematic review and meta-analysis about the risk of AF in athletes and non-athletes. Results demonstrated that the risk of AF was significantly higher in athletes compared...
Figure 2. Risk of incident AF in athletes compared with general population. AF = atrial fibrillation.

Figure 3. Subgroup analysis of risk of incident AF in athletes compared with general population. A) Gender; B) Mean age; C) Study design; D) Sample size; E) Sports mode. AF = atrial fibrillation.
to non-athletes. These results are entirely consistent with our study findings. Compared with Abdulla's work, we identified more eligible studies and performed a detailed subgroup analysis. The study carried out by Abdulla et al consisted of only 6 studies with a total of 695 cases and 895 controls, while our study analyzed data from 9 studies with 2308 athletes and 6593 non-athletes. Our study population included not only men but also women. Furthermore, our systematic review and meta-analysis demonstrated that the risk of AF was significantly higher in athletes compared with general population, especially in male athletes <60 years old.

Heterogeneity is a potential problem when interpreting the results of meta-analyses. In this meta-analysis, heterogeneity was found in overall comparison and subgroup analyses, and thus, the random-effects model was used. The “sample size” partly explained the heterogeneity across studies by logistic meta-regression analyses. There may be other reasons accounting for the heterogeneity in the risk of AF. Nevertheless, sensitivity analysis proved that our meta-analysis results were statistically reliable.

5. Limitations
First, the included studies in the athletic populations were of small size and not randomized controlled in nature. Second, the studies demonstrated significant heterogeneity. To explore the sources of heterogeneity across studies, we did stratified and logistic meta-regression analyses. The heterogeneity might be partially due to the differences in gender, mean age, and sample size. Third, few studies had AF determined by self-reported questionnaires, which might lead to an underestimation of the events.

5.1. Future directions
Future well-designed large studies are necessary to clarify the risk of AF in athletes compared with general population.
6. Conclusion

In summary, our results demonstrated that the risk of AF was significantly higher in athletes than in general population, especially among men aged <60.

Author contributions

Conceptualization: Xiangdan Li.
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References

[1] Go AS, Hylek EM, Phillips KA, et al. Prevalence of diagnosed atrial fibrillation in adults: national implications for rhythm management and stroke prevention: the anticoagulation and risk factors in atrial fibrillation (ATRIA) study. JAMA 2001;285:2370–5.
[2] Feinberg WM, Blackshear JL, Laupacis A, et al. Prevalence, age distribution, and gender of patients with atrial fibrillation. Analysis and implications. Arch Intern Med 1995;155:469–73.
[3] Benjamin EJ, Levy D, Vaziri SM, et al. Independent risk factors for atrial fibrillation in a population-based cohort. The Framingham Heart Study. JAMA 1994;271:840–4.
[4] Wang TJ, Parise H, Levy D, et al. Obesity and the risk of new-onset atrial fibrillation. JAMA 2004;292:2471–7.
[5] Schnabel RB, Sullivan LM, Levy D, et al. Development of a risk score for atrial fibrillation (Framingham Heart Study): a community-based cohort study. Lancet 2009;373:39–45.
[6] Djousse L, Levy D, Benjamin EJ, et al. Long-term alcohol consumption and the risk of atrial fibrillation in the Framingham Study. Am J Cardiol 2004;93:710–3.
[7] Sidhu K, Tang A. Modifiable risk factors in atrial fibrillation: the role of alcohol, obesity, and sleep apnea. Can J Cardiol 2017;33:947–9.
[8] Chatterjee NA, Chae CU, Kim E, et al. Modifiable risk factors for incident heart failure in atrial fibrillation. JACC Heart Fail 2017;5:552–60.
[9] Pathak RK, Middeldorp ME, Lau DH, et al. Aggressive risk factor reduction study for atrial fibrillation and implications for the outcome of ablation: the ARREST-AF cohort study. J Am Coll Cardiol 2014;64:2222–31.
[10] Pathak RK, Elliott A, Middeldorp ME, et al. Impact of CARDIOrespiratory FITness on arrhythmia recurrence in obese individuals with atrial fibrillation: the CARDIO-FIT study. J Am Coll Cardiol 2015;66:985–96.
[11] Calvo N, Brugada J, Sitges M, et al. Atrial fibrillation and atrial flutter in athletes. Br J Sports Med 2012;46(suppl 1):i37–43.
[12] Puni HR, O’Keefe JH, Lavie CJ, et al. Cardiovascular damage resulting from chronic excessive endurance exercise. Mo Med 2012;109:312–21.
[13] Flannery MD, Kalman JM, Sanders P, et al. State of the art review: atrial fibrillation in athletes. Heart Lung Circ 2017;26:983–9.
[14] Elliott AD, Mahajan R, Lau DH, et al. Atrial fibrillation in endurance athletes: from mechanism to management. Cardiol Clin 2016;34:567–78.
[15] Lee IM, Skerritt PJ. Physical activity and all-cause mortality: what is the dose-response relation. Med Sci Sports Exerc 2001;33:8459–71.
[16] Azer A, Gazzano JM, Cook NR, et al. Relation of vigorous exercise to risk of atrial fibrillation. Am J Cardiol 2009;103:1572–7.
[17] Borjian G, Laroche C, Diemänner I, et al. Asymptomatic atrial fibrillation: clinical correlates, management, and outcomes in the EORP-AF pilot general registry. Am J Med 2015;128:309–18.
[18] Paffenbarger RSJr, Laughlin ME, Buna AS, et al. Work activity of longshoremen as related to death from coronary heart disease and stroke. N Engl J Med 1970;282:1109–14.
[19] Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Ann Intern Med 2009;151:264–9.
[20] von Elm E, Altman DG, Egger M, et al. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet 2007;370:1453–7.
[21] Lau J, Ioannidis JP, Schmid CH. Quantitative synthesis in systematic reviews. Ann Intern Med 1997;127:820–6.
[22] DerSimonian R, Laird N. Meta-analysis in clinical trials. Control Clin Trials 1986;7:177–88.
[23] Egger M, Davey Smith G, Schneider M, et al. Bias in meta-analysis detected by a simple, graphical test. BMJ 1997;315:629–34.
[24] Karjalainen J, Kujala UM, Kaprio J, et al. Lone atrial fibrillation in vigorously exercising middle aged men: case-control study. BMJ 1998;316:1784–5.
[25] Elosua R, Arquer A, Mont L, et al. Sport practice and the risk of lone atrial fibrillation: a case-control study. Int J Cardiol 2006;108:332–7.
[26] Heidbuchel H, Anne W, Willems R, et al. Endurance sports is a risk factor for atrial fibrillation after ablation for atrial flutter. Int J Cardiol 2006;107:67–72.
[27] Baldesberger S, Bauersfeld U, Candinas R, et al. Sinus node disease and arrhythmias in the long-term follow-up of former professional cyclists. Eur Heart J 2008;29:71–8.
[28] Molina L, Mont L, Marrugat J, et al. Long-term endurance sport practice increases the incidence of lone atrial fibrillation in men: a follow-up study. Europace 2008;10:618–23.
[29] Mozaftarian D, Furberg CD, Przy BM, et al. Physical activity and incidence of atrial fibrillation in older adults: the cardiovascular health study. Circulation 2008;118:800–7.
[30] Myrstad M, Lochen ML, Graff-Iversen S, et al. Increased risk of atrial fibrillation among elderly Norwegian men with a history of long-term endurance sport practice. Scand J Med Sci Sports 2014;24:e238–44.
[31] Sun GZ, Guo L, Wang XZ, et al. Prevalence of atrial fibrillation and its risk factors in rural China: a cross-sectional study. Int J Cardiol 2013;162:13–7.
[32] Coelho A, Palileo E, Ashley W, et al. Tachyarrhythmias in young athletes. J Am Coll Cardiol 1986;7:237–43.
[33] Furlanello F, Bertoldi A, Dallago M, et al. Atrial fibrillation in elite athletes. J Cardiovasc Electrophysiol 1998;9:S63–8.
[34] Mont L, Sambola A, Brugada J, et al. Long-lasting sport practice and lone atrial fibrillation. Eur Heart J 2002;23:477–82.
[35] Abdulla J, Nielsen JR. Is the risk of atrial fibrillation higher in athletes than in the general population? A systematic review and meta-analysis. Europace 2009;11:1136–9.