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Prevalence of atrial fibrillation and mortality among adults with heart failure in sub-Saharan Africa: a systematic review and meta-analysis

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Abstract

Objectives: This study aimed to estimate the prevalence of atrial fibrillation (AF) in adults with heart failure (HF) and summarise the all-cause mortality rate among adult patients with co-existing HF and AF in sub-Saharan Africa (SSA).

Setting: This was a systematic review and meta-analysis of cross-sectional and cohort studies with primary data on the prevalence and incidence of AF among patients with HF and the all-cause mortality rate among patients with HF and AF in SSA. We combined text words and MeSH terms to search MEDLINE, PubMed, and Global Health Library through Ovid SP®, African Journals Online, and African Index Medicus from database inception to 10 November 2021. Random-effects meta-analysis was used to estimate pooled prevalence.

Primary outcome measures: The prevalence and incidence of AF among patients with HF and all-cause mortality rate among patients with HF and AF.

Results: Twenty-seven of the 1902 records retrieved database searches were included in the review, totalling 9,987 patients with HF. The pooled prevalence of AF among patients with HF was 15.6% (95% confidence interval: 12.0 – 19.6). At six months, the all-cause mortality was 18.4% (13.1-23.6) in a multinational registry and 67.7% (51.1-74.3) in one study in Tanzania. One-year mortality was 48.6% (32.5-64.7) in a study in the Democratic Republic of Congo.

Conclusion: Atrial fibrillation is common among patients with HF in SSA, and patients with AF and HF have poor survival. There is an urgent need for large-scale population-based prospective data to reliably estimate the prevalence, incidence and risk of mortality of AF among HF patients in SSA to better understand the burden of AF in patients with HF in the region.

Trial registration: This review was registered in the International Prospective Register of Systematic Reviews under the registration number CRD42018087564.

Strengths and limitations of this study

1. This study provides a contemporaneous and comprehensive estimate of the prevalence of atrial fibrillation (AF) among heart failure (HF) patients in sub-Saharan Africa (SSA).
2. This study highlights gaps in the availability and quality of evidence on burden of AF among HF patients in SSA and provides directives for future research.
3. The certainty of evidence on mortality among patients with AF and HF was limited by the small of studies on the topic.

Introduction

Heart failure (HF) is a global public health problem estimated to affect about 26 million people worldwide [1]. The global prevalence of HF has been on the rise owing to improvements in life expectancy, the management of acute heart conditions, and the rising prevalence of cardiovascular disease risk factors like hypertension, obesity, and diabetes mellitus [1, 2]. Heart failure disproportionately affects low- and middle-income countries, especially those in sub-Saharan Africa (SSA), where it is associated with high economic costs, poor quality of life, high readmission rates and high in-hospital and one-year mortality rates [3, 4]. For example, about 35% of patients discharged for acute HF will be readmitted within 30-days [5]. This is important in the African context, where about 90% of the cost of management of the HF is borne by the patient and their immediate families [3]. In addition, the in-hospital mortality of HF in SSA ranges from 15-35%, with one-year mortality of up to 58% [3]. The one-year mortality rate from HF is highest in Africa compared to other regions such as Southeast Asia, Middle East, and South America [6].

Atrial fibrillation (AF) is the most common cardiac arrhythmia worldwide [7]. In 2017, there were 37.6 million individuals with AF, including 3.1 million new cases [7]. Atrial fibrillation is associated with a higher risk of stroke and systemic embolism, HF, and mortality [8]. AF is associated with poorer outcomes among patients with HF, and is estimated to affect about 16-21% of patients with HF in SSA [9–12]. In addition, AF accelerates the natural history of HF and is associated with more frequent admissions, longer hospital stays, and increased mortality in patients with HF [9, 13–15].

Data on the burden of AF in patients with HF in SSA have not been appropriately summarised. Hence, this systematic review and meta-analysis sought to estimate the prevalence of AF in adults with HF and summarise the all-cause mortality rate among adult patients with co-existing HF and AF in SSA.

Methods

The review protocol was published [16]. This study is reported following the 2020 Preferred Reporting Items for Systematic reviews and Meta-analysis (PRISMA)[17].

Literature search

We searched MEDLINE, Excerpta Medica Database (Embase) and Global Health Library through Ovid SP®, African Journals Online, and African Index Medicus from database inception to 10 November 2021 with no language restrictions. The search strategy combined text words and medical subject headings related to AF and HF, and a validated geographical filter for SSA [18] (**Supplementary Tables 1-5**). We hand-searched the reference list of eligible full-text articles to obtain additional data sources.

Study selection

We included cross-sectional and cohort studies conducted in SSA that reported the prevalence and incidence of AF among patients with HF, all-cause mortality rate among patients with HF and AF, or provided sufficient data to compute these estimates. We excluded reviews, editorials, studies with fewer than 30 participants and studies conducted in persons aged < 15 years. In addition, we only included the study with the most recent, comprehensive and largest sample size for published studies that used data from the same cohort of participants (duplicate data).

Records retrieved from database searches were exported to EndNote X9 to remove duplicates and then uploaded to Rayyan QCRI for title and abstract screening. Four authors (VNA, CMM, SJP and LPS) independently screened the citations based on the titles and assessed the full texts of selected records for final inclusion in the review. Disagreement between both authors during the study inclusion process was resolved through consensus or arbitration by a third author (VNA).

Data extraction, management, and risk of bias assessment

Four authors (VNA, CMM, SNP, and LPS) used a predesigned Google Form to independently abstract data on: the surname of the first author, year of publication, country of study, study setting, study design, sampling method, timing of data collection, mean or median age of study participants, percentage of male participants, percentage of participants on beta-blockers, sample size, percentage of participants in New York Heart Association (NYHA) stage III or IV, method of diagnosis of AF, method of diagnosis of HF, and the duration of follow up for cohort studies. For multinational studies, data was extracted by the individual country study where possible.

For the outcome of prevalence and incidence of AF in HF, data was also extracted on the number of prevalent AF cases, the number of new AF cases if reported by the study, and the number of participants with HF. Where the authors did not report the number of patients with AF but reported the proportion or percentage of participants with AF, we multiplied this proportion or percentage by the number of HF patients to obtain the number of participants with AF.

For all-cause mortality rate among patients with AF and HF, we extracted data on the number of participants with HF and AF and the number of deaths from any cause.

Risk of bias assessment

Two reviewers (CMM and SNP) independently assessed the risk of bias in the included studies. An adapted version of the risk of bias assessment tool developed by Hoy *et al* [16, 19] was used to assess the risk of bias in studies reporting on the prevalence of AF in HF. In addition, we modified the original version of the Newcastle-Ottawa Scale [20] to evaluate the risk of bias in studies that reported all-cause mortality in patients with HF and AF.

Data analysis and synthesis

All analyses were conducted with R version 4.1.2 (The R Foundation for Statistical Computing, Vienna, Austria). To estimate the prevalence of AF among participants with HF, we performed a random-effects meta-analysis of proportions using the inverse variance model after stabilising the

variance using the Freeman-Tukey double-arcsine transformation [21]. The degree of heterogeneity across studies was assessed using the Cochrane's Q χ^2 test and quantified using the I-squared (I^2) statistic [22]. I^2 values below 30%, 30-49%, 50-70%, and over 70% were considered to represent low, moderate, substantial, and considerable heterogeneity, respectively [22]. P-value < 0.05 on the Cochrane's Q χ^2 test indicated significant heterogeneity between studies. We used Baujat plot to inspect for influential studies on the pooled summary effect.

We conducted subgroup analyses using random-effects meta-analysis without assuming a common between-study variance to investigate the sources of heterogeneity by region, study design, timing of data collection, method of AF diagnosis, risk of bias, age of participants, and percentage of participants in NYHA stages III or IV. The Q test was used to investigate moderation effects across subgroups. A p-value <0.1 for test of subgroup difference was used as the threshold for statistical significance [22]. Where appropriate, studies were merged into meaningful categories to minimise loss of power during subgroup analyses. Where a lone category could not be merged into other categories, this was excluded from the subgroup analysis.

Funnel plot was used to investigate small-study effect, and plot asymmetry was suggestive of small-study effect. Egger's regression test was used to test for publication bias. P-value < 0.1 from Egger's test was considered statistically significant. Sensitivity analysis was conducted to assess the impact of excluding influential studies on the overall summary prevalence.

The mortality rate was defined as the proportion of participants with AF and HF who died from any cause within a given follow-up time. Due to the small number of studies reporting on all-cause mortality rate among patients with AF and HF, this outcome was summarised narratively.

Patient and public involvement

Patients or the public were not directly involved in this study.

Results

Study selection and characteristics

From 1,902 records retrieved through database searches, 27 were eligible for inclusion in the review [23–49] (**Figure 1 and Supplementary Table 6**). The included studies provided 30 data points on the prevalence of AF in HF (data from the multinational study by Karaye et al 2021 [49] was disaggregated by the country of study). Only three studies [35, 36, 46] provided data on mortality among patients with AF and HF, and none reported on the incidence of AF in HF**.**

All included studies published from 1995 to 2021 (**Table 1**). The majority (n=23) of studies were published after 2010, and all were hospital-based. Most studies were cohort studies (n=24), conducted in West Africa (n=11), used a non-probabilistic sampling method (n=24), and diagnosed AF using 12-Lead ECG (n=23).

Table 1: Characteristics of studies included in the meta-analysis

Characteristics	N = 26 studies
Year of publication	
Range	1995 - 2021
1995-2010	7
After 2010	23
Subregion	
Central	6
East	6
South	6
West	11
Multinational registry	1
Study design	
Cohort	24
Cross-sectional	6
Study setting	
Hospital-based	30
Population-based	0
Sampling method	
Non-probabilistic	24
Not reported	6
Participants in NYHA III or IV (%)	
Below 50	8
50-80	9
Over 80	6
Not reported	7
Atrial fibrillation diagnostic procedure	
12-Lead ECG	19
Holter ECG	2
Medical history	1
Not reported	4
Risk of bias	
Low	23
Moderate	11

ECG = Electrocardiogram; NYHA = New York Heart Association

Prevalence of AF in patients with HF

A total of 9,987 patients with HF were included in the meta-analysis. Almost three-quarters of the studies reporting on the prevalence of AF in HF had a low risk of bias (**Table 1** and **Supplementary Table 7**). The pooled prevalence of AF in HF was 15.6% (95% confidence interval: 12.0 – 19.6), with considerable heterogeneity between studies (I^2 = 96.0%, p < 0.00001) (**Figure 2**). Table 2 and supplementary figures 1-9 summarise the results of the subgroup analysis. The prevalence of AF in HF was significantly higher in studies with retrospective data collection compared to those with prospective data collection (p = 0.0147) and in studies with no reported method for AF diagnosis compared to those with recommended methods for AF diagnosis (12-lead or Holter ECG, p = 0.0035) (**Table 2, Supplementary Figure 3 and 4**). In addition, the prevalence of AF in HF was significantly higher in studies where the mean age of the participants was 60 years and over compared to studies with younger participants (p = 0.0132) (**Table 2 and Supplementary Figure 5**). There was no evidence of moderation of the pooled prevalence by region, study design, the severity of HF in study participants (based on the NYHA classification), sample size, risk of bias, and percentage of males included in each study (**Table 2 and Supplementary figures 1, 2, 6-9**).

There was no evidence of publication bias (P_{Egger} = 0.2593) (**Supplementary Figure 10**). In sensitivity analysis, the studies by Ojji *et al* [44] and Ker and Myburgh [33] were identified to significantly influence the pooled summary estimate (**Supplementary Figure 11**). However, excluding these studies and re-estimating the pooled prevalence of AF in HF did not substantially change the results (pooled prevalence = 15.4% [12.6 – 18.5], **Supplementary Figure 12**).

Table 2: Prevalence of atrial fibrillation in heart failure by various subgroups

Subgroups	Number of studies	Cases of AF	Sample size	Prevalence (95%CI)	I^2 (%)	p for subgroup difference
Subregion*						0.8961
Central	6	214	1089	17.8 (12.7-23.5)	80.8	
East	6	212	1176	15.5 (9.5-22.6)	85.8	
South	6	225	1905	13.5 (4.5-26.2)	97.7	
West	11	682	4811	15.6 (9.6-22.8)	97.1	
Study design						0.7347
Cross-sectional	6	148	819	16.6 (10.7-23.4)	81.0	
Cohort	24	1394	9168	15.4 (11.4-19.9)	96.7	
Timing of data collection**						**0.0147**
Prospective/cross-sectional	23	913	7242	13.5 (9.9-17.7)	95.3	
Retrospective	7	629	2745	22.9 (16.7-29.9)	92.5	
Method of AF diagnosis						**0.0035**
12-lead or Holter ECG	23	1009	7443	14.1 (10.1-18.8)	96.3	
Not reported	6	514	2351	22.7 (19.5-26.1)	56.8	
Risk of bias						0.3025
Low	19	829	6559	14.3 (10.1-18.9)	95.8	
Moderate	11	713	3428	18.1 (12.6-24.4)	94.1	
Mean age, years***						**0.0132**
Below 55	14	613	5080	112.4 (7.9-17.8)	96.2	
55-59.9	8	338	2414	15.1 (9.5-21.8)	93.8	
60 and over	6	572	2372	25.5 (18.2-33.6)	91.6	
Participants in NYHA III or IV (%)***						0.1601
Below 50	8	615	4738	14.3 (7.2-23.3)	98.1	
50-80	9	413	2654	12.3 (8.6-16.5)	88.0	
Over 80	6	197	986	19.5 (13.3-26.6)	83.5	
Sample size						0.6415
Below 150	10	149	884	15.6 (11.0-20.1)	72.8	
150-300	10	436	2088	18.0 (11.3-25.8)	94.8	
Over 300	10	957	7015	13.6 (8.3-20.0)	98.0	
Male percentage (%)***						0.6220
Below 50	16	1135	7535	15.8 (10.6-21.8)	97.6	
50 and over	11	313	2021	13.9 (9.6-18.9)	88.4	

*The study by Sani *et al* was excluded from the analysis as this was a multinational study and the prevalence of AF in heart failure could not be disaggregated into the individual countries where the study was conducted in

**The study by Mwita *et al* was excluded as this was the only study that reported on physician-diagnosed atrial fibrillation.

***Studies with missing data were excluded.

AF = Atrial fibrillation; ECG = Electrocardiography; NYHA = New York Heart Association

All-cause mortality among patients with atrial fibrillation and heart failure

Three studies reported on all-cause mortality rate among patients with AF and HF (**Table 3**) [35, 36, 46]. Two of the studies were prospective cohort studies, while one was a retrospective cohort study. The mean ages of the participants ranged from 52.3-56.0 years and 79-80% of the participants were in NYHA stage III or IV. Two studies had low risk of bias **(Supplementary Table 8)**.

At six months, the all-cause mortality was 18.4% (13.1-23.6) in a multinational registry and 67.7% (51.1-74.3) in a study in Tanzania. All-cause mortality at one-year was 48.6% (32.5-64.7) in a study in DR Congo (**Table 3**).

Table 3: Characteristics of studies reporting on mortality among patients with atrial fibrillation and heart failure

Surname of first author	Year	Country of study	Study design	Sampling method	Timing of data collection	Median age, yr	Participants in NYHA III and IV (%)	Method of diagnosis of AF	Participants with AF and HF (n)	Deaths (n)	Mortality rate (%) (95% CI)	Follow-up (months)
Makubi	2014	Tanzania	Cohort	Non-probabilistic	Prospective	55	79	12-lead ECG	67	42	67.7 (51.1-74.3)	6
Malamba	2018	DRC	Cohort	Non-probabilistic	Retrospective	56	NR	12-lead ECG	37	18	48.6 (32.5-64.7)	12
Sani	2018	Multinational registry*	Cohort	Non-probabilistic	Prospective	52.3	80	12-lead ECG	207	38	18.4 (13.1-23.6)	6

*Study countries included: Sudan; Cameroon; South Africa; Nigeria; Ethiopia; Kenya; Uganda; Senegal; Mozambique; AF = Atrial Fibrillation; DRC = Democratic Republic of Congo; ECG = Electrocardiography; ESC = European Society of Cardiology; HF = Heart failure; n = Frequency; NYHA = New York Heart Association; Year = Year of publication

Discussion

This review sought to estimate the prevalence and incidence of AF among patients with HF and all-cause mortality among patients with AF and HF in SSA. The pooled prevalence of AF in HF was 15.6%, and varied by the timing of data collection, methods of AF diagnosis, and mean age of the study participants. Moreover, the all-cause mortality rate was 18.4 to 67.7% after six months of follow-up and approximately 49% after one year. We did not find any study reporting on the incidence of AF among patients with HF.

The pooled prevalence of AF in HF reported in this study is over two folds lower than reported in high-income countries. For instance, the prevalence of AF among HF patients in the ADHERE (United States of America) and EHFS II (Europe) HF registries were 31.0 and 39.0%, respectively [50]. In addition, in a 20-year population-based cohort of 88,416 patients with incident HF in the United Kingdom, about 39% had AF [51]. This difference in prevalence could be explained, in part, by the older age and higher prevalence of coronary heart disease in patients with HF in high-income countries compared to those in SSA [3, 50, 51]. Age, subclinical atherosclerosis, and ischaemic heart disease are associated with higher risk of AF [52, 53]. Patients with HF in high-income countries are primarily in their mid-seventies [50, 51], while those in SSA are within their early sixties [16]. We found a higher prevalence of AF in HF among studies where the mean age of participants was at least 60 years and over compared to those with younger participants. The lower prevalence of AF in HF could also be explained by a lack of adequate testing in SSA. ECG, inpatient telemetry and Holter monitors are largely absent in the region.

We observed a higher six-month and one-year mortality rate among patients with AF and HF than reports from high-income countries, including Canada and Romania [54, 55]. The high mortality in our study could be because a higher proportion of patients in this review had advanced HF compared to the studies reported in high-income countries. In addition, this high

mortality rate could reflect limited available availability, accessibility and affordability to quality of care. Advanced therapies such as mechanical circulatory supports and left ventricular assistive devices for patients with advanced HF are limited in SSA [3]. Advanced therapies such as cardiac resynchronisation, pacing and ablation for rate and rhythm control for AF, and mechanical circulatory supports and left ventricular assistive devices for patients with advanced HF are limited in SSA [3]. Observational evidence suggests that AF is associated with a higher risk of mortality among patients with HF. Makubi *et al* observed AF was associated with a three-fold higher risk of mortality among patients with HF in Tanzania [35]. In addition, Sani and collaborators also reported a 61% higher risk of mortality among HF patients with valvular AF than those without AF, even though the authors found no evidence of an association of non-valvular AF with mortality [46]. In a meta-analysis of about 61,000 cases of AF, 150,000 patients with HF, and 40,000 deaths, AF was associated with a 17% higher risk of death [56].

Atrial fibrillation in HF is associated with faster progression of HF in affected patients [57]. Atrial fibrillation could significantly worsen premature mortality in HF patients, especially in SSA, where HF patients are mostly young adults. However, whether AF in HF is associated with increased risk of mortality and how much of this association is due to confounding and reverse causation remains uncertain. Two large-scale randomised controlled trials showed no evidence of rhythm control in reducing mortality among patients with AF and HF [58, 59]. However, these trials were limited in their ability to maintain sinus rhythm in the intervention group, reducing the power of the analyses. Consequently, although contemporary evidence suggests that rhythm control might have some benefit in reducing the risk of mortality in patients with AF and HF [60], robust evidence is lacking on whether AF increases mortality risk in patients with HF or is a marker of advanced HF. The findings from this study have implications for improving research on AF among patients with HF in SSA to inform local

guidelines for the management of patients with HF. Efforts are needed to generate reliable evidence on the incidence, subtypes and prognosis of AF in HF patients in the region. In addition, collaborative efforts are warranted to assess the efficacy and safety of interventions to reduce the risk of mortality among patients with AF and HF in SSA.

This study had some limitations that are worth highlighting. The geographical coverage of studies included in this review was limited. Even though all four SSA subregions were represented in the review, the individual studies were from a limited number of countries, with about a third of all the studies conducted in West Africa. In addition, all studies were hospital-based and included patients with more advanced HF. Including patients with more advanced HF might have overestimated the prevalence of AF in HF and all-cause mortality in patients with AF and HF. Furthermore, the retrospective nature of some studies is likely to have given the authors limited control over the quality of data collected, leading to biased estimates of the prevalence of AF in HF or mortality in patients with AF and HF. We found that studies that collected data retrospectively had a higher pooled prevalence of AF in HF compared to prospective studies. This review highlights limited capacity in diagnosing AF cases among patients with HF in SSA as only two of the studies included in this review used Holter ECG for diagnosis. Even though 12-Lead ECG is widely accepted to confirm the diagnosis of AF [1], it only provides a snapshot of the electrical activity of the heart and misses cases of paroxysmal atrial fibrillation contrary to ambulatory ECG can monitors cardiac electrical activity for sustained periods [61]. Finally, only three studies reported on the mortality among patients with AF and HF, hence our estimates on all-cause mortality should be interpreted with caution. However, this study provides comprehensive and contemporary evidence on the burden of AF among HF patients in SSA.

Conclusion

Atrial fibrillation was common among patients with HF in SSA, and patients with AF and HF appear to have poor survival. There is an urgent need for large-scale population-based prospective data to reliably estimate the prevalence, incidence and risk of mortality in patients with AF and HF in SSA to better understand the burden of these conditions in SSA. Such evidence would be crucial for policies and context-specific guidelines aimed at improving the survival of patients with HF in SSA.

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Authors' contributions: VNA conceived the study. VNA, LNA, MDC and JJN designed the protocol. VNA conducted the literature search. VNA, CMM, SNP, and LPS selected the studies and extracted the relevant information. VNA synthesised the data. VNA wrote the first draft of the paper. FLT, LNA, MDC, AD, and JJN critically revised successive drafts of the paper. All authors approved the final version of the manuscript. VNA is the guarantor of the review.

Availability of data: All data related to this review have been provided in the main text and supplementary file.

Conflicts of interest: None declared.

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Figure Legends

Figure 1: PRISMA flow diagram for inclusion of articles in the meta-analysis.

Figure 2: Pooled prevalence of atrial fibrillation in patients with heart failure.

The grey squares and the horizontal bars are the study-specific prevalence and 95% confidence intervals (CI). Each study-specific estimate is weighted by the inverse of the variance using random-effect meta-analysis. The centre and the horizontal edges of the black diamond are the pooled summary prevalence and 95% confidence interval.

Figure S1: Prevalence of atrial fibrillation in heart failure by region.

Figure S2: Prevalence of atrial fibrillation in heart failure by study design.

Figure S3: Prevalence of atrial fibrillation in heart failure by the timing of data collection**.**

Figure S4: Prevalence of atrial fibrillation in heart failure by the method of diagnosis of atrial fibrillation.

Figure S5: Prevalence of atrial fibrillation in heart failure by median age of studies participants each study.

Figure S6: Prevalence of atrial fibrillation in heart failure by risk of bias in individual studies.

Figure S7: Prevalence of atrial fibrillation in heart failure by percentage of participants in New York Heart Association (NYHA) stages III or IV in each study.

Figure S8: Prevalence of atrial fibrillation in heart failure by sample size.

Figure S9: Prevalence of atrial fibrillation in heart failure by percentage of male participants.

Figure S10: Funnel plot for publication bias of studies reporting on the prevalence of atrial fibrillation in heart failure included in the meta-analysis.

Figure S11: Plot showing the influence of studies on the degree of heterogeneity in studies reporting on the prevalence of atrial fibrillation in heart failure. High squared Pearson residuals values suggest that the estimate from these studies are outliers.

Figure S12: Pooled prevalence of atrial fibrillation in patients with heart failure after excluding potentially influential studies. Conventions are as in Figure 2.

List of tables

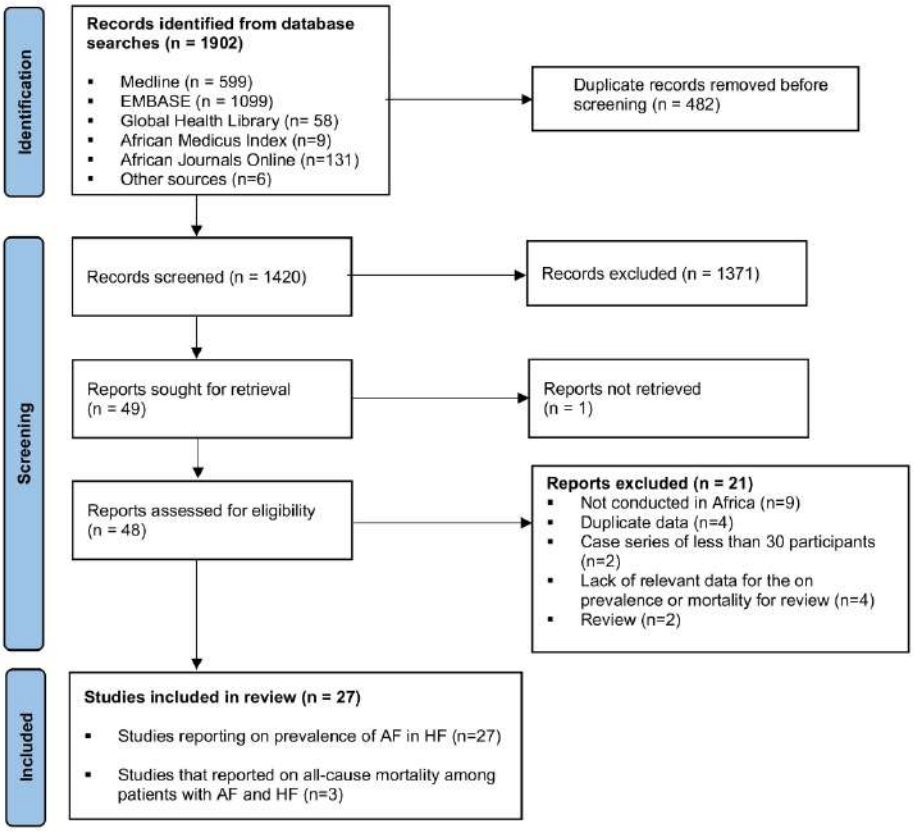

Figure 1: PRISMA flow diagram for inclusion of articles in the meta-analysis.

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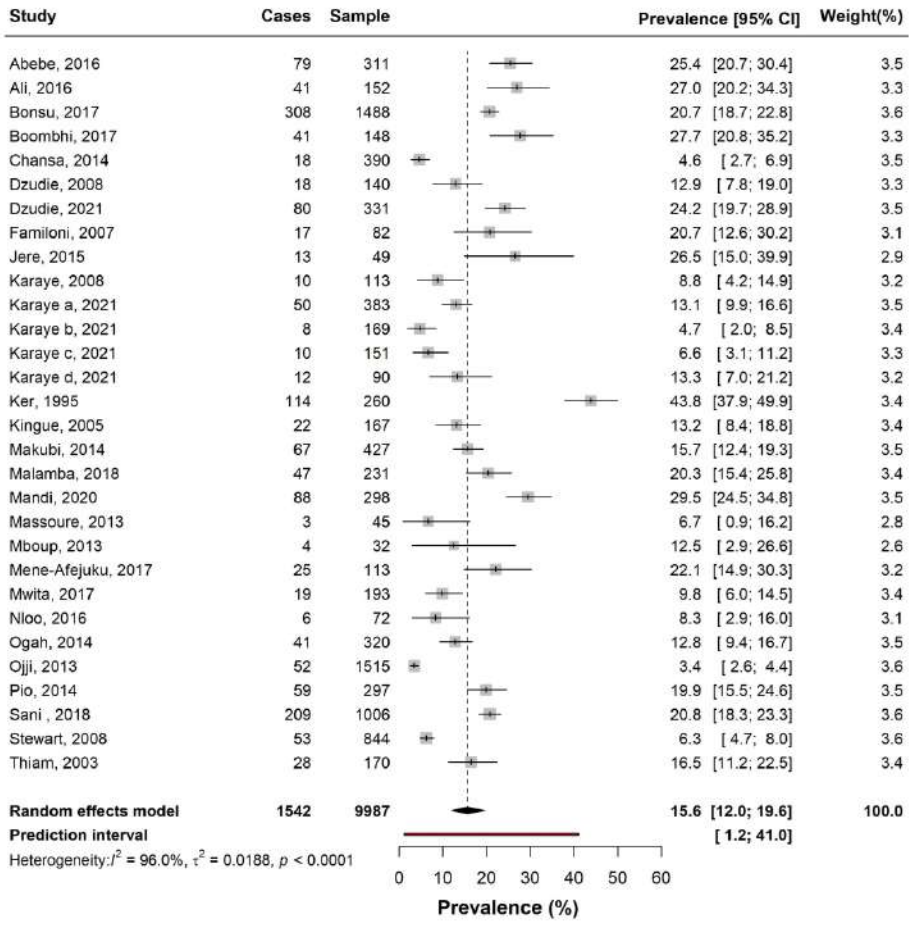

Figure 2: Pooled prevalence of atrial fibrillation in patients with heart failure. The grey squares and the horizontal bars are the study-specific prevalence and 95% confidence intervals (CI). Each study-specific estimate is weighted by the inverse of the variance using random-effect meta-analysis. The centre and the horizontal edges of the black diamond are the pooled summary prevalence and 95% confidence interval.

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SUPPLEMENTARY MATERIAL

Prevalence of atrial fibrillation and mortality among adults with heart failure in sub-Saharan Africa: a systematic review and meta-analysis

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Contents

Supplementary Table 1. Search strategy for Medline via OVID SP

SN	Search Items
1.	exp Heart Failure/ OR (Heart Failure or cardiac failure or cardia* insufficien*).mp.
2.	benin/ or burkina faso/ or cape verde/ or cote d'ivoire/ or gambia/ or ghana/ or guinea/ or guinea-bissau/ or liberia/ or mali/ or mauritania/ or nigeria/ or senegal/ or sierra leone/ or togo/ or (africa*adj2 west* or benin* or burkina fas* or cape verd* or cabo verd* or ivory coast or cote d'ivoire* or gambia* or ghana* or (guinea* not pig*) or bissau or liberia* or (mali not fowl) or malian or mauritania* or nigeria* or senegal* or sierra leon* or togo* or (Lagos or Accra or Abidjan or Dakar or Abobo or Abuja or Freetown or Ouagadougou or Conakry or Lome or Bamako or Cotonou or Kumasi or Monrovia or Ibadan or Kano or Port harcourt or Benin City or Porto Novo or Niamey or Yamoussoukro or Banjul or Timbuktu or Djenne or Abomeyu or Zaria or Tamale or Jos or Cape Coast or Maidugul or Aba or Gao or Calabar or Warri or Maiduguri or Bobo Dioulasso or Parakou or Djougou or Bohicon or Sekondi Takoradi or Sunyani or Obuasi or Teshie or Tema or Sikasso or Kalabankoro or Nouakchott or Dakhlet Nouadhibou or Benin City or Port Harcourt or Ilorin or Kaduna or Enugu or Ikorodu or Onitsha or Bauchi or Akure or Abeokuta or Sokoto or Bouake or Makeni or Kaduan or Sosgbo or Osogbo or! Gombe or Ilesa or Badagry or makurdi or Sagamu or Iseyin or obbomosho or Awka or Ado Ekiti or Nsukka or Ikeja or Katsina or Okene or Lafia or Minna or Ondo city or Umuahia or Calabar or Yola or Pikine or Touba or Thies Nones or Saint Louis or Kolak or Ziguinch or (San Pedro not (Spain or Mexico or Argentina or California or United States or Italy)) or Bandama or Daloa or Owerri or Kandi or Ifi or Dakar or Ogbomosho or Divo or Korhogo)).mp.
3.	(angola or cameroon* or chad* or tchad or congo* or DRC or equatorial guinea* or gabon* or "Sao Tome" or Principe or Luanda or lobito or kuito or huambo or Malanje or Douala or Yaounde or Bamenda or Garoua of Bafoussam or Ngaoundere or Maroua or Kouosseri or Buena or Kumba or N'Djamena or Moundou or Bangui or Bimbo or Brazzaville or Point Noire or Kinshasa or Lubumbashi or Leopoldville or Elizabethville or Mbuji Mayi or Bakwanga or Bukavu or Costermansville or Kananga or Luluabourg or Kisangani or Stanleyville or Tshikapa or Koalwezi or Likasi or Jadotville or Goma or Kikwit or Uvira or Bunia or Mbandaka or Coquilhatville or Matadi or Butembo or Kabinda or Mwene Ditu or Isiro or Paulis or Boma or Kindu or Bata or Malabo or Libreville).mp.
4.	((British Indian Ocean Territory or Burundi* or Comoros or Djibouti* or Eritrea* or Ethiopia* or Kenya* or Madagascar or Malawi or Mauritius or Mayotte or Mozambique or Reunion or Rwanda* or Seychelles or Somalia* or Sudan* or Tanzania* or Uganda* or Zambia or Zimbabwe or Crozet Islands or Iles Crozet or Scattered Islands ! or Iles E! parses or Mwanza or Zanzibar or Eldoret or Morogoro or Hargeysa or Berbera or Nyeri or Mbeya or Machakos or Marka or Tabora or Iringa or Gondar or Meru or Geita or Musoma or Mtwara or Songea or Kigoma or Dese or Mek'ele or Bahir Dar or Jimma or Sinyanga or Korogwe or Nairobi or "Dar es Salaam" or Mombasa or Addis Ababa or Kampala or Kigali or Mogadishu or Dodomoa or Bujumbura or Nakuru or Anananarivo or Kisumu or Maputo or Asmara or Lusaka or Harare or Port Louis or Arusha or kitale or lilongwe or malindi or machakos or hargeisa or Bulawayo or Ruiru or Lamu or Kire Dawa or Kikuyu or naivasha or mwanza or tanga or nanyuki or voi or garissa or lodwar of kakamega or maralal or kitui or webuye or Axum or Nyahururu or Jinja or Kismayo or Namanga or Mumias or Moshi or Moroni or Lokichogio or Hola or Rwenzori Mountains or Lake Victoria or Puntland* or (Adiharush or Ali-Addeh or Alinjugur or Buramino or Dadaab or Dagahaley or Dollo Ado or Fugnido or Hagadera or Hilaweyn or Ifo or Kakuma or Kambioos or Kayaka II or Kobe or Kyangwali Nakivale or Nyarugusu or Wad Sherife or Bokolmanyo or Melkadida or Rwamanja)) adj5 (camp or refug*)).mp.
5.	angola/ or botswana/ or lesotho/ or malawi/ or mozambique/ or namibia/ or south africa/ or swaziland/ or zambia/ or zimbabwe/ or ((africa* adj2 south*) or angola* or botswana* or lesotho* or malawi* or mozambiq* or namibia* or swaziland or zambia* or zimbabwe or Zulu or Tsonga or Xhosa or Swazi or Ndebele or Tswana or Sotho or Shona people or BaLunda or Mbundu or Ovimbundu or Chaga or Sukuma or Pretoria or Cape Town or Johannesburg or Durban or Port Elizabeth or Bloemfontein or Windhoek or Maseru or Pietermaritz or (Kimberley not Australia) or Nespruit or Soweto or Polokwane or Limpopo or Rustenburg or Mahikeng or Oudtshroom or! Stellenb! osch or Paarl or Gaborone or Luanda or Cabinda or Huambo or Lubango or Kuit or Malanje or Lobito or Lilongwe or Blantyre or Mzuzu or Maputo or Matola or Beira or Nampula or Chimoio or Nacala or Quelimane or Lusaka or Kitwe or Ndola or Kabwe or Copperbelt Harare or Bulawayo or Chitungwiza or Mutare or Masvingo or Monashonaland or Manicaland).mp.
6.	2 or 3 or 4 or 5
7.	Atrial Fibrillation/
8.	1 and 6
9.	7 and 8

Supplementary Table 2. Search strategy for EMBASE via OVID SP

SN	Search Items
1.	(Heart Failure or cardiac failure or cardia* insufficien*).mp.
2.	benin/ or burkina faso/ or cape verde/ or cote d'ivoire/ or gambia/ or ghana/ or guinea/ or guinea-bissau/ or liberia/ or mali/ or mauritania/ or nigeria/ or senegal/ or sierra leone/ or togo/ or (africa*adj2 west* or benin* or burkina fas* or cape verd* or cabo verd* or ivory coast or cote d'ivoire* or gambia* or ghana* or (guinea* not pig*) or bissau or liberia* or (mali not fowl) or malian or mauritania* or nigeria* or senegal* or sierra leon* or togo* or (Lagos or Accra or Abidjan or Dakar or Abobo or Abuja or Freetown or Ouagadougou or Conakry or Lome or Bamako or Cotonou or Kumasi or Monrovia or Ibadan or Kano or Port harcourt or Benin City or Porto Novo or Niamey or Yamoussoukro or Banjul or Timbuktu or Djenne or Abomeyu or Zaria or Tamale or Jos or Cape Coast or Maidugul or Aba or Gao or Calabar or Warri or Maiduguri or Bobo Dioulasso or Parakou or Djougou or Bohicon or Sekondi Takoradi or Sunyani or Obuasi or Teshie or Tema or Sikasso or Kalabankoro or Nouakchott or Dakhlet Nouadhibou or Benin City or Port Harcourt or Ilorin or Kaduna or Enugu or Ikorodu or Onitsha or Bauchi or Akure or Abeokuta or Sokoto or Bouake or Makeni or Kaduan or Sosgbo or Osogbo or! Gombe or Ilesa or Badagry or makurdi or Sagamu or Iseyin or obbomosho or Awka or Ado Ekiti or Nsukka or Ikeja or Katsina or Okene or Lafia or Minna or Ondo city or Umuahia or Calabar or Yola or Pikine or Touba or Thies Nones or Saint Louis or Kolak or Ziguinch or (San Pedro not (Spain or Mexico or Argentina or California or United States or Italy)) or Bandama or Daloa or Owerri or Kandi or Ifi or Dakar or Ogbomosho or Divo or Korhogo)).mp.
3.	(angola or cameroon* or chad* or tchad or congo* or DRC or equatorial guinea* or gabon* or "Sao Tome" or Principe or Luanda or lobito or kuito or huambo or Malanje or Douala or Yaounde or Bamenda or Garoua of Bafoussam or Ngaoundere or Maroua or Kouosseri or Buena or Kumba or N'Djamena or Moundou or Bangui or Bimbo or Brazzaville or Point Noire or Kinshasa or Lubumbashi or Leopoldville or Elizabethville or Mbuji Mayi or Bakwanga or Bukavu or Costermansville or Kananga or Luluabourg or Kisangani or Stanleyville or Tshikapa or Koalwezi or Likasi or Jadotville or Goma or Kikwit or Uvira or Bunia or Mbandaka or Coquilhatville or Matadi or Butembo or Kabinda or Mwene Ditu or Isiro or Paulis or Boma or Kindu or Bata or Malabo or Libreville).mp.
4.	((British Indian Ocean Territory or Burundi* or Comoros or Djibouti* or Eritrea* or Ethiopia* or Kenya* or Madagascar or Malawi or Mauritius or Mayotte or Mozambique or Reunion or Rwanda* or Seychelles or Somalia* or Sudan* or Tanzania* or Uganda* or Zambia or Zimbabwe or Crozet Islands or Iles Crozet or Scattered Islands ! or Iles E! parses or Mwanza or Zanzibar or Eldoret or Morogoro or Hargeysa or Berbera or Nyeri or Mbeya or Machakos or Marka or Tabora or Iringa or Gondar or Meru or Geita or Musoma or Mtwara or Songea or Kigoma or Dese or Mek'ele or Bahir Dar or Jimma or Sinyanga or Korogwe or Nairobi or "Dar es Salaam" or Mombasa or Addis Ababa or Kampala or Kigali or Mogadishu or Dodomoa or Bujumbura or Nakuru or Anananarivo or Kisumu or Maputo or Asmara or Lusaka or Harare or Port Louis or Arusha or kitale or lilongwe or malindi or machakos or hargeisa or Bulawayo or Ruiru or Lamu or Kire Dawa or Kikuyu or naivasha or mwanza or tanga or nanyuki or voi or garissa or lodwar of kakamega or maralal or kitui or webuye or Axum or Nyahururu or Jinja or Kismayo or Namanga or Mumias or Moshi or Moroni or Lokichogio or Hola or Rwenzori Mountains or Lake Victoria or Puntland* or (Adiharush or Ali-Addeh or Alinjugur or Buramino or Dadaab or Dagahaley or Dollo Ado or Fugnido or Hagadera or Hilaweyn or Ifo or Kakuma or Kambioos or Kayaka II or Kobe or Kyangwali Nakivale or Nyarugusu or Wad Sherife or Bokolmanyo or Melkadida or Rwamanja)) adj5 (camp or refug*)).mp.
5.	angola/ or botswana/ or lesotho/ or malawi/ or mozambique/ or namibia/ or south africa/ or swaziland/ or zambia/ or zimbabwe/ or ((africa* adj2 south*) or angola* or botswana* or lesotho* or malawi* or mozambiq* or namibia* or swaziland or zambia* or zimbabwe or Zulu or Tsonga or Xhosa or Swazi or Ndebele or Tswana or Sotho or Shona people or BaLunda or Mbundu or Ovimbundu or Chaga or Sukuma or Pretoria or Cape Town or Johannesburg or Durban or Port Elizabeth or Bloemfontein or Windhoek or Maseru or Pietermaritz or (Kimberley not Australia) or Nespruit or Soweto or Polokwane or Limpopo or Rustenburg or Mahikeng or Oudtshroom or! Stellenb! osch or Paarl or Gaborone or Luanda or Cabinda or Huambo or Lubango or Kuit or Malanje or Lobito or Lilongwe or Blantyre or Mzuzu or Maputo or Matola or Beira or Nampula or Chimoio or Nacala or Quelimane or Lusaka or Kitwe or Ndola or Kabwe or Copperbelt Harare or Bulawayo or Chitungwiza or Mutare or Masvingo or Monashonaland or Manicaland).mp.
6.	2 or 3 or 4 or 5
7.	Atrial Fibrillation.mp.
8.	1 and 6
9.	7 and 8

Supplementary Table 3. Search strategy for Global Health Library via OVID SP

SN	Search Items
1.	(Heart Failure or cardiac failure or cardia* insufficien*).mp.
2.	benin/ or burkina faso/ or cape verde/ or cote d'ivoire/ or gambia/ or ghana/ or guinea/ or guinea-bissau/ or liberia/ or mali/ or mauritania/ or nigeria/ or senegal/ or sierra leone/ or togo/ or (africa*adj2 west* or benin* or burkina fas* or cape verd* or cabo verd* or ivory coast or cote d'ivoire* or gambia* or ghana* or (guinea* not pig*) or bissau or liberia* or (mali not fowl) or malian or mauritania* or nigeria* or senegal* or sierra leon* or togo* or (Lagos or Accra or Abidjan or Dakar or Abobo or Abuja or Freetown or Ouagadougou or Conakry or Lome or Bamako or Cotonou or Kumasi or Monrovia or Ibadan or Kano or Port harcourt or Benin City or Porto Novo or Niamey or Yamoussoukro or Banjul or Timbuktu or Djenne or Abomeyu or Zaria or Tamale or Jos or Cape Coast or Maidugul or Aba or Gao or Calabar or Warri or Maiduguri or Bobo Dioulasso or Parakou or Djougou or Bohicon or Sekondi Takoradi or Sunyani or Obuasi or Teshie or Tema or Sikasso or Kalabankoro or Nouakchott or Dakhlet Nouadhibou or Benin City or Port Harcourt or Ilorin or Kaduna or Enugu or Ikorodu or Onitsha or Bauchi or Akure or Abeokuta or Sokoto or Bouake or Makeni or Kaduan or Sosgbo or Osogbo or! Gombe or Ilesa or Badagry or makurdi or Sagamu or Iseyin or obbomosho or Awka or Ado Ekiti or Nsukka or Ikeja or Katsina or Okene or Lafia or Minna or Ondo city or Umuahia or Calabar or Yola or Pikine or Touba or Thies Nones or Saint Louis or Kolak or Ziguinch or (San Pedro not (Spain or Mexico or Argentina or California or United States or Italy)) or Bandama or Daloa or Owerri or Kandi or Ifi or Dakar or Ogbomosho or Divo or Korhogo)).mp.
3.	(angola or cameroon* or chad* or tchad or congo* or DRC or equatorial guinea* or gabon* or "Sao Tome" or Principe or Luanda or lobito or kuito or huambo or Malanje or Douala or Yaounde or Bamenda or Garoua of Bafoussam or Ngaoundere or Maroua or Kouosseri or Buena or Kumba or N'Djamena or Moundou or Bangui or Bimbo or Brazzaville or Point Noire or Kinshasa or Lubumbashi or Leopoldville or Elizabethville or Mbuji Mayi or Bakwanga or Bukavu or Costermansville or Kananga or Luluabourg or Kisangani or Stanleyville or Tshikapa or Koalwezi or Likasi or Jadotville or Goma or Kikwit or Uvira or Bunia or Mbandaka or Coquilhatville or Matadi or Butembo or Kabinda or Mwene Ditu or Isiro or Paulis or Boma or Kindu or Bata or Malabo or Libreville).mp.
4.	((British Indian Ocean Territory or Burundi* or Comoros or Djibouti* or Eritrea* or Ethiopia* or Kenya* or Madagascar or Malawi or Mauritius or Mayotte or Mozambique or Reunion or Rwanda* or Seychelles or Somalia* or Sudan* or Tanzania* or Uganda* or Zambia or Zimbabwe or Crozet Islands or Iles Crozet or Scattered Islands ! or Iles E! parses or Mwanza or Zanzibar or Eldoret or Morogoro or Hargeysa or Berbera or Nyeri or Mbeya or Machakos or Marka or Tabora or Iringa or Gondar or Meru or Geita or Musoma or Mtwara or Songea or Kigoma or Dese or Mek'ele or Bahir Dar or Jimma or Sinyanga or Korogwe or Nairobi or "Dar es Salaam" or Mombasa or Addis Ababa or Kampala or Kigali or Mogadishu or Dodomoa or Bujumbura or Nakuru or Anananarivo or Kisumu or Maputo or Asmara or Lusaka or Harare or Port Louis or Arusha or kitale or lilongwe or malindi or machakos or hargeisa or Bulawayo or Ruiru or Lamu or Kire Dawa or Kikuyu or naivasha or mwanza or tanga or nanyuki or voi or garissa or lodwar of kakamega or maralal or kitui or webuye or Axum or Nyahururu or Jinja or Kismayo or Namanga or Mumias or Moshi or Moroni or Lokichogio or Hola or Rwenzori Mountains or Lake Victoria or Puntland* or (Adiharush or Ali-Addeh or Alinjugur or Buramino or Dadaab or Dagahaley or Dollo Ado or Fugnido or Hagadera or Hilaweyn or Ifo or Kakuma or Kambioos or Kayaka II or Kobe or Kyangwali Nakivale or Nyarugusu or Wad Sherife or Bokolmanyo or Melkadida or Rwamanja)) adj5 (camp or refug*)).mp.
5.	angola/ or botswana/ or lesotho/ or malawi/ or mozambique/ or namibia/ or south africa/ or swaziland/ or zambia/ or zimbabwe/ or ((africa* adj2 south*) or angola* or botswana* or lesotho* or malawi* or mozambiq* or namibia* or swaziland or zambia* or zimbabwe or Zulu or Tsonga or Xhosa or Swazi or Ndebele or Tswana or Sotho or Shona people or BaLunda or Mbundu or Ovimbundu or Chaga or Sukuma or Pretoria or Cape Town or Johannesburg or Durban or Port Elizabeth or Bloemfontein or Windhoek or Maseru or Pietermaritz or (Kimberley not Australia) or Nespruit or Soweto or Polokwane or Limpopo or Rustenburg or Mahikeng or Oudtshroom or! Stellenb! osch or Paarl or Gaborone or Luanda or Cabinda or Huambo or Lubango or Kuit or Malanje or Lobito or Lilongwe or Blantyre or Mzuzu or Maputo or Matola or Beira or Nampula or Chimoio or Nacala or Quelimane or Lusaka or Kitwe or Ndola or Kabwe or Copperbelt Harare or Bulawayo or Chitungwiza or Mutare or Masvingo or Monashonaland or Manicaland).mp.
6.	2 or 3 or 4 or 5
7.	Atrial Fibrillation.mp.
8.	1 and 6
9.	7 and 8

Supplementary Table 4. Search strategy for WHO African Medicus Index

SN	Search Items
1.	(tw:(Heart Failure))
2.	(tw:(atrial fibrillation))
3.	1 and 2

Supplementary Table 5. Search strategy for African Journals Online

SN	Search Items
1.	"heart failure"
2.	"cardiac failure"
3.	"cardia* insufficien*"
4.	1 OR 2 OR 3
5.	"atrial fibrillation"
6.	4 AND 5

Supplementary Table 6. Characteristics of studies reporting on prevalence of atrial fibrillation in heart failure

Surname of first author	Year of publication	Country of study	African region	Study setting	Study design	Sampling method	Timing of data collection	median age, yr	Males (%)	Participants on beta-blockers (%)	Sample size	Participants in NYHA III/IV (%)	Method of diagnosis of AF	Method of diagnosis of Heart failure
Abebe	2016	Ethiopia	East	Hospital-based	Cohort	Non-probabilistic	Retrospective	53.6	30.2	38	311	100	NR	Framingham criteria
Ali	2016	Ethiopia	East	Hospital-based	Cohort	Non-probabilistic	Prospective	50.9	50.7	NR	152	89	NR	Framingham criteria
Bonsu	2017	Ghana	West	Hospital-based	Cohort	NR	Retrospective	60.3	45.6	33	1488	42.5	NR	Framingham criteria
Boombhi	2017	Cameroon	Central	Hospital-based	Cross-sectional	Non-probabilistic	Retrospective	61.5	NR	NR	148	NR	NR	Framingham criteria
Chansa	2014	Zambia	South	Hospital-based	Cohort	Non-probabilistic	Prospective	50	41	2	390	NR	12-lead ECG	Trans-thoracic echocardiography
Dzudie	2008	Cameroon	Central	Hospital-based	Cross-sectional	Non-probabilistic	Retrospective	54.9	61.4	NR	140	44.2	12-lead ECG	Framingham criteria
Dzudie	2021	Cameroon	Central	Hospital-based	Cohort	Non-probabilistic	Prospective	64	49.3	NR	331	42.2	12-lead ECG	ESC 2016 criteria
Familoni	2007	Nigeria	West	Hospital-based	Cohort	Non-probabilistic	Prospective	57.6	67.1	NR	82	100	NR	Trans-thoracic echocardiography
Jere	2015	Zambia	South	Hospital-based	Cross-sectional	Non-probabilistic	Prospective	NR	49	NR	49	100	12-lead ECG, Holter ECG	Physician diagnosed heart failure
Karaye	2008	Nigeria	West	Hospital-based	Cross-sectional	Non-probabilistic	Prospective	42.8	37.2	NR	113	NR	12-lead ECG	ESC 2005 criteria
Karaye a	2021	Nigeria	West	Hospital-based	Cohort	Non-probabilistic	Prospective	50.8	54.3	29.1	383	61.7	12-lead ECG	Boston criteria for HF
Karaye b	2021	South Africa	South	Hospital-based	Cohort	Non-probabilistic	Prospective	53.3	56.2	63.8	169	56.2	12-lead ECG	Boston criteria for HF
Karaye c	2021	Uganda	East	Hospital-based	Cohort	Non-probabilistic	Prospective	52.3	27.5	71.8	151	78.6	12-lead ECG	Boston criteria for HF
Karaye d	2021	Mozambique	East	Hospital-based	Cohort	Non-probabilistic	Prospective	46.2	40.1	49.3	90	23.3	12-lead ECG	Boston criteria for HF
Ker	1995	South Africa	South	Hospital-based	Cohort	Non-probabilistic	Retrospective	69	38	NR	260	NR	12-lead ECG	Physician diagnosed heart failure
Kingue	2005	Cameroon	Central	Hospital-based	Cross-sectional	Non-probabilistic	Retrospective	57.3	59.3	NR	167	53	12-lead ECG	Framingham criteria
Makubi	2014	Tanzania	East	Hospital-based	Cohort	Non-probabilistic	Prospective	55	49	42	427	79	12-lead ECG	Framingham criteria
Malamba	2018	DRC	Central	Hospital-based	Cohort	Non-probabilistic	Retrospective	56	47	60	231	NR	12-lead ECG	ESC 2005 criteria
Mandi	2020	Burkina Faso	West	Hospital-based	Cohort	Non-probabilistic	Prospective	58.6	50.3	19	298	27.9	12-lead ECG	ESC 2012 criteria
Massoure	2013	Djibouti	East	Hospital-based	Cross-sectional	Non-probabilistic	Prospective	55	84	NR	45	55.6	12-lead ECG	Framingham criteria
Mboup	2013	Senegal	West	Hospital-based	cohort	NR	Prospective	65.7	43.8	41	32	41	12-lead ECG	ESC 2012 criteria
Mene-Afejuku	2017	Nigeria	West	Hospital-based	Cohort	NR	Prospective	66.9	NR	NR	113	73.1	Holter ECG	ESC 2012 criteria
Mwita	2017	Botswana	South	Hospital-based	Cohort	Non-probabilistic	Prospective	54	53.9	72	193	77.5	Physician diagnosed	ESC 2012 criteria
Nloo	2016	Cameroon	Central	Hospital-based	Cohort	Non-probabilistic	Prospective	NR	62.5	52	72	100	12-lead ECG	Physician diagnosed heart failure.
Ogah	2014	Nigeria	West	Hospital-based	Cohort	Non-probabilistic	Prospective	59.3	57.5	3	320	82.2	12-lead ECG	Framingham criteria
Ojji	2013	Nigeria	West	Hospital-based	Cohort	Non-probabilistic	Prospective	49	49.9	NR	1515	11.1	12-lead ECG	ESC 2005 criteria
Pio	2014	Togo	West	Hospital-based	Cross-sectional	Non-probabilistic	Prospective	52.2	48.1	NR	297	NR	12-lead ECG	Framingham criteria, and ESC 2012 criteria
Sani	2018	Multinational registry*		Hospital-based	Cohort	Non-probabilistic	Prospective	52.3	49.2	NR	1006	80	12-lead ECG	Framingham criteria, and ESC 2012 criteria
Stewart	2008	South Africa	South	Hospital-based	Cohort	NR	Prospective	55	43	25	844	34	12-lead ECG	ESC 2005 criteria
Thiam	2003	Senegal	West	Hospital-based	Cohort	NR	Prospective	50	NR	NR	170	NR	NR	Physician diagnosed heart failure

*Study countries included: Sudan; Cameroon; South Africa; Nigeria; Ethiopia; Kenya; Uganda; Senegal; Mozambique; AF = Atrial Fibrillation; DRC = Democratic Republic of Congo; ECG = Electrocardiography; ESC = European Society of Cardiology; HF = Heart failure; n = Frequency; NR = Not reported; NYHA = New York Heart Association; Year = Year of publication

Supplementary Table 7. Risk of bias in studies reporting on the prevalence of atrial fibrillation in patients with heart failure

Surname of first author	Year of publication	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Total score	Risk of bias
Abebe	2016	1	1	0	1	0	1	1	0	0	5	Moderate
Ali	2016	1	0	1	0	0	1	1	0	0	4	Moderate
Bonsu	2017	0	1	0	1	0	1	1	0	0	4	Moderate
Boohmbi	2017	1	0	0	1	1	1	0	0	0	4	Moderate
Chansa	2014	0	0	0	0	0	1	0	0	0	1	Low
Dzudie	2008	0	0	0	1	0	1	1	0	0	3	Low
Dzudie	2021	0	1	1	0	0	0	0	0	0	2	Low
Familoni	2007	0	0	1	0	0	1	1	0	0	3	Low
Jere	2015	0	0	1	0	1	1	0	0	0	3	Low
Karaye	2008	0	0	0	0	0	1	0	0	0	1	Low
Karaye a	2021	0	0	0	1	1	1	1	1	1	6	Moderate
Karaye b	2021	0	0	0	1	1	1	1	1	1	6	Moderate
Karaye c	2021	0	0	0	1	1	1	1	1	1	6	Moderate
Karaye d	2021	0	0	0	1	1	1	1	1	1	6	Moderate
Ker	1995	1	1	1	1	1	0	0	0	0	5	Moderate
Kingue	2005	0	0	0	1	0	0	0	0	1	2	Low
Makubi	2014	0	0	1	0	0	0	0	0	0	1	Low
Malamba	2018	1	1	1	1	0	0	0	1	0	5	Moderate
Mandi	2020	0	1	0	0	0	0	0	0	0	1	Low
Massoure	2013	1	1	0	0	0	0	0	0	0	2	Moderate
Mboup	2013	1	1	1	0	0	0	0	0	0	3	Low
Mene-Afejuku	2017	0	0	1	0	0	1	0	0	0	2	Low
Mwita	2017	0	1	0	0	0	0	0	0	0	1	Low
Nloo	2016	0	1	0	0	0	0	0	0	0	1	Low
Ogah	2014	0	1	0	0	0	0	0	0	0	1	Low
Ojji	2013	0	1	0	0	0	0	0	0	1	2	Low
Pio	2014	0	0	0	0	0	1	1	0	1	3	Low
Sani	2018	1	0	1	0	0	0	0	0	0	2	Low
Stewart	2008	0	1	0	0	0	0	0	0	0	1	Low
Thiam	2003	0	1	0	0	0	0	0	0	0	1	Low
Interpretation of the total score 7-9: High risk of bias; 4-6: Moderate risk of bias; 0-3: Low risk of bias												

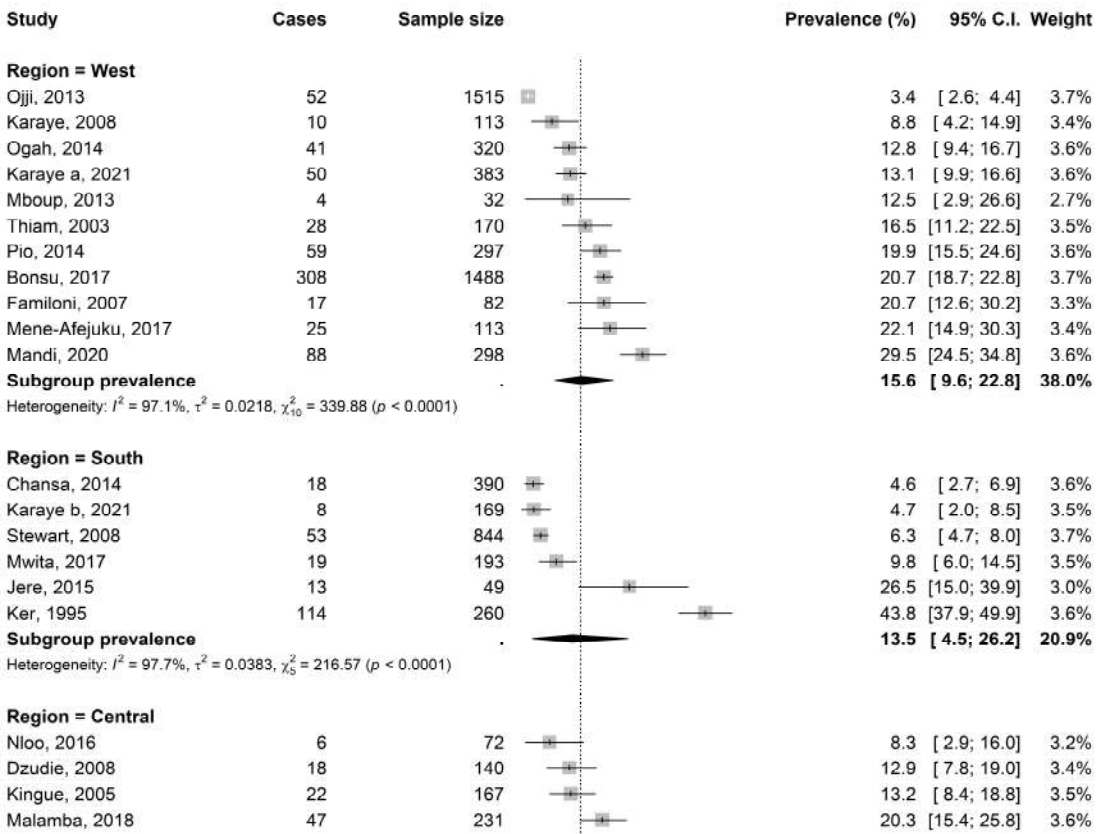
Supplementary Table 8. Risk of bias in studies reporting on all-cause mortality in patients with heart failure and atrial fibrillation

Surname of first author	Year of publication	Selection Item 1	Selection Item 2	Selection Item 3	Selection Item 4	Total Selection	Outcome Item 1	Outcome Item 2	Outcome Item 3	Total Outcome	Risk of bias
Makubi	2014	0	1	1	1	3	1	1	1	3	Low
Malamba	2018	0	1	1	1	3	1	1	0	2	Moderate
Sani	2018	1	1	1	1	4	1	1	1	3	Low

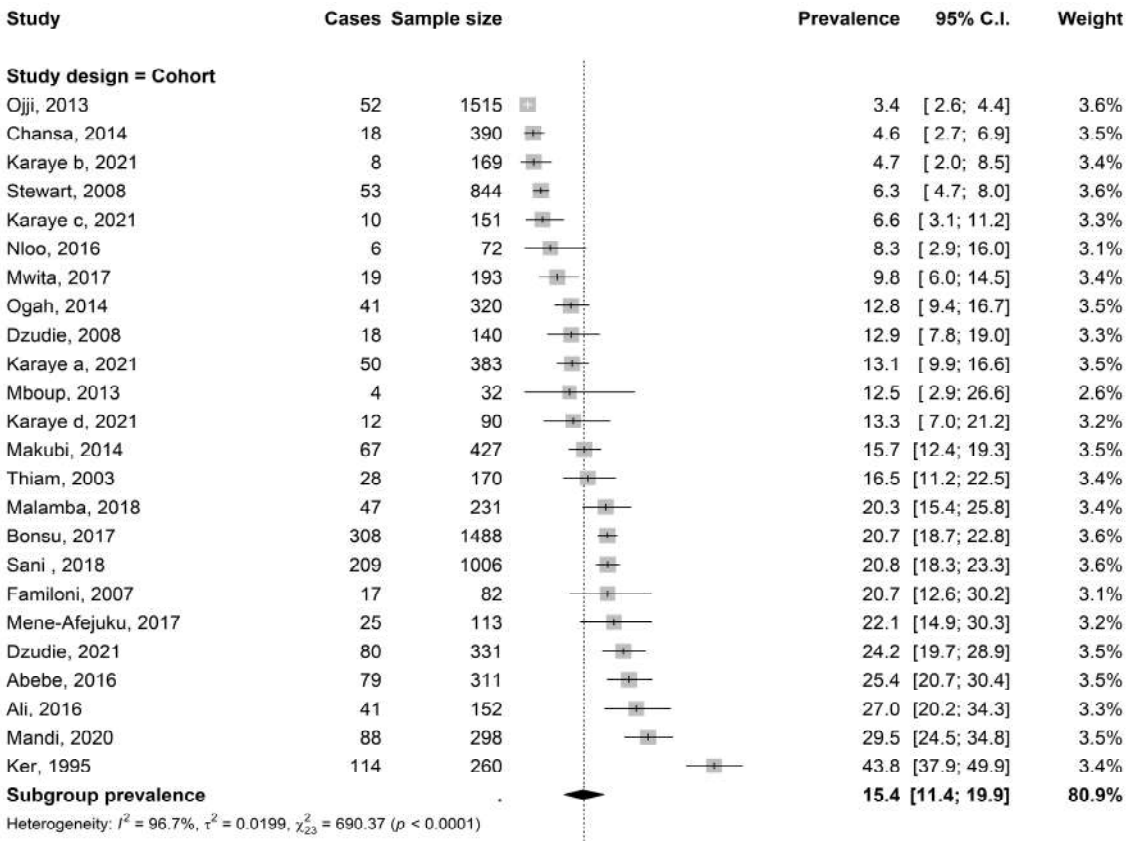
Selection Item 1 (Sample representativeness); Selection Item 2 (Ascertainment of atrial fibrillation); Selection Item 3 (Ascertainment of heart failure); Selection Item 4 (Absence of Outcome [mortality] from the start of the study)

Outcome Item 1 (Outcome assessment); Outcome Item 2 (Follow-up duration for outcome); Outcome Item 3 (Completeness of follow-up)

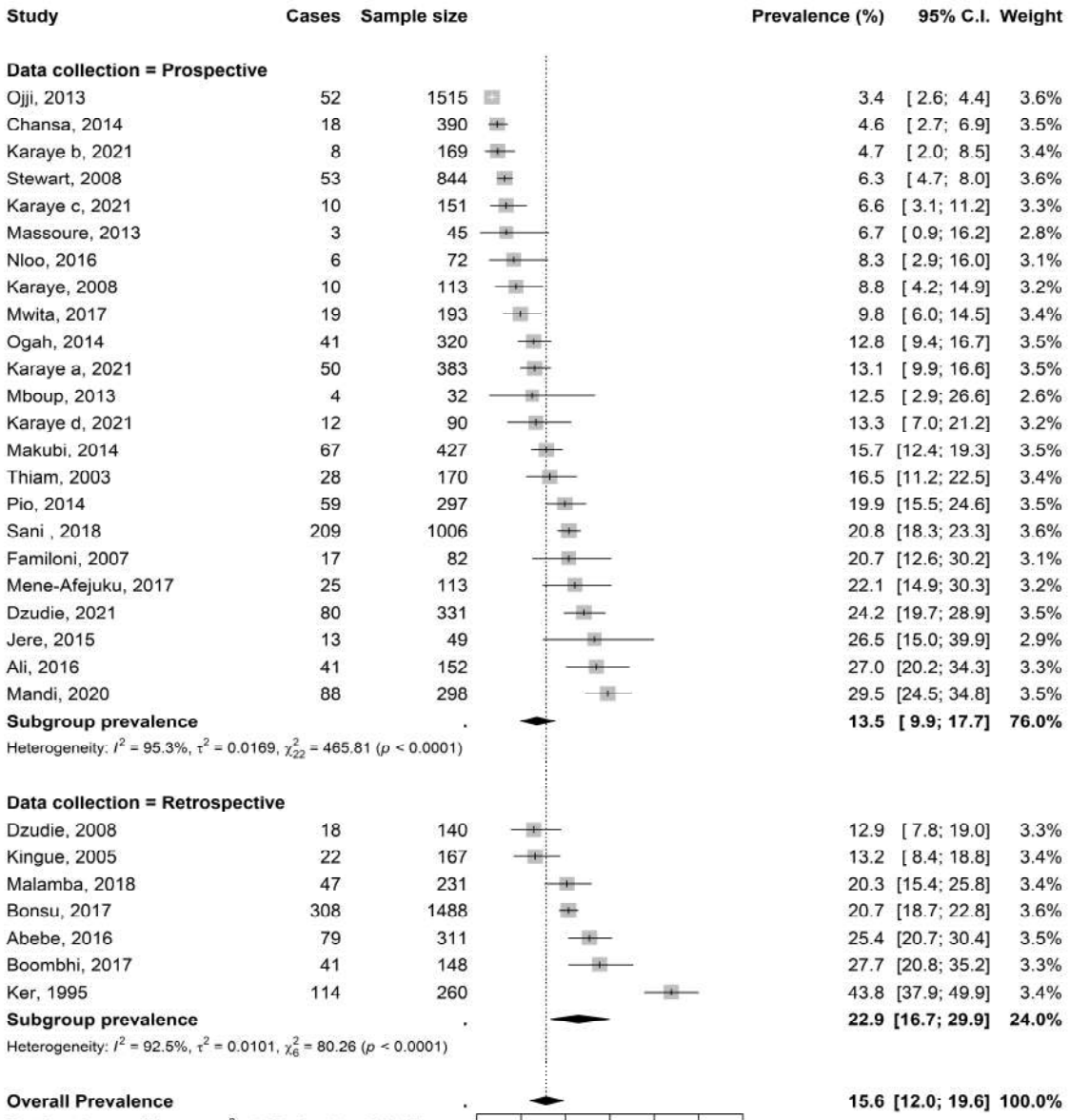
Interpretation of the score
High risk of bias: 0-1 stars in for total selection and 1 star for total outcome scores
Moderate risk of bias: Two stars in total selection and 2 or 3 stars total outcome scores
Low risk of bias: Three or 4 stars in total selection and 2 or 3 stars total outcome scores



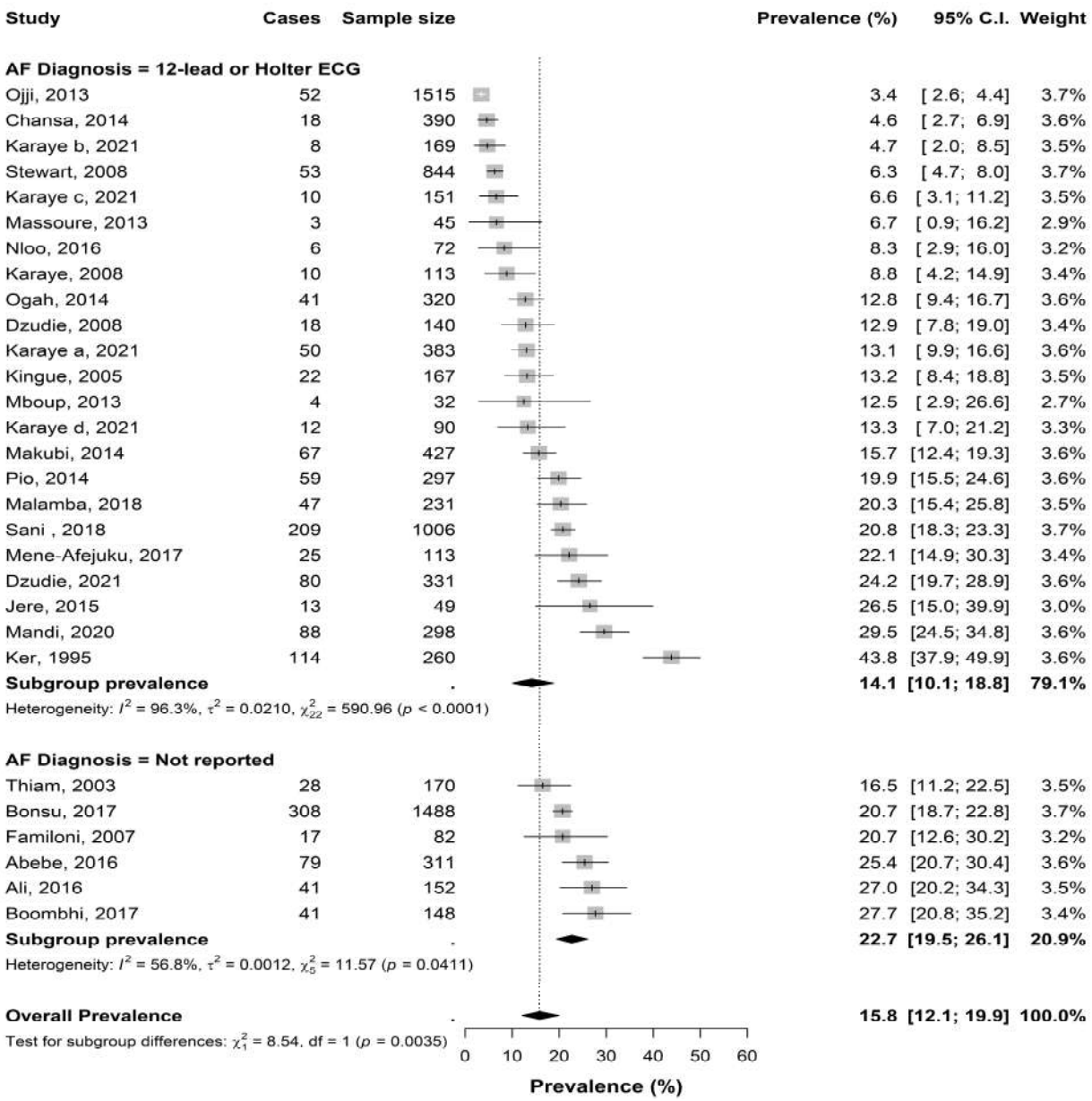
Supplementary Figure 1. Prevalence of atrial fibrillation in heart failure by region



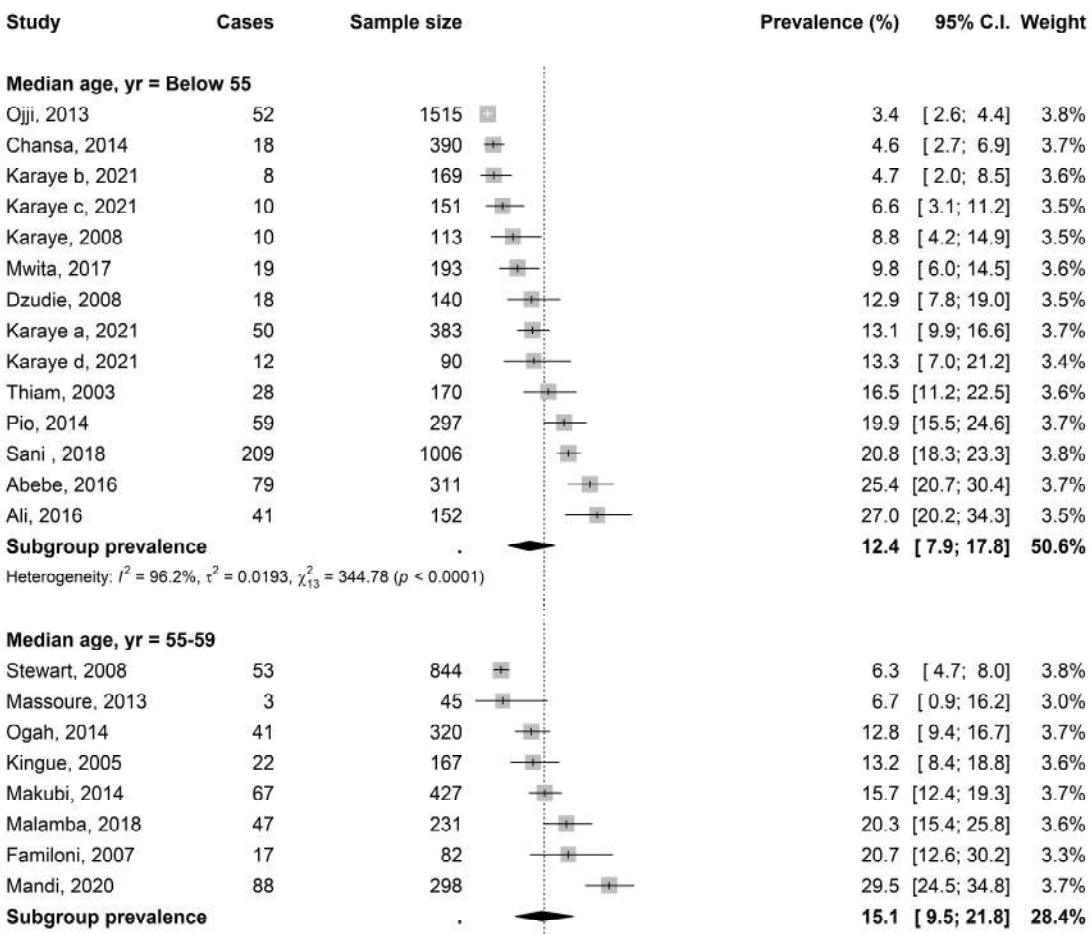
Supplementary Figure 2. Prevalence of atrial fibrillation in heart failure by study design



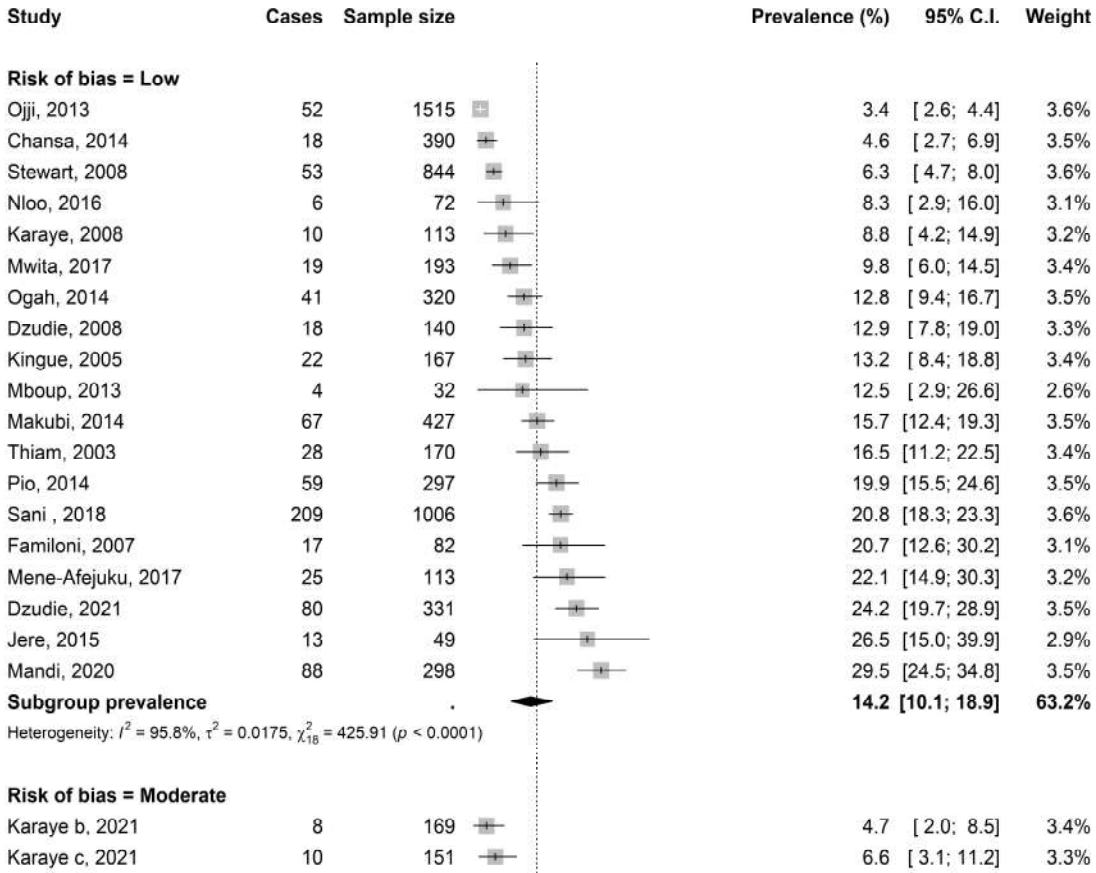
Supplementary Figure 3. Prevalence of atrial fibrillation in heart failure by the timing of data collection



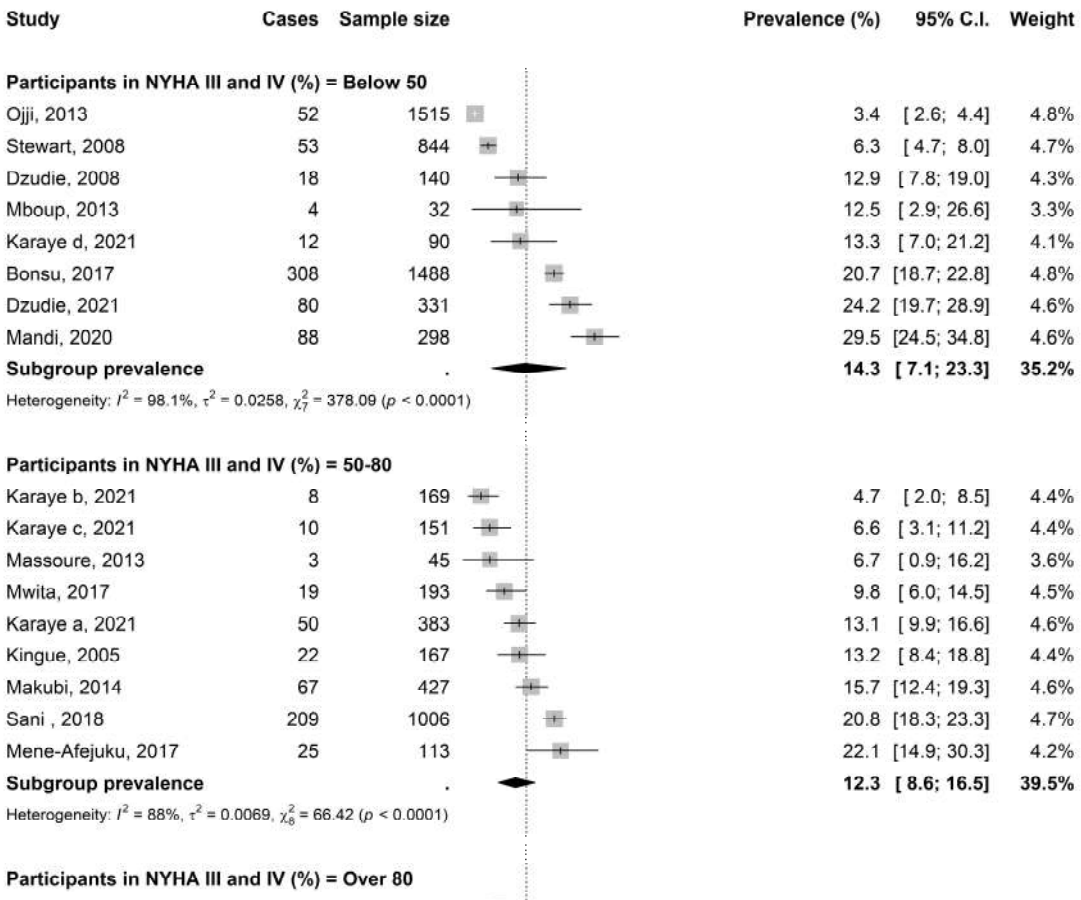
Supplementary Figure 4. Prevalence of atrial fibrillation in heart failure by method of diagnosis of atrial fibrillation



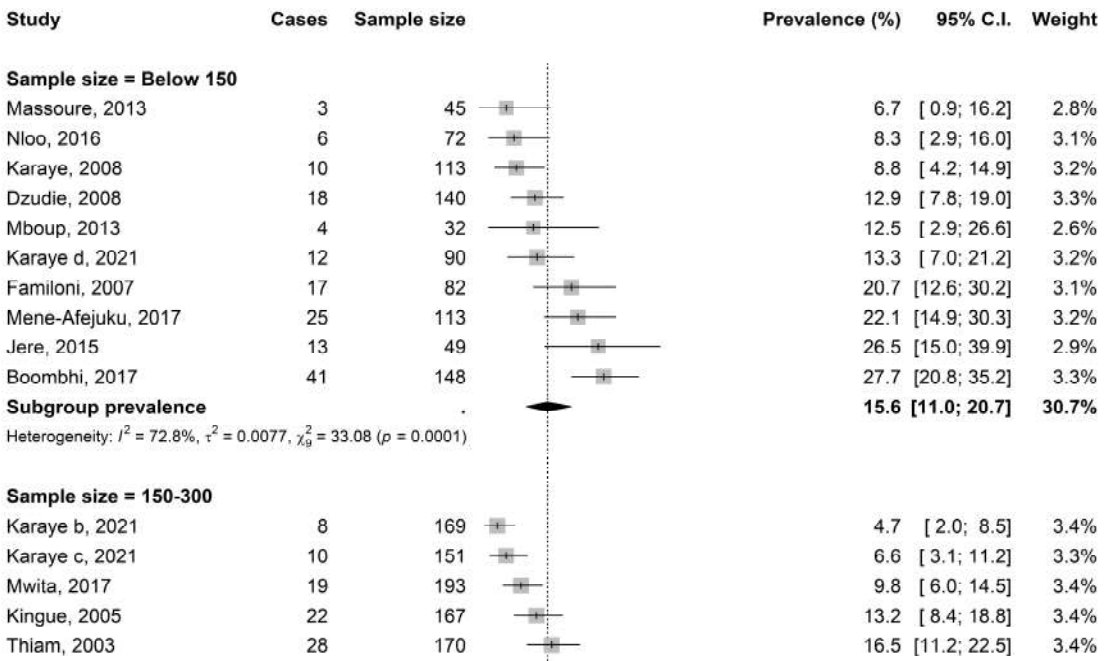
Supplementary Figure 5. Prevalence of atrial fibrillation in heart failure by age of studies participants each study



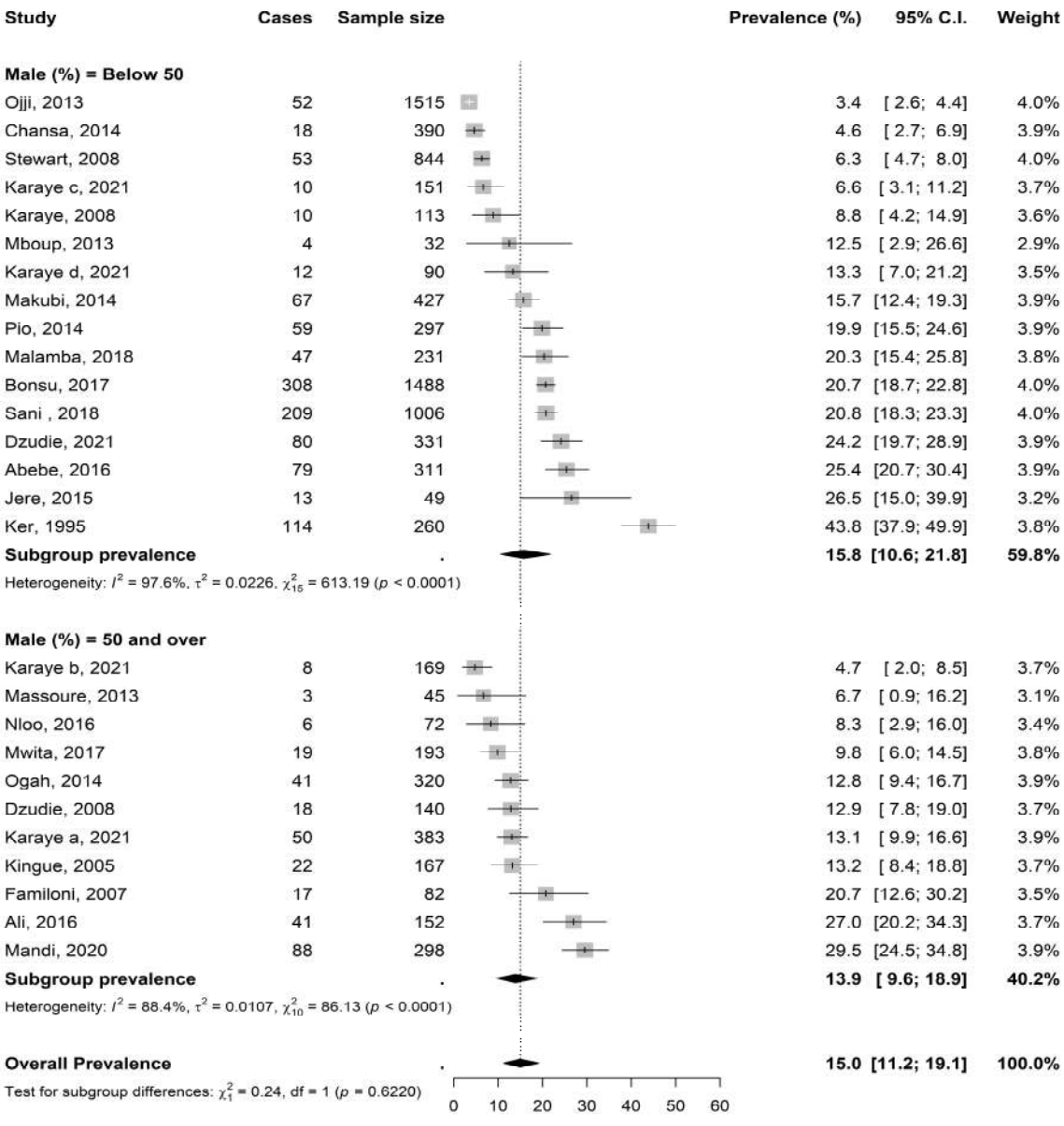
Supplementary Figure 6. Prevalence of atrial fibrillation in heart failure by risk of bias in individual studies



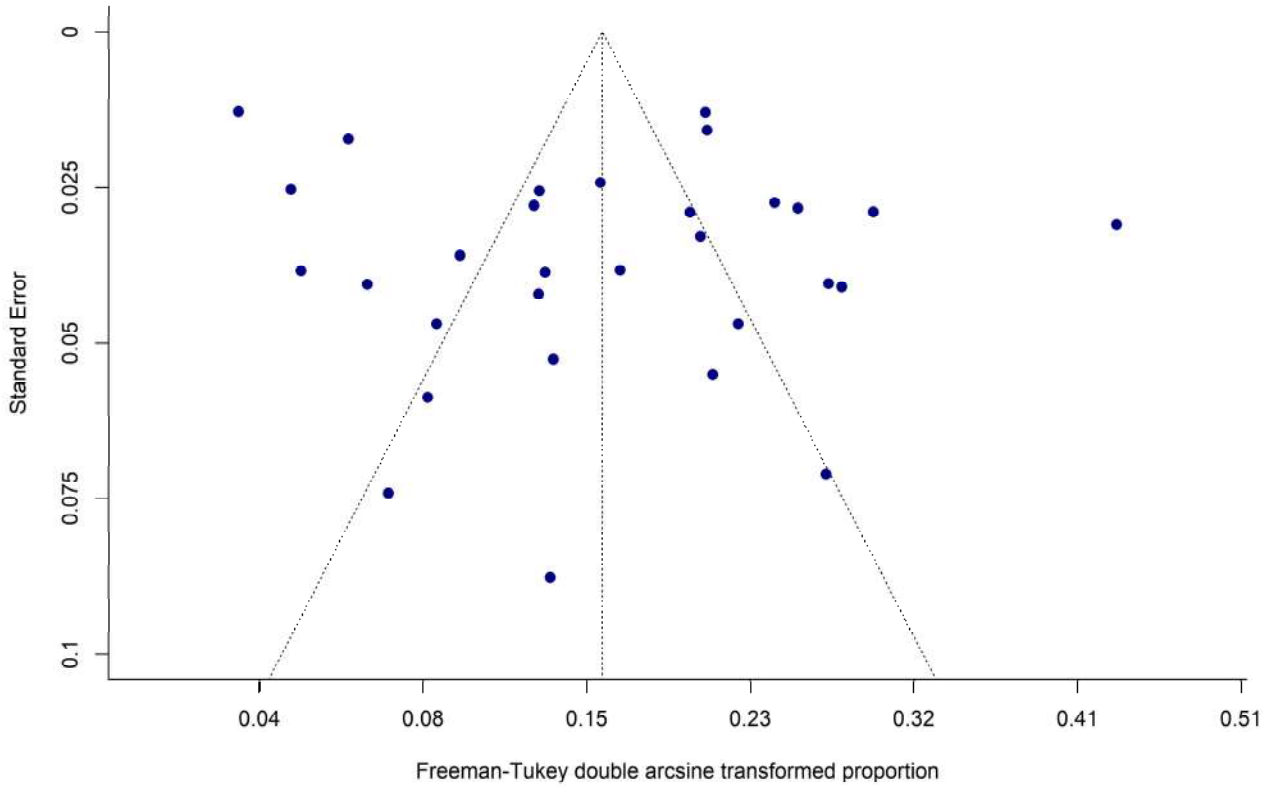
Supplementary Figure 7. Prevalence of atrial fibrillation in heart failure by percentage of participants in New York Heart Association (NYHA) stages III or IV in each study



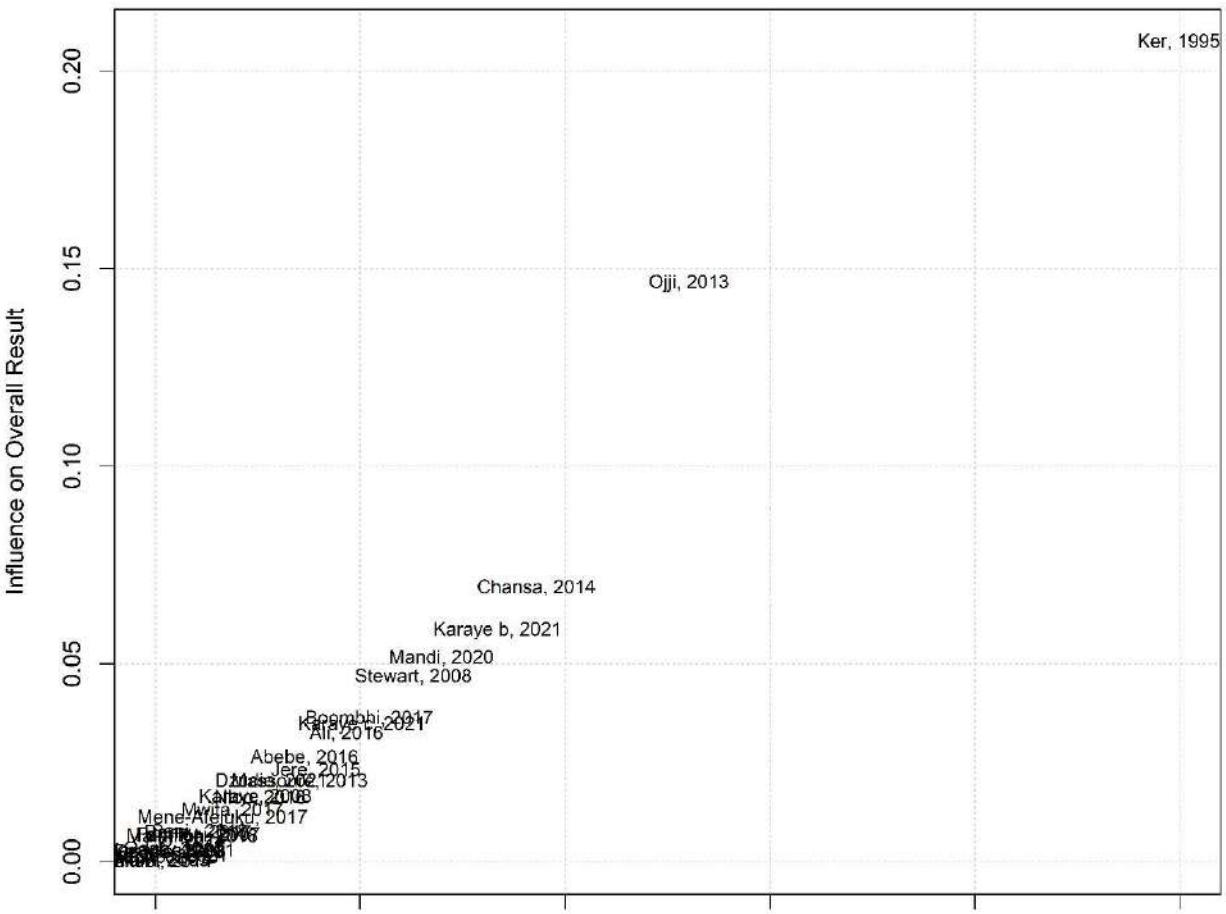
Supplementary Figure 8. Prevalence of atrial fibrillation in heart failure by sample size



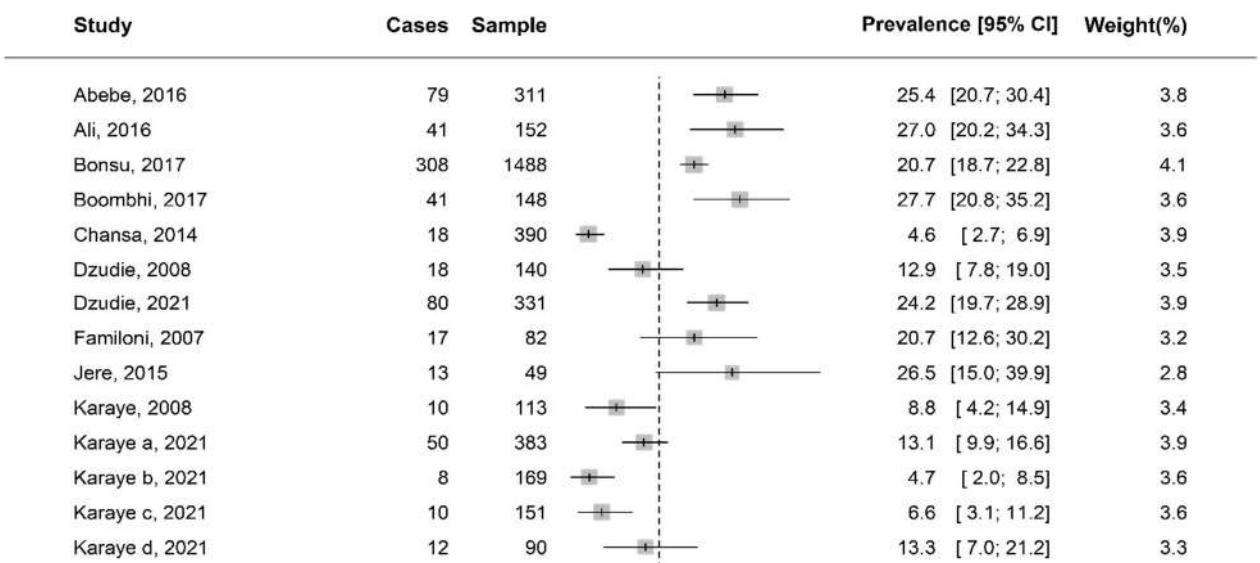
Supplementary Figure 9. Prevalence of atrial fibrillation in heart failure by percentage of male participants



Supplementary Figure 10. Funnel plot for publication bias of studies reporting on the prevalence of atrial fibrillation in heart failure included in the meta-analysis



Supplementary Figure 11. Baujat plot showing the influence of studies on the degree of heterogeneity in studies reporting on the prevalence of atrial fibrillation in heart failure



Supplementary Figure 12. Pooled prevalence of atrial fibrillation in patients with heart failure after excluding potentially influential studies. The grey squares and the horizontal bars are the study-specific prevalence and 95% confidence intervals (CI). Each study-specific estimate is weighted by the inverse of the variance using random-effect meta-analysis. The centre and the horizontal edges of the black diamond are the pooled summary prevalence and 95% confidence interval.

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Page # where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	3
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	3
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	4
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	4
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Tables S1-5
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	4
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	5
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	5
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	5
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	5
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	5
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	6
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	6
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	6
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	6
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	6
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	6
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	6
Certainty	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	6

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Page # where item is reported
assessment			
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	7
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	7
Study characteristics	17	Cite each included study and present its characteristics.	7
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	7-8
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	7-8
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	7
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	7-8
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	8
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	8
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	NA
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	8-10
	23b	Discuss any limitations of the evidence included in the review.	10-11
	23c	Discuss any limitations of the review processes used.	10-11
	23d	Discuss implications of the results for practice, policy, and future research.	10
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	4
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	4
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	5-6
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	11
Competing interests	26	Declare any competing interests of review authors.	11
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	11

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PRISMA 2020 Checklist

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Burden of atrial fibrillation among adults with heart failure in sub-Saharan Africa: a systematic review and meta-analysis

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Burden of atrial fibrillation among adults with heart failure in sub-Saharan Africa: a systematic review and meta-analysis

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Number of tables = 3; Number of figures 2; Supplementary files = 1

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Abstract

Objectives: This study aimed to estimate the prevalence of atrial fibrillation (AF) in adults with heart failure (HF) and summarise the all-cause mortality ratio among adult patients with co-existing HF and AF in sub-Saharan Africa (SSA).

Setting: This was a systematic review and meta-analysis of cross-sectional and cohort studies with primary data on the prevalence and incidence of AF among patients with HF and the all-cause mortality ratio among patients with HF and AF in SSA. We combined text words and MeSH terms to search MEDLINE, PubMed, and Global Health Library through Ovid SP®, African Journals Online, and African Index Medicus from database inception to 10 November 2021. Random-effects meta-analysis was used to estimate pooled prevalence.

Primary outcome measures: The prevalence and incidence of AF among patients with HF and all-cause mortality ratio among patients with HF and AF.

Results: Twenty-seven of the 1902 records retrieved database searches were included in the review, totalling 9,987 patients with HF. The pooled prevalence of AF among patients with HF was 15.6% (95% confidence interval: 12.0 – 19.6). At six months, the all-cause mortality was 18.4% (13.1-23.6) in a multinational registry and 67.7% (51.1-74.3) in one study in Tanzania. One-year mortality was 48.6% (32.5-64.7) in a study in the Democratic Republic of Congo. We did not find any study reporting the incidence of AF in HF.

Conclusion: Atrial fibrillation is common among patients with HF in SSA, and patients with AF and HF have poor survival. There is an urgent need for large-scale population-based prospective data to reliably estimate the prevalence, incidence and risk of mortality of AF among HF patients in SSA to better understand the burden of AF in patients with HF in the region.

Trial registration: This review was registered in the International Prospective Register of Systematic Reviews under the registration number CRD42018087564.

Strengths and limitations of this study

1. This study provides a systematic summary of the prevalence of AF among HF patients in SSA.
2. We highlight gaps in the availability of evidence on the burden of AF among HF patients in SSA.
3. Limited country-level estimates prevent the generalisability of the study's findings.
4. The certainty of evidence on mortality in AF and HF was limited by a small sample size.

Introduction

Heart failure (HF) is a global public health problem estimated to affect about 26 million people worldwide [1]. The global prevalence of HF has been on the rise owing to improvements in life expectancy, the management of acute heart conditions, and the rising prevalence of cardiovascular disease risk factors like hypertension, obesity, and diabetes mellitus [1, 2]. Heart failure disproportionately affects low- and middle-income countries, especially those in sub-Saharan Africa (SSA), where it is associated with high economic costs, poor quality of life, high readmission rates and high in-hospital and one-year mortality rates [3, 4]. For example, about 35% of patients discharged for acute HF will be readmitted within 30-days [5]. This is important in the African context, where about 90% of the cost of management of HF is borne by the patient and their immediate families [3]. In addition, the in-hospital mortality of HF in SSA ranges from 15-35%, with one-year mortality of up to 58% [3]. The one-year mortality rate from HF is highest in Africa compared to other regions such as Southeast Asia, Middle East, and South America [6].

Atrial fibrillation (AF) is the most common cardiac arrhythmia worldwide [7]. In 2017, there were 37.6 million individuals with AF, including 3.1 million new cases [7]. Atrial fibrillation is associated with a higher risk of stroke and systemic embolism, HF, and mortality [8]. AF is associated with poorer outcomes among patients with HF, and is estimated to affect about 16-21% of patients with HF in SSA [9–12]. In addition, AF accelerates the natural history of HF and is associated with more frequent admissions, longer hospital stays, and increased mortality in patients with HF [9, 13–15].

Data on the burden of AF in patients with HF in SSA have not been systematically summarised. Hence, this systematic review and meta-analysis sought to estimate the prevalence of AF in adults with HF and summarise the all-cause mortality ratio among adult patients with co-existing HF and AF in SSA.

Methods

The review protocol was published [16]. This study is reported following the 2020 Preferred Reporting Items for Systematic reviews and Meta-analysis (PRISMA)[17].

Literature search

We searched MEDLINE, Excerpta Medica Database (Embase) and Global Health Library through Ovid SP®, African Journals Online, and African Index Medicus from database inception to 10 November 2021 with no language restrictions. The search strategy combined text words and medical subject headings related to AF and HF, and a validated geographical filter for SSA [18] (**Supplementary Tables 1-5**). We hand-searched the reference list of eligible full-text articles to obtain additional data sources.

Study selection

We included cross-sectional and cohort studies conducted in SSA that reported the prevalence and incidence of AF among patients with HF, all-cause mortality ratio among patients with HF and AF, or provided sufficient data to compute these estimates. We excluded reviews, editorials, studies with fewer than 30 participants and studies conducted in persons aged < 15 years. In addition, we only included the study with the most recent, comprehensive and largest sample size for published studies that used data from the same cohort of participants (duplicate data).

Records retrieved from database searches were exported to EndNote X9 to remove duplicates and then uploaded to Rayyan QCRI for title and abstract screening. Three authors (CMM, SJP and LPS) independently screened the citations based on titles and abstract and assessed the full texts of selected records for final inclusion in the review. Disagreement between authors during the study inclusion process was resolved through consensus or arbitration by a fourth author (VNA).

Data extraction, management, and risk of bias assessment

Four authors (VNA, CMM, SNP, and LPS) used a predesigned Google Form to independently abstract data on: the surname of the first author, year of publication, country of study, study setting, study design, sampling method, timing of data collection, mean or median age of study participants, percentage of male participants, percentage of participants on beta-blockers, sample size, percentage of participants in New York Heart Association (NYHA) stage III or IV, method of diagnosis of AF, method of diagnosis of HF, and the duration of follow up for cohort studies. For multinational studies, data was extracted by the individual country study where possible.

For the outcome of prevalence and incidence of AF in HF, data was also extracted on the number of prevalent AF cases, the number of new AF cases if reported by the study, and the number of participants with HF. Where the authors did not report the number of patients with AF but reported the proportion or percentage of participants with AF, we multiplied this proportion or percentage by the number of HF patients to obtain the number of participants with AF.

For all-cause mortality ratio among patients with AF and HF, we extracted data on the number of participants with HF and AF and the number of deaths from any cause.

Risk of bias assessment

Two reviewers (CMM and SNP) independently assessed the risk of bias in the included studies. An adapted version of the risk of bias assessment tool developed by Hoy *et al* [16, 19] was used to assess the risk of bias in studies reporting on the prevalence of AF in HF. In addition, we modified the original version of the Newcastle-Ottawa Scale [20] to evaluate the risk of bias in studies that reported all-cause mortality in patients with HF and AF.

Data analysis and synthesis

All analyses were conducted with R version 4.1.2 (The R Foundation for Statistical Computing, Vienna, Austria). To estimate the prevalence of AF among participants with HF, we performed an inverse-variance weighted random-effects meta-analysis of proportions after stabilising the variance

using the Freeman-Tukey double-arcsine transformation [21]. The degree of heterogeneity across studies was assessed using the Cochrane's Q χ^2 test and quantified using the I-squared (I^2) statistic [22]. I^2 values below 30%, 30-49%, 50-70%, and over 70% were considered to represent low, moderate, substantial, and considerable degree of heterogeneity, respectively [22]. P-value < 0.05 on the Cochrane's Q χ^2 test indicated significant heterogeneity between studies. We used Baujat plot to inspect for influential studies on the pooled summary effect.

We conducted subgroup analyses using random-effects meta-analysis without assuming a common between-study variance to investigate the sources of heterogeneity by region, study design, timing of data collection, method of AF diagnosis, risk of bias, age of participants, and percentage of participants in NYHA stages III or IV. The Q test was used to investigate moderation effects across subgroups. A p-value <0.1 for test of subgroup difference was used as the threshold for statistical significance [22]. Where appropriate, studies were merged into meaningful categories to minimise loss of power during subgroup analyses. Where a lone category could not be merged into other categories, this was excluded from the subgroup analysis.

Funnel plot was used to investigate small-study effect, and plot asymmetry was suggestive of small-study effect. Egger's regression test was used to test for publication bias. P-value < 0.1 from Egger's test was considered statistically significant. Sensitivity analysis was conducted to assess the impact of excluding influential studies on the overall summary prevalence.

Mortality ratio was defined as the proportion of participants with AF and HF who died from any cause within a given follow-up time. Due to the small number of studies reporting on all-cause mortality ratio among patients with AF and HF, this outcome was summarised narratively.

Patient and public involvement

Patients or the public were not directly involved in this study.

Results

Study selection and characteristics

From 1,902 records retrieved through database searches, 27 were eligible for inclusion in the review [23–49] (**Figure 1 and Supplementary Table 6**). The included studies provided 30 data points on the prevalence of AF in HF (data from the multinational study by Karaye et al 2021 [49] was disaggregated by the country of study). Only three studies [35, 36, 46] provided data on mortality among patients with AF and HF, and none reported on the incidence of AF in HF**.**

All included studies were published from 1995 to 2021 (**Table 1**). The majority (n=23, 76.7%) of studies were published after 2010, and all were hospital-based. Most studies were cohort studies (n=24, 80%), conducted in West Africa (n=11, 36.7%), used a non-probabilistic sampling method (n=24, 80%), and diagnosed AF using 12-Lead ECG (n=23, 76.7%).

Table 1: Characteristics of studies included in the meta-analysis

Characteristics	N = 30
Year of publication	
Range	1995 - 2021
1995-2010	7 (23.3%)
After 2010	23 (76.7%)
Subregion	
Central	6 (20.0%)
East	6 (20.0%)
South	6 (20.0%)
West	11 (36.7)
Multinational registry	1 (3.3%)
Study design	
Cohort	24 (80.0%)
Cross-sectional	6 (20.0%)
Study setting	
Hospital-based	30 (100.0%)
Population-based	0 (0.0%)
Sampling method	
Non-probabilistic	24 (80.0%)
Not reported	6 (20.0%)
Participants in NYHA III or IV (%)	
Below 50	8 (26.7%)
50-80	9 (30.0%)
Over 80	6 (20.0%)
Not reported	7 (23.3%)
Atrial fibrillation diagnostic procedure	
12-Lead ECG	19 (63.3%)
Holter ECG	2 (6.7%)
Medical history	1 (3.3%)
Not reported	4 (13.3%)
Risk of bias	
Low	19 (63.3%)
Moderate	11 (36.7)

ECG = Electrocardiogram; NYHA = New York Heart Association

Prevalence of AF in patients with HF

A total of 9,987 patients with HF were included in the meta-analysis. Almost three-quarters of the studies reporting on the prevalence of AF in HF had a low risk of bias (**Table 1** and **Supplementary Table 7**). The pooled prevalence of AF in HF was 15.6% (95% confidence interval: 12.0 – 19.6), with considerable heterogeneity between studies (I^2 = 96.0%, p < 0.00001) (**Figure 2**). Table 2 and supplementary figures 1-9 summarise the results of the subgroup analysis. The prevalence of AF in HF was significantly higher in studies with retrospective data collection compared to those with prospective data collection (p = 0.0147) and in studies with no reported method for AF diagnosis compared to those with recommended methods for AF diagnosis (12-lead or Holter ECG, p = 0.0035) (**Table 2, Supplementary Figure 3 and 4**). In addition, the prevalence of AF in HF was significantly higher in studies where the mean age of the participants was 60 years and over compared to studies with younger participants (p = 0.0132) (**Table 2 and Supplementary Figure 5**). There was no evidence of moderation of the pooled prevalence by region, study design, the severity of HF in study participants (based on the NYHA classification), sample size, risk of bias, and percentage of males included in each study (**Table 2 and Supplementary figures 1, 2, 6-9**).

There was no evidence of publication bias (P_{Egger} = 0.2593) (**Supplementary Figure 10**). In sensitivity analysis, the studies by Ojji *et al* [44] and Ker and Myburgh [33] were identified to significantly influence the pooled summary estimate (**Supplementary Figure 11**). However, excluding these studies and re-estimating the pooled prevalence of AF in HF did not substantially change the results (pooled prevalence = 15.4% [12.6 – 18.5], **Supplementary Figure 12**).

Table 2: Prevalence of atrial fibrillation in heart failure by various subgroups

Subgroups	Number of studies	Cases of AF	Sample size	Prevalence (95%CI)	I^2 (%)	p for subgroup difference
Subregion*						0.8961
Central	6	214	1089	17.7 (12.7-23.4)	80.8	
East	6	212	1176	15.5 (9.5-22.6)	85.8	
South	6	225	1905	13.5 (4.5-26.2)	97.7	
West	11	682	4811	15.6 (9.6-22.8)	97.1	
Study design						0.7347
Cross-sectional	6	148	819	16.6 (10.7-23.3)	81.0	
Cohort	24	1394	9168	15.4 (11.4-19.9)	96.7	
Timing of data collection**						**0.0147**
Prospective/cross-sectional	23	913	7242	13.5 (9.9-17.7)	95.3	
Retrospective	7	629	2745	22.9 (16.7-29.9)	92.5	
Method of AF diagnosis						**0.0035**
12-lead or Holter ECG	23	1009	7443	14.1 (10.1-18.8)	96.3	
Not reported	6	514	2351	22.7 (19.5-26.1)	56.8	
Risk of bias						0.3025
Low	19	829	6559	14.2 (10.1-18.9)	95.8	
Moderate	11	713	3428	18.1 (12.6-24.4)	94.1	
Mean age, years***						**0.0132**
Below 55	14	613	5080	12.4 (7.9-17.8)	96.2	
55-59.9	8	338	2414	15.1 (9.5-21.8)	93.8	
60 and over	6	572	2372	25.5 (18.2-33.6)	91.6	
Participants in NYHA III or IV (%)***						0.1601
Below 50	8	615	4738	14.3 (7.2-23.3)	98.1	
50-80	9	413	2654	12.3 (8.6-16.5)	88.0	
Over 80	6	197	986	19.5 (13.3-26.6)	83.5	
Sample size						0.6415
Below 150	10	149	884	15.6 (11.0-20.7)	72.8	
150-300	10	436	2088	18.0 (11.3-25.8)	94.8	
Over 300	10	957	7015	13.6 (8.3-20.0)	98.0	
Male percentage (%)***						0.6220
Below 50	16	1135	7535	15.8 (10.6-21.8)	97.6	
50 and over	11	313	2021	13.9 (9.6-18.9)	88.4	

*The study by Sani *et al* was excluded from the analysis as this was a multinational study and the prevalence of AF in heart failure could not be disaggregated into the individual countries where the study was conducted in

**The study by Mwita *et al* was excluded as this was the only study that reported on physician-diagnosed atrial fibrillation.

***Studies with missing data were excluded.

AF = Atrial fibrillation; ECG = Electrocardiography; NYHA = New York Heart Association

All-cause mortality among patients with atrial fibrillation and heart failure

Three studies reported on all-cause mortality among patients with AF and HF (**Table 3**) [35, 36, 46]. Two of the studies were prospective cohort studies, while one was a retrospective cohort study. The mean ages of the participants ranged from 52.3-56.0 years and 79-80% of the participants were in NYHA stage III or IV. Two studies had low risk of bias **(Supplementary Table 8)**.

At six months, the all-cause mortality was 18.4% (13.1-23.6) in a multinational registry and 67.7% (51.1-74.3) in a study in Tanzania. All-cause mortality at one-year was 48.6% (32.5-64.7) in a study in DR Congo (**Table 3**).

Table 3: Characteristics of studies reporting on mortality among patients with atrial fibrillation and heart failure

Surname of first author	Year	Country of study	Study design	Sampling method	Timing of data collection	Median age, yr	Participants in NYHA III and IV (%)	Method of diagnosis of AF	Participants with AF and HF (n)	Deaths (n)	Mortality ratio (%) (95% CI)	Follow-up (months)
Makubi	2014	Tanzania	Cohort	Non-probabilistic	Prospective	55	79	12-lead ECG	67	42	67.7 (51.1-74.3)	6
Malamba	2018	DRC	Cohort	Non-probabilistic	Retrospective	56	NR	12-lead ECG	37	18	48.6 (32.5-64.7)	12
Sani	2018	Multinational registry*	Cohort	Non-probabilistic	Prospective	52.3	80	12-lead ECG	207	38	18.4 (13.1-23.6)	6

*Study countries included: Sudan; Cameroon; South Africa; Nigeria; Ethiopia; Kenya; Uganda; Senegal; Mozambique; AF = Atrial Fibrillation; DRC = Democratic Republic of Congo; ECG = Electrocardiography; ESC = European Society of Cardiology; HF = Heart failure; n = Frequency; NYHA = New York Heart Association; Year = Year of publication

Discussion

This review sought to estimate the prevalence and incidence of AF among patients with HF and all-cause mortality among patients with AF and HF in SSA. The pooled prevalence of AF in HF was 15.6%, and varied by the timing of data collection, methods of AF diagnosis, and mean age of the study participants. Moreover, the all-cause mortality ratio was 18.4 to 67.7% after six months of follow-up and approximately 49% after one year. We did not find any study reporting on the incidence of AF among patients with HF.

The pooled prevalence of AF in HF in this study was lower than reports from North and South America, Europe, and East Asia [50–54]. The prevalence of AF among HF patients in the ADHERE (United States of America), EHFS II (Europe) HF, and China-HF registries were 31.0, 39.0, and 24.4%, respectively [50]. In addition, in a 20-year population-based cohort of 88,416 patients with incident HF in the United Kingdom, about 39% had AF [55]. In contrast, the pooled prevalence of AF in this study was similar to studies from North Africa and Middle East, except Egypt where the prevalence was higher [51, 56]. This difference in prevalence could be explained, in part, by variation age distributions and the prevalence of coronary heart disease in patients with HF across populations [3, 50, 55]. Older age, subclinical atherosclerosis, and ischaemic heart disease are associated with higher risk of AF [57, 58]. We found a higher prevalence of AF in HF among studies where the mean age of participants was at least 60 years and over compared to those with younger participants. The lower prevalence of AF in HF could also be explained by a lack of adequate testing in SSA, as ECG, inpatient telemetry and Holter monitors are largely absent in the region.

We observed a higher six-month and one-year mortality ratio among patients with AF and HF than reports from high-income countries, including Canada and Romania [59, 60]. The high mortality in our study could be because a higher proportion of patients in this review had advanced HF compared to the studies reported in high-income countries. In addition, this high

mortality ratio could reflect limited available availability, accessibility and affordability to quality of care. Advanced therapies such as mechanical circulatory supports and left ventricular assistive devices for patients with advanced HF are limited in SSA [3]. Advanced therapies such as cardiac resynchronisation, pacing and ablation for rate and rhythm control for AF, and mechanical circulatory supports and left ventricular assistive devices for patients with advanced HF are limited in SSA [3]. Observational evidence suggests that AF is associated with a higher risk of mortality among patients with HF. Makubi *et al* observed AF was associated with a three-fold higher risk of mortality among patients with HF in Tanzania [35]. In addition, Sani and collaborators also reported a 61% higher risk of mortality among HF patients with valvular AF than those without AF, even though the authors found no evidence of an association of non-valvular AF with mortality [46]. In a meta-analysis of about 61,000 cases of AF, 150,000 patients with HF, and 40,000 deaths, AF was associated with a 17% higher risk of death [61].

Atrial fibrillation in HF is associated with faster progression of HF in affected patients [62]. Atrial fibrillation could significantly worsen premature mortality in HF patients, especially in SSA, where HF patients are mostly young adults. However, whether AF in HF is associated with increased risk of mortality and how much of this association is due to confounding and reverse causation remains uncertain. Two large-scale randomised controlled trials showed no evidence of rhythm control in reducing mortality among patients with AF and HF [63, 64]. However, these trials were limited in their ability to maintain sinus rhythm in the intervention group, reducing the power of the analyses. Consequently, although contemporary evidence suggests that rhythm control might have some benefit in reducing the risk of mortality in patients with AF and HF [65], robust evidence is lacking on whether AF increases mortality risk in patients with HF or is a marker of advanced HF.

The findings from this study have implications for improving research on AF among patients with HF in SSA to inform local guidelines for the management of patients with HF. Efforts are needed to generate reliable evidence on the incidence, subtypes and prognosis of AF in HF patients in the region. In addition, collaborative efforts are warranted to assess the efficacy and safety of interventions to reduce the risk of mortality among patients with AF and HF in SSA.

This study had some limitations that are worth highlighting. The geographical coverage of studies included in this review was limited. Even though all four SSA subregions were represented in the review, the individual studies were from a limited number of countries, with about a third of all the studies conducted in West Africa. In addition, all studies were hospital-based and included patients with more advanced HF. Including patients with more advanced HF might have overestimated the prevalence of AF in HF and all-cause mortality in patients with AF and HF. Furthermore, the retrospective nature of some studies is likely to have given the authors limited control over the quality of data collected, leading to biased estimates of the prevalence of AF in HF or mortality in patients with AF and HF. We found that studies that collected data retrospectively had a higher pooled prevalence of AF in HF compared to prospective studies. This review highlights limited capacity in diagnosing AF cases among patients with HF in SSA as only two of the studies included in this review used Holter ECG for diagnosis. Even though 12-Lead ECG is widely accepted to confirm the diagnosis of AF [1], it only provides a snapshot of the electrical activity of the heart and misses cases of paroxysmal atrial fibrillation contrary to ambulatory ECG can monitors cardiac electrical activity for sustained periods [66]. Finally, only three studies reported on the mortality among patients with AF and HF, hence our estimates on all-cause mortality should be interpreted with caution. However, this study provides comprehensive and contemporary evidence on the burden of AF among HF patients in SSA.

Conclusion

Atrial fibrillation was common among patients with HF in SSA, and patients with AF and HF appear to have poor survival. There is an urgent need for large-scale population-based prospective data to reliably estimate the prevalence, incidence and risk of mortality in patients with AF and HF in SSA to better understand the burden of these conditions in SSA. Such evidence would be crucial for policies and context-specific guidelines aimed at improving the survival of patients with HF in SSA.

Acknowledgements: The authors appreciate the contribution of Dr Lisa Holland in reviewing the search strategy.

Authors' contributions: VNA conceived the study. VNA, LNA, MDC and JJN designed the protocol. VNA conducted the literature search. VNA, CMM, SNP, and LPS selected the studies and extracted the relevant information. VNA synthesised the data. VNA wrote the first draft of the paper. FLT, LNA, MDC, AD, and JJN critically revised successive drafts of the paper. All authors approved the final version of the manuscript. VNA is the guarantor of the review.

Availability of data: All data related to this review have been provided in the main text and supplementary file.

Conflicts of interest: None declared.

Ethics Approval: No ethical approval was sought for this study as it was based on already published data.

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Figure Legends

Figure 1: PRISMA flow diagram for inclusion of articles in the meta-analysis.

Figure 2: Pooled prevalence of atrial fibrillation in patients with heart failure.

The grey squares and the horizontal bars are the study-specific prevalence and 95% confidence intervals (CI). Each study-specific estimate is weighted by the inverse of the variance using random-effect meta-analysis. The centre and the horizontal edges of the black diamond are the pooled summary prevalence and 95% confidence interval.

Figure S1: Prevalence of atrial fibrillation in heart failure by region.

Figure S2: Prevalence of atrial fibrillation in heart failure by study design.

Figure S3: Prevalence of atrial fibrillation in heart failure by the timing of data collection**.**

Figure S4: Prevalence of atrial fibrillation in heart failure by the method of diagnosis of atrial fibrillation.

Figure S5: Prevalence of atrial fibrillation in heart failure by median age of studies participants each study.

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Figure S7: Prevalence of atrial fibrillation in heart failure by percentage of participants in New York Heart Association (NYHA) stages III or IV in each study.

Figure S8: Prevalence of atrial fibrillation in heart failure by sample size.

Figure S9: Prevalence of atrial fibrillation in heart failure by percentage of male participants.

Figure S10: Funnel plot for publication bias of studies reporting on the prevalence of atrial fibrillation in heart failure included in the meta-analysis.

Figure S11: Plot showing the influence of studies on the degree of heterogeneity in studies reporting on the prevalence of atrial fibrillation in heart failure. High squared Pearson residuals values suggest that the estimate from these studies are outliers.

Figure S12: Pooled prevalence of atrial fibrillation in patients with heart failure after excluding potentially influential studies. Conventions are as in Figure 2.

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Table S2: Search strategy for EMBASE via OVID SP

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Table S4: Search strategy for WHO African Medicus Index

Table S5: Search strategy for African Journals Online

Table S6: Characteristics of studies reporting on the prevalence of atrial fibrillation in heart failure

Table S7: Risk of bias in studies reporting on the prevalence of atrial fibrillation in patients with heart failure

Table S8: Risk of bias in studies reporting on all-cause mortality in patients with heart failure and atrial fibrillation

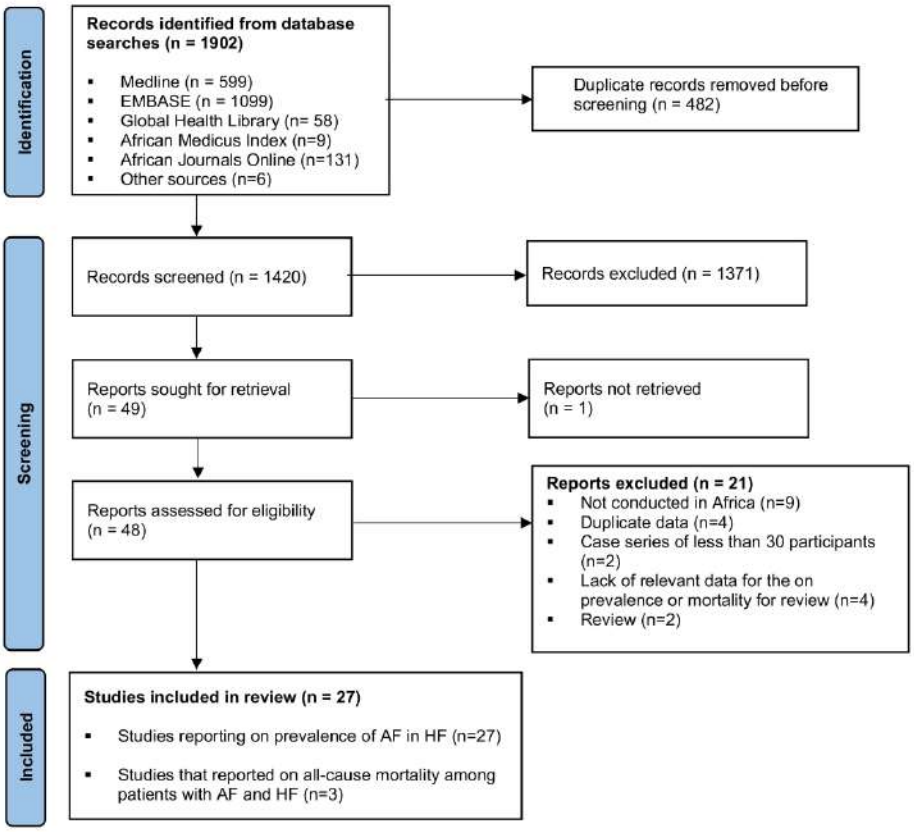

Figure 1: PRISMA flow diagram for inclusion of articles in the meta-analysis.

1522x1422mm (72 x 72 DPI)

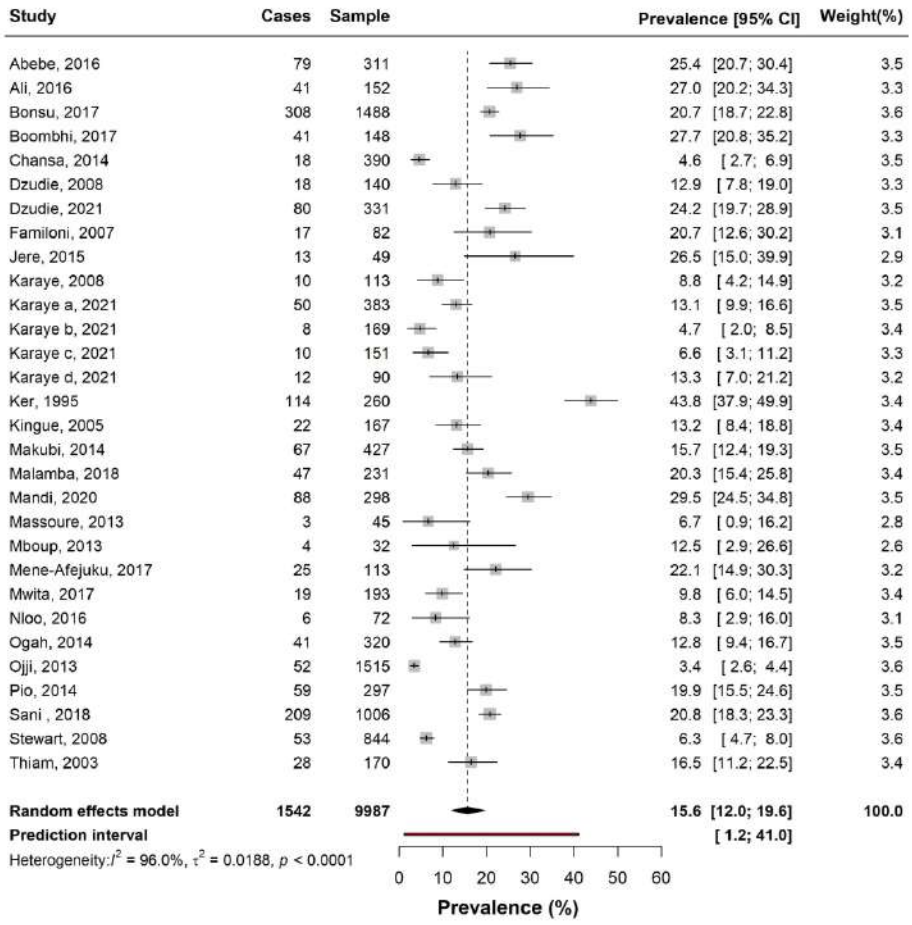

Figure 2: Pooled prevalence of atrial fibrillation in patients with heart failure. The grey squares and the horizontal bars are the study-specific prevalence and 95% confidence intervals (CI). Each study-specific estimate is weighted by the inverse of the variance using random-effect meta-analysis. The centre and the horizontal edges of the black diamond are the pooled summary prevalence and 95% confidence interval.

228x228mm (300 x 300 DPI)

SUPPLEMENTARY MATERIAL

Prevalence of atrial fibrillation and mortality among adults with heart failure in sub-Saharan Africa: a systematic review and meta-analysis

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Contents

Supplementary Table 1. Search strategy for Medline via OVID SP

SN	Search Items
1.	exp Heart Failure/ OR (Heart Failure or cardiac failure or cardia* insufficien*).mp.
2.	benin/ or burkina faso/ or cape verde/ or cote d'ivoire/ or gambia/ or ghana/ or guinea/ or guinea-bissau/ or liberia/ or mali/ or mauritania/ or nigeria/ or senegal/ or sierra leone/ or togo/ or (africa*adj2 west* or benin* or burkina fas* or cape verd* or cabo verd* or ivory coast or cote d'ivoire* or gambia* or ghana* or (guinea* not pig*) or bissau or liberia* or (mali not fowl) or malian or mauritania* or nigeria* or senegal* or sierra leon* or togo* or (Lagos or Accra or Abidjan or Dakar or Abobo or Abuja or Freetown or Ouagadougou or Conakry or Lome or Bamako or Cotonou or Kumasi or Monrovia or Ibadan or Kano or Port harcourt or Benin City or Porto Novo or Niamey or Yamoussoukro or Banjul or Timbuktu or Djenne or Abomeyu or Zaria or Tamale or Jos or Cape Coast or Aba or Gao or Calabar or Warri or Maiduguri or Bobo Dioulasso or Parakou or Djougou or Bohicon or Sekondi Takoradi or Sunyani or Obuasi or Teshie or Tema or Sikasso or Kalabankoro or Nouakchott or Dakhlet Nouadhibou or Benin City or Port Harcourt or Ilorin or Kaduna or Enugu or Ikorodu or Onitsha or Bauchi or Akure or Abeokuta or Sokoto or Bouake or Makeni or Kaduna or Sosgbo or Osogbo or Gombe or Ilesa or Badagry or makurdi or Sagamu or Iseyin or obbomosho or Awka or Ado Ekiti or Nsukka or Ikeja or Katsina or Okene or Lafia or Minna or Ondo city or Umuahia or Calabar or Yola or Pikine or Touba or Thies Nones or Saint Louis or Kolak or Ziguinchor or (San Pedro not (Spain or Mexico or Argentina or California or United States or Italy)) or Bandama or Daloa or Owerri or Kandi or Ifi or Dakar or Ogbomosho or Divo or Korhogo)).mp.
3.	(angola or cameroon* or chad* or tchad or congo* or DRC or equatorial guinea* or gabon* or "Sao Tome" or Principe or Luanda or lobito or kuito or huambo or Malanje or Douala or Yaounde or Bamenda or Garoua of Bafoussam or Ngaoundere or Maroua or Kouosseri or Buea or Kumba or N'Djamena or Moundou or Bangui or Bimbo or Brazzaville or Pointe Noire or Kinshasa or Lubumbashi or Leopoldville or Elizabethville or Mbuji Mayi or Bakwanga or Bukavu or Costermansville or Kananga or Luluabourg or Kisangani or Stanleyville or Tshikapa or Kolwezi or Likasi or Jadotville or Goma or Kikwit or Uvira or Bunia or Mbandaka or Coquilhatville or Matadi or Butembo or Kabinda or Mwene Ditu or Isiro or Paulis or Boma or Kindu or Bata or Malabo or Libreville).mp.
4.	((British Indian Ocean Territory or Burundi* or Comoros or Djibouti* or Eritrea* or Ethiopia* or Kenya* or Madagascar or Malawi or Mauritius or Mayotte or Mozambique or Reunion or Rwanda* or Seychelles or Somalia* or Sudan* or Tanzania* or Uganda* or Zambia or Zimbabwe or Crozet Islands or Iles Crozet or Scattered Islands ! or Iles Eparses or Mwanza or Zanzibar or Eldoret or Morogoro or Hargeysa or Berbera or Nyeri or Mbeya or Machakos or Marka or Tabora or Iringa or Gondar or Meru or Geita or Musoma or Mtwara or Songea or Kigoma or Dese or Mek'ele or Bahir Dar or Jimma or Shinyanga or Korogwe or Nairobi or "Dar es Salaam" or Mombasa or Addis Ababa or Kampala or Kigali or Mogadishu or Dodoma or Bujumbura or Nakuru or Antananarivo or Kisumu or Maputo or Asmara or Lusaka or Harare or Port Louis or Arusha or kitale or lilongwe or malindi or machakos or hargeisa or Bulawayo or Ruiru or Lamu or Dire Dawa or Kikuyu or naivasha or mwanza or tanga or nanyuki or voi or garissa or lodwar of kakamega or maralal or kitui or webuye or Axum or Nyahururu or Jinja or Kismayo or Namanga or Mumias or Moshi or Moroni or Lokichogio or Hola or Rwenzori Mountains or Lake Victoria or Puntland* or (Adi-harush or Ali-Addeh or Alinjugur or Buramino or Dadaab or Dagahaley or Dollo Ado or Fugnido or Hagadera or Hilaweyn or Ifo or Kakuma or Kambioos or Kayaka II or Kobe or Kyangwali Nakivale or Nyarugusu or Wad Sherife or Bokolmanyo or Melkadida or Rwamanja)) adj5 (camp or refug*)).mp.
5.	angola/ or botswana/ or lesotho/ or malawi/ or mozambique/ or namibia/ or south africa/ or swaziland/ or zambia/ or zimbabwe/ or ((africa* adj2 south*) or angola* or botswana* or lesotho* or malawi* or mozambiq* or namibia* or swaziland or zambia* or zimbabwe or Zulu or Tsonga or Xhosa or Swazi or Ndebele or Tswana or Sotho or Shona people or BaLunda or Mbundu or Ovimbundu or Chaga or Sukuma or Pretoria or Cape Town or Johannesburg or Durban or Port Elizabeth or Bloemfontein or Windhoek or Maseru or Pietermaritz or (Kimberley not Australia) or Nelspruit or Soweto or Polokwane or Limpopo or Rustenburg or Mahikeng or Oudtshoorn or! Stellenbosch or Paarl or Gaborone or Luanda or Cabinda or Huambo or Lubango or Kuit or Malanje or Lobito or Lilongwe or Blantyre or Mzuzu or Maputo or Matola or Beira or Nampula or Chimoio or Nacala or Quelimane or Lusaka or Kitwe or Ndola or Kabwe or Copperbelt Harare or Bulawayo or Chitungwiza or Mutare or Masvingo or Monashonaland or Manicaland).mp.
6.	2 or 3 or 4 or 5
7.	Atrial Fibrillation/
8.	1 and 6
9.	7 and 8

Supplementary Table 2. Search strategy for EMBASE via OVID SP

SN	Search Items
1.	exp Heart Failure/ OR (Heart Failure or cardiac failure or cardia* insufficien*).mp.
2.	benin/ or burkina faso/ or cape verde/ or cote d'ivoire/ or gambia/ or ghana/ or guinea/ or guinea-bissau/ or liberia/ or mali/ or mauritania/ or nigeria/ or senegal/ or sierra leone/ or togo/ or (africa*adj2 west* or benin* or burkina fas* or cape verd* or cabo verd* or ivory coast or cote d'ivoire* or gambia* or ghana* or (guinea* not pig*) or bissau or liberia* or (mali not fowl) or malian or mauritania* or nigeria* or senegal* or sierra leon* or togo* or (Lagos or Accra or Abidjan or Dakar or Abobo or Abuja or Freetown or Ouagadougou or Conakry or Lome or Bamako or Cotonou or Kumasi or Monrovia or Ibadan or Kano or Port harcourt or Benin City or Porto Novo or Niamey or Yamoussoukro or Banjul or Timbuktu or Djenne or Abomeyu or Zaria or Tamale or Jos or Cape Coast or Aba or Gao or Calabar or Warri or Maiduguri or Bobo Dioulasso or Parakou or Djougou or Bohicon or Sekondi Takoradi or Sunyani or Obuasi or Teshie or Tema or Sikasso or Kalabankoro or Nouakchott or Dakhlet Nouadhibou or Benin City or Port Harcourt or Ilorin or Kaduna or Enugu or Ikorodu or Onitsha or Bauchi or Akure or Abeokuta or Sokoto or Bouake or Makeni or Kaduna or Sosgbo or Osogbo or Gombe or Ilesa or Badagry or makurdi or Sagamu or Iseyin or obbomosho or Awka or Ado Ekiti or Nsukka or Ikeja or Katsina or Okene or Lafia or Minna or Ondo city or Umuahia or Calabar or Yola or Pikine or Touba or Thies Nones or Saint Louis or Kolak or Ziguinchor or (San Pedro not (Spain or Mexico or Argentina or California or United States or Italy)) or Bandama or Daloa or Owerri or Kandi or Ifi or Dakar or Ogbomosho or Divo or Korhogo)).mp.
3.	(angola or cameroon* or chad* or tchad or congo* or DRC or equatorial guinea* or gabon* or "Sao Tome" or Principe or Luanda or lobito or kuito or huambo or Malanje or Douala or Yaounde or Bamenda or Garoua of Bafoussam or Ngaoundere or Maroua or Kouosseri or Buea or Kumba or N'Djamena or Moundou or Bangui or Bimbo or Brazzaville or Pointe Noire or Kinshasa or Lubumbashi or Leopoldville or Elizabethville or Mbuji Mayi or Bakwanga or Bukavu or Costermansville or Kananga or Luluabourg or Kisangani or Stanleyville or Tshikapa or Kolwezi or Likasi or Jadotville or Goma or Kikwit or Uvira or Bunia or Mbandaka or Coquilhatville or Matadi or Butembo or Kabinda or Mwene Ditu or Isiro or Paulis or Boma or Kindu or Bata or Malabo or Libreville).mp.
4.	((British Indian Ocean Territory or Burundi* or Comoros or Djibouti* or Eritrea* or Ethiopia* or Kenya* or Madagascar or Malawi or Mauritius or Mayotte or Mozambique or Reunion or Rwanda* or Seychelles or Somalia* or Sudan* or Tanzania* or Uganda* or Zambia or Zimbabwe or Crozet Islands or Iles Crozet or Scattered Islands ! or Iles Eparses or Mwanza or Zanzibar or Eldoret or Morogoro or Hargeysa or Berbera or Nyeri or Mbeya or Machakos or Marka or Tabora or Iringa or Gondar or Meru or Geita or Musoma or Mtwara or Songea or Kigoma or Dese or Mek'ele or Bahir Dar or Jimma or Shinyanga or Korogwe or Nairobi or "Dar es Salaam" or Mombasa or Addis Ababa or Kampala or Kigali or Mogadishu or Dodoma or Bujumbura or Nakuru or Antananarivo or Kisumu or Maputo or Asmara or Lusaka or Harare or Port Louis or Arusha or kitale or lilongwe or malindi or machakos or hargeisa or Bulawayo or Ruiru or Lamu or Dire Dawa or Kikuyu or naivasha or mwanza or tanga or nanyuki or voi or garissa or lodwar of kakamega or maralal or kitui or webuye or Axum or Nyahururu or Jinja or Kismayo or Namanga or Mumias or Moshi or Moroni or Lokichogio or Hola or Rwenzori Mountains or Lake Victoria or Puntland* or (Adi-harush or Ali-Addeh or Alinjugur or Buramino or Dadaab or Dagahaley or Dollo Ado or Fugnido or Hagadera or Hilaweyn or Ifo or Kakuma or Kambioos or Kayaka II or Kobe or Kyangwali Nakivale or Nyarugusu or Wad Sherife or Bokolmanyo or Melkadida or Rwamanja)) adj5 (camp or refug*)).mp.
5.	angola/ or botswana/ or lesotho/ or malawi/ or mozambique/ or namibia/ or south africa/ or swaziland/ or zambia/ or zimbabwe/ or ((africa* adj2 south*) or angola* or botswana* or lesotho* or malawi* or mozambiq* or namibia* or swaziland or zambia* or zimbabwe or Zulu or Tsonga or Xhosa or Swazi or Ndebele or Tswana or Sotho or Shona people or BaLunda or Mbundu or Ovimbundu or Chaga or Sukuma or Pretoria or Cape Town or Johannesburg or Durban or Port Elizabeth or Bloemfontein or Windhoek or Maseru or Pietermaritz or (Kimberley not Australia) or Nelspruit or Soweto or Polokwane or Limpopo or Rustenburg or Mahikeng or Oudtshoorn or! Stellenbosch or Paarl or Gaborone or Luanda or Cabinda or Huambo or Lubango or Kuit or Malanje or Lobito or Lilongwe or Blantyre or Mzuzu or Maputo or Matola or Beira or Nampula or Chimoio or Nacala or Quelimane or Lusaka or Kitwe or Ndola or Kabwe or Copperbelt Harare or Bulawayo or Chitungwiza or Mutare or Masvingo or Monashonaland or Manicaland).mp.
6.	2 or 3 or 4 or 5
7.	Atrial Fibrillation/
8.	1 and 6
9.	7 and 8

Supplementary Table 3. Search strategy for Global Health Library via OVID SP

SN	Search Items
1.	exp Heart Failure/ OR (Heart Failure or cardiac failure or cardia* insufficien*).mp.
2.	benin/ or burkina faso/ or cape verde/ or cote d'ivoire/ or gambia/ or ghana/ or guinea/ or guinea-bissau/ or liberia/ or mali/ or mauritania/ or nigeria/ or senegal/ or sierra leone/ or togo/ or (africa*adj2 west* or benin* or burkina fas* or cape verd* or cabo verd* or ivory coast or cote d'ivoire* or gambia* or ghana* or (guinea* not pig*) or bissau or liberia* or (mali not fowl) or malian or mauritania* or nigeria* or senegal* or sierra leon* or togo* or (Lagos or Accra or Abidjan or Dakar or Abobo or Abuja or Freetown or Ouagadougou or Conakry or Lome or Bamako or Cotonou or Kumasi or Monrovia or Ibadan or Kano or Port harcourt or Benin City or Porto Novo or Niamey or Yamoussoukro or Banjul or Timbuktu or Djenne or Abomeyu or Zaria or Tamale or Jos or Cape Coast or Aba or Gao or Calabar or Warri or Maiduguri or Bobo Dioulasso or Parakou or Djougou or Bohicon or Sekondi Takoradi or Sunyani or Obuasi or Teshie or Tema or Sikasso or Kalabankoro or Nouakchott or Dakhlet Nouadhibou or Benin City or Port Harcourt or Ilorin or Kaduna or Enugu or Ikorodu or Onitsha or Bauchi or Akure or Abeokuta or Sokoto or Bouake or Makeni or Kaduna or Sosgbo or Osogbo or Gombe or Ilesa or Badagry or makurdi or Sagamu or Iseyin or obbomosho or Awka or Ado Ekiti or Nsukka or Ikeja or Katsina or Okene or Lafia or Minna or Ondo city or Umuahia or Calabar or Yola or Pikine or Touba or Thies Nones or Saint Louis or Kolak or Ziguinchor or (San Pedro not (Spain or Mexico or Argentina or California or United States or Italy)) or Bandama or Daloa or Owerri or Kandi or Ifi or Dakar or Ogbomosho or Divo or Korhogo)).mp.
3.	(angola or cameroon* or chad* or tchad or congo* or DRC or equatorial guinea* or gabon* or "Sao Tome" or Principe or Luanda or lobito or kuito or huambo or Malanje or Douala or Yaounde or Bamenda or Garoua of Bafoussam or Ngaoundere or Maroua or Kouosseri or Buea or Kumba or N'Djamena or Moundou or Bangui or Bimbo or Brazzaville or Pointe Noire or Kinshasa or Lubumbashi or Leopoldville or Elizabethville or Mbuji Mayi or Bakwanga or Bukavu or Costermansville or Kananga or Luluabourg or Kisangani or Stanleyville or Tshikapa or Kolwezi or Likasi or Jadotville or Goma or Kikwit or Uvira or Bunia or Mbandaka or Coquilhatville or Matadi or Butembo or Kabinda or Mwene Ditu or Isiro or Paulis or Boma or Kindu or Bata or Malabo or Libreville).mp.
4.	((British Indian Ocean Territory or Burundi* or Comoros or Djibouti* or Eritrea* or Ethiopia* or Kenya* or Madagascar or Malawi or Mauritius or Mayotte or Mozambique or Reunion or Rwanda* or Seychelles or Somalia* or Sudan* or Tanzania* or Uganda* or Zambia or Zimbabwe or Crozet Islands or Iles Crozet or Scattered Islands ! or Iles Eparses or Mwanza or Zanzibar or Eldoret or Morogoro or Hargeysa or Berbera or Nyeri or Mbeya or Machakos or Marka or Tabora or Iringa or Gondar or Meru or Geita or Musoma or Mtwara or Songea or Kigoma or Dese or Mek'ele or Bahir Dar or Jimma or Shinyanga or Korogwe or Nairobi or "Dar es Salaam" or Mombasa or Addis Ababa or Kampala or Kigali or Mogadishu or Dodoma or Bujumbura or Nakuru or Antananarivo or Kisumu or Maputo or Asmara or Lusaka or Harare or Port Louis or Arusha or kitale or lilongwe or malindi or machakos or hargeisa or Bulawayo or Ruiru or Lamu or Dire Dawa or Kikuyu or naivasha or mwanza or tanga or nanyuki or voi or garissa or lodwar of kakamega or maralal or kitui or webuye or Axum or Nyahururu or Jinja or Kismayo or Namanga or Mumias or Moshi or Moroni or Lokichogio or Hola or Rwenzori Mountains or Lake Victoria or Puntland* or (Adi-harush or Ali-Addeh or Alinjugur or Buramino or Dadaab or Dagahaley or Dollo Ado or Fugnido or Hagadera or Hilaweyn or Ifo or Kakuma or Kambioos or Kayaka II or Kobe or Kyangwali Nakivale or Nyarugusu or Wad Sherife or Bokolmanyo or Melkadida or Rwamanja)) adj5 (camp or refug*)).mp.
5.	angola/ or botswana/ or lesotho/ or malawi/ or mozambique/ or namibia/ or south africa/ or swaziland/ or zambia/ or zimbabwe/ or ((africa* adj2 south*) or angola* or botswana* or lesotho* or malawi* or mozambiq* or namibia* or swaziland or zambia* or zimbabwe or Zulu or Tsonga or Xhosa or Swazi or Ndebele or Tswana or Sotho or Shona people or BaLunda or Mbundu or Ovimbundu or Chaga or Sukuma or Pretoria or Cape Town or Johannesburg or Durban or Port Elizabeth or Bloemfontein or Windhoek or Maseru or Pietermaritz or (Kimberley not Australia) or Nelspruit or Soweto or Polokwane or Limpopo or Rustenburg or Mahikeng or Oudtshoorn or! Stellenbosch or Paarl or Gaborone or Luanda or Cabinda or Huambo or Lubango or Kuit or Malanje or Lobito or Lilongwe or Blantyre or Mzuzu or Maputo or Matola or Beira or Nampula or Chimoio or Nacala or Quelimane or Lusaka or Kitwe or Ndola or Kabwe or Copperbelt Harare or Bulawayo or Chitungwiza or Mutare or Masvingo or Monashonaland or Manicaland).mp.
6.	2 or 3 or 4 or 5
7.	Atrial Fibrillation/
8.	1 and 6
9.	7 and 8

Supplementary Table 4. Search strategy for WHO African Medicus Index

SN	Search Items
1.	(tw:(Heart Failure))
2.	(tw:(atrial fibrillation))
3.	1 and 2

Supplementary Table 5. Search strategy for African Journals Online

SN	Search Items
1.	"heart failure"
2.	"cardiac failure"
3.	"cardia* insufficien*"
4.	1 OR 2 OR 3
5.	"atrial fibrillation"
6.	4 AND 5

Supplementary Table 6. Characteristics of studies reporting on prevalence of atrial fibrillation in heart failure

Surname of first author	Year of publication	Country of study	African region	Study setting	Study design	Sampling method	Timing of data collection	median age, yr	Males (%)	Participants on beta-blockers (%)	Sample size	Participants in NYHA III/IV (%)	Method of diagnosis of AF	Method of diagnosis of Heart failure
Abebe	2016	Ethiopia	East	Hospital-based	Cohort	Non-probabilistic	Retrospective	53.6	30.2	38	311	100	NR	Framingham criteria
Ali	2016	Ethiopia	East	Hospital-based	Cohort	Non-probabilistic	Prospective	50.9	50.7	NR	152	89	NR	Framingham criteria
Bonsu	2017	Ghana	West	Hospital-based	Cohort	NR	Retrospective	60.3	45.6	33	1488	42.5	NR	Framingham criteria
Boombhi	2017	Cameroon	Central	Hospital-based	Cross-sectional	Non-probabilistic	Retrospective	61.5	NR	NR	148	NR	NR	Framingham criteria
Chansa	2014	Zambia	South	Hospital-based	Cohort	Non-probabilistic	Prospective	50	41	2	390	NR	12-lead ECG	Trans-thoracic echocardiography
Dzudie	2008	Cameroon	Central	Hospital-based	Cross-sectional	Non-probabilistic	Retrospective	54.9	61.4	NR	140	44.2	12-lead ECG	Framingham criteria
Dzudie	2021	Cameroon	Central	Hospital-based	Cohort	Non-probabilistic	Prospective	64	49.3	NR	331	42.2	12-lead ECG	ESC 2016 criteria
Familoni	2007	Nigeria	West	Hospital-based	Cohort	Non-probabilistic	Prospective	57.6	67.1	NR	82	100	NR	Trans-thoracic echocardiography
Jere	2015	Zambia	South	Hospital-based	Cross-sectional	Non-probabilistic	Prospective	NR	49	NR	49	100	12-lead ECG, Holter ECG	Physician diagnosed heart failure
Karaye	2008	Nigeria	West	Hospital-based	Cross-sectional	Non-probabilistic	Prospective	42.8	37.2	NR	113	NR	12-lead ECG	ESC 2005 criteria
Karaye a	2021	Nigeria	West	Hospital-based	Cohort	Non-probabilistic	Prospective	50.8	54.3	29.1	383	61.7	12-lead ECG	Boston criteria for HF
Karaye b	2021	South Africa	South	Hospital-based	Cohort	Non-probabilistic	Prospective	53.3	56.2	63.8	169	56.2	12-lead ECG	Boston criteria for HF
Karaye c	2021	Uganda	East	Hospital-based	Cohort	Non-probabilistic	Prospective	52.3	27.5	71.8	151	78.6	12-lead ECG	Boston criteria for HF
Karaye d	2021	Mozambique	East	Hospital-based	Cohort	Non-probabilistic	Prospective	46.2	40.1	49.3	90	23.3	12-lead ECG	Boston criteria for HF
Ker	1995	South Africa	South	Hospital-based	Cohort	Non-probabilistic	Retrospective	69	38	NR	260	NR	12-lead ECG	Physician diagnosed heart failure
Kingue	2005	Cameroon	Central	Hospital-based	Cross-sectional	Non-probabilistic	Retrospective	57.3	59.3	NR	167	53	12-lead ECG	Framingham criteria
Makubi	2014	Tanzania	East	Hospital-based	Cohort	Non-probabilistic	Prospective	55	49	42	427	79	12-lead ECG	Framingham criteria
Malamba	2018	DRC	Central	Hospital-based	Cohort	Non-probabilistic	Retrospective	56	47	60	231	NR	12-lead ECG	ESC 2005 criteria
Mandi	2020	Burkina Faso	West	Hospital-based	Cohort	Non-probabilistic	Prospective	58.6	50.3	19	298	27.9	12-lead ECG	ESC 2012 criteria
Massoure	2013	Djibouti	East	Hospital-based	Cross-sectional	Non-probabilistic	Prospective	55	84	NR	45	55.6	12-lead ECG	Framingham criteria
Mboup	2013	Senegal	West	Hospital-based	cohort	NR	Prospective	65.7	43.8	41	32	41	12-lead ECG	ESC 2012 criteria
Mene-Afejuku	2017	Nigeria	West	Hospital-based	Cohort	NR	Prospective	66.9	NR	NR	113	73.1	Holter ECG	ESC 2012 criteria
Mwita	2017	Botswana	South	Hospital-based	Cohort	Non-probabilistic	Prospective	54	53.9	72	193	77.5	Physician diagnosed	ESC 2012 criteria
Nloo	2016	Cameroon	Central	Hospital-based	Cohort	Non-probabilistic	Prospective	NR	62.5	52	72	100	12-lead ECG	Physician diagnosed heart failure.
Ogah	2014	Nigeria	West	Hospital-based	Cohort	Non-probabilistic	Prospective	59.3	57.5	3	320	82.2	12-lead ECG	Framingham criteria
Ojji	2013	Nigeria	West	Hospital-based	Cohort	Non-probabilistic	Prospective	49	49.9	NR	1515	11.1	12-lead ECG	ESC 2005 criteria
Pio	2014	Togo	West	Hospital-based	Cross-sectional	Non-probabilistic	Prospective	52.2	48.1	NR	297	NR	12-lead ECG	Framingham criteria, and ESC 2012 criteria
Sani	2018	Multinational registry*		Hospital-based	Cohort	Non-probabilistic	Prospective	52.3	49.2	NR	1006	80	12-lead ECG	Framingham criteria, and ESC 2012 criteria
Stewart	2008	South Africa	South	Hospital-based	Cohort	NR	Prospective	55	43	25	844	34	12-lead ECG	ESC 2005 criteria
Thiam	2003	Senegal	West	Hospital-based	Cohort	NR	Prospective	50	NR	NR	170	NR	NR	Physician diagnosed heart failure

*Study countries included: Sudan; Cameroon; South Africa; Nigeria; Ethiopia; Kenya; Uganda; Senegal; Mozambique; AF = Atrial Fibrillation; DRC = Democratic Republic of Congo; ECG = Electrocardiography; ESC = European Society of Cardiology; HF = Heart failure; n = Frequency; NR = Not reported; NYHA = New York Heart Association; Year = Year of publication

Supplementary Table 7. Risk of bias in studies reporting on the prevalence of atrial fibrillation in patients with heart failure

Surname of first author	Year of publication	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Total score	Risk of bias
Abebe	2016	1	1	0	1	0	1	1	0	0	5	Moderate
Ali	2016	1	0	1	0	0	1	1	0	0	4	Moderate
Bonsu	2017	0	1	0	1	0	1	1	0	0	4	Moderate
Boohmbi	2017	1	0	0	1	1	1	0	0	0	4	Moderate
Chansa	2014	0	0	0	0	0	1	0	0	0	1	Low
Dzudie	2008	0	0	0	1	0	1	1	0	0	3	Low
Dzudie	2021	0	1	1	0	0	0	0	0	0	2	Low
Familoni	2007	0	0	1	0	0	1	1	0	0	3	Low
Jere	2015	0	0	1	0	1	1	0	0	0	3	Low
Karaye	2008	0	0	0	0	0	1	0	0	0	1	Low
Karaye a	2021	0	0	0	1	1	1	1	1	1	6	Moderate
Karaye b	2021	0	0	0	1	1	1	1	1	1	6	Moderate
Karaye c	2021	0	0	0	1	1	1	1	1	1	6	Moderate
Karaye d	2021	0	0	0	1	1	1	1	1	1	6	Moderate
Ker	1995	1	1	1	1	1	0	0	0	0	5	Moderate
Kingue	2005	0	0	0	1	0	0	0	0	1	2	Low
Makubi	2014	0	0	1	0	0	0	0	0	0	1	Low
Malamba	2018	1	1	1	1	0	0	0	1	0	5	Moderate
Mandi	2020	0	1	0	0	0	0	0	0	0	1	Low
Massoure	2013	1	1	0	0	0	0	0	0	0	2	Moderate
Mboup	2013	1	1	1	0	0	0	0	0	0	3	Low
Mene-Afejuku	2017	0	0	1	0	0	1	0	0	0	2	Low
Mwita	2017	0	1	0	0	0	0	0	0	0	1	Low
Nloo	2016	0	1	0	0	0	0	0	0	0	1	Low
Ogah	2014	0	1	0	0	0	0	0	0	0	1	Low
Ojji	2013	0	1	0	0	0	0	0	0	1	2	Low
Pio	2014	0	0	0	0	0	1	1	0	1	3	Low
Sani	2018	1	0	1	0	0	0	0	0	0	2	Low
Stewart	2008	0	1	0	0	0	0	0	0	0	1	Low
Thiam	2003	0	1	0	0	0	0	0	0	0	1	Low
Interpretation of the total score 7-9: High risk of bias; 4-6: Moderate risk of bias; 0-3: Low risk of bias												

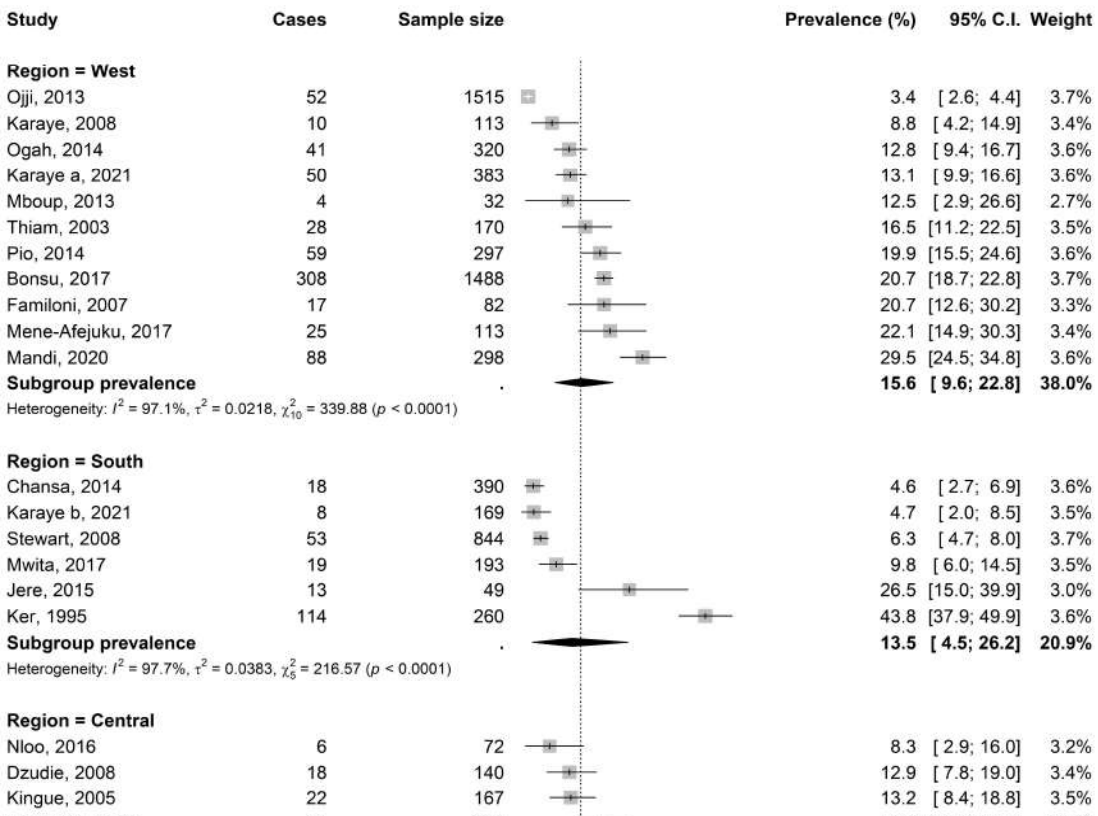
Supplementary Table 8. Risk of bias in studies reporting on all-cause mortality in patients with heart failure and atrial fibrillation

Surname of first author	Year of publication	Selection Item 1	Selection Item 2	Selection Item 3	Selection Item 4	Total Selection	Outcome Item 1	Outcome Item 2	Outcome Item 3	Total Outcome	Risk of bias
Makubi	2014	0	1	1	1	3	1	1	1	3	Low
Malamba	2018	0	1	1	1	3	1	1	0	2	Moderate
Sani	2018	1	1	1	1	4	1	1	1	3	Low

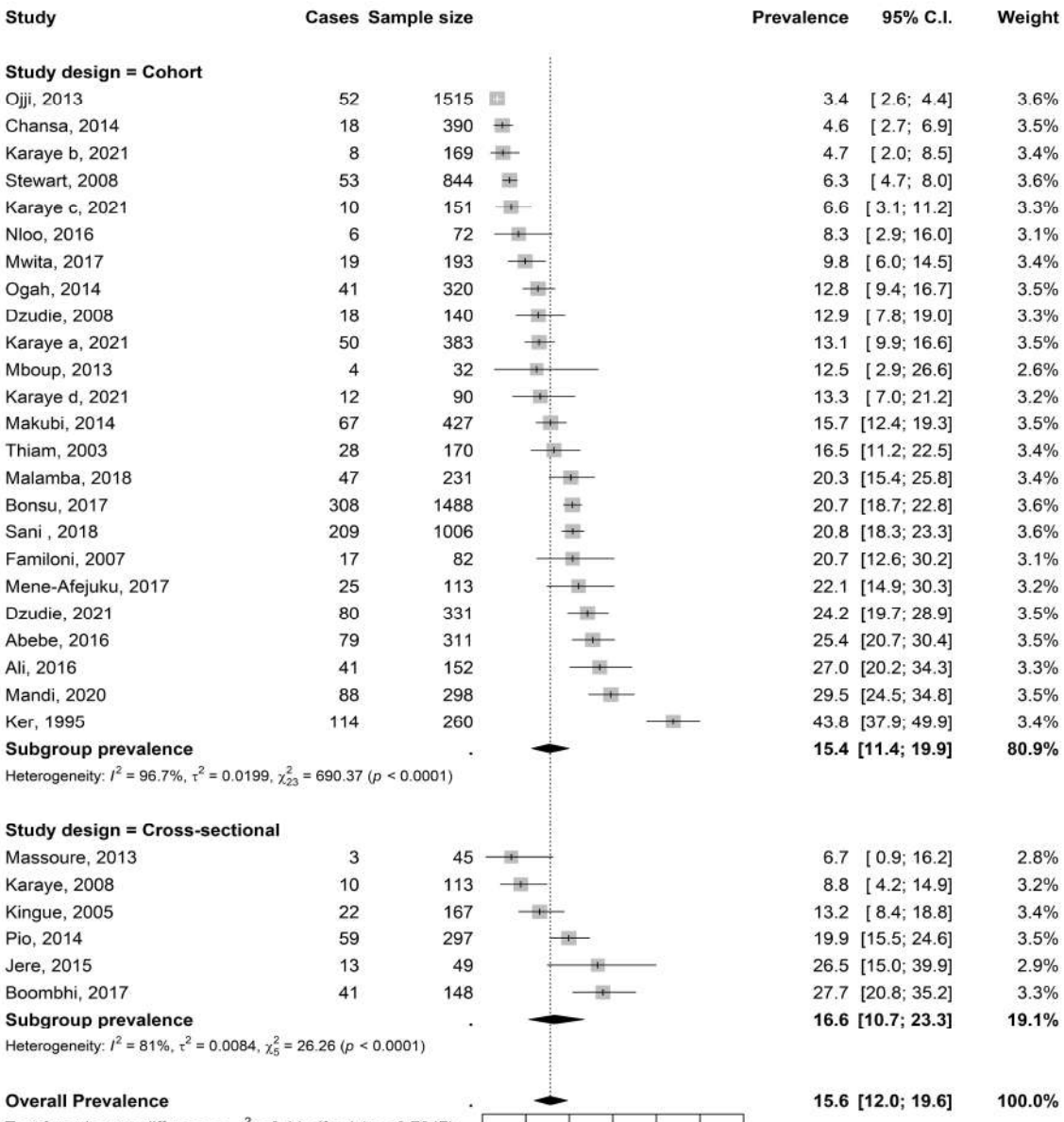
Selection Item 1 (Sample representativeness); Selection Item 2 (Ascertainment of atrial fibrillation); Selection Item 3 (Ascertainment of heart failure); Selection Item 4 (Absence of Outcome [mortality] from the start of the study)

Outcome Item 1 (Outcome assessment); Outcome Item 2 (Follow-up duration for outcome); Outcome Item 3 (Completeness of follow-up)

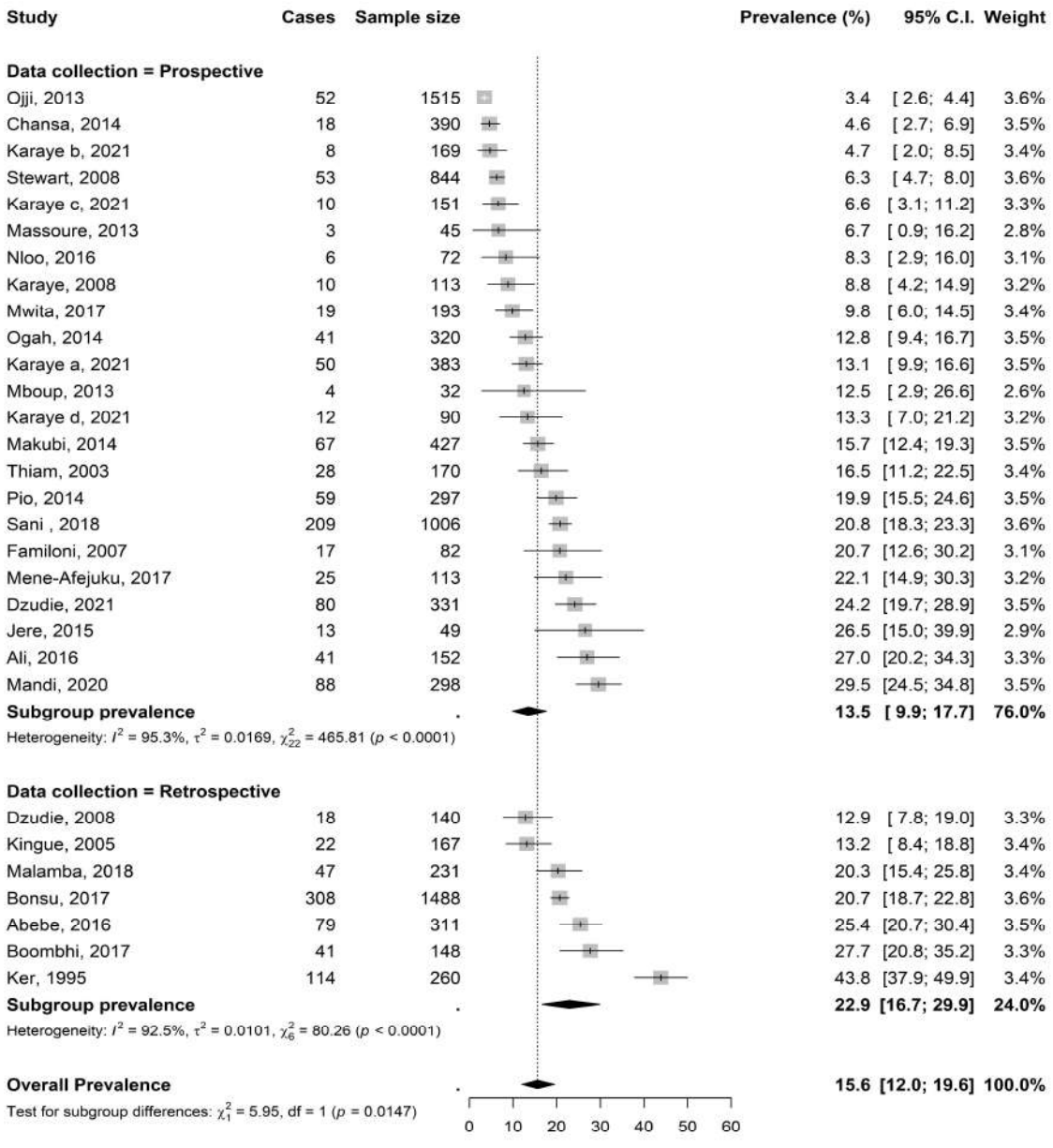
Interpretation of the score
High risk of bias: 0-1 stars in for total selection and 1 star for total outcome scores
Moderate risk of bias: Two stars in total selection and 2 or 3 stars total outcome scores
Low risk of bias: Three or 4 stars in total selection and 2 or 3 stars total outcome scores



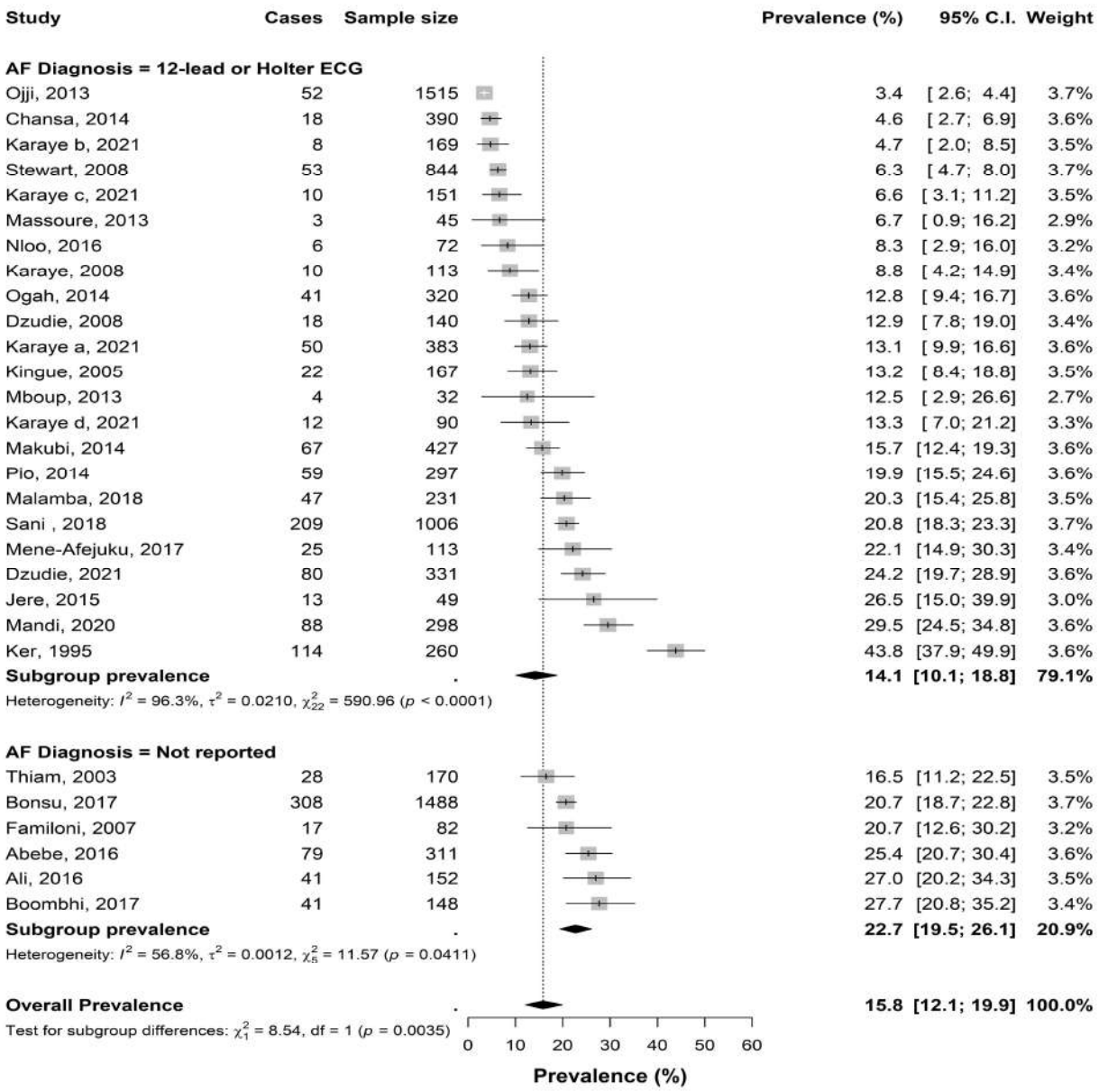
Supplementary Figure 1. Prevalence of atrial fibrillation in heart failure by region



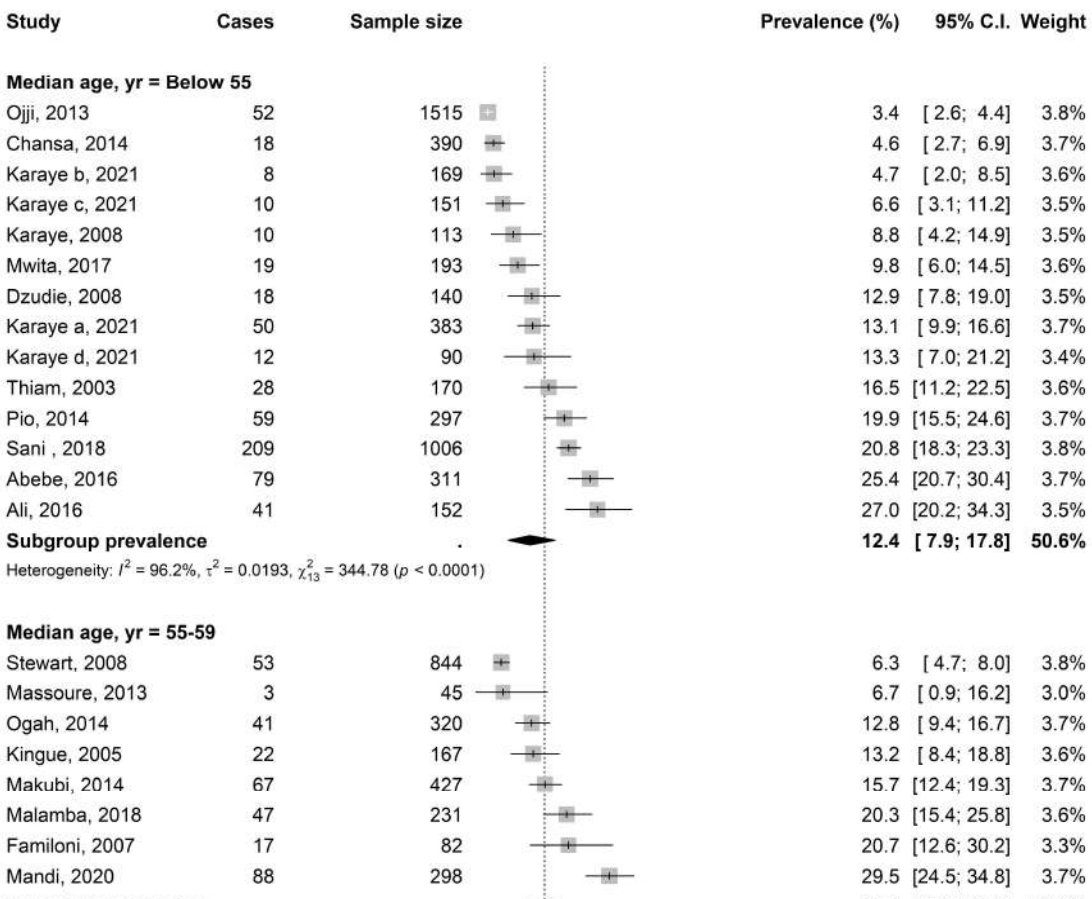
Supplementary Figure 2. Prevalence of atrial fibrillation in heart failure by study design



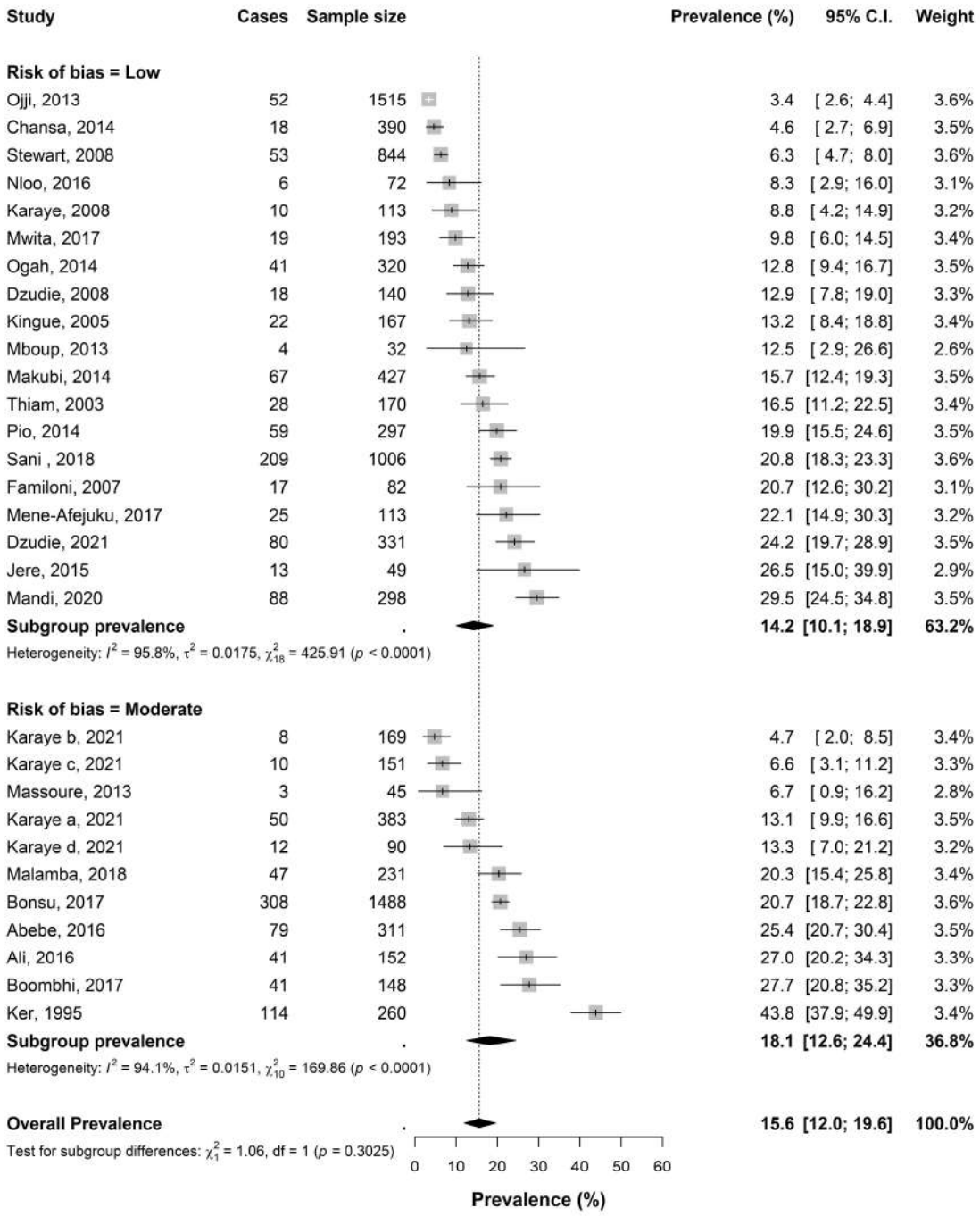
Supplementary Figure 3. Prevalence of atrial fibrillation in heart failure by the timing of data collection



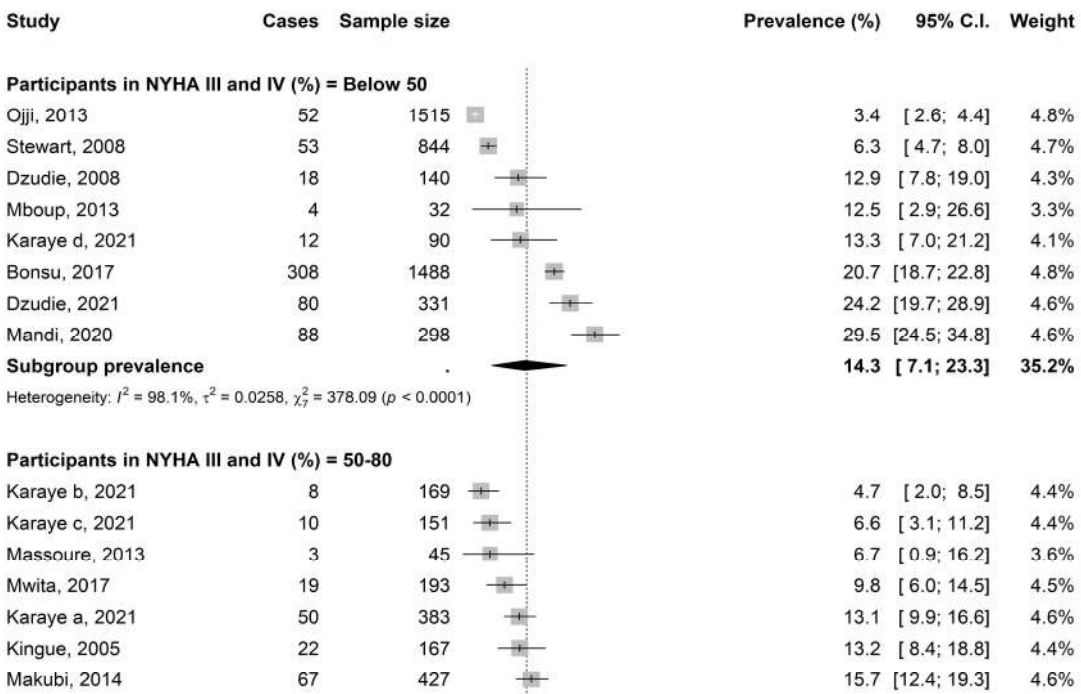
Supplementary Figure 4. Prevalence of atrial fibrillation in heart failure by method of diagnosis of atrial fibrillation



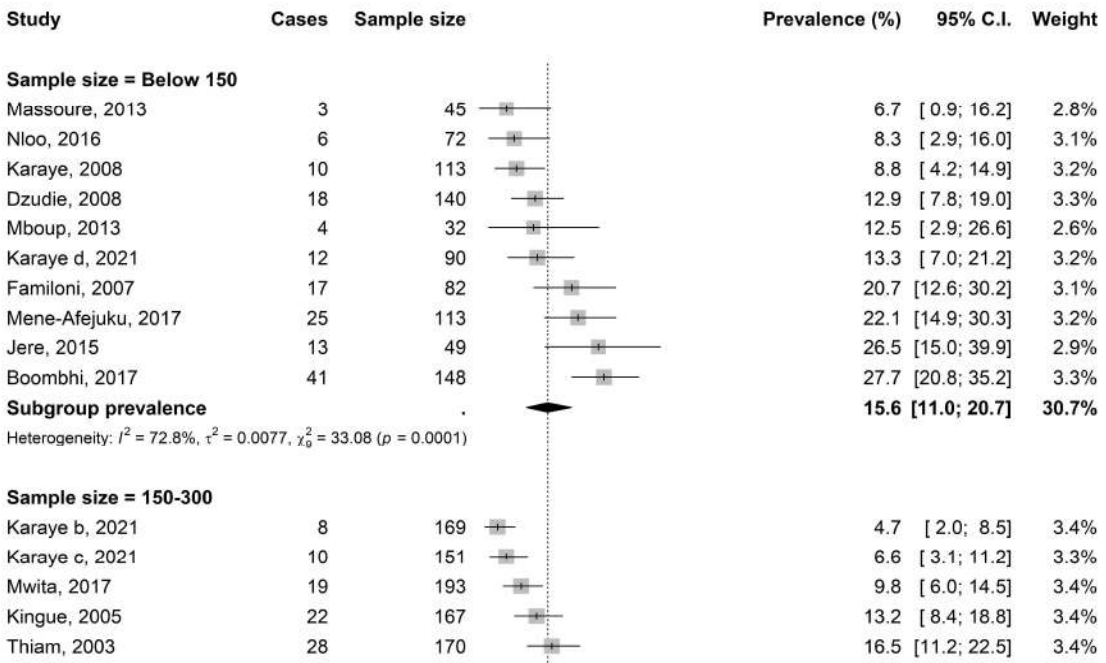
Supplementary Figure 5. Prevalence of atrial fibrillation in heart failure by age of studies participants each study



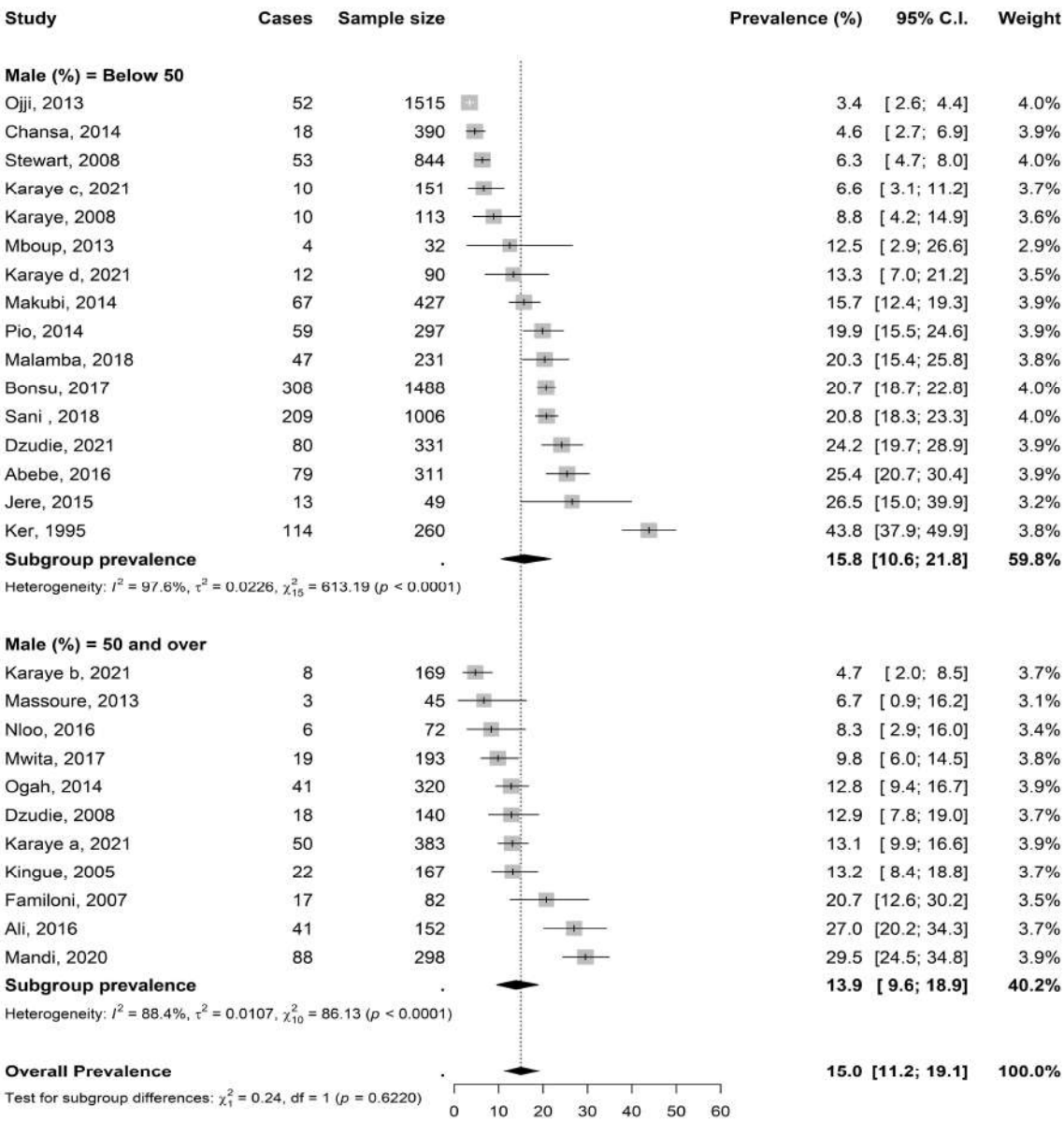
Supplementary Figure 6. Prevalence of atrial fibrillation in heart failure by risk of bias in individual studies



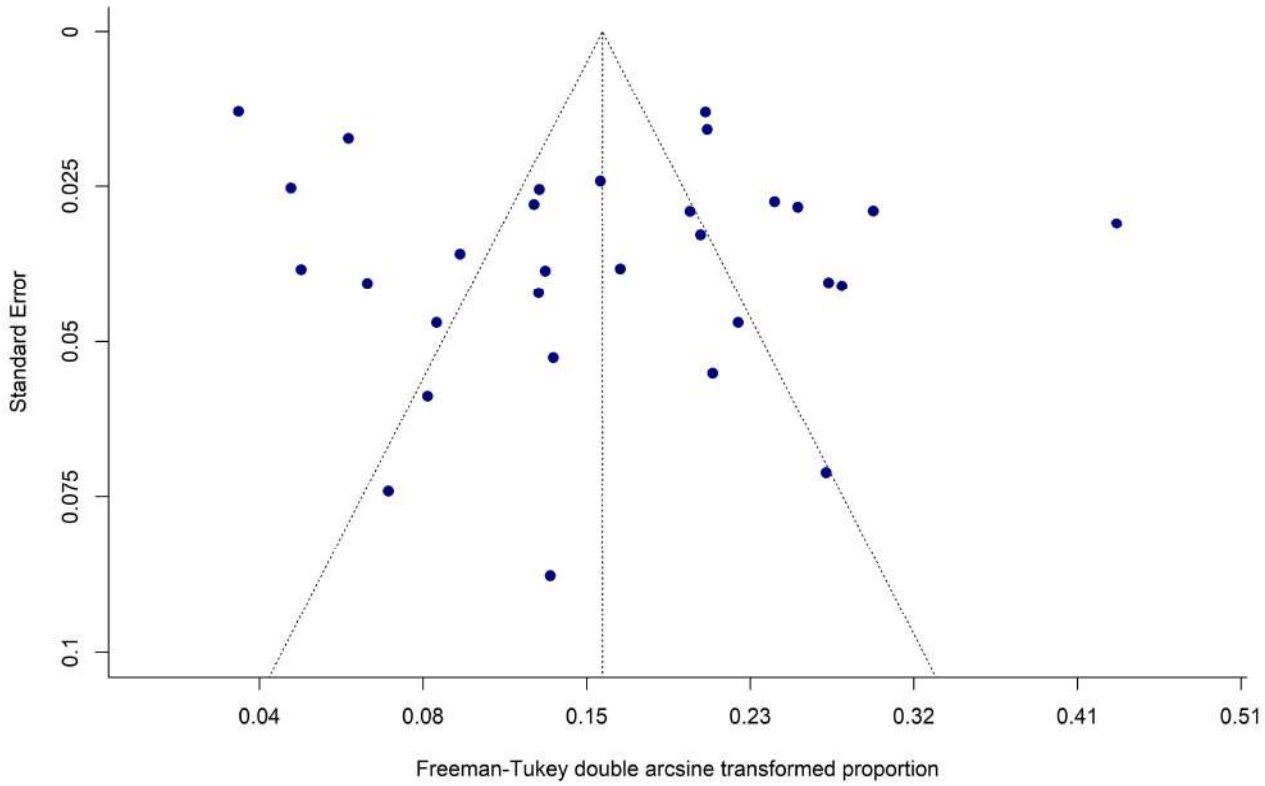
Supplementary Figure 7. Prevalence of atrial fibrillation in heart failure by percentage of participants in New York Heart Association (NYHA) stages III or IV in each study



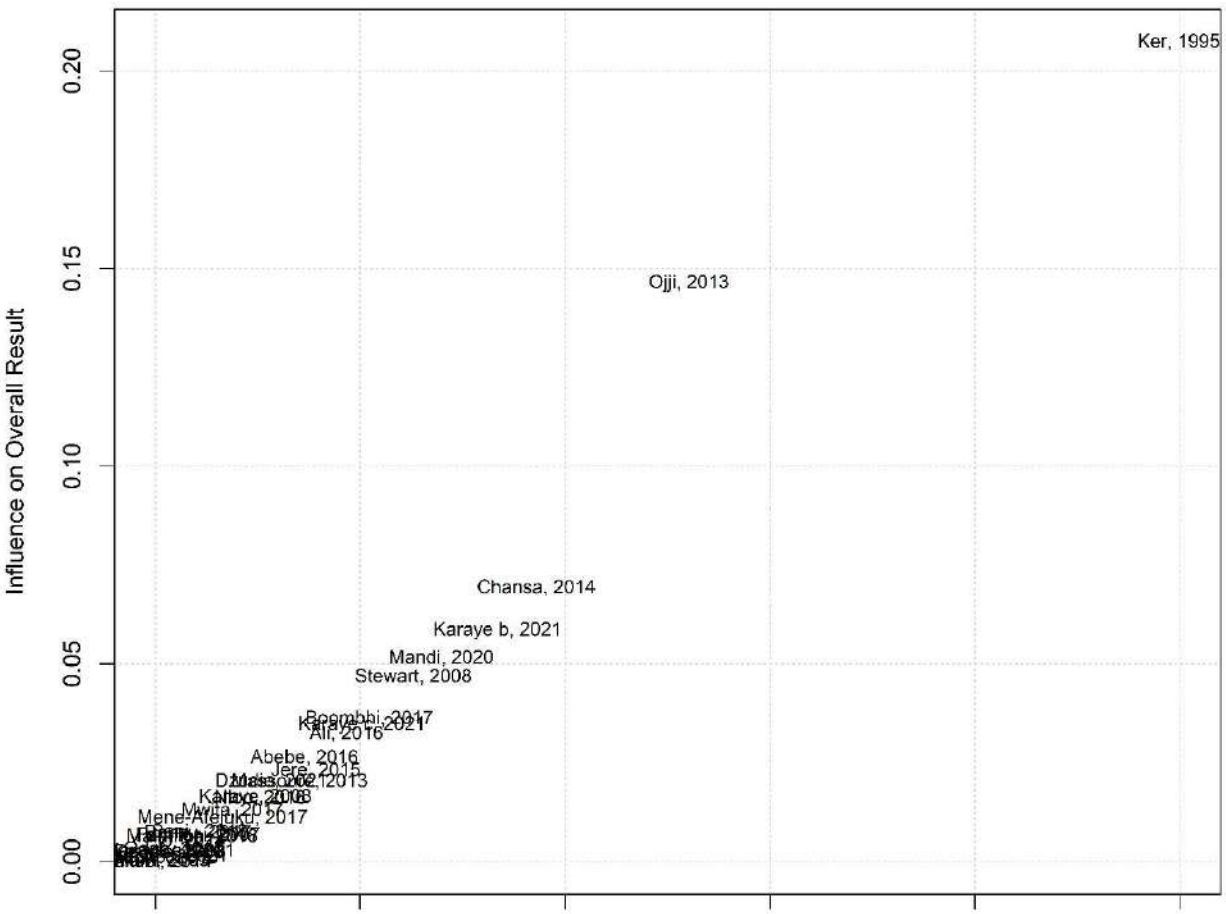
Supplementary Figure 8. Prevalence of atrial fibrillation in heart failure by sample size



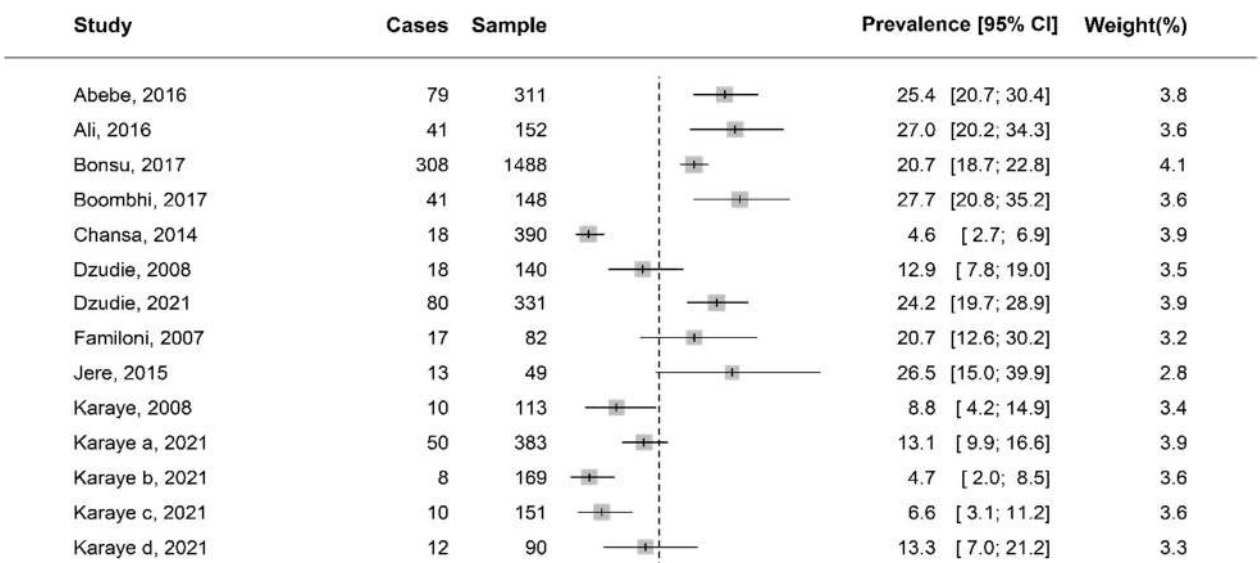
Supplementary Figure 9. Prevalence of atrial fibrillation in heart failure by percentage of male participants



Supplementary Figure 10. Funnel plot for publication bias of studies reporting on the prevalence of atrial fibrillation in heart failure included in the meta-analysis



Supplementary Figure 11. Baujat plot showing the influence of studies on the degree of heterogeneity in studies reporting on the prevalence of atrial fibrillation in heart failure



Supplementary Figure 12. Pooled prevalence of atrial fibrillation in patients with heart failure after excluding potentially influential studies. The grey squares and the horizontal bars are the study-specific prevalence and 95% confidence intervals (CI). Each study-specific estimate is weighted by the inverse of the variance using random-effect meta-analysis. The centre and the horizontal edges of the black diamond are the pooled summary prevalence and 95% confidence interval.

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Page # where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	3
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	3
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	4
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	4
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Tables S1-5
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	4
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	5
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	5
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	5
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	5
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	5
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	6
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	6
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	6
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	6
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	6
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	6
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	6
Certainty	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	6

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Page # where item is reported
assessment			
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	7
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	7
Study characteristics	17	Cite each included study and present its characteristics.	7
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	7-8
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	7-8
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	7
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	7-8
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	8
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	8
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	NA
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	8-10
	23b	Discuss any limitations of the evidence included in the review.	10-11
	23c	Discuss any limitations of the review processes used.	10-11
	23d	Discuss implications of the results for practice, policy, and future research.	10
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	4
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	4
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	5-6
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	11
Competing interests	26	Declare any competing interests of review authors.	11
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	11

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi:

PRISMA 2020 Checklist

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Burden of atrial fibrillation among adults with heart failure in sub-Saharan Africa: a systematic review and meta-analysis

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Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Global health, Cardiovascular medicine
Keywords:	Heart failure < CARDIOLOGY, Adult cardiology < CARDIOLOGY, EPIDEMIOLOGY

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Burden of atrial fibrillation among adults with heart failure in sub-Saharan Africa: a systematic review and meta-analysis

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Keywords: Prevalence, incidence, mortality, atrial fibrillation, heart failure, sub-Saharan Africa

Number of tables = 3; Number of figures 2; Supplementary files = 1

Word count: Abstract = 289; main text: 2675

Abstract

Objectives: This study aimed to estimate the prevalence of atrial fibrillation (AF) in adults with heart failure (HF) and summarise the all-cause mortality ratio among adult patients with co-existing HF and AF in sub-Saharan Africa (SSA).

Setting: This was a systematic review and meta-analysis of cross-sectional and cohort studies with primary data on the prevalence and incidence of AF among patients with HF and the all-cause mortality ratio among patients with HF and AF in SSA. We combined text words and MeSH terms to search MEDLINE, PubMed, and Global Health Library through Ovid SP®, African Journals Online, and African Index Medicus from database inception to 10 November 2021. Random-effects meta-analysis was used to estimate pooled prevalence.

Primary outcome measures: The prevalence and incidence of AF among patients with HF and all-cause mortality ratio among patients with HF and AF.

Results: Twenty-seven of the 1902 records retrieved database searches were included in the review, totalling 9,987 patients with HF. The pooled prevalence of AF among patients with HF was 15.6% (95% confidence interval: 12.0 – 19.6). At six months, the all-cause mortality was 18.4% (13.1-23.6) in a multinational registry and 67.7% (51.1-74.3) in one study in Tanzania. One-year mortality was 48.6% (32.5-64.7) in a study in the Democratic Republic of Congo. We did not find any study reporting the incidence of AF in HF.

Conclusion: Atrial fibrillation is common among patients with HF in SSA, and patients with AF and HF have poor survival. There is an urgent need for large-scale population-based prospective data to reliably estimate the prevalence, incidence and risk of mortality of AF among HF patients in SSA to better understand the burden of AF in patients with HF in the region.

Trial registration: This review was registered in the International Prospective Register of Systematic Reviews under the registration number CRD42018087564.

Strengths and limitations of this study

1. This study used a systematic approach to summarise prevalence of AF among HF patients in SSA.
2. Limited country-level estimates prevent the generalisability of the study's findings.
3. The certainty of evidence on mortality in AF and HF was limited by a small sample size.

Introduction

Heart failure (HF) is a global public health problem estimated to affect about 26 million people worldwide [1]. The global prevalence of HF has been on the rise owing to improvements in life expectancy, the management of acute heart conditions, and the rising prevalence of cardiovascular disease risk factors like hypertension, obesity, and diabetes mellitus [1, 2]. Heart failure disproportionately affects low- and middle-income countries, especially those in sub-Saharan Africa (SSA), where it is associated with high economic costs, poor quality of life, high readmission rates and high in-hospital and one-year mortality rates [3, 4]. For example, about 35% of patients discharged for acute HF will be readmitted within 30-days [5]. This is important in the African context, where about 90% of the cost of management of HF is borne by the patient and their immediate families [3]. In addition, the in-hospital mortality of HF in SSA ranges from 15-35%, with one-year mortality of up to 58% [3]. The one-year mortality rate from HF is highest in Africa compared to other regions such as Southeast Asia, Middle East, and South America [6].

Atrial fibrillation (AF) is the most common cardiac arrhythmia worldwide [7]. In 2017, there were 37.6 million individuals with AF, including 3.1 million new cases [7]. Atrial fibrillation is associated with a higher risk of stroke and systemic embolism, HF, and mortality [8]. AF is associated with poorer outcomes among patients with HF, and is estimated to affect about 16-21% of patients with HF in SSA [9–12]. In addition, AF accelerates the natural history of HF and is associated with more frequent admissions, longer hospital stays, and increased mortality in patients with HF [9, 13–15].

Data on the burden of AF in patients with HF in SSA have not been systematically summarised. Hence, this systematic review and meta-analysis sought to estimate the prevalence of AF in adults with HF and summarise the all-cause mortality ratio among adult patients with co-existing HF and AF in SSA.

Methods

The review protocol was published [16]. This study is reported following the 2020 Preferred Reporting Items for Systematic reviews and Meta-analysis (PRISMA)[17].

Literature search

We searched MEDLINE, Excerpta Medica Database (Embase) and Global Health Library through Ovid SP®, African Journals Online, and African Index Medicus from database inception to 10 November 2021 with no language restrictions. The search strategy combined text words and medical subject headings related to AF and HF, and a validated geographical filter for SSA [18] (**Supplementary Tables 1-5**). We hand-searched the reference list of eligible full-text articles to obtain additional data.

Study selection

We included cross-sectional and cohort studies conducted in SSA that reported the prevalence and incidence of AF among patients with HF, all-cause mortality ratio among patients with HF and AF, or provided sufficient data to compute these estimates. We excluded reviews, editorials, studies with fewer than 30 participants and studies conducted in persons aged < 15 years. In addition, we only included the study with the most recent, comprehensive and largest sample size for published studies that used data from the same cohort of participants (duplicate data).

Records retrieved from database searches were exported to EndNote X9 to remove duplicates and then uploaded to Rayyan QCRI for title and abstract screening. Three authors (CMM, SJP and LPS) independently screened the citations based on titles and abstract and assessed the full texts of selected records for final inclusion in the review. Disagreement between authors during the study inclusion process was resolved through consensus or arbitration by a fourth author (VNA).

Data extraction, management, and risk of bias assessment

Four authors (VNA, CMM, SNP, and LPS) used a predesigned Google Form to independently abstract data on: the surname of the first author, year of publication, country of study, study setting, study design, sampling method, timing of data collection, mean or median age of study participants, percentage of male participants, percentage of participants on beta-blockers, sample size, percentage of participants in New York Heart Association (NYHA) stage III or IV, method of diagnosis of AF, method of diagnosis of HF, and the duration of follow up for cohort studies. For multinational studies, data was extracted by the individual country of the study where possible.

For the outcome of prevalence and incidence of AF in HF, data was also extracted on the number of prevalent AF cases, the number of new AF cases if reported by the study, and the number of participants with HF. Where the authors did not report the number of patients with AF but reported the proportion or percentage of participants with AF, we multiplied this proportion or percentage by the number of HF patients to obtain the number of participants with AF.

For all-cause mortality ratio among patients with AF and HF, we extracted data on the number of participants with HF and AF and the number of deaths from any cause.

Risk of bias assessment

Two reviewers (CMM and SNP) independently assessed the risk of bias in the included studies. An adapted version of the risk of bias assessment tool developed by Hoy *et al* [16, 19] was used to assess the risk of bias in studies reporting on the prevalence of AF in HF. In addition, we modified the original version of the Newcastle-Ottawa Scale [20] to evaluate the risk of bias in studies that reported all-cause mortality in patients with HF and AF.

Data analysis and synthesis

All analyses were conducted with the *"meta"* package of R version 4.1.2 (The R Foundation for Statistical Computing, Vienna, Austria). To estimate the prevalence of AF among participants with HF, we performed an inverse-variance weighted random-effects meta-analysis of proportions after

stabilising the variance using the Freeman-Tukey double-arcsine transformation [21]. The degree of heterogeneity across studies was assessed using the Cochrane's Q χ^2 test and quantified using the I-squared (I^2) statistic [22]. I^2 values below 30%, 30-49%, 50-70%, and over 70% were considered to represent low, moderate, substantial, and considerable degree of heterogeneity, respectively [22]. P-value < 0.05 on the Cochrane's Q χ^2 test indicated significant heterogeneity between studies. We used the Baujat plot to inspect for influential studies on the pooled summary effect.

We conducted subgroup analyses using random-effects meta-analysis without assuming a common between-study variance to investigate the sources of heterogeneity by region, study design, timing of data collection, method of AF diagnosis, risk of bias, age of participants, and percentage of participants in NYHA stages III or IV. The Q test was used to investigate moderation effects across subgroups. A p-value <0.1 for test of subgroup difference was used as the threshold for statistical significance [22]. Where appropriate, studies were merged into meaningful categories to minimise loss of power during subgroup analyses. Where a lone category could not be merged into other categories, this was excluded from the subgroup analysis.

Funnel plot was used to investigate small-study effect, and plot asymmetry was suggestive of small-study effect. Egger's regression test was used to test for publication bias. P-value < 0.1 from Egger's test was considered statistically significant. A sensitivity analysis was conducted to assess the impact of excluding influential studies on the overall summary prevalence.

Mortality ratio was defined as the proportion of participants with AF and HF who died from any cause within a given follow-up time. Due to the small number of studies reporting on all-cause mortality ratio among patients with AF and HF, this outcome was summarised narratively.

Patient and public involvement

Patients or the public were not directly involved in this study.

Results

Study selection and characteristics

From 1,902 records retrieved through database searches, 27 were eligible for inclusion in the review [23–49] (**Figure 1 and Supplementary Table 6**). The included studies provided 30 data points on the prevalence of AF in HF (data from the multinational study by Karaye *et al* 2021 [49] was disaggregated by the country of study). Only three studies [35, 36, 46] provided data on mortality among patients with AF and HF, and none reported on the incidence of AF in HF**.**

All included studies were published from 1995 to 2021 (**Table 1**). The majority (n=23, 76.7%) of studies were published after 2010, and all were hospital-based. Most studies were cohort studies (n=24, 80%), conducted in West Africa (n=11, 36.7%), used a non-probabilistic sampling method (n=24, 80%), and diagnosed AF using 12-Lead ECG (n=23, 76.7%).

Table 1: Characteristics of studies included in the meta-analysis

Characteristics	N = 30
Year of publication	
Range	1995 - 2021
1995-2010	7 (23.3%)
After 2010	23 (76.7%)
Subregion	
Central	6 (20.0%)
East	6 (20.0%)
South	6 (20.0%)
West	11 (36.7)
Multinational registry	1 (3.3%)
Study design	
Cohort	24 (80.0%)
Cross-sectional	6 (20.0%)
Study setting	
Hospital-based	30 (100.0%)
Population-based	0 (0.0%)
Sampling method	
Non-probabilistic	24 (80.0%)
Not reported	6 (20.0%)
Participants in NYHA III or IV (%)	
Below 50	8 (26.7%)
50-80	9 (30.0%)
Over 80	6 (20.0%)
Not reported	7 (23.3%)
Atrial fibrillation diagnostic procedure	
12-Lead ECG	19 (63.3%)
Holter ECG	2 (6.7%)
Medical history	1 (3.3%)
Not reported	4 (13.3%)
Risk of bias	
Low	19 (63.3%)
Moderate	11 (36.7)

ECG = Electrocardiogram; NYHA = New York Heart Association

Prevalence of AF in patients with HF

A total of 9,987 patients with HF were included in the meta-analysis. Almost three-quarters of the studies reporting on the prevalence of AF in HF had a low risk of bias (**Table 1** and **Supplementary Table 7**). The pooled prevalence of AF in HF was 15.6% (95% confidence interval: 12.0 – 19.6), with considerable heterogeneity between studies (I^2 = 96.0%, p < 0.00001) (**Figure 2**). Table 2 and supplementary figures 1-9 summarise the results of the subgroup analysis. The prevalence of AF in HF was significantly higher in studies with retrospective data collection compared to those with prospective data collection (p = 0.0147) and in studies with no reported method for AF diagnosis compared to those with recommended methods for AF diagnosis (12-lead or Holter ECG, p = 0.0035) (**Table 2, Supplementary Figure 3 and 4**). In addition, the prevalence of AF in HF was significantly higher in studies where the mean age of the participants was 60 years and over compared to studies with younger participants (p = 0.0132) (**Table 2 and Supplementary Figure 5**). There was no evidence of moderation of the pooled prevalence by region, study design, the severity of HF in study participants (based on the NYHA classification), sample size, risk of bias, and percentage of males included in each study (**Table 2 and Supplementary figures 1, 2, 6-9**).

There was no evidence of publication bias (P_{Egger} = 0.2593) (**Supplementary Figure 10**). In sensitivity analysis, the studies by Ojji *et al* [44] and Ker and Myburgh [33] were identified to significantly influence the pooled summary estimate (**Supplementary Figure 11**). However, excluding these studies and re-estimating the pooled prevalence of AF in HF did not substantially change the results (pooled prevalence = 15.4% [12.6 – 18.5], **Supplementary Figure 12**).

Table 2: Prevalence of atrial fibrillation in heart failure by various subgroups

Subgroups	Number of studies	Cases of AF	Sample size	Prevalence (95%CI)	I^2 (%)	p for subgroup difference
Subregion*						0.8961
Central	6	214	1089	17.7 (12.7-23.4)	80.8	
East	6	212	1176	15.5 (9.5-22.6)	85.8	
South	6	225	1905	13.5 (4.5-26.2)	97.7	
West	11	682	4811	15.6 (9.6-22.8)	97.1	
Study design						0.7347
Cross-sectional	6	148	819	16.6 (10.7-23.3)	81.0	
Cohort	24	1394	9168	15.4 (11.4-19.9)	96.7	
Timing of data collection**						**0.0147**
Prospective/cross-sectional	23	913	7242	13.5 (9.9-17.7)	95.3	
Retrospective	7	629	2745	22.9 (16.7-29.9)	92.5	
Method of AF diagnosis						**0.0035**
12-lead or Holter ECG	23	1009	7443	14.1 (10.1-18.8)	96.3	
Not reported	6	514	2351	22.7 (19.5-26.1)	56.8	
Risk of bias						0.3025
Low	19	829	6559	14.2 (10.1-18.9)	95.8	
Moderate	11	713	3428	18.1 (12.6-24.4)	94.1	
Mean age, years***						**0.0132**
Below 55	14	613	5080	12.4 (7.9-17.8)	96.2	
55-59.9	8	338	2414	15.1 (9.5-21.8)	93.8	
60 and over	6	572	2372	25.5 (18.2-33.6)	91.6	
Participants in NYHA III or IV (%)***						0.1601
Below 50	8	615	4738	14.3 (7.2-23.3)	98.1	
50-80	9	413	2654	12.3 (8.6-16.5)	88.0	
Over 80	6	197	986	19.5 (13.3-26.6)	83.5	
Sample size						0.6415
Below 150	10	149	884	15.6 (11.0-20.7)	72.8	
150-300	10	436	2088	18.0 (11.3-25.8)	94.8	
Over 300	10	957	7015	13.6 (8.3-20.0)	98.0	
Male percentage (%)***						0.6220
Below 50	16	1135	7535	15.8 (10.6-21.8)	97.6	
50 and over	11	313	2021	13.9 (9.6-18.9)	88.4	

*The study by Sani *et al* was excluded from the analysis as this was a multinational study and the prevalence of AF in heart failure could not be disaggregated into the individual countries where the study was conducted in

**The study by Mwita *et al* was excluded as this was the only study that reported on physician-diagnosed atrial fibrillation.

***Studies with missing data were excluded.

AF = Atrial fibrillation; ECG = Electrocardiography; NYHA = New York Heart Association

All-cause mortality among patients with atrial fibrillation and heart failure

Three studies reported on all-cause mortality among patients with AF and HF (**Table 3**) [35, 36, 46]. Two of the studies were prospective cohort studies, while one was a retrospective cohort study. The mean ages of the participants ranged from 52.3-56.0 years and 79-80% of the participants were in NYHA stage III or IV. Two studies had low risk of bias **(Supplementary Table 8)**.

At six months, the all-cause mortality was 18.4% (13.1-23.6) in a multinational registry and 67.7% (51.1-74.3) in a study in Tanzania. All-cause mortality at one-year was 48.6% (32.5-64.7) in a study in DR Congo (**Table 3**).

Table 3: Characteristics of studies reporting on mortality among patients with atrial fibrillation and heart failure

Surname of first author	Year	Country of study	Study design	Sampling method	Timing of data collection	Median age, yr	Participants in NYHA III and IV (%)	Method of diagnosis of AF	Participants with AF and HF (n)	Deaths (n)	Mortality ratio (%) (95% CI)	Follow-up (months)
Makubi	2014	Tanzania	Cohort	Non-probabilistic	Prospective	55	79	12-lead ECG	67	42	67.7 (51.1-74.3)	6
Malamba	2018	DRC	Cohort	Non-probabilistic	Retrospective	56	NR	12-lead ECG	37	18	48.6 (32.5-64.7)	12
Sani	2018	Multinational registry*	Cohort	Non-probabilistic	Prospective	52.3	80	12-lead ECG	207	38	18.4 (13.1-23.6)	6

*Study countries included: Sudan; Cameroon; South Africa; Nigeria; Ethiopia; Kenya; Uganda; Senegal; Mozambique; AF = Atrial Fibrillation; DRC = Democratic Republic of Congo; ECG = Electrocardiography; ESC = European Society of Cardiology; HF = Heart failure; n = Frequency; NYHA = New York Heart Association; Year = Year of publication

Discussion

This review sought to estimate the prevalence and incidence of AF among patients with HF and all-cause mortality among patients with AF and HF in SSA. The pooled prevalence of AF in HF was 15.6%, and varied by the timing of data collection, methods of AF diagnosis, and mean age of the study participants. Moreover, the all-cause mortality ratio was 18.4 to 67.7% after six months of follow-up and approximately 49% after one year. We did not find any study reporting on the incidence of AF among patients with HF.

The pooled prevalence of AF in HF in this study was lower than reports from North and South America, Europe, and East Asia [50–54]. The prevalence of AF among HF patients in the ADHERE (United States of America), EHFS II (Europe) HF, and China-HF registries were 31.0, 39.0, and 24.4%, respectively [50]. In addition, in a 20-year population-based cohort of 88,416 patients with incident HF in the United Kingdom, about 39% had AF [55]. In contrast, the pooled prevalence of AF in this study was similar to studies from North Africa and the Middle East, except in Egypt where the prevalence was higher [51, 56]. This difference in prevalence could be explained, in part, by variations in age distributions and the prevalence of coronary heart disease in patients with HF across populations [3, 50, 55]. Older age, subclinical atherosclerosis, and ischaemic heart disease are associated with a higher risk of AF [57, 58]. We found a higher prevalence of AF in HF among studies where the mean age of participants was at least 60 years and over compared to those with younger participants. The lower prevalence of AF in HF could also be explained by a lack of adequate testing in SSA, as ECG, inpatient telemetry and Holter monitors are largely absent in the region.

We observed a higher six-month and one-year mortality ratio among patients with AF and HF than reports from high-income countries, including Canada and Romania [59, 60]. The high mortality in our study could be because a higher proportion of patients in this review had advanced HF compared to the studies reported in high-income countries. In addition, this high

mortality ratio could reflect limited availability, accessibility and affordability of good quality care. Advanced therapies such as mechanical circulatory support and left ventricular assistive devices for patients with advanced HF are limited in SSA [3]. Advanced therapies such as cardiac resynchronisation, pacing and ablation for rate and rhythm control for AF, and mechanical circulatory supports and left ventricular assistive devices for patients with advanced HF are limited in SSA [3]. Observational evidence suggests that AF is associated with a higher risk of mortality among patients with HF. Makubi *et al* observed AF was associated with a three-fold higher risk of mortality among patients with HF in Tanzania [35]. In addition, Sani and collaborators also reported a 61% higher risk of mortality among HF patients with valvular AF than those without AF, even though the authors found no evidence of an association of non-valvular AF with mortality [46]. In a meta-analysis of about 61,000 cases of AF, 150,000 patients with HF, and 40,000 deaths, AF was associated with a 17% higher risk of death [61].

Atrial fibrillation in HF is associated with faster progression of HF in affected patients [62]. Atrial fibrillation could significantly worsen premature mortality in HF patients, especially in SSA, where HF patients are mostly young adults. However, whether AF in HF is associated with increased risk of mortality and how much of this association is due to confounding and reverse causation remains uncertain. Two large-scale randomised controlled trials showed no evidence of rhythm control in reducing mortality among patients with AF and HF [63, 64]. However, these trials were limited in their ability to maintain sinus rhythm in the intervention group, reducing the power of the analyses. Consequently, although contemporary evidence suggests that rhythm control might have some benefit in reducing the risk of mortality in patients with AF and HF [65], robust evidence is lacking on whether AF increases mortality risk in patients with HF or is a marker of advanced HF.

The findings from this study have implications for improving research on AF among patients with HF in SSA to inform local guidelines for managing patients with HF. Efforts are needed to generate reliable evidence on the incidence, subtypes and prognosis of AF in HF patients in the region. In addition, collaborative efforts are warranted to assess the efficacy and safety of interventions to reduce the risk of mortality among patients with AF and HF in SSA.

We made minor amendments to the methods of the initial protocol to improve transparency, reliability and interpretation of the results [16]. Instead of the proposed Quality In Prognosis Studies tool, the Newcastle-Ottawa Scale was used to assess the risk of bias in studies reporting on all-cause mortality among patients with AF and HF because we found it relatively easier to use and interpret. In addition, the Newcastle-Ottawa tool can easily be adapted to assess the risk of bias in descriptive cohort studies. Furthermore, data on the type of AF, valvular or non-valvular causes of HF, ejection fraction and percentage of participants on anticoagulants were not reported as data on the variables were missing in over 50% of the included studies.

This study had some limitations that are worth highlighting. The geographical coverage of studies included in this review was limited. Although all four SSA subregions were represented in this review, the individual studies were from a limited number of countries, with about a third of all the studies conducted in West Africa. In addition, all studies were hospital-based and included patients with more advanced HF. Including patients with more advanced HF might have overestimated the prevalence of AF in HF and all-cause mortality in patients with AF and HF. Furthermore, the retrospective nature of some studies is likely to have given the authors limited control over the quality of data collected, leading to biased estimates of the prevalence of AF in HF or mortality in patients with AF and HF. We found that studies that collected data retrospectively had a higher pooled prevalence of AF in HF compared to prospective studies. This review highlights limited capacity in diagnosing AF cases among patients with HF in SSA as only two of the studies included in this review used Holter ECG

for diagnosis. Even though 12-Lead ECG is widely accepted to confirm the diagnosis of AF [1], it only provides a snapshot of the electrical activity of the heart. Consequently, the standard 12-Lead ECG is more likely to miss cases of paroxysmal atrial fibrillation, contrary to ambulatory ECG, which monitors cardiac electrical activity for sustained periods [66]. Finally, only three studies reported on mortality among patients with AF and HF. Hence our estimates on all-cause mortality should be interpreted with caution. However, this study provides comprehensive and contemporary evidence on the burden of AF among HF patients in SSA.

Conclusion

Atrial fibrillation was common among patients with HF in SSA, and patients with AF and HF appear to have poor survival. There is an urgent need for large-scale population-based prospective data to reliably estimate the prevalence, incidence and risk of mortality in patients with AF and HF in SSA to better understand the burden of these conditions in SSA. Such evidence would be crucial for policies and context-specific guidelines aimed at improving the survival of patients with HF in SSA.

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66. Su L, Borov S, Zrenner B. 12-lead Holter electrocardiography. Herzschr Elektrophys. 2013;24:92–6.

Figure Legends

Figure 1: PRISMA flow diagram for inclusion of articles in the meta-analysis.

Figure 2: Pooled prevalence of atrial fibrillation in patients with heart failure.

The grey squares and the horizontal bars are the study-specific prevalence and 95% confidence intervals (CI). Each study-specific estimate is weighted by the inverse of the variance using random-effect meta-

analysis. The centre and the horizontal edges of the black diamond are the pooled summary prevalence and 95% confidence interval.

Figure S1: Prevalence of atrial fibrillation in heart failure by region.

Figure S2: Prevalence of atrial fibrillation in heart failure by study design.

Figure S3: Prevalence of atrial fibrillation in heart failure by the timing of data collection**.**

Figure S4: Prevalence of atrial fibrillation in heart failure by the method of diagnosis of atrial fibrillation.

Figure S5: Prevalence of atrial fibrillation in heart failure by median age of studies participants each study.

Figure S6: Prevalence of atrial fibrillation in heart failure by risk of bias in individual studies.

Figure S7: Prevalence of atrial fibrillation in heart failure by percentage of participants in New York Heart Association (NYHA) stages III or IV in each study.

Figure S8: Prevalence of atrial fibrillation in heart failure by sample size.

Figure S9: Prevalence of atrial fibrillation in heart failure by percentage of male participants.

Figure S10: Funnel plot for publication bias of studies reporting on the prevalence of atrial fibrillation in heart failure included in the meta-analysis.

Figure S11: Plot showing the influence of studies on the degree of heterogeneity in studies reporting on the prevalence of atrial fibrillation in heart failure. High squared Pearson residuals values suggest that the estimate from these studies are outliers.

Figure S12: Pooled prevalence of atrial fibrillation in patients with heart failure after excluding potentially influential studies. Conventions are as in Figure 2.

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Table S7: Risk of bias in studies reporting on the prevalence of atrial fibrillation in patients with heart failure

Table S8: Risk of bias in studies reporting on all-cause mortality in patients with heart failure and atrial fibrillation

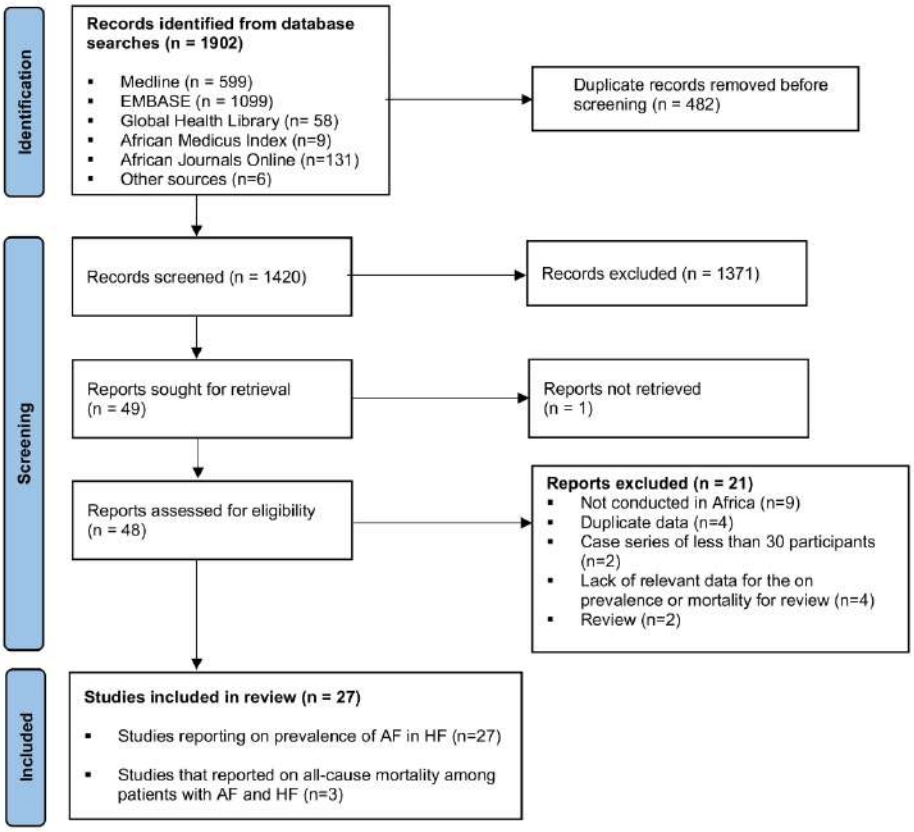

Figure 1: PRISMA flow diagram for inclusion of articles in the meta-analysis.

1522x1422mm (72 x 72 DPI)

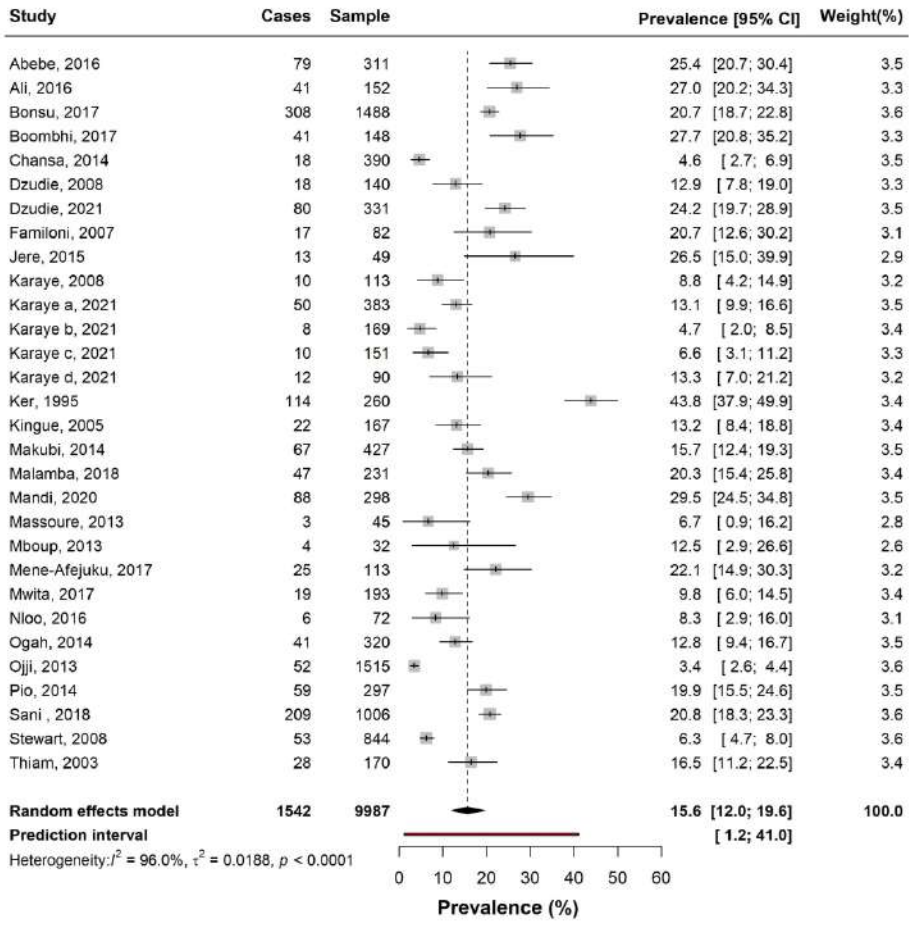

Figure 2: Pooled prevalence of atrial fibrillation in patients with heart failure. The grey squares and the horizontal bars are the study-specific prevalence and 95% confidence intervals (CI). Each study-specific estimate is weighted by the inverse of the variance using random-effect meta-analysis. The centre and the horizontal edges of the black diamond are the pooled summary prevalence and 95% confidence interval.

228x228mm (300 x 300 DPI)

SUPPLEMENTARY MATERIAL

Prevalence of atrial fibrillation and mortality among adults with heart failure in sub-Saharan Africa: a systematic review and meta-analysis

Authors: Valirie Ndip Agbor[1,2]*; Frank-Leonel Tianyi[3]; Leopold Ndemnge Aminde[4]; Clarence Mvalo Mbanga[5]; Saint-Juste Ngassa Petnga[6]; Larissa Pone Simo[7]; Anastase Dzudie[6], Muchi Ditah Chobufo[8]; Jean Jacques Noubiap[9]

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Contents

Supplementary Table 1. Search strategy for Medline via OVID SP

SN	Search Items
1.	exp Heart Failure/ OR (Heart Failure or cardiac failure or cardia* insufficien*).mp.
2.	benin/ or burkina faso/ or cape verde/ or cote d'ivoire/ or gambia/ or ghana/ or guinea/ or guinea-bissau/ or liberia/ or mali/ or mauritania/ or nigeria/ or senegal/ or sierra leone/ or togo/ or (africa*adj2 west* or benin* or burkina fas* or cape verd* or cabo verd* or ivory coast or cote d'ivoire* or gambia* or ghana* or (guinea* not pig*) or bissau or liberia* or (mali not fowl) or malian or mauritania* or nigeria* or senegal* or sierra leon* or togo* or (Lagos or Accra or Abidjan or Dakar or Abobo or Abuja or Freetown or Ouagadougou or Conakry or Lome or Bamako or Cotonou or Kumasi or Monrovia or Ibadan or Kano or Port harcourt or Benin City or Porto Novo or Niamey or Yamoussoukro or Banjul or Timbuktu or Djenne or Abomeyu or Zaria or Tamale or Jos or Cape Coast or Aba or Gao or Calabar or Warri or Maiduguri or Bobo Dioulasso or Parakou or Djougou or Bohicon or Sekondi Takoradi or Sunyani or Obuasi or Teshie or Tema or Sikasso or Kalabankoro or Nouakchott or Dakhlet Nouadhibou or Benin City or Port Harcourt or Ilorin or Kaduna or Enugu or Ikorodu or Onitsha or Bauchi or Akure or Abeokuta or Sokoto or Bouake or Makeni or Kaduna or Sosgbo or Osogbo or Gombe or Ilesa or Badagry or makurdi or Sagamu or Iseyin or obbomosho or Awka or Ado Ekiti or Nsukka or Ikeja or Katsina or Okene or Lafia or Minna or Ondo city or Umuahia or Calabar or Yola or Pikine or Touba or Thies Nones or Saint Louis or Kolak or Ziguinchor or (San Pedro not (Spain or Mexico or Argentina or California or United States or Italy)) or Bandama or Daloa or Owerri or Kandi or Ifi or Dakar or Ogbomosho or Divo or Korhogo)).mp.
3.	(angola or cameroon* or chad* or tchad or congo* or DRC or equatorial guinea* or gabon* or "Sao Tome" or Principe or Luanda or lobito or kuito or huambo or Malanje or Douala or Yaounde or Bamenda or Garoua of Bafoussam or Ngaoundere or Maroua or Kouosseri or Buea or Kumba or N'Djamena or Moundou or Bangui or Bimbo or Brazzaville or Pointe Noire or Kinshasa or Lubumbashi or Leopoldville or Elizabethville or Mbuji Mayi or Bakwanga or Bukavu or Costermansville or Kananga or Luluabourg or Kisangani or Stanleyville or Tshikapa or Kolwezi or Likasi or Jadotville or Goma or Kikwit or Uvira or Bunia or Mbandaka or Coquilhatville or Matadi or Butembo or Kabinda or Mwene Ditu or Isiro or Paulis or Boma or Kindu or Bata or Malabo or Libreville).mp.
4.	((British Indian Ocean Territory or Burundi* or Comoros or Djibouti* or Eritrea* or Ethiopia* or Kenya* or Madagascar or Malawi or Mauritius or Mayotte or Mozambique or Reunion or Rwanda* or Seychelles or Somalia* or Sudan* or Tanzania* or Uganda* or Zambia or Zimbabwe or Crozet Islands or Iles Crozet or Scattered Islands ! or Iles Eparses or Mwanza or Zanzibar or Eldoret or Morogoro or Hargeysa or Berbera or Nyeri or Mbeya or Machakos or Marka or Tabora or Iringa or Gondar or Meru or Geita or Musoma or Mtwara or Songea or Kigoma or Dese or Mek'ele or Bahir Dar or Jimma or Shinyanga or Korogwe or Nairobi or "Dar es Salaam" or Mombasa or Addis Ababa or Kampala or Kigali or Mogadishu or Dodoma or Bujumbura or Nakuru or Antananarivo or Kisumu or Maputo or Asmara or Lusaka or Harare or Port Louis or Arusha or kitale or lilongwe or malindi or machakos or hargeisa or Bulawayo or Ruiru or Lamu or Dire Dawa or Kikuyu or naivasha or mwanza or tanga or nanyuki or voi or garissa or lodwar of kakamega or maralal or kitui or webuye or Axum or Nyahururu or Jinja or Kismayo or Namanga or Mumias or Moshi or Moroni or Lokichogio or Hola or Rwenzori Mountains or Lake Victoria or Puntland* or (Adi-harush or Ali-Addeh or Alinjugur or Buramino or Dadaab or Dagahaley or Dollo Ado or Fugnido or Hagadera or Hilaweyn or Ifo or Kakuma or Kambioos or Kayaka II or Kobe or Kyangwali Nakivale or Nyarugusu or Wad Sherife or Bokolmanyo or Melkadida or Rwamanja)) adj5 (camp or refug*)).mp.
5.	angola/ or botswana/ or lesotho/ or malawi/ or mozambique/ or namibia/ or south africa/ or swaziland/ or zambia/ or zimbabwe/ or ((africa* adj2 south*) or angola* or botswana* or lesotho* or malawi* or mozambiq* or namibia* or swaziland or zambia* or zimbabwe or Zulu or Tsonga or Xhosa or Swazi or Ndebele or Tswana or Sotho or Shona people or BaLunda or Mbundu or Ovimbundu or Chaga or Sukuma or Pretoria or Cape Town or Johannesburg or Durban or Port Elizabeth or Bloemfontein or Windhoek or Maseru or Pietermaritz or (Kimberley not Australia) or Nelspruit or Soweto or Polokwane or Limpopo or Rustenburg or Mahikeng or Oudtshoorn or! Stellenbosch or Paarl or Gaborone or Luanda or Cabinda or Huambo or Lubango or Kuit or Malanje or Lobito or Lilongwe or Blantyre or Mzuzu or Maputo or Matola or Beira or Nampula or Chimoio or Nacala or Quelimane or Lusaka or Kitwe or Ndola or Kabwe or Copperbelt Harare or Bulawayo or Chitungwiza or Mutare or Masvingo or Monashonaland or Manicaland).mp.
6.	2 or 3 or 4 or 5
7.	Atrial Fibrillation/
8.	1 and 6
9.	7 and 8

Supplementary Table 2. Search strategy for EMBASE via OVID SP

SN	Search Items
1.	exp Heart Failure/ OR (Heart Failure or cardiac failure or cardia* insufficien*).mp.
2.	benin/ or burkina faso/ or cape verde/ or cote d'ivoire/ or gambia/ or ghana/ or guinea/ or guinea-bissau/ or liberia/ or mali/ or mauritania/ or nigeria/ or senegal/ or sierra leone/ or togo/ or (africa*adj2 west* or benin* or burkina fas* or cape verd* or cabo verd* or ivory coast or cote d'ivoire* or gambia* or ghana* or (guinea* not pig*) or bissau or liberia* or (mali not fowl) or malian or mauritania* or nigeria* or senegal* or sierra leon* or togo* or (Lagos or Accra or Abidjan or Dakar or Abobo or Abuja or Freetown or Ouagadougou or Conakry or Lome or Bamako or Cotonou or Kumasi or Monrovia or Ibadan or Kano or Port harcourt or Benin City or Porto Novo or Niamey or Yamoussoukro or Banjul or Timbuktu or Djenne or Abomeyu or Zaria or Tamale or Jos or Cape Coast or Aba or Gao or Calabar or Warri or Maiduguri or Bobo Dioulasso or Parakou or Djougou or Bohicon or Sekondi Takoradi or Sunyani or Obuasi or Teshie or Tema or Sikasso or Kalabankoro or Nouakchott or Dakhlet Nouadhibou or Benin City or Port Harcourt or Ilorin or Kaduna or Enugu or Ikorodu or Onitsha or Bauchi or Akure or Abeokuta or Sokoto or Bouake or Makeni or Kaduna or Sosgbo or Osogbo or Gombe or Ilesa or Badagry or makurdi or Sagamu or Iseyin or obbomosho or Awka or Ado Ekiti or Nsukka or Ikeja or Katsina or Okene or Lafia or Minna or Ondo city or Umuahia or Calabar or Yola or Pikine or Touba or Thies Nones or Saint Louis or Kolak or Ziguinchor or (San Pedro not (Spain or Mexico or Argentina or California or United States or Italy)) or Bandama or Daloa or Owerri or Kandi or Ifi or Dakar or Ogbomosho or Divo or Korhogo)).mp.
3.	(angola or cameroon* or chad* or tchad or congo* or DRC or equatorial guinea* or gabon* or "Sao Tome" or Principe or Luanda or lobito or kuito or huambo or Malanje or Douala or Yaounde or Bamenda or Garoua of Bafoussam or Ngaoundere or Maroua or Kouosseri or Buea or Kumba or N'Djamena or Moundou or Bangui or Bimbo or Brazzaville or Pointe Noire or Kinshasa or Lubumbashi or Leopoldville or Elizabethville or Mbuji Mayi or Bakwanga or Bukavu or Costermansville or Kananga or Luluabourg or Kisangani or Stanleyville or Tshikapa or Kolwezi or Likasi or Jadotville or Goma or Kikwit or Uvira or Bunia or Mbandaka or Coquilhatville or Matadi or Butembo or Kabinda or Mwene Ditu or Isiro or Paulis or Boma or Kindu or Bata or Malabo or Libreville).mp.
4.	((British Indian Ocean Territory or Burundi* or Comoros or Djibouti* or Eritrea* or Ethiopia* or Kenya* or Madagascar or Malawi or Mauritius or Mayotte or Mozambique or Reunion or Rwanda* or Seychelles or Somalia* or Sudan* or Tanzania* or Uganda* or Zambia or Zimbabwe or Crozet Islands or Iles Crozet or Scattered Islands ! or Iles Eparses or Mwanza or Zanzibar or Eldoret or Morogoro or Hargeysa or Berbera or Nyeri or Mbeya or Machakos or Marka or Tabora or Iringa or Gondar or Meru or Geita or Musoma or Mtwara or Songea or Kigoma or Dese or Mek'ele or Bahir Dar or Jimma or Shinyanga or Korogwe or Nairobi or "Dar es Salaam" or Mombasa or Addis Ababa or Kampala or Kigali or Mogadishu or Dodoma or Bujumbura or Nakuru or Antananarivo or Kisumu or Maputo or Asmara or Lusaka or Harare or Port Louis or Arusha or kitale or lilongwe or malindi or machakos or hargeisa or Bulawayo or Ruiru or Lamu or Dire Dawa or Kikuyu or naivasha or mwanza or tanga or nanyuki or voi or garissa or lodwar of kakamega or maralal or kitui or webuye or Axum or Nyahururu or Jinja or Kismayo or Namanga or Mumias or Moshi or Moroni or Lokichogio or Hola or Rwenzori Mountains or Lake Victoria or Puntland* or (Adi-harush or Ali-Addeh or Alinjugur or Buramino or Dadaab or Dagahaley or Dollo Ado or Fugnido or Hagadera or Hilaweyn or Ifo or Kakuma or Kambioos or Kayaka II or Kobe or Kyangwali Nakivale or Nyarugusu or Wad Sherife or Bokolmanyo or Melkadida or Rwamanja)) adj5 (camp or refug*)).mp.
5.	angola/ or botswana/ or lesotho/ or malawi/ or mozambique/ or namibia/ or south africa/ or swaziland/ or zambia/ or zimbabwe/ or ((africa* adj2 south*) or angola* or botswana* or lesotho* or malawi* or mozambiq* or namibia* or swaziland or zambia* or zimbabwe or Zulu or Tsonga or Xhosa or Swazi or Ndebele or Tswana or Sotho or Shona people or BaLunda or Mbundu or Ovimbundu or Chaga or Sukuma or Pretoria or Cape Town or Johannesburg or Durban or Port Elizabeth or Bloemfontein or Windhoek or Maseru or Pietermaritz or (Kimberley not Australia) or Nelspruit or Soweto or Polokwane or Limpopo or Rustenburg or Mahikeng or Oudtshoorn or! Stellenbosch or Paarl or Gaborone or Luanda or Cabinda or Huambo or Lubango or Kuit or Malanje or Lobito or Lilongwe or Blantyre or Mzuzu or Maputo or Matola or Beira or Nampula or Chimoio or Nacala or Quelimane or Lusaka or Kitwe or Ndola or Kabwe or Copperbelt Harare or Bulawayo or Chitungwiza or Mutare or Masvingo or Monashonaland or Manicaland).mp.
6.	2 or 3 or 4 or 5
7.	Atrial Fibrillation/
8.	1 and 6
9.	7 and 8

Supplementary Table 3. Search strategy for Global Health Library via OVID SP

SN	Search Items
1.	exp Heart Failure/ OR (Heart Failure or cardiac failure or cardia* insufficien*).mp.
2.	benin/ or burkina faso/ or cape verde/ or cote d'ivoire/ or gambia/ or ghana/ or guinea/ or guinea-bissau/ or liberia/ or mali/ or mauritania/ or nigeria/ or senegal/ or sierra leone/ or togo/ or (africa*adj2 west* or benin* or burkina fas* or cape verd* or cabo verd* or ivory coast or cote d'ivoire* or gambia* or ghana* or (guinea* not pig*) or bissau or liberia* or (mali not fowl) or malian or mauritania* or nigeria* or senegal* or sierra leon* or togo* or (Lagos or Accra or Abidjan or Dakar or Abobo or Abuja or Freetown or Ouagadougou or Conakry or Lome or Bamako or Cotonou or Kumasi or Monrovia or Ibadan or Kano or Port harcourt or Benin City or Porto Novo or Niamey or Yamoussoukro or Banjul or Timbuktu or Djenne or Abomeyu or Zaria or Tamale or Jos or Cape Coast or Aba or Gao or Calabar or Warri or Maiduguri or Bobo Dioulasso or Parakou or Djougou or Bohicon or Sekondi Takoradi or Sunyani or Obuasi or Teshie or Tema or Sikasso or Kalabankoro or Nouakchott or Dakhlet Nouadhibou or Benin City or Port Harcourt or Ilorin or Kaduna or Enugu or Ikorodu or Onitsha or Bauchi or Akure or Abeokuta or Sokoto or Bouake or Makeni or Kaduna or Sosgbo or Osogbo or Gombe or Ilesa or Badagry or makurdi or Sagamu or Iseyin or obbomosho or Awka or Ado Ekiti or Nsukka or Ikeja or Katsina or Okene or Lafia or Minna or Ondo city or Umuahia or Calabar or Yola or Pikine or Touba or Thies Nones or Saint Louis or Kolak or Ziguinchor or (San Pedro not (Spain or Mexico or Argentina or California or United States or Italy)) or Bandama or Daloa or Owerri or Kandi or Ifi or Dakar or Ogbomosho or Divo or Korhogo)).mp.
3.	(angola or cameroon* or chad* or tchad or congo* or DRC or equatorial guinea* or gabon* or "Sao Tome" or Principe or Luanda or lobito or kuito or huambo or Malanje or Douala or Yaounde or Bamenda or Garoua of Bafoussam or Ngaoundere or Maroua or Kouosseri or Buea or Kumba or N'Djamena or Moundou or Bangui or Bimbo or Brazzaville or Pointe Noire or Kinshasa or Lubumbashi or Leopoldville or Elizabethville or Mbuji Mayi or Bakwanga or Bukavu or Costermansville or Kananga or Luluabourg or Kisangani or Stanleyville or Tshikapa or Kolwezi or Likasi or Jadotville or Goma or Kikwit or Uvira or Bunia or Mbandaka or Coquilhatville or Matadi or Butembo or Kabinda or Mwene Ditu or Isiro or Paulis or Boma or Kindu or Bata or Malabo or Libreville).mp.
4.	((British Indian Ocean Territory or Burundi* or Comoros or Djibouti* or Eritrea* or Ethiopia* or Kenya* or Madagascar or Malawi or Mauritius or Mayotte or Mozambique or Reunion or Rwanda* or Seychelles or Somalia* or Sudan* or Tanzania* or Uganda* or Zambia or Zimbabwe or Crozet Islands or Iles Crozet or Scattered Islands ! or Iles Eparses or Mwanza or Zanzibar or Eldoret or Morogoro or Hargeysa or Berbera or Nyeri or Mbeya or Machakos or Marka or Tabora or Iringa or Gondar or Meru or Geita or Musoma or Mtwara or Songea or Kigoma or Dese or Mek'ele or Bahir Dar or Jimma or Shinyanga or Korogwe or Nairobi or "Dar es Salaam" or Mombasa or Addis Ababa or Kampala or Kigali or Mogadishu or Dodoma or Bujumbura or Nakuru or Antananarivo or Kisumu or Maputo or Asmara or Lusaka or Harare or Port Louis or Arusha or kitale or lilongwe or malindi or machakos or hargeisa or Bulawayo or Ruiru or Lamu or Dire Dawa or Kikuyu or naivasha or mwanza or tanga or nanyuki or voi or garissa or lodwar of kakamega or maralal or kitui or webuye or Axum or Nyahururu or Jinja or Kismayo or Namanga or Mumias or Moshi or Moroni or Lokichogio or Hola or Rwenzori Mountains or Lake Victoria or Puntland* or (Adi-harush or Ali-Addeh or Alinjugur or Buramino or Dadaab or Dagahaley or Dollo Ado or Fugnido or Hagadera or Hilaweyn or Ifo or Kakuma or Kambioos or Kayaka II or Kobe or Kyangwali Nakivale or Nyarugusu or Wad Sherife or Bokolmanyo or Melkadida or Rwamanja)) adj5 (camp or refug*)).mp.
5.	angola/ or botswana/ or lesotho/ or malawi/ or mozambique/ or namibia/ or south africa/ or swaziland/ or zambia/ or zimbabwe/ or ((africa* adj2 south*) or angola* or botswana* or lesotho* or malawi* or mozambiq* or namibia* or swaziland or zambia* or zimbabwe or Zulu or Tsonga or Xhosa or Swazi or Ndebele or Tswana or Sotho or Shona people or BaLunda or Mbundu or Ovimbundu or Chaga or Sukuma or Pretoria or Cape Town or Johannesburg or Durban or Port Elizabeth or Bloemfontein or Windhoek or Maseru or Pietermaritz or (Kimberley not Australia) or Nelspruit or Soweto or Polokwane or Limpopo or Rustenburg or Mahikeng or Oudtshoorn or! Stellenbosch or Paarl or Gaborone or Luanda or Cabinda or Huambo or Lubango or Kuit or Malanje or Lobito or Lilongwe or Blantyre or Mzuzu or Maputo or Matola or Beira or Nampula or Chimoio or Nacala or Quelimane or Lusaka or Kitwe or Ndola or Kabwe or Copperbelt Harare or Bulawayo or Chitungwiza or Mutare or Masvingo or Monashonaland or Manicaland).mp.
6.	2 or 3 or 4 or 5
7.	Atrial Fibrillation/
8.	1 and 6
9.	7 and 8

Supplementary Table 4. Search strategy for WHO African Medicus Index

SN	Search Items
1.	(tw:(Heart Failure))
2.	(tw:(atrial fibrillation))
3.	1 and 2

Supplementary Table 5. Search strategy for African Journals Online

SN	Search Items
1.	"heart failure"
2.	"cardiac failure"
3.	"cardia* insufficien*"
4.	1 OR 2 OR 3
5.	"atrial fibrillation"
6.	4 AND 5

Supplementary Table 6. Characteristics of studies reporting on prevalence of atrial fibrillation in heart failure

Surname of first author	Year of publication	Country of study	African region	Study setting	Study design	Sampling method	Timing of data collection	median age, yr	Males (%)	Participants on beta-blockers (%)	Sample size	Participants in NYHA III/IV (%)	Method of diagnosis of AF	Method of diagnosis of Heart failure
Abebe	2016	Ethiopia	East	Hospital-based	Cohort	Non-probabilistic	Retrospective	53.6	30.2	38	311	100	NR	Framingham criteria
Ali	2016	Ethiopia	East	Hospital-based	Cohort	Non-probabilistic	Prospective	50.9	50.7	NR	152	89	NR	Framingham criteria
Bonsu	2017	Ghana	West	Hospital-based	Cohort	NR	Retrospective	60.3	45.6	33	1488	42.5	NR	Framingham criteria
Boombhi	2017	Cameroon	Central	Hospital-based	Cross-sectional	Non-probabilistic	Retrospective	61.5	NR	NR	148	NR	NR	Framingham criteria
Chansa	2014	Zambia	South	Hospital-based	Cohort	Non-probabilistic	Prospective	50	41	2	390	NR	12-lead ECG	Trans-thoracic echocardiography
Dzudie	2008	Cameroon	Central	Hospital-based	Cross-sectional	Non-probabilistic	Retrospective	54.9	61.4	NR	140	44.2	12-lead ECG	Framingham criteria
Dzudie	2021	Cameroon	Central	Hospital-based	Cohort	Non-probabilistic	Prospective	64	49.3	NR	331	42.2	12-lead ECG	ESC 2016 criteria
Familoni	2007	Nigeria	West	Hospital-based	Cohort	Non-probabilistic	Prospective	57.6	67.1	NR	82	100	NR	Trans-thoracic echocardiography
Jere	2015	Zambia	South	Hospital-based	Cross-sectional	Non-probabilistic	Prospective	NR	49	NR	49	100	12-lead ECG, Holter ECG	Physician diagnosed heart failure
Karaye	2008	Nigeria	West	Hospital-based	Cross-sectional	Non-probabilistic	Prospective	42.8	37.2	NR	113	NR	12-lead ECG	ESC 2005 criteria
Karaye a	2021	Nigeria	West	Hospital-based	Cohort	Non-probabilistic	Prospective	50.8	54.3	29.1	383	61.7	12-lead ECG	Boston criteria for HF
Karaye b	2021	South Africa	South	Hospital-based	Cohort	Non-probabilistic	Prospective	53.3	56.2	63.8	169	56.2	12-lead ECG	Boston criteria for HF
Karaye c	2021	Uganda	East	Hospital-based	Cohort	Non-probabilistic	Prospective	52.3	27.5	71.8	151	78.6	12-lead ECG	Boston criteria for HF
Karaye d	2021	Mozambique	East	Hospital-based	Cohort	Non-probabilistic	Prospective	46.2	40.1	49.3	90	23.3	12-lead ECG	Boston criteria for HF
Ker	1995	South Africa	South	Hospital-based	Cohort	Non-probabilistic	Retrospective	69	38	NR	260	NR	12-lead ECG	Physician diagnosed heart failure
Kingue	2005	Cameroon	Central	Hospital-based	Cross-sectional	Non-probabilistic	Retrospective	57.3	59.3	NR	167	53	12-lead ECG	Framingham criteria
Makubi	2014	Tanzania	East	Hospital-based	Cohort	Non-probabilistic	Prospective	55	49	42	427	79	12-lead ECG	Framingham criteria
Malamba	2018	DRC	Central	Hospital-based	Cohort	Non-probabilistic	Retrospective	56	47	60	231	NR	12-lead ECG	ESC 2005 criteria
Mandi	2020	Burkina Faso	West	Hospital-based	Cohort	Non-probabilistic	Prospective	58.6	50.3	19	298	27.9	12-lead ECG	ESC 2012 criteria
Massoure	2013	Djibouti	East	Hospital-based	Cross-sectional	Non-probabilistic	Prospective	55	84	NR	45	55.6	12-lead ECG	Framingham criteria
Mboup	2013	Senegal	West	Hospital-based	cohort	NR	Prospective	65.7	43.8	41	32	41	12-lead ECG	ESC 2012 criteria
Mene-Afejuku	2017	Nigeria	West	Hospital-based	Cohort	NR	Prospective	66.9	NR	NR	113	73.1	Holter ECG	ESC 2012 criteria
Mwita	2017	Botswana	South	Hospital-based	Cohort	Non-probabilistic	Prospective	54	53.9	72	193	77.5	Physician diagnosed	ESC 2012 criteria
Nloo	2016	Cameroon	Central	Hospital-based	Cohort	Non-probabilistic	Prospective	NR	62.5	52	72	100	12-lead ECG	Physician diagnosed heart failure.
Ogah	2014	Nigeria	West	Hospital-based	Cohort	Non-probabilistic	Prospective	59.3	57.5	3	320	82.2	12-lead ECG	Framingham criteria
Ojji	2013	Nigeria	West	Hospital-based	Cohort	Non-probabilistic	Prospective	49	49.9	NR	1515	11.1	12-lead ECG	ESC 2005 criteria
Pio	2014	Togo	West	Hospital-based	Cross-sectional	Non-probabilistic	Prospective	52.2	48.1	NR	297	NR	12-lead ECG	Framingham criteria, and ESC 2012 criteria
Sani	2018	Multinational registry*		Hospital-based	Cohort	Non-probabilistic	Prospective	52.3	49.2	NR	1006	80	12-lead ECG	Framingham criteria, and ESC 2012 criteria
Stewart	2008	South Africa	South	Hospital-based	Cohort	NR	Prospective	55	43	25	844	34	12-lead ECG	ESC 2005 criteria
Thiam	2003	Senegal	West	Hospital-based	Cohort	NR	Prospective	50	NR	NR	170	NR	NR	Physician diagnosed heart failure

*Study countries included: Sudan; Cameroon; South Africa; Nigeria; Ethiopia; Kenya; Uganda; Senegal; Mozambique; AF = Atrial Fibrillation; DRC = Democratic Republic of Congo; ECG = Electrocardiography; ESC = European Society of Cardiology; HF = Heart failure; n = Frequency; NR = Not reported; NYHA = New York Heart Association; Year = Year of publication

Supplementary Table 7. Risk of bias in studies reporting on the prevalence of atrial fibrillation in patients with heart failure

Surname of first author	Year of publication	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Total score	Risk of bias
Abebe	2016	1	1	0	1	0	1	1	0	0	5	Moderate
Ali	2016	1	0	1	0	0	1	1	0	0	4	Moderate
Bonsu	2017	0	1	0	1	0	1	1	0	0	4	Moderate
Boohmbi	2017	1	0	0	1	1	1	0	0	0	4	Moderate
Chansa	2014	0	0	0	0	0	1	0	0	0	1	Low
Dzudie	2008	0	0	0	1	0	1	1	0	0	3	Low
Dzudie	2021	0	1	1	0	0	0	0	0	0	2	Low
Familoni	2007	0	0	1	0	0	1	1	0	0	3	Low
Jere	2015	0	0	1	0	1	1	0	0	0	3	Low
Karaye	2008	0	0	0	0	0	1	0	0	0	1	Low
Karaye a	2021	0	0	0	1	1	1	1	1	1	6	Moderate
Karaye b	2021	0	0	0	1	1	1	1	1	1	6	Moderate
Karaye c	2021	0	0	0	1	1	1	1	1	1	6	Moderate
Karaye d	2021	0	0	0	1	1	1	1	1	1	6	Moderate
Ker	1995	1	1	1	1	1	0	0	0	0	5	Moderate
Kingue	2005	0	0	0	1	0	0	0	0	1	2	Low
Makubi	2014	0	0	1	0	0	0	0	0	0	1	Low
Malamba	2018	1	1	1	1	0	0	0	1	0	5	Moderate
Mandi	2020	0	1	0	0	0	0	0	0	0	1	Low
Massoure	2013	1	1	0	0	0	0	0	0	0	2	Moderate
Mboup	2013	1	1	1	0	0	0	0	0	0	3	Low
Mene-Afejuku	2017	0	0	1	0	0	1	0	0	0	2	Low
Mwita	2017	0	1	0	0	0	0	0	0	0	1	Low
Nloo	2016	0	1	0	0	0	0	0	0	0	1	Low
Ogah	2014	0	1	0	0	0	0	0	0	0	1	Low
Ojji	2013	0	1	0	0	0	0	0	0	1	2	Low
Pio	2014	0	0	0	0	0	1	1	0	1	3	Low
Sani	2018	1	0	1	0	0	0	0	0	0	2	Low
Stewart	2008	0	1	0	0	0	0	0	0	0	1	Low
Thiam	2003	0	1	0	0	0	0	0	0	0	1	Low
Interpretation of the total score 7-9: High risk of bias; 4-6: Moderate risk of bias; 0-3: Low risk of bias												

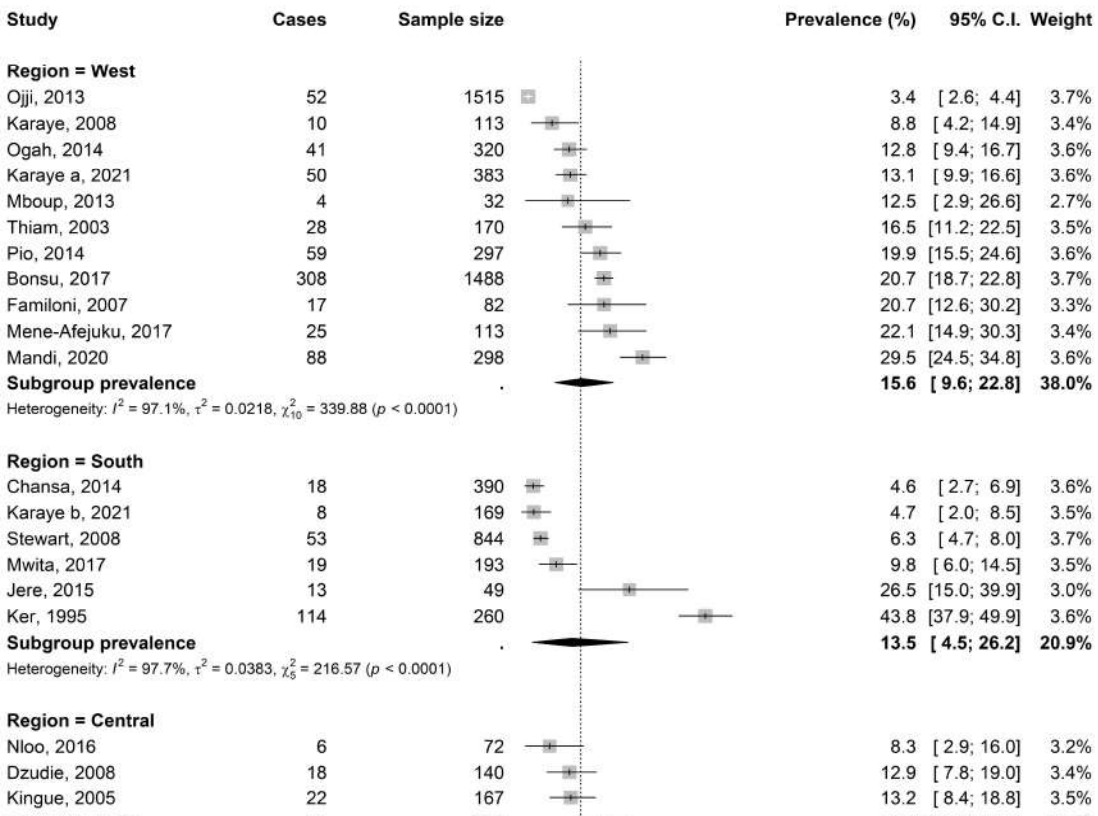
Supplementary Table 8. Risk of bias in studies reporting on all-cause mortality in patients with heart failure and atrial fibrillation

Surname of first author	Year of publication	Selection Item 1	Selection Item 2	Selection Item 3	Selection Item 4	Total Selection	Outcome Item 1	Outcome Item 2	Outcome Item 3	Total Outcome	Risk of bias
Makubi	2014	0	1	1	1	3	1	1	1	3	Low
Malamba	2018	0	1	1	1	3	1	1	0	2	Moderate
Sani	2018	1	1	1	1	4	1	1	1	3	Low

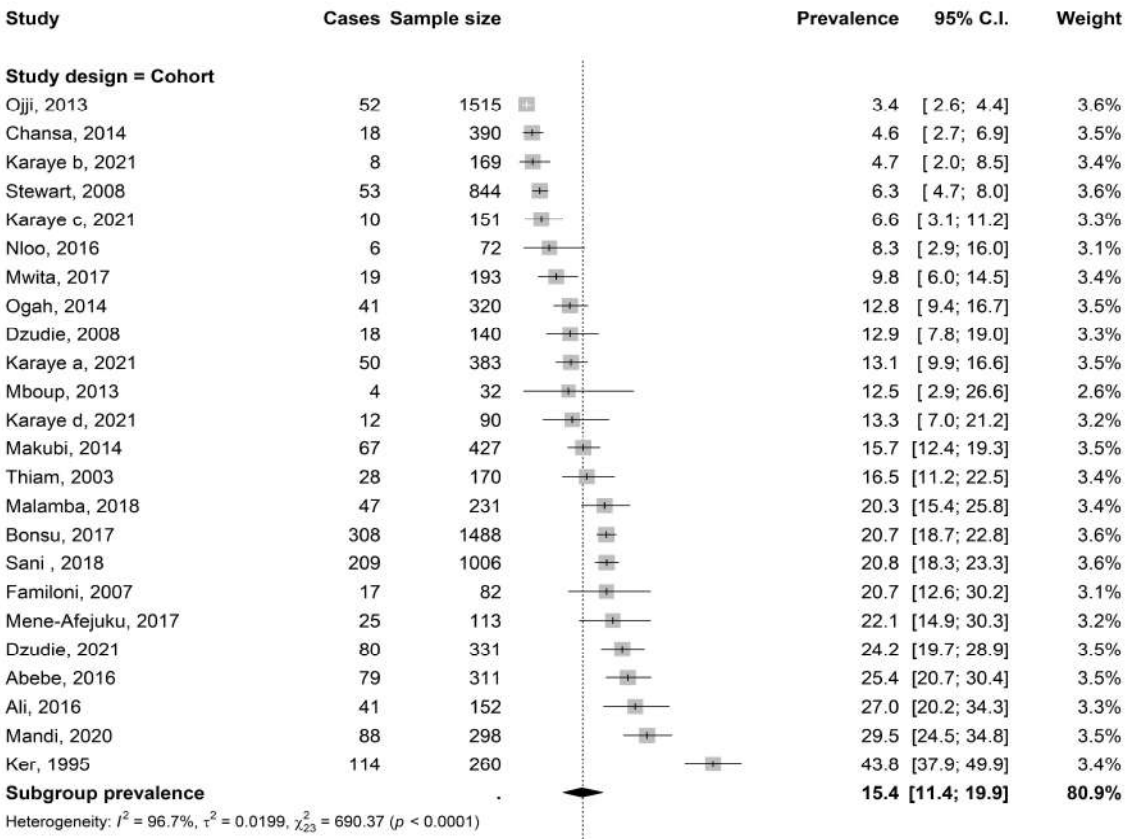
Selection Item 1 (Sample representativeness); Selection Item 2 (Ascertainment of atrial fibrillation); Selection Item 3 (Ascertainment of heart failure); Selection Item 4 (Absence of Outcome [mortality] from the start of the study)

Outcome Item 1 (Outcome assessment); Outcome Item 2 (Follow-up duration for outcome); Outcome Item 3 (Completeness of follow-up)

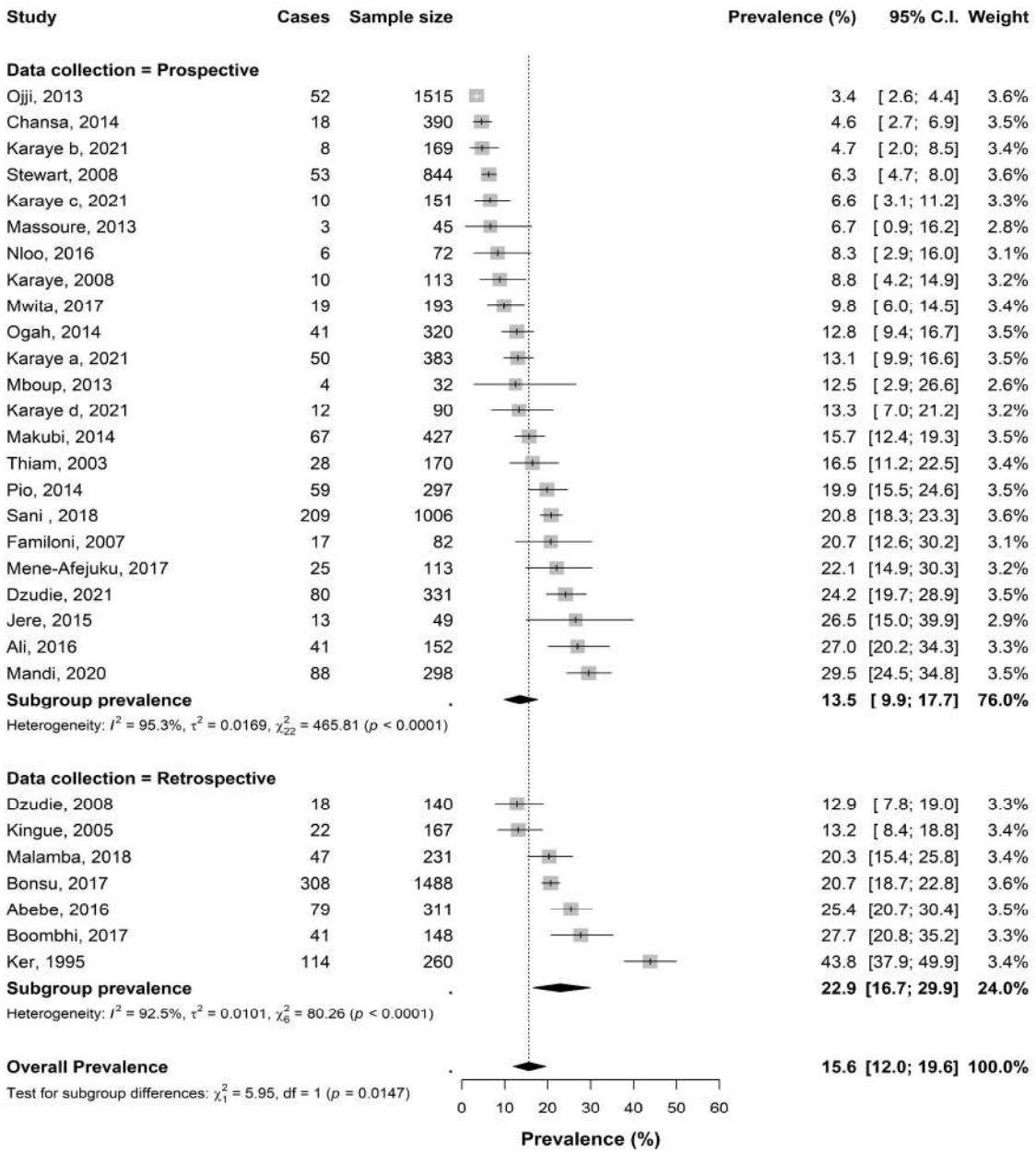
Interpretation of the score
High risk of bias: 0-1 stars in for total selection and 1 star for total outcome scores
Moderate risk of bias: Two stars in total selection and 2 or 3 stars total outcome scores
Low risk of bias: Three or 4 stars in total selection and 2 or 3 stars total outcome scores



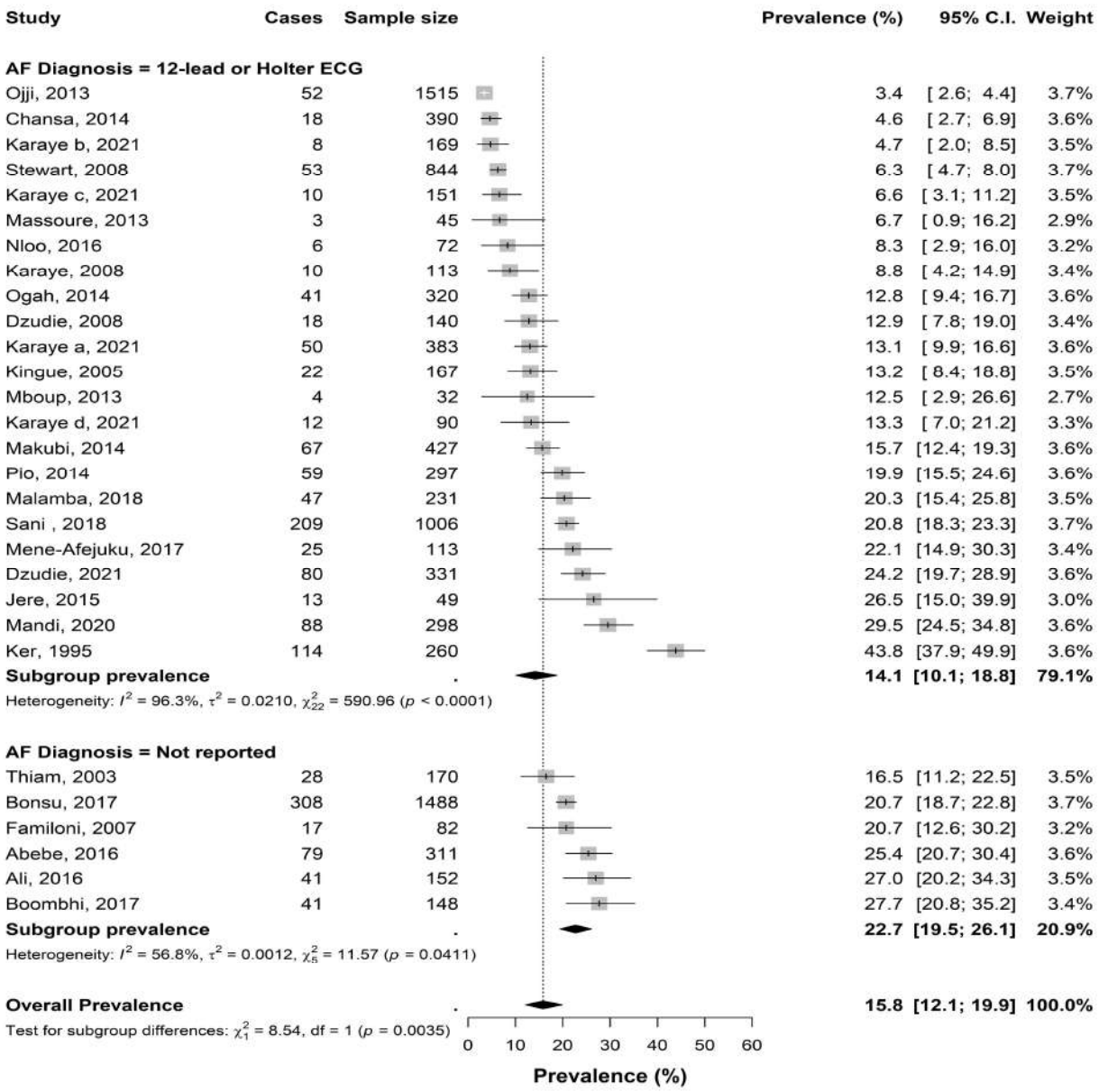
Supplementary Figure 1. Prevalence of atrial fibrillation in heart failure by region



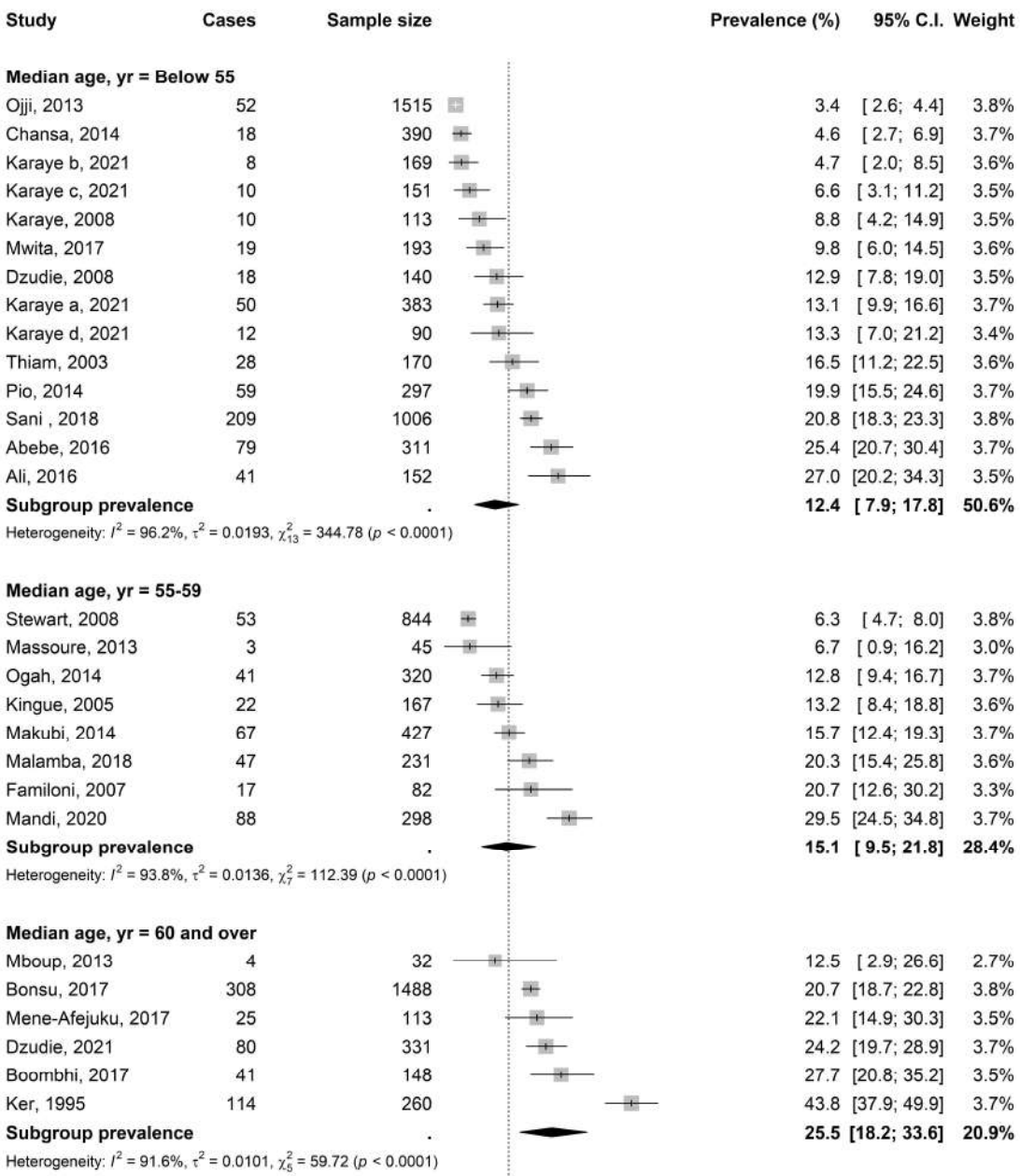
Supplementary Figure 2. Prevalence of atrial fibrillation in heart failure by study design



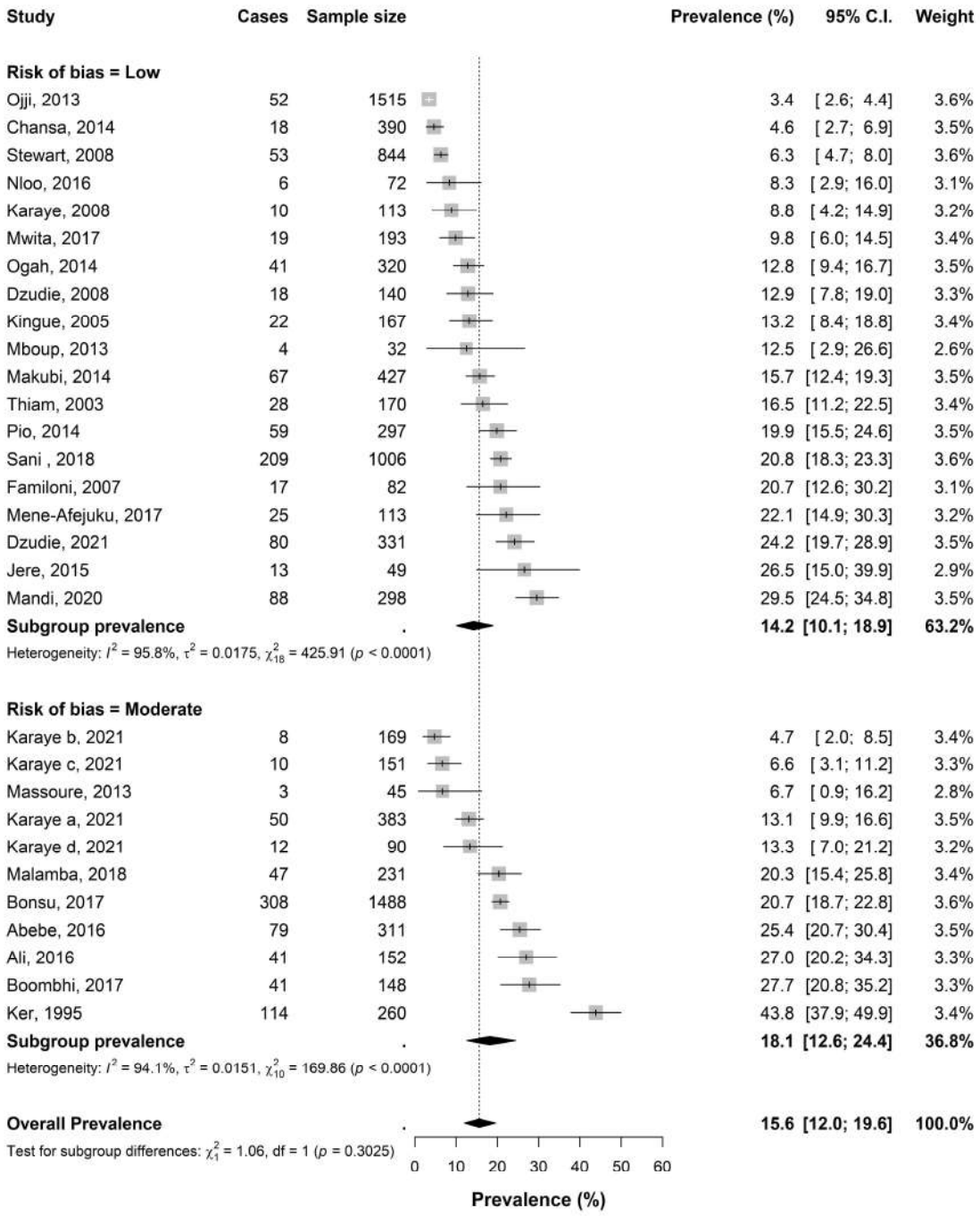
Supplementary Figure 3. Prevalence of atrial fibrillation in heart failure by the timing of data collection



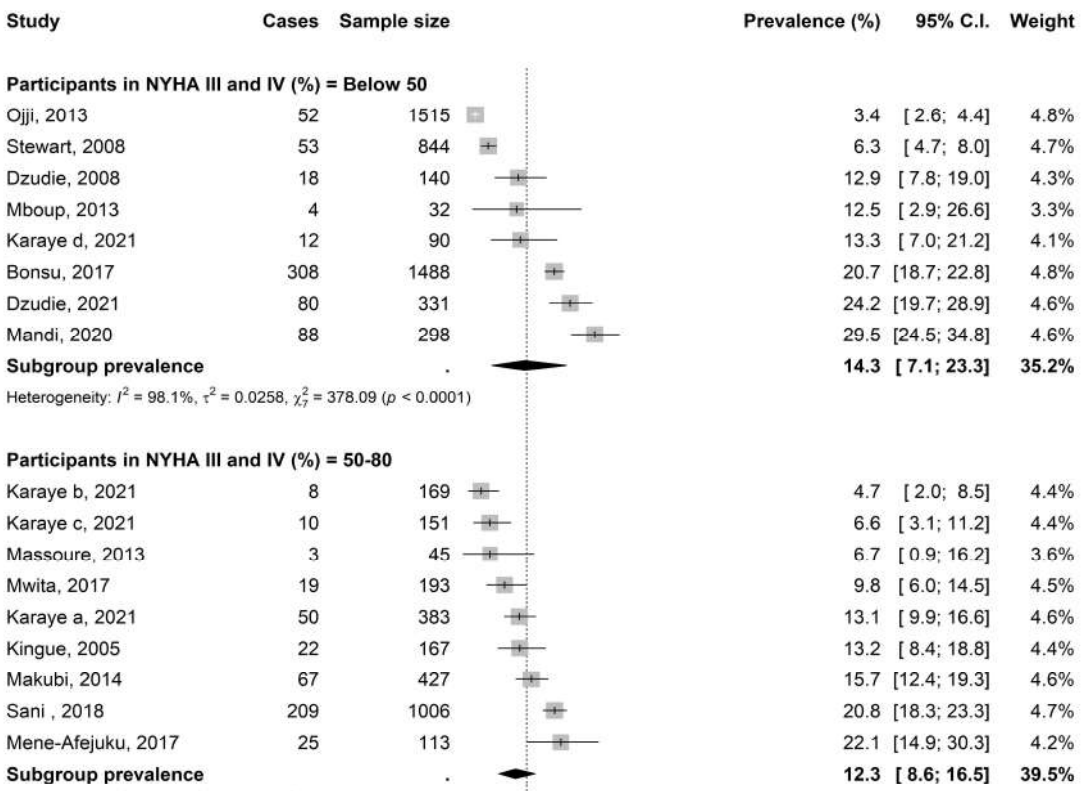
Supplementary Figure 4. Prevalence of atrial fibrillation in heart failure by method of diagnosis of atrial fibrillation



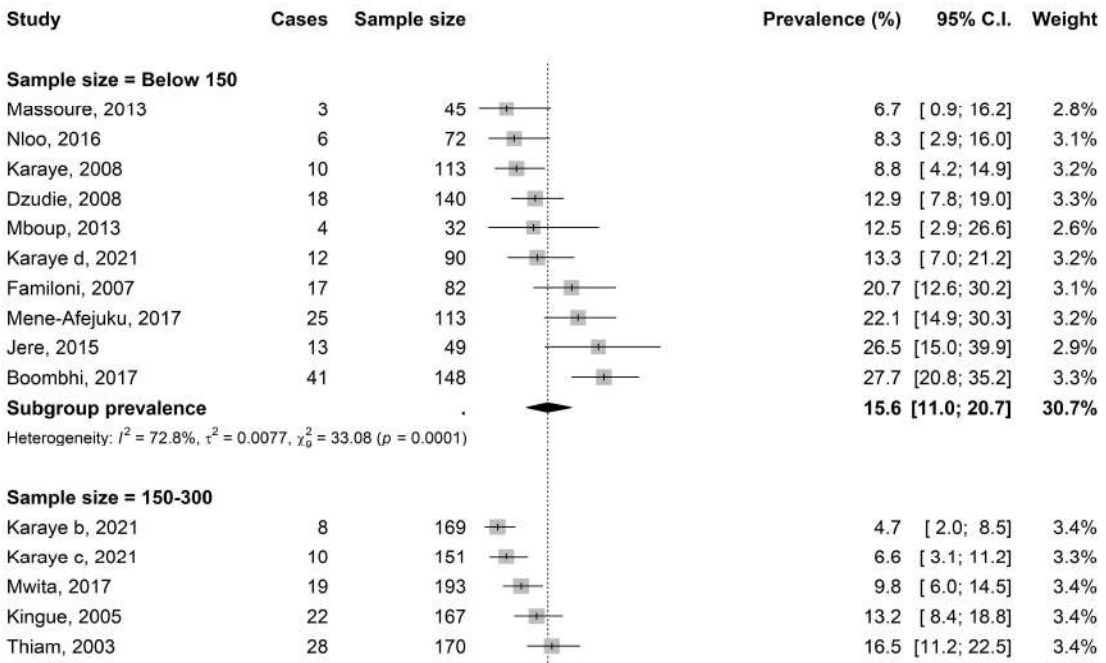
Supplementary Figure 5. Prevalence of atrial fibrillation in heart failure by age of studies participants each study



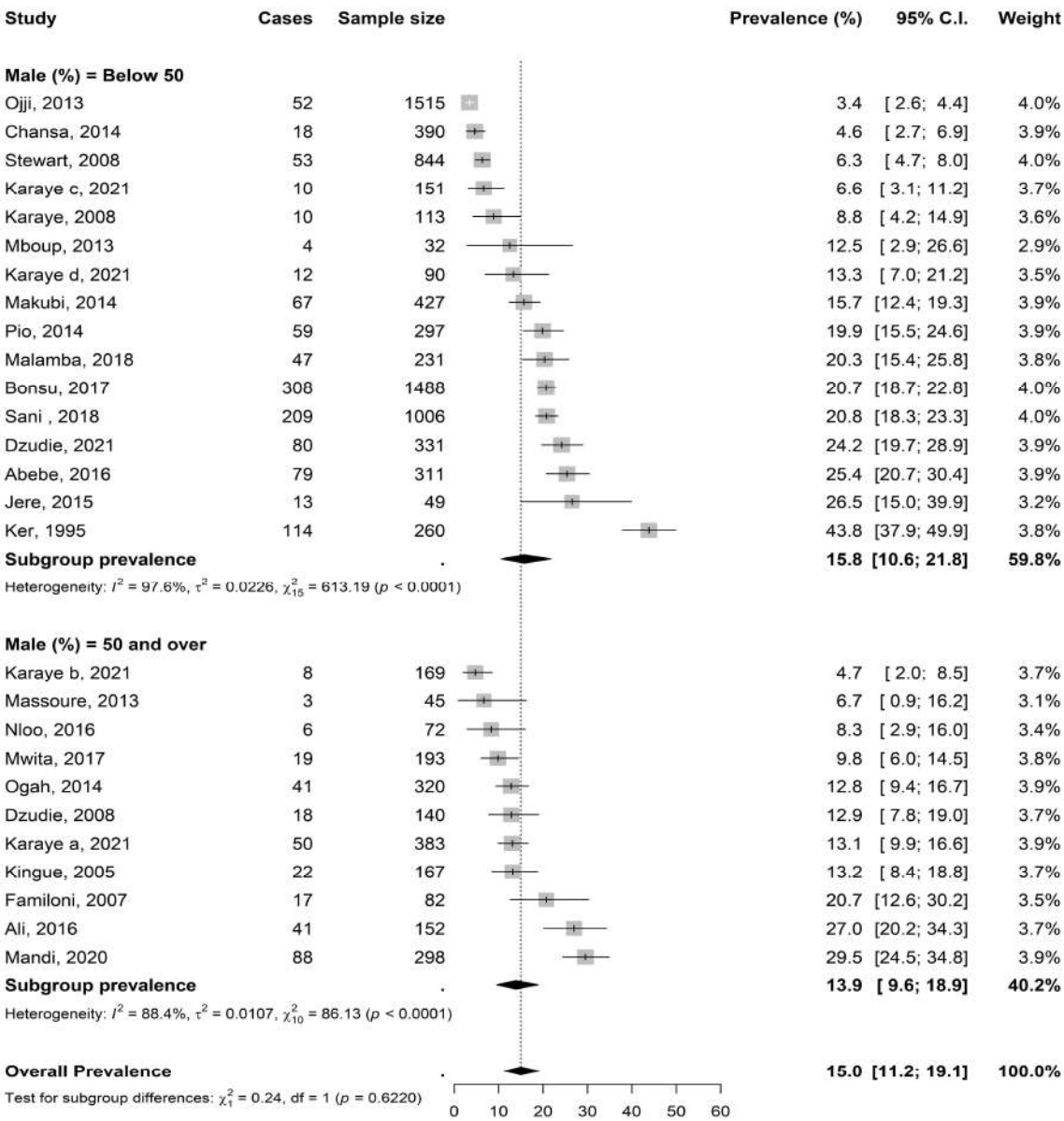
Supplementary Figure 6. Prevalence of atrial fibrillation in heart failure by risk of bias in individual studies



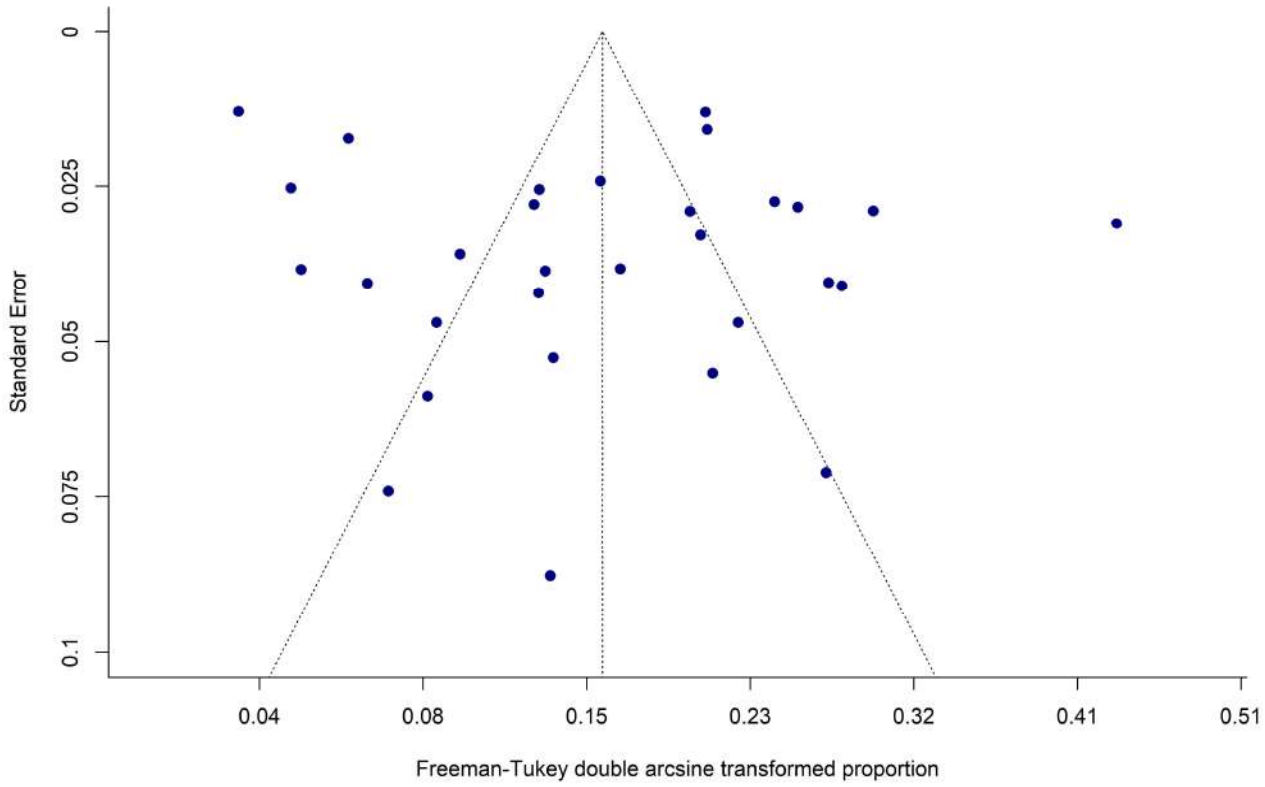
Supplementary Figure 7. Prevalence of atrial fibrillation in heart failure by percentage of participants in New York Heart Association (NYHA) stages III or IV in each study



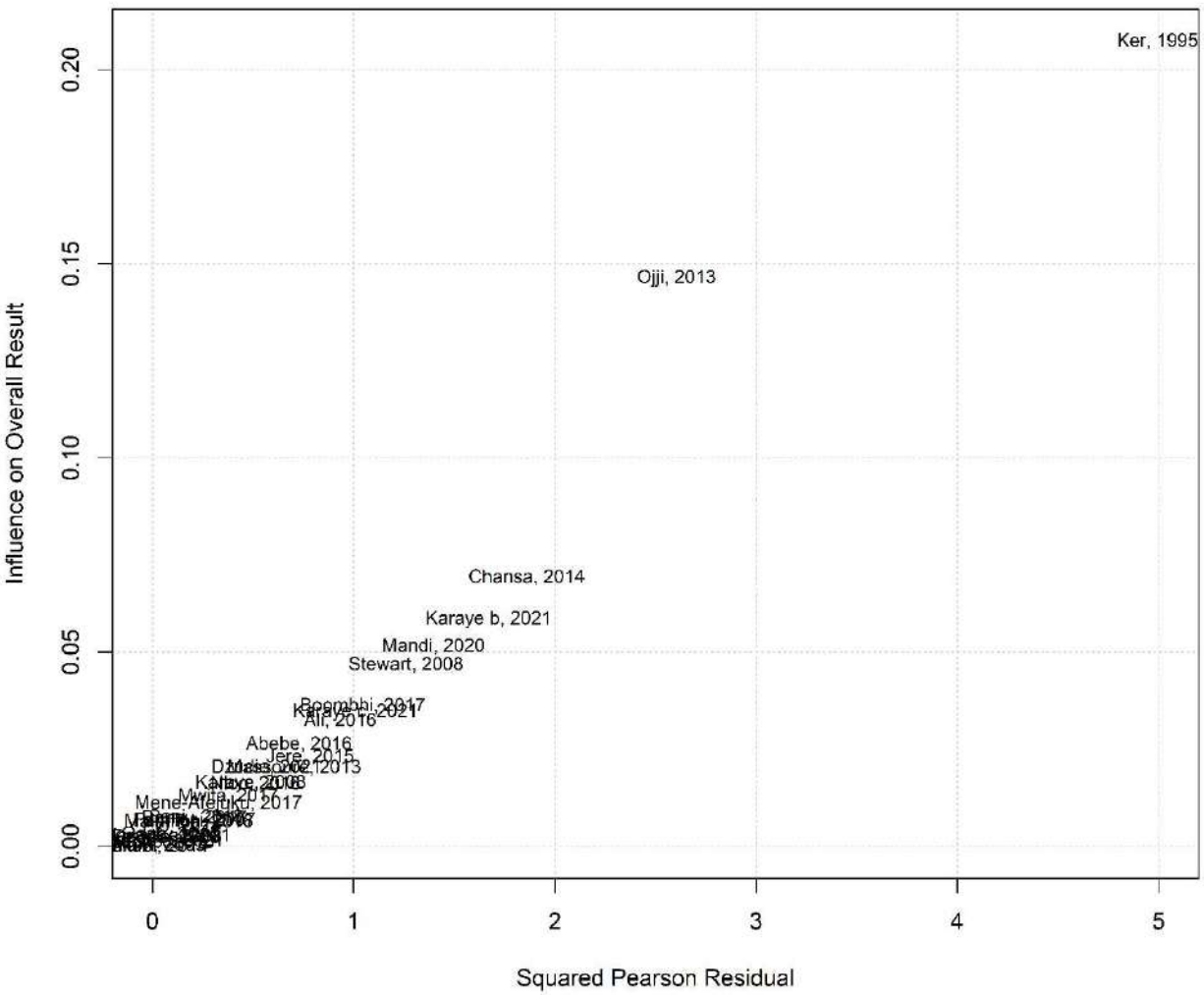
Supplementary Figure 8. Prevalence of atrial fibrillation in heart failure by sample size



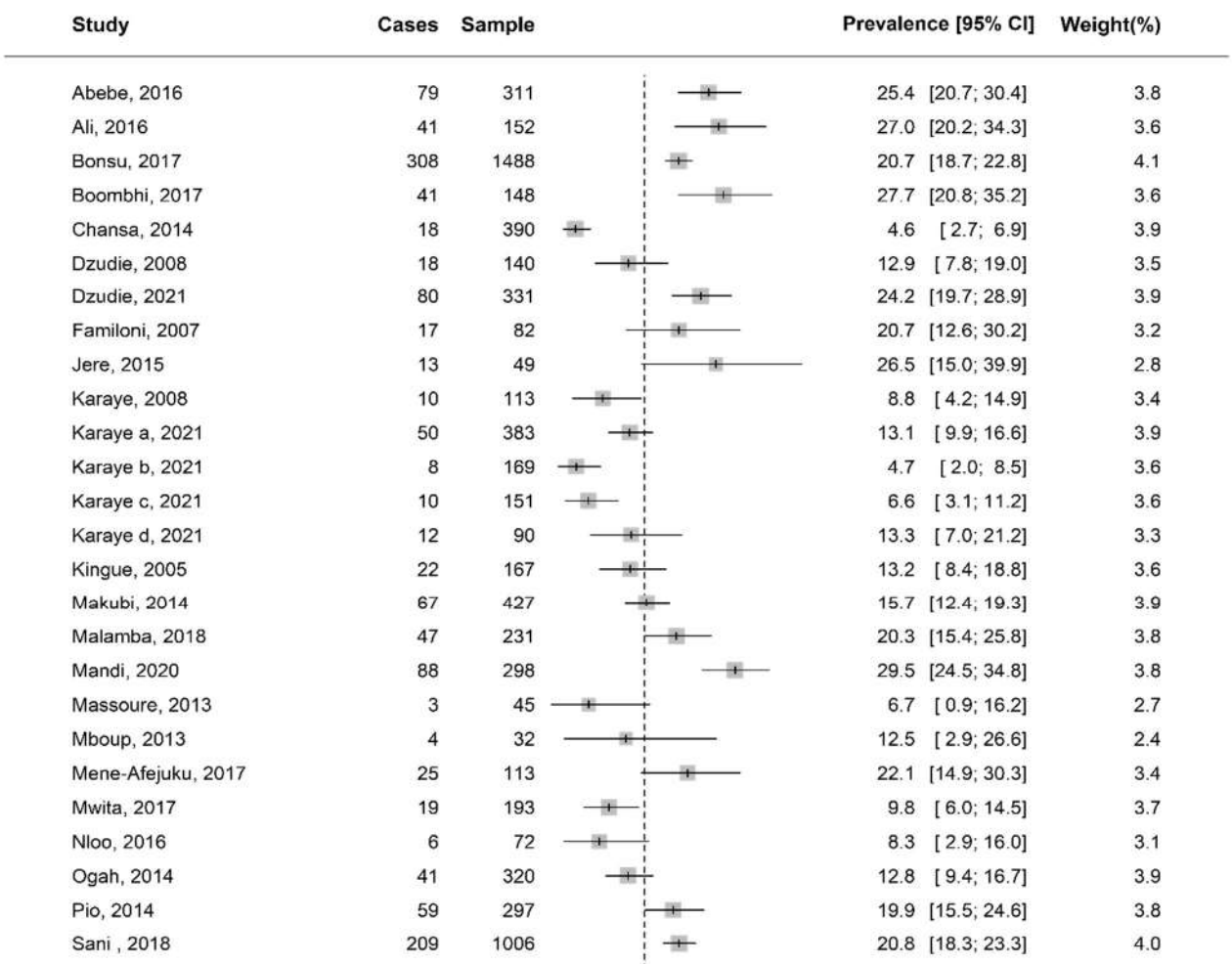
Supplementary Figure 9. Prevalence of atrial fibrillation in heart failure by percentage of male participants



Supplementary Figure 10. Funnel plot for publication bias of studies reporting on the prevalence of atrial fibrillation in heart failure included in the meta-analysis



Supplementary Figure 11. Baujat plot showing the influence of studies on the degree of heterogeneity in studies reporting on the prevalence of atrial fibrillation in heart failure



Supplementary Figure 12. Pooled prevalence of atrial fibrillation in patients with heart failure after excluding potentially influential studies. The grey squares and the horizontal bars are the study-specific prevalence and 95% confidence intervals (CI). Each study-specific estimate is weighted by the inverse of the variance using random-effect meta-analysis. The centre and the horizontal edges of the black diamond are the pooled summary prevalence and 95% confidence interval.

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Page # where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	3
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	3
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	4
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	4
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Tables S1-5
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	4
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	5
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	5
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	5
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	5
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	5
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	6
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	6
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	6
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	6
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	6
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	6
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	6
Certainty	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	6

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Page # where item is reported
assessment			
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	7
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	7
Study characteristics	17	Cite each included study and present its characteristics.	7
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	7-8
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	7-8
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	7
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	7-8
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	8
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	8
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	NA
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	8-10
	23b	Discuss any limitations of the evidence included in the review.	10-11
	23c	Discuss any limitations of the review processes used.	10-11
	23d	Discuss implications of the results for practice, policy, and future research.	10
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	4
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	4
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	5-6
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	11
Competing interests	26	Declare any competing interests of review authors.	11
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	11

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi:

PRISMA 2020 Checklist

10.1136/bmj.n71

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