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REVIEW

Pooled prevalences of obstructive sleep apnea and heart failure: a systematic review and meta-analysis

Wisarud Prechaporn[1] · Phasu Hantrakul[1] · Chetta Ngamjarus[2] · Wattana Sukeepaisarnjaroen[1] · Kittisak Sawanyawisuth[1] · Sittichai Khamsai[1]

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Abstract

Obstructive sleep apnea (OSA) is a disease with intermittent hypoxemia during sleep. It has been shown that OSA is related to several cardiovascular diseases including heart failure. Both OSA and heart failure have a close association bidirectionally. This study aimed to estimate the pooled prevalence of OSA in patients with heart failure as well as pooled prevalence of heart failure in patients with OSA. This was a systematic review with a meta-analysis. The inclusion criteria were observational or epidemiological studies conducted in adult patients with heart failure to evaluate the prevalence of OSA and patients with OSA to evaluate the prevalence of heart failure. The outcomes of this study were prevalence of OSA in patients with heart failure and prevalence of heart failure in patients with OSA. Four databases were used for systematic searching including PubMed, Science Direct, Scopus, and CINAHL Plus. Manual searches for related studies were also conducted. Proportion meta-analyses using a random-effects model were conducted to identify pooled proportion (prevalence) of heart failure in patients with OSA and vice versa. Among 3,941 articles from the four databases met the study criteria. Thirty-three studies showed the prevalence of OSA in patients with heart failure, while thirteen studies presented the prevalence of heart failure in patients with OSA. The prevalence of OSA in patients with heart failure was 38.4% (95% CI 31.9 to 45.2; I^2 of 96.1%). Using a diagnostic criterion of OSA of more than 10 events/hr had the highest prevalence of OSA in patients with heart failure at 53.4% (95% CI 42.0 to 64.5). The highest prevalence of OSA in patients with heart failure was 60.1% (95% CI 51.4 to 68.3) in a report from India. The pooled prevalence of heart failure in patients with OSA was 12.8% (95% CI 8.1 to 19.5; I^2 of 94.6%). The prevalence in Romania was highest at 22.6% (95% CI 20.4 to 24.9). The pooled prevalence of OSA in patients with heart failure was higher than the pooled prevalence of heart failure in patients with OSA. The pooled prevalence rates of these associations varied among the diagnostic criteria of OSA and countries.

Keywords Obstructive sleep apnea · Heart failure · Prevalence Systematic review

Introduction

Obstructive sleep apnea (OSA) is a common disease with a prevalence of 9–38% in the general population [1]. Its prevalence is slightly more in men than in women (22% vs. 17%), with extremely high figures in some populations such as the elderly (90% in men and 78% in women) [1, 2]. The mechanism of OSA is repeated hypoxemia during sleep, which may lead to several cardiovascular conditions including heart failure [3–9]. A Mendelian randomization study found that OSA increased the risk of heart failure by 1.13 times (95% CI 1.01 to 1.27) after adjusting for several variables [9]. Additionally, patients with OSA were related with diastolic dysfunction evidence by lower ratio of early to late mitral inflow velocities (E/A) by -0.62 compared with non-OSA patients (p-value = 0.001) [10].

Heart failure is a global health issue, which affects more than 25 million people worldwide, with new admissions of over one million per year in the US [11]. Hospital admissions for heart failure were 6.5 million hospital days

✉ Kittisak Sawanyawisuth
kittisak@kku.ac.th

✉ Sittichai Khamsai
sittikh@kku.ac.th

[1] Department of Medicine, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand

[2] Department of Epidemiology and Biostatistics, Faculty of Public Health, Khon Kaen University, Khon Kaen, Thailand

annually with an annual cost of over 40 billion USD [11]. A recent study of 111 patients with heart failure found that OSA was highly prevalent at 63.5% [12]. To emphasize the correlation between OSA and heart failure, this study aimed to estimate the prevalence of OSA in patients with heart failure and the prevalence of heart failure in patients with OSA by a systematic review.

Methods

The inclusion criteria were survey or observational studies on the prevalence of OSA in patients with heart failure and the prevalence of heart failure in patients with OSA. We excluded studies with randomized controlled trials, case report/case series, commentaries, books, or reviews. Those studies without a prevalence or incidence of OSA or a diagnosis of OSA other than polysomnography were also excluded. Four databases were used for systematic searching, namely PubMed, Science Direct, Scopus, and CINAHL. In addition, manual searches for related studies were also performed. Search terms included obstructive sleep apnea, prevalence, incidence, epidemiological study, and observational study. The full list of search terms is shown in Appendix. The final search was performed on September 26, 2022.

After duplication removal, initial screening was carried out for nonrelevant articles [13–16]. The initial screening process was performed by two authors (WP, SK) independently. Titles and abstracts were screened and included for any observational studies on OSA and heart failure. The full-text review and data extraction were performed by two independent authors (WP, SK). A PRISMA flow chart of article searching and included studies is shown in Fig. 1.

Data collection of each included study was retrieved for the following section publication characteristics, study characteristics, and outcomes. The publication characteristics comprised the first author, year of publication, and country of study origin, whereas study characteristics included study design, age of patients with heart failure or OSA, diagnosis of heart failure, and diagnosis of OSA. The primary outcome was the prevalence of OSA in patients with heart failure and the prevalence of heart failure in patients with OSA. Study quality of observational studies was evaluated by using the Newcastle–Ottawa Scale; but not the descriptive studies.

Statistical analysis

The I^2 statistic and Cochran's Q test were calculated to assess the heterogeneity of proportions among included studies. Subgroup analyses by diagnostic method, country, and region were used to investigate the heterogeneity between results of included studies. Proportion meta-analyses using a random-effects model were conducted to identify pooled proportion (prevalence) of heart failure in OSA patients and pooled proportion of OSA in heart failure patients. Publication bias was evaluated using Egger's test. RStudio, R language, and the "meta" package in R were used to perform all data analyses [17–19].

Results

Prevalence of OSA in patients with heart failure

There were 3,941 articles eligible for the screening process. Of these, 46 articles entered the full-text review; 13 articles were excluded due to unavailability of polysomnography for OSA diagnosis (10 articles) or no OSA prevalence (3 articles). In total, 33 articles were included for the analysis (Fig. 1). All selected articles had been published between 1997 and 2022; they were mostly from the U.S. (8 articles); and most of them were prospective/cohort studies (18 articles) [20–52]. Diagnosis of OSA was made by evidence of an apnea–hypopnea index (AHI) of 5, 10, or 15 times/hr, while patients with heart failure had a low-left ventricular function of less than 35–55% (Table 1). One study conducted in patients with rheumatic valvular heart disease [25].

The studies contained data from 8,480 patients with heart failure. Of these, 3,079 patients (38.4%) had OSA (95% CI 31.9 to 45.2%), with an I^2 of 96.1% (Fig. 2). A subgroup analysis by diagnostic criteria of OSA showed that AHI of more than 10 times/hr had the highest prevalence of OSA at 53.4% (95% CI 42.0 to 64.5%) (Fig. 2). Patients with heart failure in the Asia region had the highest prevalence of OSA with heart failure of 43.4% (95% CI 29.5 to 58.3) when compared with other regions (Fig. 3). Among the countries, India had the highest prevalence of OSA (2 studies, 60.1% with 95% CI 51.4 to 68.3) [36, 51], followed by Hong Kong (1 studies, 55.0% with 95% CI 31.5 to 76.9) [23], as shown in Fig. 4. Regarding study quality, five studies were observational studies; four cohort studies and one case-control study. Three out of four cohort studies had a good quality, while the case-control study had a poor quality (Table 2).

Prevalence of heart failure in patients with OSA

Among the 3,940 articles for screening, 22 articles met the criteria for full-text review (Fig. 5). Of these, 13 articles were included for the analysis that were published between 2003 and 2021, were mostly prospective/cohort studies (6 articles), and were conducted in the U.S. (4 articles) or China (3 articles) [53–65]. Diagnostic criteria for OSA

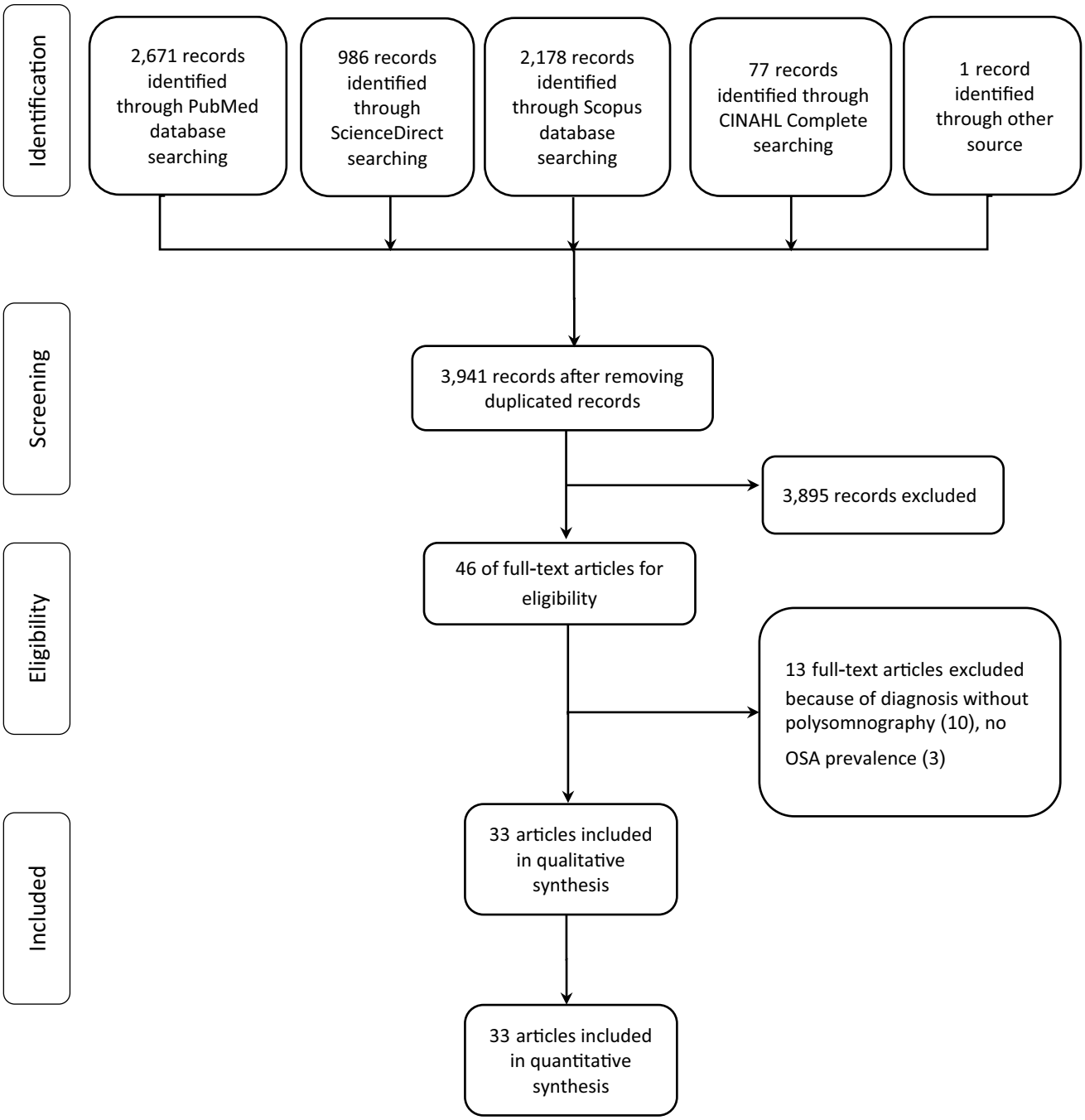

Fig. 1 PRISMA flow for evaluating prevalence of obstructive sleep apnea in patients with heart failure

varied from AHI of 5–15 times/hr, while most studies did not report the diagnostic criteria for heart failure (Table 3).

The pooled prevalence of heart failure in patients with OSA was 12.8% (95% CI 8.1 to 19.5; I^2 of 94.6%) based on 5,250 patients with OSA (Fig. 6). In subgroup analysis by diagnostic criteria for OSA (Fig. 6), the pooled prevalence from five studies was 18.8% (95% CI 14.5 to 24.1) when using an AHI of 5 events/hr or more. Europe had the highest prevalence of heart failure at 15.8% (95% CI 10.5 to 23.1), as shown in Fig. 7. At the country level, the prevalence in Romania was highest at 22.6% (1 studies, 95% CI 20.4 to 24.9), as shown in Fig. 8. There were seven observational studies; five cohort and two cross-sectional studies (Table 4). One out of five cohort studies had a good quality, while both cross-sectional studies had a good quality. Based on Egger's test, there was no evidence of significant publication bias among included studies that determined the prevalence of OSA in patients with heart

Table 1 Characteristics of included studies of patients with heart failure (HF) to evaluate prevalence of obstructive sleep apnea (OSA)

Study	Year	Country	N, OSA	N, total	Study design	Age, years[a]	OSA diagnosis	HF diagnosis
Alvi	2018	USA	143	1124	Cohort	62 ± 7.6	AHI ≥ 5	LVEF < 50%
Arzt	2017	Germany	452	1557	Descriptive	66 ± 11	AHI ≥ 15	LVEF ≤ 45%
Bitter	2009	Germany	97	244	Prospective, descriptive	66.8 ± 1.9	AHI ≥ 5	LVEF > 55%
Chan	1997	Hong Kong	11	20	Descriptive	65 ± 6	AHI > 10	NYHA 2 or 3 or echocardiogram
Damy	2012	France	238	384	Prospective, descriptive	63 ± 13	AHI ≥ 5	LVEF < 45%
Ding*VHD	2011	China	42	260	Cross-sectional, descriptive	54.8 (52.1–57.6)	AHI ≥ 5	RHD, NYHA ≥ 2
Dolliner	2013	Austria	88	176	Descriptive	68.3(33.1–85.9)	AHI ≥ 15	Echocardiogram
Donovan	2016	USA	66	98	Cross-sectional, descriptive	55.1 (45.6–64.6)	AHI ≥ 5	NA
Ferrier	2005	New Zealand	28	53	Cross-sectional, descriptive	60.1 ± 9.8	AHI > 10	LVEF < 45%
Gupta	2020	India	16	25	Case-control	60.5 ± 9.8	AHI > 5	Clinical, LVEF ≥ 50%, elevated BNP
Herrscher	2011	Norway	62	115	Prospective, descriptive	62.4 ± 9.2	AHI ≥ 5	Clinical, echocardiogram, or elevated BNP
Holtstrand Hjälm	2018	Sweden	7	121	Longitudinal cohort	NA	AHI ≥ 15	Any LVEF
Huang	2020	China	189	382	Prospective, descriptive	57 ± 13[b]	AHI ≥ 15	Clinical, echocardiogram, or elevated BNP
Javaheri	1998	USA	41	81	Prospective, descriptive	66 ± 9	AHI ≥ 15	LVEF < 45%
Javaheri	2006	USA	49	100	Prospective, descriptive	NA	AHI ≥ 15	LVEF ≤ 45%
Javaheri	2016	USA	102	174	Prospective, descriptive	78.3 ± 5.5	AHI ≥ 15	Hospital admission
Khayat	2009	USA	226	395	Prospective, descriptive	60 ± 0.9	AHI ≥ 15	Clinical, echocardiogram, or elevated BNP
Kishan	2021	India	61	103	Cross-sectional, descriptive	62.65 ± 11.8	AHI ≥ 5	Any LVEF
Lombardi	2018	Italy	241	370	Prospective, descriptive	63.4 ± 11.6[b] (OSA)	AHI ≥ 5	LVEF < 35%
MacDonald	2008	USA	32	108	Prospective, descriptive	57 ± 2[b]	AHI ≥ 15	LVEF < 40%
Oldenburg	2007	Germany	253	700	Descriptive	65.02 ± 9.5[b]	AHI > 5	LVEF ≤ 40%
Oldenburg	2009	Netherlands	24	105	Descriptive	60.4 ± 11.7[b]	AHI > 5	LVEF ≤ 40%
Padeletti	2009	USA	0	29	Descriptive	56.7 ± 17.1	AHI > 5	LVEF < 40%
Paulino	2009	France	178	316	Descriptive	59 ± 3	AHI ≥ 10	LVEF ≤ 45%
Roebuck	2004	Australia	22	78	Prospective, descriptive	53 ± 9	AHI > 5	LVEF ≤ 55%
Sin	2003	Canada	121	301	Cross-sectional, descriptive	59.4 ± 1.1[b]	AHI ≥ 10	LVEF ≤ 40%
Suda	2018	Japan	28	105	Prospective, descriptive	62.9 ± 13.6	AHI ≥ 5	LVEF < 50%
Tamisier	2019	France	94	183	Prospective cohort	67.34 (59.27–75.66)	AHI ≥ 15	Any LVEF
Tremel	1999	France	7	34	Prospective, descriptive	62 ± 9	AHI > 15	LVEF < 45%
Vazir	2007	UK	8	55	Prospective, descriptive	61 ± 12	AHI > 5	LVEF < 45%

Table 1 (continued)

Study	Year	Country	N, OSA	N, total	Study design	Age, years[a]	OSA diagnosis	HF diagnosis
Wang	2007	Canada	56	218	Prospective observational	NA	AHI ≥ 15	LVEFs ≤ 45%
Wang	2022	China	118	248	Descriptive	70.4 ± 12.4	AHI ≥ 5	2016 European Society of Cardiology guidelines
Yumino	2009	Canada	56	218	Cross-sectional, descriptive	56.3 ± 12.1[b]	AHI ≥ 15	LVEF ≤ 45%

NA not applicable, *PSG* polysomnography, *AHI* apnea-hypopnea index, *LVEF* left ventricular ejection fraction, *NYHA* New York Heart Association classification, *RHD* rheumatic heart disease, *BNP* B-type natriuretic peptide

[a]Indicated mean ± SD or median (interquartile range)

[b]Indicated age of patients with heart failure and OSA

failure (p-value = 0.6574) and the prevalence of heart failure in OSA patients (p-value = 0.0646) as shown in Figs. 9 and 10, respectively.

Discussion

OSA is connected to heart failure through several mechanisms, including hemodynamic, neurohormonal, and oxidative/vascular effects [66–68]. Apnea induces an increase of intrathoracic pressure leading to a rise in left ventricular transmural pressure and afterload. Oxidative stress from apneic events also increases endothelial dysfunction and sympathetic activation. Cyclical hypoxemia activates endothelial cell inflammation and adhesion. These factors indicate how the underlying mechanism of OSA contributes to heart failure development.

The present review found more patients in the analysis of the prevalence of OSA in patients with heart failure than did the analysis of the prevalence of heart failure in patients with OSA (8,480 vs. 5,250), as shown in Figs. 2 and 6. The prevalence of OSA in patients with heart failure was also higher than the prevalence of heart failure in patients with OSA (38.4% vs. 12.8%), from 33 articles vs. 13 articles, respectively. These data may indicate that OSA may be the most common contributing factor in patients with heart failure. A previous review found that OSA had a prevalence of 53% in patients with heart failure with reduced ejection fraction, and 62% in patients with heart failure with preserved ejection fraction [28, 68]. The prevalence of OSA in patients with heart failure was high as these studies were conducted in those patients who already had consequences of OSA. Similarly, two previous studies found that the prevalence of OSA in patients with stroke or TIA was approximately 70% [69, 70]. On the other hand, the prevalence of heart failure in patients with OSA was low, as these studies enrolled those with and without consequences of OSA. These may result in a low prevalence of heart failure. However, patients with OSA may increase the risk of cardiovascular consequences of OSA if left untreated or undiagnosed.

This study found that prevalence rates of both diseases may be varied among countries. India had the highest prevalence of OSA in patients with heart failure at 60.1%. There are several explanations for these findings. First, the prevalence of moderate to severe OSA in Indian population by the type 1 polysomnography was high at 32.5% [71]. Second, the prevalence of OSA in South Asians was significantly higher than white Europeans who were severe obesity at 85% vs. 66%; p-value = 0.017 [72]. Third, the prevalence of metabolic syndrome in urban Indians was high at 43%; 32.4% were diagnosed as OSA. Fourth, the prevalence of coronary artery disease in Indians was 4.4 to 8.56 times higher than in the US; 11% in non-diabetic Indians and 21.4% in diabetic Indians vs. 2.5% in the US [73]. Additionally, major risk factors of coronary artery disease in Indian population were quite high including hypertension (36.9%), diabetes (21%), high cholesterol (54.1%), and smoking (42%). These data may imply that Indians are very high risk for both OSA and heart failure resulting in the highest prevalence of OSA in patients with heart failure. In another direction, prevalence of heart failure was highest in patients with OSA from Romania at 22.6% (Fig. 8). Other studies reported prevalence of heart failure in patients with OSA from 6.8 to 22.0% (Fig. 3). The different study population may explain varied prevalence rates among countries. The study from Romania enrolled patients with 34.2% of coronary artery disease. Additionally, only 76 patients (6%) had normal weight, while the others were overweight or obese. These two factors may result in high prevalence of heart failure in this study. Another implication is that it may take quite a long period of time to develop heart failure in patients with OSA. Note that not all countries evaluated the

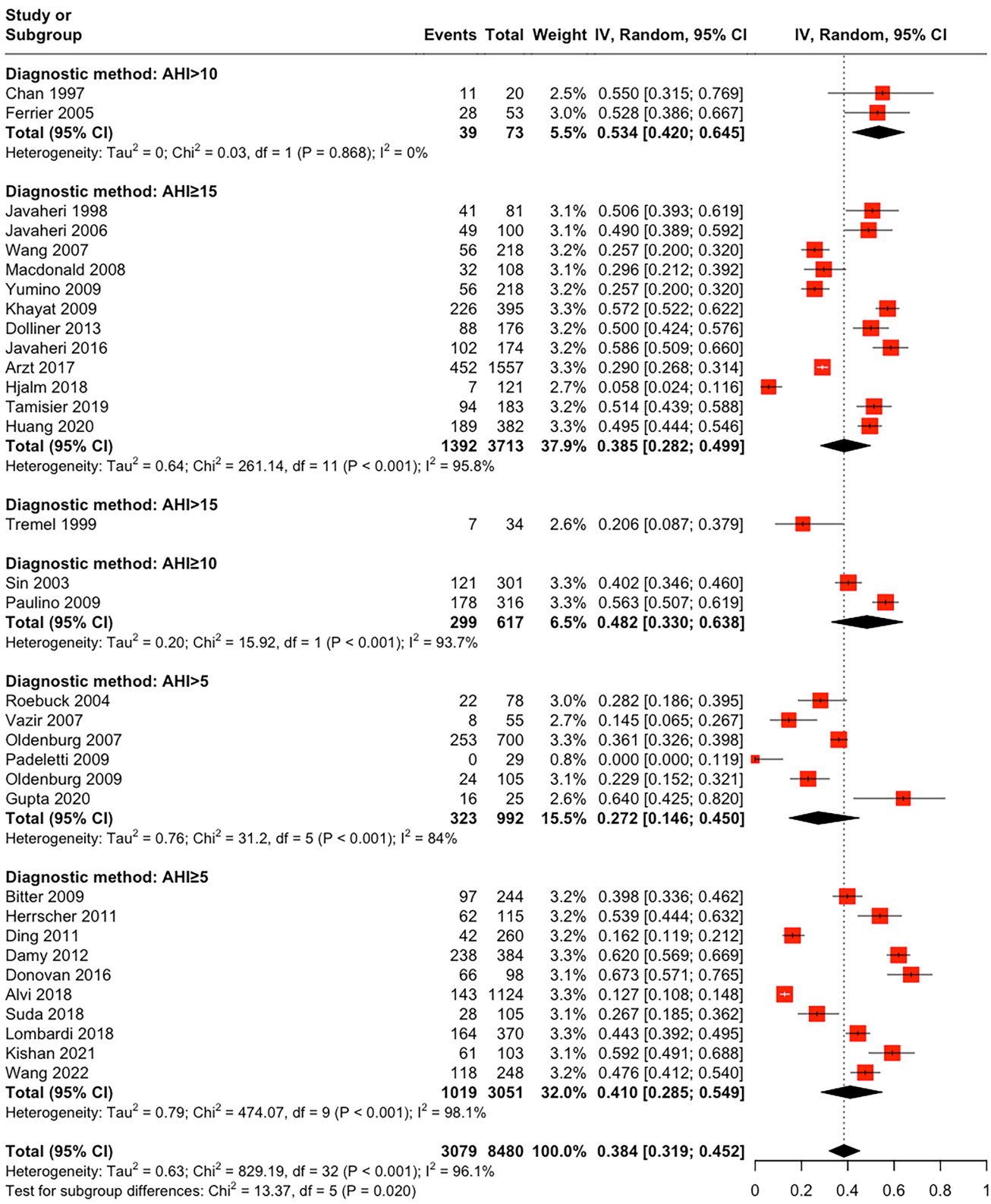

Fig. 2 Meta-analysis of the prevalence of obstructive sleep apnea in patients with heart failure by diagnostic criteria

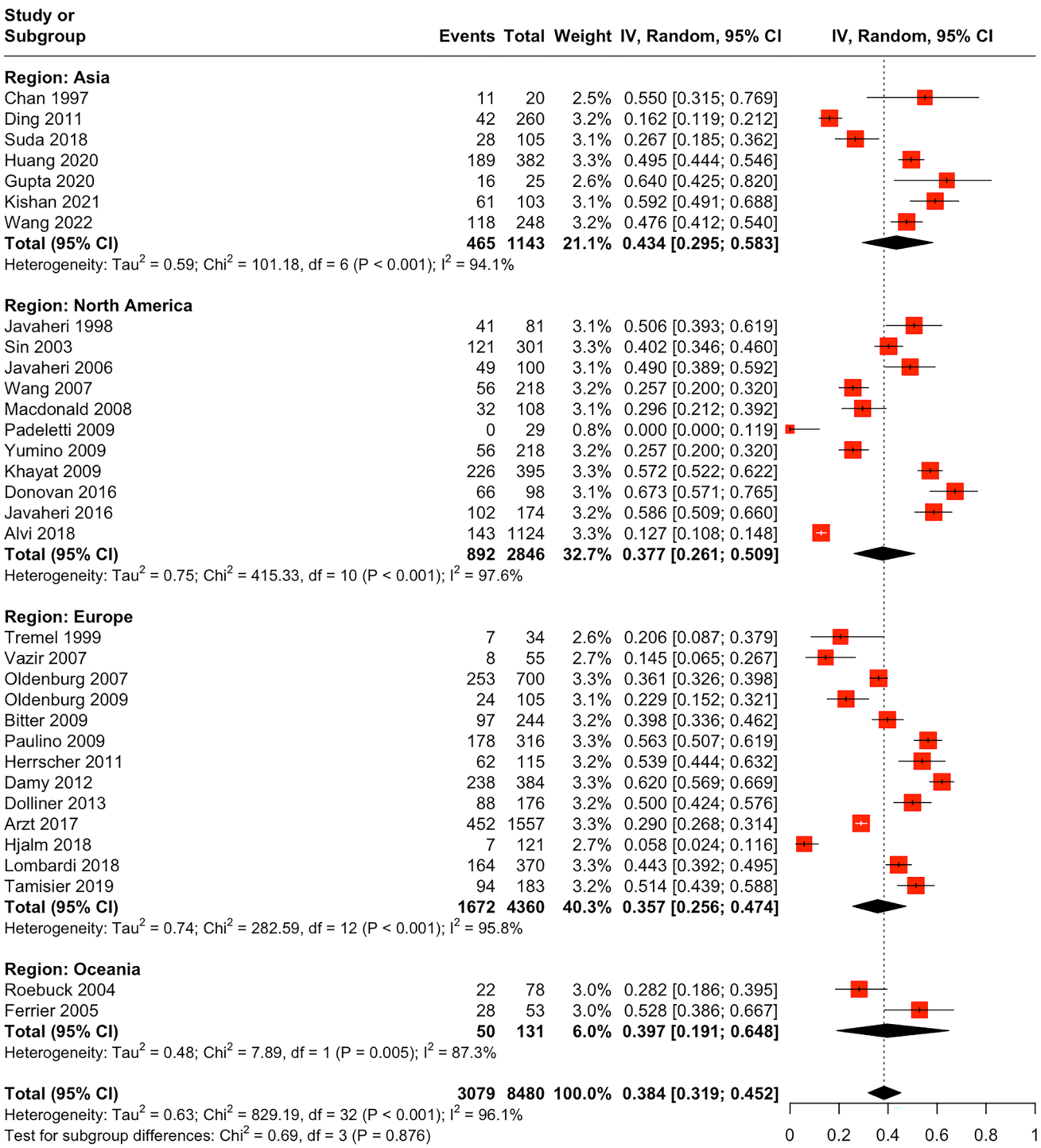

Fig. 3 Meta-analysis of the prevalence of obstructive sleep apnea in patients with heart failure by region

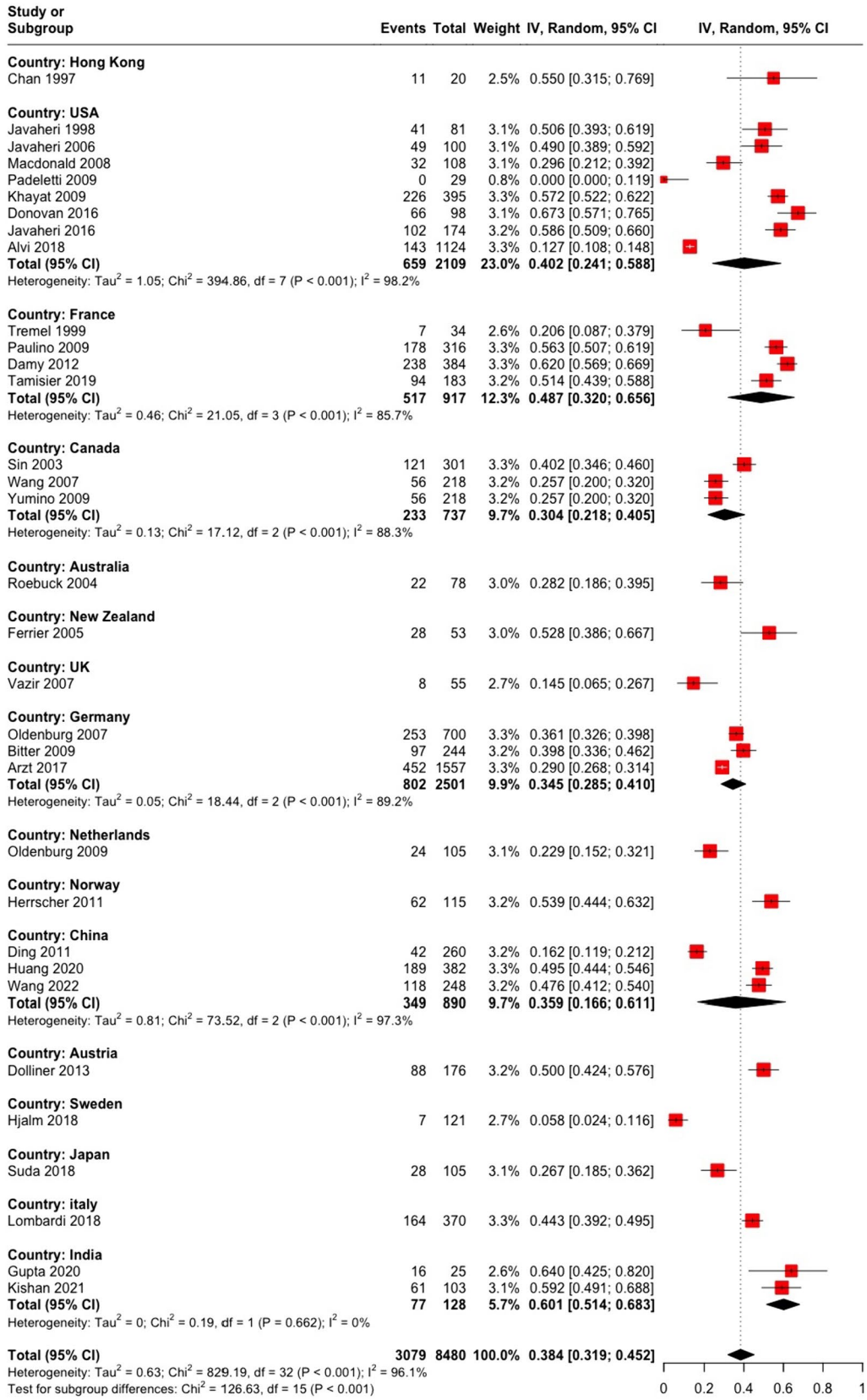

Fig. 4 Meta-analysis of the prevalence of obstructive sleep apnea in patients with heart failure by country

Table 2 Study quality evaluation using the Newcastle-Ottawa Scale of included studies of patients with heart failure to evaluate prevalence of obstructive sleep apnea

Study	Year	Study design	Selection process (4)	Comparability (2)	Outcome measures (3)	Total (9)	Interpretation
A: Cohort studies							
Alvi	2016	Cohort	3	1	3	7	Good
Holtstrand Hjälm	2018	Longitudinal cohort	3	1	3	7	Good
Tamisier	2019	Prospective cohort	2	1	3	6	Fair
Wang	2007	Prospective	4	1	3	8	Good
B: Case-control study							
Gupta	2020	Case-control	1	2	2	5	Poor

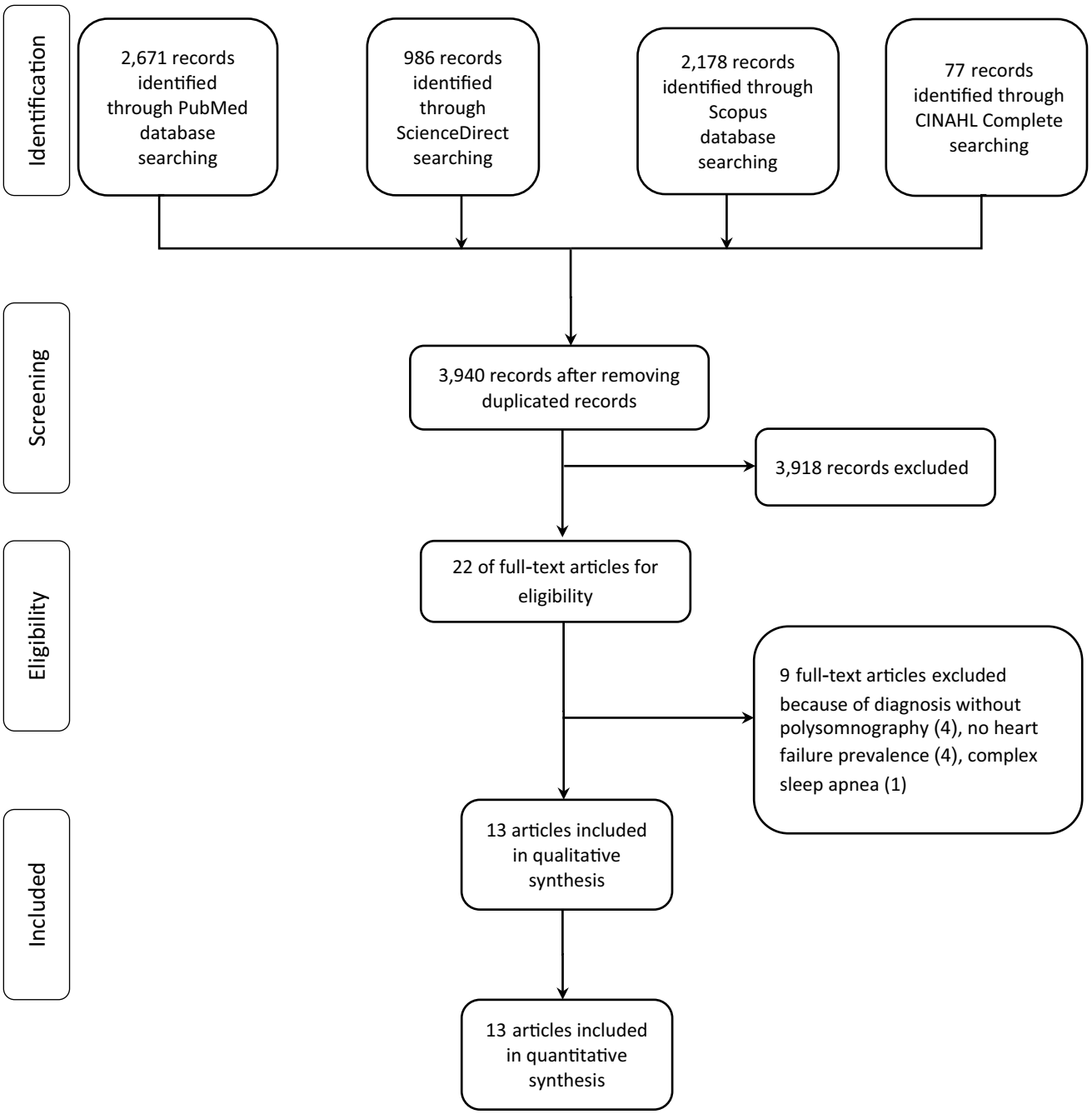

Fig. 5 PRISMA flow for evaluating prevalence of heart failure in patients with obstructive sleep apnea

Table 3 Characteristics of included studies of patients with obstructive sleep apnea (OSA) to evaluate prevalence of heart failure (HF)

Study	Year	Country	Study Design	HF	total	Age, years[a]	OSA Diagnosis	HF Diagnosis
Bosanquet	2011	USA	Retrospective, descriptive	26	130	53.5 (29–84)	AHI ≥ 5	NA
Cai	2018	China	Prospective cohort	91	383	56.6 ± 11.7	AHI ≥ 15	ICD-9
Fan	2019	China	Prospective, descriptive	3	403	57.5 ± 10.2	AHI ≥ 15	Clinical
Frangopoulos	2020	Cyprus	Cross-sectional, analytical	10	92	NA	REI ≥ 15	Medical history
Mazzotti	2019	USA	Prospective cohort	50	1207	66 ± 10.5	AHI ≥ 15	NA
Platek	2017	Poland	Cross-sectional, analytical	7	48	57.1 ± 10.2	AHI ≥ 15	NA
Pleavă	2016	Romania	Retrospective cohort	310	1370	49.7 ± 10.9	AHI ≥ 5	NA
Quintos	2019	USA	Cross-sectional, descriptive	126	553	62.1 ± 12.5, 58.9 ± 11.7	AHI ≥ 5	NA
Roche	2003	France	Cross-sectional, descriptive	5	66	54.5 ± 10.7	AHI ≥ 10	NA
Sharma	2017	USA	Cross-sectional, descriptive	101	458	60.7 ± 15.2	AHI ≥ 5/ODI ≥ 5	NA
Sweed	2019	Egypt	Retrospective, descriptive	29	244	56.92 ± 12.36	AHI ≥ 5	NA
Tafelmeier	2021	Germany	Prospective observational	13	59	67.4 ± 8.4	AHI ≥ 15	NA
Tang	2021	China	Retrospective cohort	29	237	60.6 ± 9.5	unknown AHI	NA

NA not applicable, *PSG* polysomnography, *AHI* apnea-hypopnea index, *ODI* oxygen desaturation index, *NYHA* New York Heart Association classification

[a]Indicated mean ± SD or median (interquartile range)

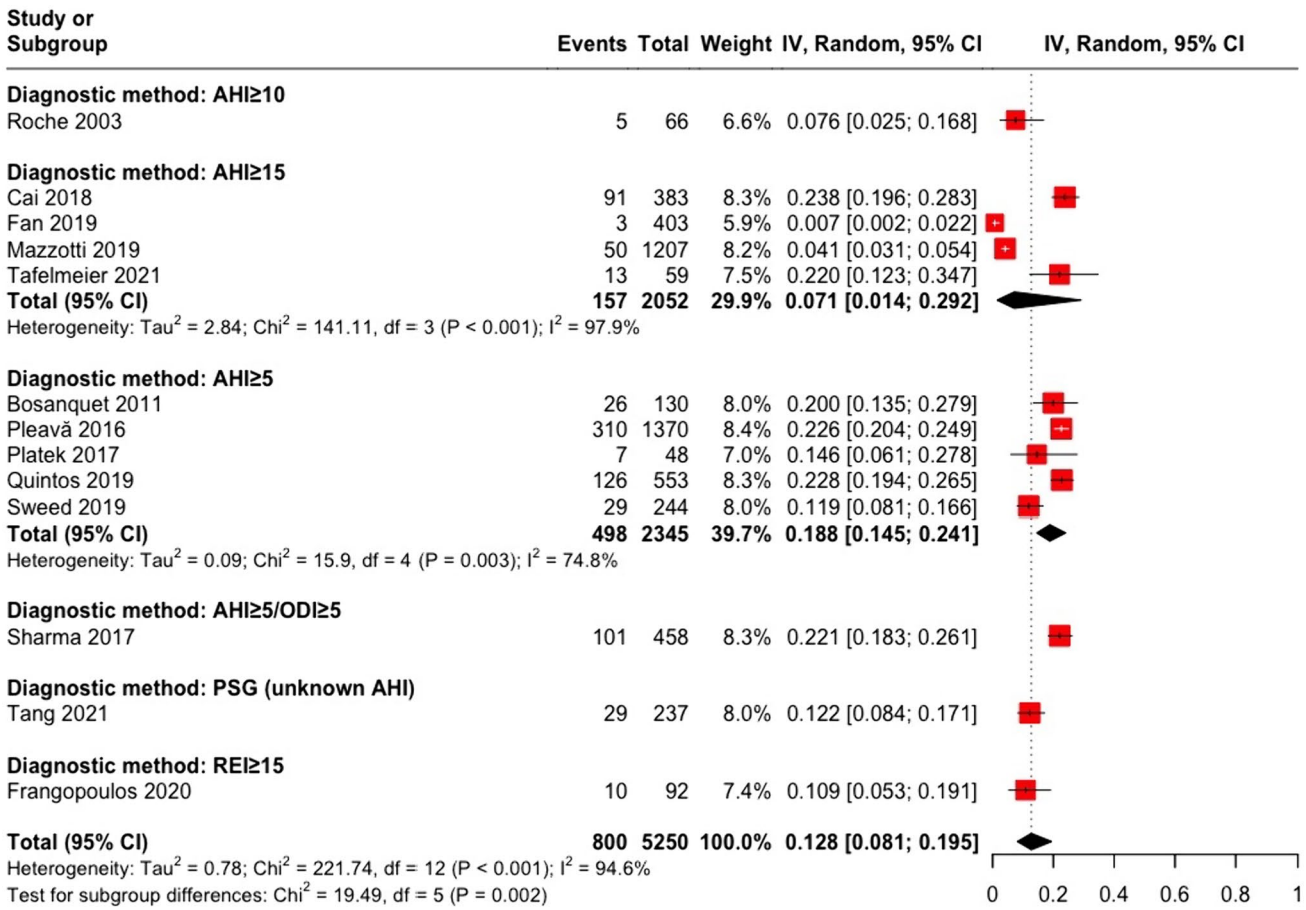

Fig. 6 Meta-analysis of the prevalence of heart failure in patients with obstructive sleep apnea by diagnostic criteria of OSA.

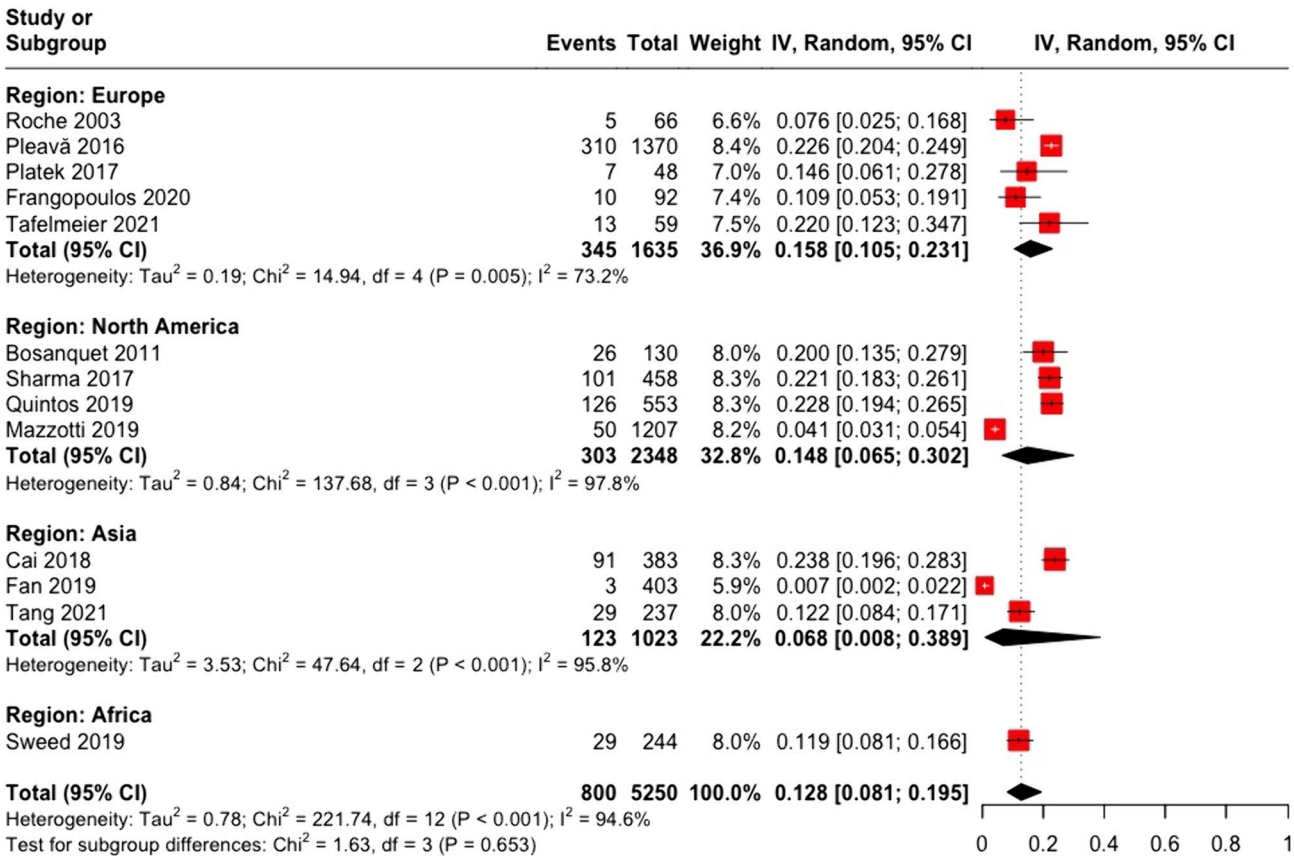

Fig. 7 Meta-analysis of the prevalence of heart failure in patients with obstructive sleep apnea by region

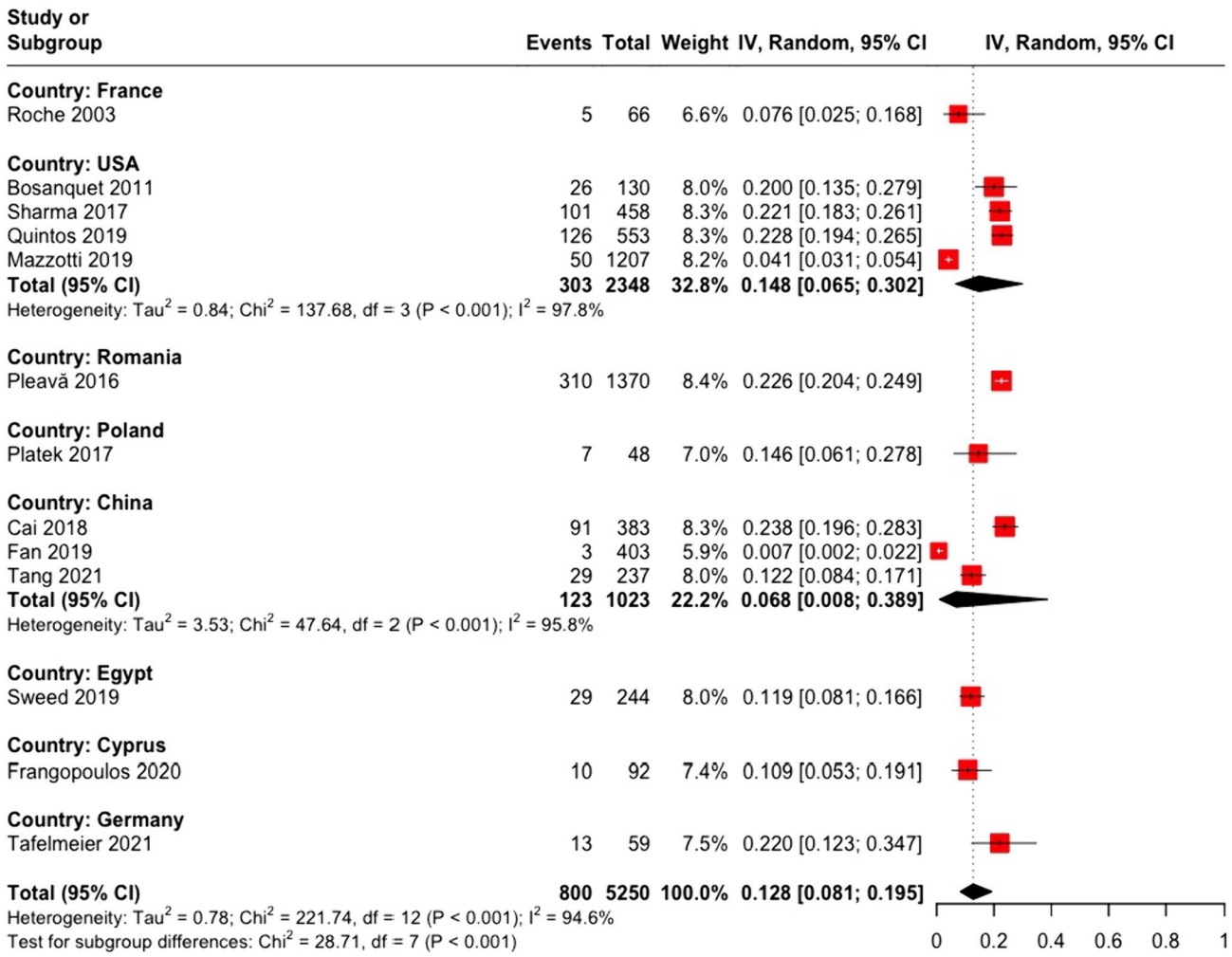

Fig. 8 Meta-analysis of the prevalence of heart failure in patients with obstructive sleep apnea by country

Table 4 Study quality evaluation using the Newcastle-Ottawa Scale of included studies of patients with obstructive sleep apnea to evaluate prevalence of heart failure

Study	Year	Study design	Selection process (4)	Comparability (2)	Outcome measures (3)	Total (9)	Interpretation
A: Cohort studies							
Cai	2018	Prospective cohort	3	1	2	6	Fair
Mazzotti	2019	Prospective cohort	2	1	3	6	Fair
Pleavă	2016	Retrospective cohort	2	1	3	6	Fair
Tafelmeier	2021	Prospective observational	1	1	2	4	Poor
Tang	2021	Retrospective cohort	4	1	3	8	Good
B: Cross-sectional studies							
Frangopoulos	2020	Cross-sectional	3	1	3	7	Good
Platek	2017	Cross-sectional	3	1	3	7	Good

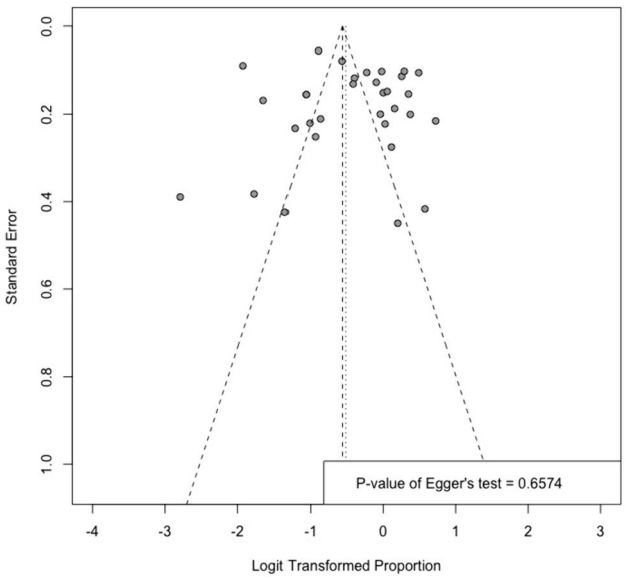

Fig. 9 Funnel of the prevalence of obstructive sleep apnea in patients with heart failure

associations of OSA and heart failure. Further studies and possible explanations of different prevalence rates of both diseases are needed.

This meta-analysis reported on large sample sizes in both aspects. However, there are some limitations. First, the risk factors of heart failure in patients with OSA were not studied as well as the risk factors of OSA in patients with heart failure. This study did not evaluate the association between these two diseases. Second, no intervention or CPAP therapy was assessed [74–77]. Third, none of the prospective studies reported an annual incidence. Therefore, pooled incidence rates were not calculated. Finally, diagnostic criteria for OSA or heart failure were different among studies. In particular, only one study showed criteria for heart failure diagnosis in patients with OSA [78].

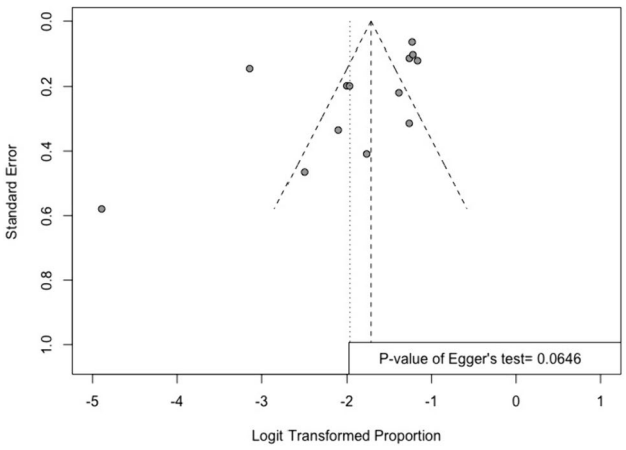

Fig. 10 Funnel of the prevalence of heart failure in patients with obstructive sleep apnea

Conclusions

The pooled prevalence of OSA in patients with heart failure was higher than the pooled prevalence of heart failure in patients with OSA. The pooled prevalence rates of these associations varied among the diagnostic criteria of OSA and the different countries where the studies were undertaken.

Appendix

1. Searching method for PubMed on 26 September 2022

Search Number	Query
1	sleep apnea, obstructive[MeSH Terms] OR obstructive sleep apnea[Title/Abstract] OR OSA[Title/Abstract]
2	"Prevalence"[Mesh] OR "Incidence"[Mesh] OR "Epidemiology"[Mesh] OR Prevalence[Title/Abstract] OR Incidence[Title/Abstract] OR Epidemiolog*[Title/Abstract]
3	"Observational Study"[Publication Type] OR "Observational Studies as Topic"[Mesh] OR "Epidemiologic Studies"[Mesh]
4	(#1 AND #2) AND #3

2. Searching method for ScienceDirect on 26 September 2022

   Title, abstract, keywords: obstructive sleep apnea AND (prevalence OR incidence OR epidemiology), filter: Research articles
3. Searching method for Scopus on 26 September 2022

   ((TITLE-ABS-KEY (obstructive AND sleep AND apnea) OR TITLE-ABS-KEY (osa))) AND ((TITLE-ABS-KEY (prevalence) OR TITLE-ABS-KEY (incidence) OR TITLE-ABS-KEY (epidemiolog*))) AND ((TITLE-ABS-KEY (observational AND study) OR TITLE-ABS-KEY (case-control AND study) OR TITLE-ABS-KEY (cross-sectional AND study) OR TITLE-ABS-KEY (cohort AND study))) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (EXACTKEYWORD, "Sleep Apnea, Obstructive") OR LIMIT-TO (EXACTKEYWORD, "Prevalence"))
4. Searching method for CINAHL on 26 September 2022

Search Number	Query
1	TI obstructive sleep apnea OR AB obstructive sleep apnea OR TI osa OR AB osa Expanders - Apply equivalent subjects Search modes - Find all my search terms
2	TI (prevalence or incidence or epidemiology) OR AB (prevalence or incidence or epidemiology) Expanders - Apply equivalent subjects Search modes - Find all my search terms
3	TI Observational Study OR AB Observational Study OR PT Observational Study Expanders - Apply equivalent subjects Search modes - Find all my search terms
4	#1 AND #2 AND #3 Expanders - Apply equivalent subjects Search modes - Find all my search terms

Author contributions Study concept and design: W.P., P.H., K.S., and S.K. Acquisition of data: all authors. Analysis and interpretation of data: all authors. Searching: C.N. Statistical analysis: C.N. and K.S. Drafting of the manuscript: W.P. and S.K. Critical revision of the manuscript for important intellectual content: all authors.

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Data availability The authors confirm that the data supporting the findings of this study are available within the article and/or its supplementary materials.

Declarations

Ethical approval This work required no ethical approval.

Conflict of interest The authors declare no competing interests.

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