



ASSOCIATION BETWEEN EARTHQUAKE EXPOSURE AND TACHYARRHYTHMIAS: A SYSTEMATIC REVIEW

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ABSTRACT

Background: Major earthquakes impose sudden physical and psychological stress and may trigger cardiac rhythm disturbances, yet evidence on post-earthquake tachyarrhythmias remains inconsistent. We reviewed comparative studies reporting tachyarrhythmia-related outcomes after earthquake exposure.

Methods: We searched PubMed, Europe PMC, ScienceDirect, OpenAlex, and Google Scholar through 31 August 2026 for comparative observational studies published from January 2016 onward. Eligible outcomes were tachyarrhythmias or arrhythmia-directed therapies as defined by each study. Risk of bias was assessed using ROBINS-E domains. Because study designs, outcomes, observation periods, and statistical structures differed substantially, we did not pool results; reporting was informed by SWiM principles.

Results: Five studies met eligibility criteria from 19 verified de-duplicated records. Ranjbar et al. reported increased sustained ventricular arrhythmia, whereas SVT did not increase significantly. Chan et al. found no increase in ventricular arrhythmias or device therapy after two Christchurch earthquakes. Babić et al. observed more paroxysmal arrhythmias requiring electrical cardioversion near the epicentres. Yıldırım et al. reported more AF admissions but no significant increase in VT. Polat et al. found increased device-detected ventricular arrhythmia and therapy, particularly subacutely. Three independent risk-ratio estimates from two studies were displayed without pooling; all five studies contributed to direction-of-effect synthesis.

Conclusions: Earthquake exposure may be associated with more tachyarrhythmic events in selected settings, but findings vary by population, outcome, and post-earthquake period. The evidence remains limited and heterogeneous. Better designed prospective multicentre studies are needed.

Keywords: earthquake; tachyarrhythmia; atrial fibrillation; ventricular tachycardia; ventricular fibrillation; implantable cardioverter-defibrillator; disaster medicine.

INTRODUCTION

Major earthquakes create a sudden combination of physical strain, fear, sleep disruption, dehydration, altered diet, medication interruption, displacement, and reduced access to healthcare. These changes can affect the cardiovascular system through sympathetic activation, catecholamine release, changes in blood pressure and myocardial oxygen demand, and greater electrical instability. Previous reviews have linked major earthquakes with a broad range of cardiovascular events, including acute coronary syndromes, sudden cardiac death, heart failure, stress cardiomyopathy, stroke, hypertension, and arrhythmias [4–6].

Evidence specifically focused on tachyarrhythmias is much smaller and less uniform. Studies based on ICD or CRT-D recordings can capture ventricular rhythm events continuously, even when a patient does not seek care. Hospital and emergency-department studies, in contrast, capture clinically important presentations but may also be influenced by damaged facilities, altered referral pathways, and changes in care-seeking after a disaster. Not surprisingly, the published findings are mixed [7–11].

We used tachyarrhythmias as an umbrella term because the included studies did not examine one uniform rhythm endpoint. During data extraction, each outcome was kept in the form reported by the original investigators. We did not treat one rhythm category as the preferred outcome unless the source study itself did so.

Our aim was to identify, appraise, and bring together comparative observational evidence published from 2016 through August 2026 on tachyarrhythmic events after earthquake exposure. We considered meta-analysis only if the studies were sufficiently alike in outcome, estimand, denominator, observation period, and statistical structure.

METHODS

Reporting framework

We prepared the review in accordance with PRISMA 2020 [1]. Because the eligible studies could not be combined into a single clinically meaningful pooled estimate, reporting of the synthesis without meta-analysis was informed by relevant SWiM principles [2]. Risk of bias was considered using ROBINS-E domains for non-randomized exposure studies [3].

Review question and eligibility

We framed the review question using PECO. The population was people exposed to an earthquake; the exposure was direct or geographical earthquake exposure; comparators included a pre-earthquake period, a less-exposed geographical population, or another study-defined comparison group; and the outcome was any clinically identifiable tachyarrhythmia-related endpoint reported by the investigators. We retained the terminology used in each original study rather than forcing different rhythm outcomes into a single category.

We included comparative observational studies published between 1 January 2016 and 31 August 2026. Cohort, retrospective cohort-like, repeated-measures pre-post, and comparative before-after designs were eligible. Studies had to report a clinically identifiable tachyarrhythmia or an intervention given for an underlying tachyarrhythmia. Depending on the study, these included AF, SVT, VT, VF, device-detected VA, ATP, ICD shock, or electrical cardioversion. Eligibility did not depend on any single arrhythmia subtype.

We excluded case reports and uncontrolled case series, narrative or systematic reviews, editorials, conference-only abstracts without adequate comparative data, duplicate or secondary reports of an already represented study, publications outside the prespecified period, and studies that did not report an eligible tachyarrhythmia outcome.

Information sources and search date

We searched PubMed/MEDLINE, Europe PMC, ScienceDirect, OpenAlex, and Google Scholar through 31 August 2026. We also checked the reference lists and citing papers of the included studies and major contemporary reviews [4–6].

Search strategy

Source	Search strategy	Date limits
PubMed/MEDLINE	((("earthquake"[Title/Abstract] OR "earthquakes"[Title/Abstract] OR seismic[Title/Abstract]) AND (arrhythmi*[Title/Abstract] OR tachyarrhythmi*[Title/Abstract] OR "atrial fibrillation"[Title/Abstract] OR "supraventricular tachycardia"[Title/Abstract] OR "ventricular tachycardia"[Title/Abstract] OR "ventricular fibrillation"[Title/Abstract] OR "implantable cardioverter defibrillator"[Title/Abstract]))	2016-01-01 to 2026-08-31
Europe PMC	TITLE_ABS earthquake/seismic terms AND TITLE_ABS arrhythmia/tachyarrhythmia/AF/SVT/VT/VF/ICD terms	2016-01-01 to 2026-08-31
ScienceDirect	("earthquake" OR "earthquakes" OR seismic) AND (arrhythmia OR tachyarrhythmia OR "atrial fibrillation" OR "supraventricular tachycardia" OR "ventricular tachycardia" OR "ventricular fibrillation" OR ICD)	2016–2026
OpenAlex	Separate searches: earthquake arrhythmia; earthquake atrial fibrillation; earthquake supraventricular tachycardia; earthquake ventricular tachycardia; earthquake ventricular fibrillation; earthquake ICD.	2016-01-01 to 2026-08-31
Google Scholar	Phrase searches combining "earthquake" with	2016–2026

	arrhythmia, tachyarrhythmia, "atrial fibrillation", "ventricular tachycardia", "ventricular fibrillation", and ICD.	
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The searches were refined iteratively, and the original source-specific export counts before deduplication were not retained. We therefore did not try to reconstruct or estimate those numbers after the fact. The PRISMA flow begins with the 19 unique records that could be verified in the final screening set. This limitation is reported explicitly rather than replacing missing search-log information with unverifiable counts.

Study selection and data extraction

We screened the 19 verified unique records by title and abstract and then reviewed the complete reports that remained potentially eligible. For each included study, we extracted the publication details, setting, earthquake, study design, population, sample size, exposure and comparator definitions, observation window, arrhythmia outcome, event counts, effect estimates, and statistical tests. When numerical values differed between a publisher webpage and the final article PDF, we used the final typeset article. This was relevant to Yıldırım et al., for which the downloadable PDF provides internally consistent AF data and effect estimates [10].

Risk of bias

Risk-of-bias appraisal considered the ROBINS-E domains of confounding, participant selection, exposure measurement, post-exposure processes, missing data, outcome measurement, and selective reporting [3]. In this literature, the main practical concerns were survival and attendance bias, changes in referral patterns after the disaster, geographical classification of exposure, unequal observation periods, and the dependence created by repeated measurements in the same device patients.

Statistical synthesis and meta-analysis feasibility

Before considering meta-analysis, we first asked whether the studies were estimating effects that were clinically and statistically comparable. They were not. Ranjbar et al. and Polat et al. repeatedly measured the same implanted-device patients; Chan et al. reported event-rate and log-rank analyses; and Babić et al. and Yıldırım et al. provided independent-group comparisons but for

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different clinical endpoints. Treating these as one common effect would therefore be difficult to justify.

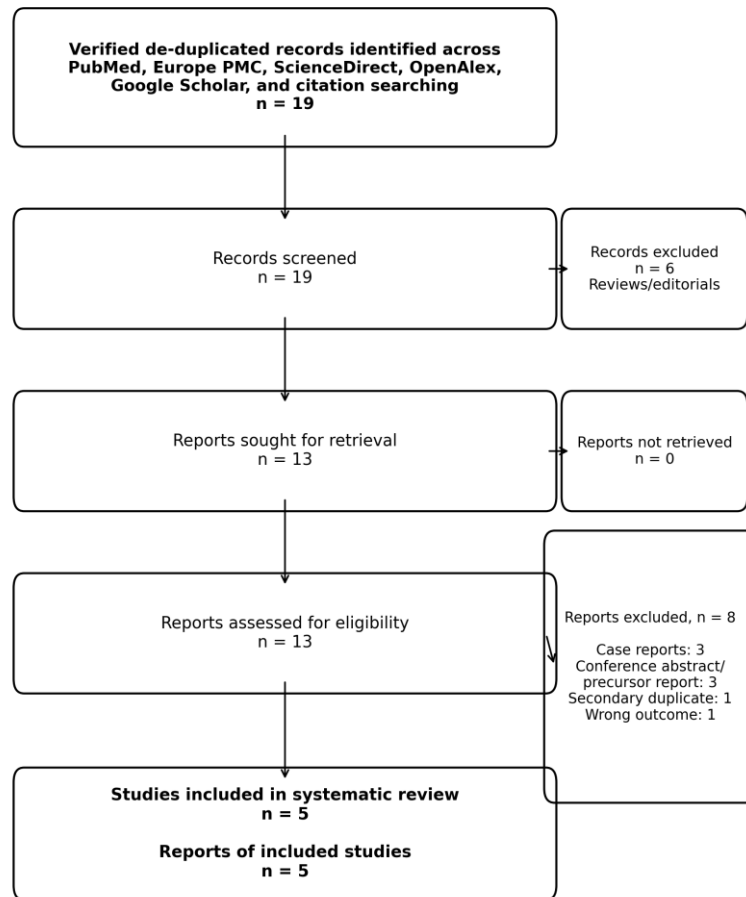
For that reason, the forest plot is deliberately non-pooled and includes only outcomes for which an independent-group risk ratio can be estimated directly from the published data. The figure is a way of displaying compatible effect estimates, not a ranking of rhythm types. The other studies remain fully represented in the narrative and direction-of-effect synthesis. We did not calculate a pooled diamond, I^2 statistic, funnel plot, or publication-bias test.

RESULTS

Study selection

We screened 19 verified de-duplicated records. Six reviews or editorials were removed at title/abstract screening. Thirteen reports were retrieved for full-text assessment. Eight were excluded at this stage: three case reports, three conference abstract or precursor reports without adequate independent comparative data, one secondary duplicate report, and one study with an ineligible primary outcome. Five comparative observational studies, each represented by one report, were included in the review.

PRISMA 2020 Study-Selection Flow



The original source-specific pre-deduplication export counts were not retained. Accordingly, the auditable flow begins with the verified de-duplicated screening set. Database names, final search strategies, and search dates are reported in Methods and the search appendix.

Figure 1. PRISMA 2020 study-selection flow. The final PRISMA box reports the 5 studies and 5 reports included in the review; PRISMA 2020 does not require a separate meta-analysis count.

Characteristics of included studies

Study	Country	Design	Population	Comparison	Outcomes	Principal finding
Ranjbar 2016 [7]	Iran	Prospective comparative device cohort	132 ICD recipients; exposed area n=98	Pre/post and geographical comparator	SVT; sustained VT/VF; ICD therapy	Exposed-area sustained VA increased 21/98→35/98, p=0.02; SVT not significant.
Chan 2019 [8]	New Zealand	Retrospective ICD review	Regional ICD registry; 211 and 236 exposed to two earthquakes	30 days before vs 30 days after	Sustained/non-sustained VA; ATP/shock	No significant post-earthquake increase; p=0.85 and p=0.80 for therapy-free comparisons.
Babić 2023 [9]	Croatia	Multicentre comparative before–after ED study	1,251 cardiac-chief-complaint ED visits	7 days before vs earthquake day + 6 days after	Arrhythmia diagnosis; electrical cardioversion	Within 20 km, cardioverted paroxysmal arrhythmia increased 2/221→9/202, p=0.022.
Yıldırım 2025 [10]	Türkiye	Single-centre retrospective comparative	1,765 pre vs 1,640 post	Two equal two-month periods	AF; sustained VT	AF RR 2.35 (1.15–4.78), p=0.015; VT

		hospital study	cardiology admissions			RR 1.37 (0.62–3.01), p=0.431.
Polat 2026 [11]	Türkiye	Retrospective repeated-measures ICD/CRT-D study	163 device patients	30-day pre vs acute, early, subacute periods	VT/VF; ATP/shock	Subacute VA 12.2%→30.7%, p<0.001; therapy 9.8%→23.9%, p<0.001.

Study-level results

Ranjbar et al. studied 132 ICD recipients, 98 of whom lived in the earthquake area and 34 in a comparison area. Among exposed patients, sustained VT/VF was recorded in 21/98 before the earthquake and 35/98 afterward (p=0.02). The increase was also significant when sustained ventricular arrhythmia was considered across the full cohort. SVT and total ICD therapies, however, did not show statistically significant increases [7].

Chan et al. examined ICD recordings around the 2010 and 2011 Christchurch earthquakes, using 30-day periods before and after each event. After the 2010 earthquake, the proportion of patients free from shock or ATP was 0.943 before and 0.933 after the event (p=0.85). For the 2011 earthquake, the corresponding figures were 0.957 and 0.961 (p=0.80). Overall, the study did not identify a significant increase in sustained or non-sustained ventricular arrhythmia [8].

Babić et al. examined emergency cardiac presentations around two Croatian earthquakes. In hospitals located within 20 km of an epicentre, paroxysmal arrhythmias requiring electrical cardioversion increased from 2/221 (0.9%) before the earthquake to 9/202 (4.5%) afterward (p=0.022). Based on these published counts, the crude RR is approximately 4.92 (95% CI 1.08–22.52). The broader emergency-department arrhythmia category did not show the same pattern, which illustrates how strongly the result depends on the outcome definition [9].

Yıldırım et al. compared two equal two-month periods surrounding the 2023 Türkiye earthquake. In the final typeset PDF, AF admissions rose from 11/1,765 (0.62%) before the earthquake to 24/1,640 (1.46%) afterward, corresponding to an RR of 2.35 (95% CI 1.15–4.78;

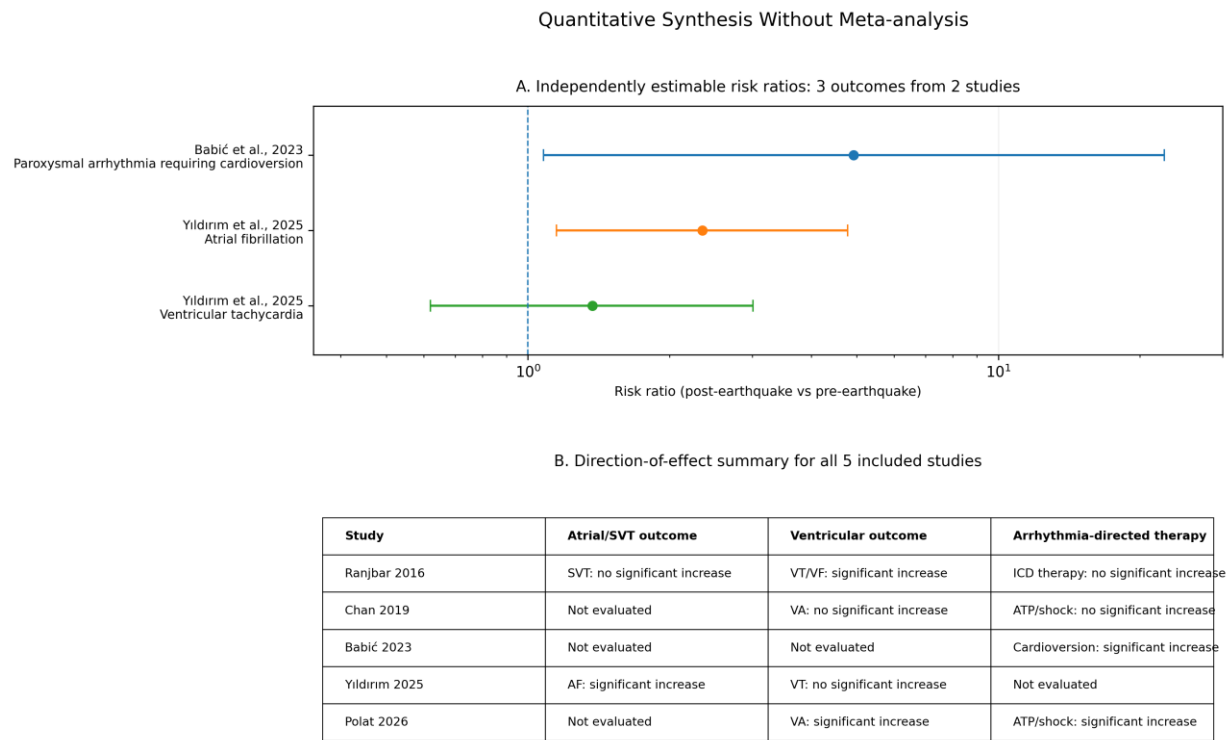
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$p=0.015$). VT admissions changed from 11/1,765 (0.62%) to 14/1,640 (0.85%), an RR of 1.37 (95% CI 0.62–3.01; $p=0.431$). The final PDF was used because the publisher webpage displays discordant percentages [10].

Polat et al. reviewed 163 patients with ICD or CRT-D devices and compared repeated observations using McNemar tests. VA was recorded in 20/163 (12.2%) during the 30 days before the earthquake, 8/163 (4.9%) on the earthquake day, 16/163 (9.8%) during the following week, and 50/163 (30.7%) in the subacute period. ATP or shock occurred in 16/163 (9.8%) before the earthquake and 39/163 (23.9%) in the subacute period. Because the observations were paired and the time windows were unequal, these proportions were not treated as independent risks [11].

Quantitative synthesis without meta-analysis

All five studies were included in the systematic review, but only two could contribute to the conventional risk-ratio display. Babić et al. provided one independently estimable comparison, while Yildirim et al. provided two separate outcomes, AF and VT. This is why the forest plot contains three rows even though the review includes five studies. Ranjbar, Chan, and Polat were not dropped; their results are presented in the form reported by the original studies and are included in the direction-of-effect synthesis.



The forest display is non-pooled. All five studies remain in the systematic review; only statistically compatible independent-group risk ratios are shown in Panel A.

Figure 2. Quantitative synthesis without meta-analysis. Panel A shows 3 independently estimable RR outcomes from 2 studies. Panel B summarizes direction of effect across all 5 included studies.

Risk of bias

Study	Confounding	Selection	Exposure	Outcome	Time/dependency	Overall
Ranjbar 2016	Serious	Serious	Moderate	Low	Serious	Serious
Chan 2019	Moderate	Moderate	Moderate	Low	Low–moderate	Moderate
Babić 2023	Serious	Serious	Moderate	Moderate	Moderate	Serious
Yıldırım 2025	Serious	Serious	Moderate	Low	Low	Serious

Polat 2026	Serious	Moderate	Low	Low	Serious	Serious
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Overall risk of bias was predominantly serious. Principal concerns were uncontrolled time-varying confounding, survivor or hospital-attendance selection, earthquake-related referral changes, exposure classification, and unequal or statistically dependent observation windows. Device studies provided objective outcome ascertainment but remained vulnerable to selection and temporal bias.

DISCUSSION

Principal findings

Taken together, the five studies do not point to a single, uniform post-earthquake response. They examined different patient groups, rhythm outcomes, monitoring methods, and time windows. Several study-specific outcomes increased significantly, while others did not. The most cautious interpretation is therefore to read the findings in the context of each study rather than assume that all tachyarrhythmias behave in the same way after an earthquake.

Heterogeneity of reported outcomes

The included studies covered a wide range of endpoints: SVT, sustained VT/VF, device-detected ventricular arrhythmia, ICD therapy, electrical cardioversion, AF, and hospitalized VT. These are related clinically, but they are not interchangeable outcomes. For that reason, we kept the original definitions and interpreted each result within its own clinical and methodological setting. In this review, tachyarrhythmias is a useful umbrella term, not a single endpoint that can be pooled across studies.

Potential mechanisms

Several mechanisms could plausibly connect earthquake exposure with arrhythmic events. Acute sympathetic activation and catecholamine release may increase electrical instability, while myocardial ischemia, dehydration, electrolyte disturbance, interrupted medication use, sleep deprivation, and persistent psychological stress may extend vulnerability beyond the immediate event. The magnitude of these effects is likely to depend on the severity of the earthquake,

proximity to the epicentre, aftershock burden, displacement, and the degree of healthcare disruption [4–6].

Rationale for not pooling the studies

A pooled meta-analysis would only be useful if the included estimates represented sufficiently similar clinical and statistical effects. Here they do not. The evidence combines paired device recordings, event-rate analyses, hospital-admission proportions, different rhythm definitions, and unequal observation periods. Putting all of these into one pooled RR would produce a neat-looking number without a clear clinical meaning. A structured synthesis without pooling is therefore the more defensible choice.

Clinical implications

From a clinical perspective, the findings support maintaining cardiovascular care and paying closer attention to vulnerable patients after a severe earthquake, rather than giving prophylactic antiarrhythmic treatment simply because an earthquake has occurred. The studies mainly involved patients with implanted cardiac devices or established cardiovascular disease. In practice, medication continuity, hydration, correction of electrolyte abnormalities, access to device follow-up, and prompt evaluation of palpitations, syncope, rapid arrhythmia, or ICD shocks remain sensible priorities.

Strengths and limitations

This review has several strengths. We kept the outcome definitions used by the original studies, checked full-text numerical data rather than relying only on abstracts or webpages, separated paired from independent designs, documented numerical discrepancies between publisher formats, and avoided producing a pooled effect when the underlying studies were not comparable enough to support one.

The limitations are equally important. Only five comparative studies met the eligibility criteria, the outcomes and observation periods differed considerably, and the studies had important risk-of-bias concerns. Hospital-based findings may partly reflect changes in access to care and referral patterns after a disaster, not only changes in arrhythmia occurrence. In addition, the original source-specific search exports before deduplication were not retained, so the PRISMA flow starts

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with the auditable de-duplicated set rather than unverifiable database counts. A future journal-level update would be stronger with archived RIS/CSV exports, protocol registration, and independent duplicate screening and extraction.

CONCLUSION

Overall, earthquake exposure may be followed by more tachyarrhythmic events in some settings and high-risk cardiovascular populations, but the available studies do not show a consistent effect across rhythm types, patient groups, or post-earthquake periods. Some study-specific outcomes increased significantly, while others remained unchanged. Because the evidence is observational and heterogeneous, causal conclusions should remain cautious. A single pooled meta-analysis is not justified with the current data. Future prospective multicentre studies should use standardized rhythm definitions, comparable observation windows, clearer exposure measures, and appropriate statistical methods for repeated measurements.

DECLARATIONS

Ethics approval: Not required for a systematic review of published aggregate data.

Protocol registration: Not registered.

Funding: No specific funding was received for preparation of this review draft.

Conflicts of interest: None declared for this review draft.

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APPENDIX

Appendix A. Full-text eligibility decisions

Report	Decision	Reason
Ranjbar et al., 2016	Include	Comparative observational study; eligible SVT and ventricular arrhythmia outcomes.
Biffi et al., 2017	Exclude	Case report.
Ranjbar et al., 2017 letter	Exclude	Secondary report of the Ranjbar 2016 cohort.
Tamaki et al., 2017	Exclude	Conference abstract only; insufficient complete comparative data.
Nakagawa et al., 2019	Exclude	Case report.
Chan et al., 2019	Include	Comparative implanted-device study.
Tamaki et al., 2020	Exclude	Conference abstract only; insufficient complete

		comparative data.
Radić et al., 2022	Exclude	Conference/precursor report of the later Croatian study.
Babić et al., 2023	Include	Comparative before–after study with arrhythmia/cardioversion data.
Polat et al., 2023	Exclude	Case report.
Akkuş et al., 2024	Exclude	Primary outcome was CIED utilization/implantation rather than tachyarrhythmia incidence.
Yıldırım et al., 2025	Include	Comparative AF and VT hospital-admission outcomes.
Polat et al., 2026	Include	Repeated-measures device study with ventricular arrhythmia/therapy outcomes.

Appendix B. Interpretation of PRISMA versus synthesis counts

PRISMA 2020 reports the number of studies and reports included in the review. It does not require a final box stating how many studies entered a meta-analysis. In this review, five studies are included. For the specific non-pooled risk-ratio display, only two studies provide independent-group data suitable for that effect measure, and one of those studies contributes two distinct outcomes, resulting in three forest-plot rows. All five studies remain represented in the systematic review and direction-of-effect synthesis.