

R E V I E W

Assessing atrial fibrillation-related quality of life improvements one year after ablation: A systematic review and meta-analysis.

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Abstract. *Background and aim:* This systematic review and meta-analysis quantify the magnitude of change in overall and domain-specific health-related quality of life (HRQoL) following atrial fibrillation (AF) ablation and evaluate the consistency of these improvements across different study designs. *Methods:* A systematic search was conducted in four electronic databases: PubMed, Scopus, Web of Science, ScienceDirect, and Google Scholar, using a standard search strategy. Mean differences in Atrial Fibrillation Effect on Quality-of-Life (AFEQT) questionnaire with 95 % confidence intervals were calculated in R using meta and metafor packages. *Results:* Our meta-analysis of 14 studies involving 25,507 patients demonstrates that AF ablation yields substantial and clinically meaningful quality-of-life gains at 12 months: the pooled overall AFEQT score improved by 25.7 points (21.7–29.6), with domain-specific increases of 23.6 points in symptoms (19.1–28.0); 28.2 points in daily activities (24.0–32.5), 23.6 points in treatment concern (19.2–28.0), and 24.9 points in treatment satisfaction (18.9–31.0). *Conclusions:* AF ablation yields large, clinically meaningful HRQoL improvements across all AFEQT domains. Routine integration of AFEQT monitoring into clinical pathways is warranted. Future studies should standardize protocols, extend follow-up beyond one year, and target domains with smaller gains to sustain benefits. (www.actabiomedica.it)

Key words: atrial fibrillation, catheter ablation, health-related quality of life, AFEQT questionnaire, systematic review, meta-analysis, patient-reported outcomes, quality-of-life domains

Introduction

Atrial fibrillation (AF) is the most prevalent cardiac arrhythmia in clinical settings, impacting approximately 2% of the general population, with a rising incidence over time (1). AF is associated with substantial morbidity, including increased risks of stroke,

heart failure, and all-cause mortality (2). Beyond these clinical outcomes, AF imposes a considerable burden on patients' health-related quality of life (HRQoL), manifesting as symptomatic palpitations, exercise intolerance, and anxiety, which collectively diminish daily functioning and well-being (3,4). According to recent meta-analysis findings, approximately 27% of

AF patients may remain asymptomatic, though this proportion varies depending on population-specific AF risk factors (5). Nevertheless, studies demonstrate significantly reduced health-related quality of life (HRQL) scores among AF patients when compared to healthy individuals of similar age (6). Given that AF prevalence increases with aging populations, a key priority in modern electrophysiology is optimizing strategies to restore sinus rhythm and reduce symptom burden (7). Catheter-based and hybrid ablation techniques have emerged as first-line interventions for patients with symptomatic AF refractory to antiarrhythmic drugs, demonstrating efficacy in maintaining sinus rhythm and reducing AF recurrence (8,9). In patients with predominantly low-burden paroxysmal AF, ablation-mediated reductions in arrhythmia burden are often accompanied by clinically significant improvements in quality of life (10). The Atrial Fibrillation Effect on Quality-of-Life (AFEQT) questionnaire is a validated, disease-specific instrument that quantifies patient perceptions across four domains—symptoms, daily activities, treatment concern, and treatment satisfaction—and has demonstrated responsiveness to clinical change in AF cohorts (11). Several randomized trials have reported improvements in generic HRQoL measures following ablation (12,13); however, such instruments may lack sensitivity to capture AF-specific concerns, such as treatment-related anxieties and subtle limitations in daily activities. Previous meta-analyses have evaluated HRQoL changes after AF ablation, often comparing outcomes with antiarrhythmic drug therapy or focusing on specific ablation modalities, such as radiofrequency ablation (6,14–16). Yet, these reviews have typically pooled results from heterogeneous HRQoL instruments (17), each emphasizing different aspects of quality of life. This methodological heterogeneity limits the ability to draw precise conclusions about which AF-specific domains benefit most from ablation and where residual deficits may persist. To our knowledge, no prior meta-analysis has exclusively synthesized evidence from studies using the AFEQT questionnaire, despite its widespread validation and domain-specific sensitivity. To address this knowledge gap, we conducted a systematic review and meta-analysis of studies reporting

baseline and 12-month post-ablation AFEQT scores. This work aims to determine the magnitude of change in overall and domain-specific HRQoL following AF ablation and to assess the consistency of these improvements across cohort studies, registry analyses, and randomized controlled trials.

Materials and Methods

Study registration and search strategy

This systematic review and meta-analysis were conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 (PRISMA 2020) guidelines (18). The review protocol was registered prospectively with PROSPERO, the international database of registered systematic reviews maintained by the National Institute for Health and Care Research (ID: CRD420251087188), after confirming that no similar reviews were underway. We searched the following databases and platforms without applying date, language, or other restrictions: PubMed, Scopus, Web of Science, ScienceDirect, and Google Scholar. To develop our search terms, we first ran a preliminary Scopus query to identify keywords from studies that used the Atrial Fibrillation Effect on Quality of Life (AFEQT) questionnaire to assess quality of life at 12 months post-AF ablation. From those results, we constructed the final search strategy as follows: “atrial fibrillation” AND (“catheter ablation” OR “radiofrequency ablation” OR “pulmonary vein isolation”) AND (“AFEQT” OR “Atrial Fibrillation Effect on Quality of Life”) AND (“12 months” OR “1-year” OR “one year” OR “long-term”).

Eligibility criteria, study selection and data collection

Eligibility criteria framed by Population, Intervention, Comparator, Outcome, and Study Design (PICOS) are summarized in Table 1. Studies were eligible for inclusion if they enrolled adult patients (≥ 18 years) with a confirmed diagnosis of atrial fibrillation who underwent any form of AF-focused ablation (e.g., catheter ablation, cryoablation, pulmonary vein

Table 1. Inclusion and exclusion criteria of study selection based on the PICOS framework

PICOS framework	Inclusion criteria	Exclusion criteria
Population	Adult patients with AF	Patients without a formal diagnosis of AF; Studies restricted to pediatric populations (<18 years)
Intervention or Exposure (based on your research topic)	Any ablation procedure (e.g., catheter ablation, cryoablation, pulmonary vein isolation, radiofrequency ablation, hybrid ablation)	Non-ablative treatments only (e.g., medical therapy, cardioversion without ablation); Ablation combined with other major surgical procedures not focused on AF
Comparator	Not applicable	Not applicable
Outcome	AF-related quality of life assessed by the AFEQT questionnaire at baseline and 12 months post-procedure, including: AFEQT total score; AFEQT symptom domain; AFEQT activities domain; AFEQT treatment concern domain; AFEQT treatment satisfaction domain	QoL assessed by any instrument other than AFEQT; Follow-up shorter or longer than 12 months (unless interim 12-month data are reported separately); Missing baseline or 12-month AFEQT data
Study design	Cross-sectional studies, observational studies, and RCT	Reviews, abstracts, editorials, and commentaries; studies published in languages other than English.

Abbreviations: AF – atrial fibrillation; AFEQT – Atrial Fibrillation Effect on Quality-of-Life questionnaire; RCT – randomized controlled trials.

isolation, radiofrequency ablation, or hybrid ablation). Included studies were required to report AFEQT questionnaire at both baseline and at 12 months post-procedure—specifically the total score and any of its four domains (symptoms, daily activities, treatment concern, and treatment satisfaction). We included cross-sectional, observational, and randomized controlled trial (RCT) designs. Studies were excluded if they included patients without a formal AF diagnosis or those limited to pediatric populations (<18 years), as well as investigations of non-ablative therapies (e.g., medical management or cardioversion alone) or ablation performed as part of other major cardiac surgeries not targeting AF. Studies using any QoL instrument other than the AFEQT, those with follow-up periods shorter or longer than 12 months (unless separate 12-month data were provided), or those lacking either baseline or 12-month AFEQT data were also excluded. Finally, review articles, meeting abstracts, editorials, commentaries, and studies published in languages other than English were not considered. When multiple publications reported results from the same study, we selected the one that provided the most comprehensive data.

Screening and data extraction followed PRISMA recommendations (18). Two reviewers (K.Y. and M.K.) independently executed the database searches. Two reviewers (K.Y. and M.K.) independently conducted the database searches. All retrieved citations were consolidated into a single Excel file, and duplicates were removed using RStudio (version 4.3.2) (19). The remaining unique records underwent title and abstract screening for relevance. In the final eligibility stage, full-text articles were assessed against the predefined inclusion criteria, and key study details were recorded on a standardized data-collection form. Extracted data included: first author's surname, publication year, country, study design and name (if applicable), ablation procedure type, patient age, body mass index, sample size at baseline and 12-month follow-up, number of female participants, number of participants with paroxysmal AF, and AFEQT scores (total and domain means and standard deviations (SD) at baseline and 12 months). K.Y. and M.K. independently populated separate Excel sheets, which were then compared and merged. Any discrepancies in study selection or data extraction were resolved

through discussion with a third author (S.A.), achieving full consensus on all included studies and extracted variables. Studies lacking mean values were excluded from the meta-analysis. When SDs were missing, we imputed them using the reported range alongside SDs observed in other included studies, in accordance with recommendations from a systematic review on handling missing SDs in meta-analyses (20).

Meta-analysis

The meta-analysis was conducted using RStudio (version 2024.12.1.563) running R (version 4.3.2, 2023-10-31) (19). We used the meta and metafor packages to calculate mean differences with 95 % confidence intervals via the metacont() function. Given substantial heterogeneity ($I^2 > 50\%$), we report random-effects model estimates (21). Results were visualized with forest plots, and heterogeneity was quantified by I^2 (22). To identify potential drivers of heterogeneity, we conducted meta-regression and leave-one-out sensitivity analyses. Because more than ten studies contributed to the pooled effect estimates, publication bias was assessed using funnel plots and Egger's test (21). Finally, to reduce heterogeneity and refine our estimates, we performed subgroup analyses by study type (cohort studies, registry analyses, and RCT).

Risk of bias

The methodological rigor of included studies was appraised using the Mixed Methods Appraisal Tool (MMAT), targeting both RCT and non-randomized quantitative designs for cohort studies and registry analysis. This instrument comprises seven criteria, each scored as "yes," "no," or "cannot tell." The first two criteria—clarity of the research question and alignment of the study design—apply universally. Design-specific risk-of-bias assessments and their MMAT ratings are detailed in Table 2. Every study satisfied at least five of the seven MMAT criteria, indicating acceptable methodological quality and minimal bias, and was therefore advanced to the meta-analysis stage.

Certainty of evidence evaluation

In accordance with the Cochrane Handbook for Systematic Reviews of Interventions, we evaluated the certainty of evidence using the GRADE framework (37), following established guidance for its application in systematic reviews (38). Analyses were conducted in RStudio (using the GRADE package), and the results are presented in a summary table. GRADE assesses five domains: (1) Risk of Bias, evaluated with the MMAT for both quantitative descriptive studies and RCTs; (2) Inconsistency, quantified via the I^2 statistic; (3) Indirectness, judged against the predefined PICO criteria described above; (4) Imprecision, determined by whether the 95% CI of the pooled estimate crosses the threshold of clinical relevance; and (5) Publication Bias, assessed through the results of the Egger's regression test.

Results

Study selection and characteristics of the included studies

A total of 234 records were retrieved through the systematic search. After removing 89 duplicates, 145 unique titles and abstracts were screened, of which eight were excluded at this stage. The remaining 137 articles underwent full-text review; one full-text was unavailable, yielding 136 articles assessed against our PICOS eligibility criteria. Ultimately, 14 studies met all inclusion criteria and were incorporated into the systematic review and meta-analysis. Reasons for exclusion were as follows: 42 studies used QoL instruments other than AFEQT; 23 reported only the AFEQT total score without domain data; 15 lacked both baseline and 12-month follow-up AFEQT measurements; six assessed QoL in AF patients who had not undergone ablation; seven duplicated results from the already included studies to the present analysis (39–45); one was published in non-English languages (46); and three did not report mean AFEQT scores (47–49). A PRISMA flowchart summarizing the selection process is presented in Figure 1 (18).

Table 2. Risk of bias evaluation results

Author's last name, year	Assessment 1	Assessment 2	Assessment 3	Assessment 4	Assessment 5	Assessment 6	Assessment 7
Quantitative descriptive	Clear RQ	RQ addressed	Sampling relevant	Sample representative	Measurement appropriate	Nonresponse bias low	Analysis appropriate
Potter, 2018 (23)	yes	Yes	yes	yes	yes	can't tell	yes
Osmancik, 2020 (24)	yes	Yes	yes	yes	yes	can't tell	can't tell
Gupta, 2021 (25)	yes	Yes	yes	yes	yes	can't tell	yes
Chen, 2023 (26)	yes	yes	yes	yes	yes	can't tell	yes
Aker, 2024 (27)	yes	yes	yes	yes	yes	can't tell	yes
Kiankhooy, 2024 (28)	yes	yes	yes	yes	yes	can't tell	yes
Vos, 2024 (29)	yes	yes	yes	yes	yes	can't tell	yes
Boersma, 2020 (30)	yes	yes	yes	yes	yes	can't tell	yes
Ikemura, 2021 (31)	yes	yes	yes	yes	yes	can't tell	yes
Vermeer, 2024 (32)	yes	yes	yes	yes	yes	can't tell	yes
Quantitative RCT	Clear RQ	RQ addressed	Randomization appropriate	Comparable groups	Outcome data complete	Blind assessment	Participant adherence
Risom, 2020 (33)	yes	yes	yes	yes	yes	yes	yes
Pavlovic, 2021 (34)	yes	yes	yes	yes	yes	yes	yes
Safarikova, 2024 (35)	yes	yes	yes	yes	yes	yes	yes
Meretz, 2025 (36)	yes	yes	yes	yes	yes	yes	yes

Abbreviations: RCT – randomized controlled trials; RQ – research question.

Of the 15 included studies, three were multinational, six were conducted in Europe, two in Japan, and one each in China, the UK, Ukraine, and the USA. Seven were cohort studies, four were registry analyses, and four were RCTs. In total, these studies comprised 26,420 patients, of whom 8,687 were female and 18,369 had paroxysmal AF. Further details on study characteristics and ablation procedures are provided in Table 3.

Meta-analysis results

The results of the meta-analysis of quality-of-life changes following AF ablation are shown in Figure 2. Panel A displays the overall AFEQT score change 12 months post-procedure. Across all studies, the pooled mean difference was 25.7 points (95% CI: 21.7–29.6; $I^2=99\%$; $p=0$), indicating substantial heterogeneity. In the cohort study subgroup, the mean difference

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases

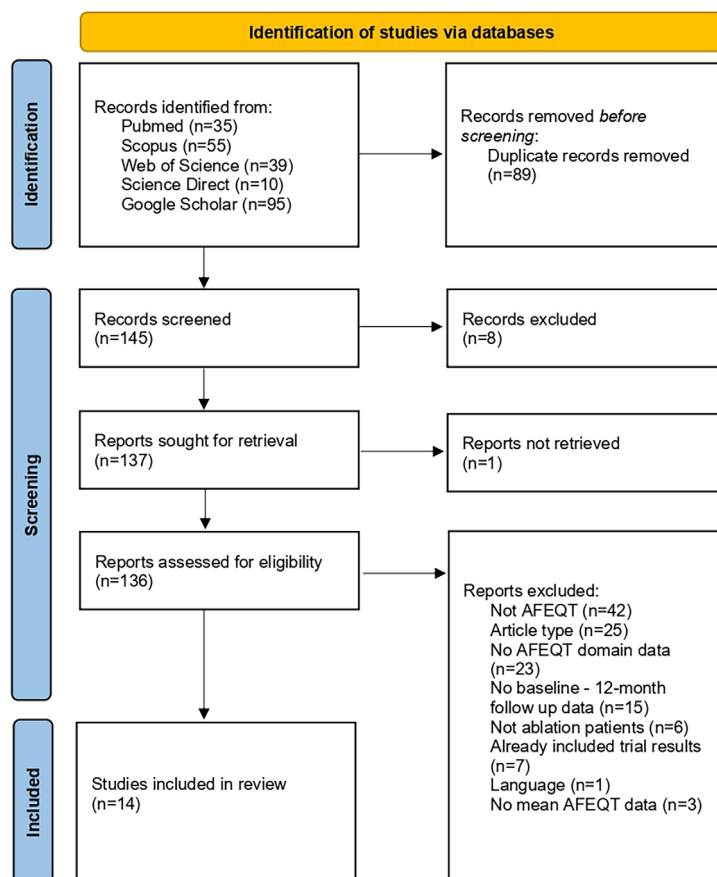


Figure 1. PRISMA flowchart of study inclusion.

was 23.92 (95% CI: 16.8–31.0 $I^2=98\%$; $p<0.01$). Registry analyses yielded a higher pooled effect of 28.6 (95% CI: 18.2–38.9; $I^2=100\%$; $p<0.01$), while showed a mean difference of 25.9 (95% CI: 20.1–31.7; $I^2=89\%$; $p<0.01$). All subgroups exhibited high heterogeneity. Panel B displays the AFEQT symptoms domain score change 12 months post-procedure. Across all studies, the pooled mean difference was 23.6 points (95% CI: 19.1–28.0; $I^2=97\%$; $p<0.01$), indicating high heterogeneity. In the cohort study subgroup, the mean difference was 24.1 points (95% CI: 15.2–32.9; $I^2=96\%$; $p<0.01$). Registry analyses yielded the mean difference of 22.2 (95% CI: 14.7–29.7; $I^2=99\%$; $p<0.01$), while showed a mean difference of 23.9 (95% CI: 16.1–31.7; $I^2=93\%$; $p<0.01$). All subgroups exhibited high heterogeneity. Panel C displays the AFEQT activities domain score

change 12 months post-procedure. Across all studies, the pooled mean difference was 28.2 points (95% CI: 24.0–32.5; $I^2=98\%$; $p<0.01$), indicating high heterogeneity. In the cohort study subgroup, the mean difference was 28.1 (95% CI: 20.8–35.4; $I^2=96\%$; $p<0.01$). Registry analyses yielded the mean difference of 27.7 (95% CI: 14.3–41.1; $I^2=100\%$; $p<0.01$), while showed a mean difference of 28.7 (95% CI: 22.5–34.9; $I^2=81\%$; $p<0.01$). All subgroups exhibited high heterogeneity. Panel D displays the AFEQT treatment concern domain score change 12 months post-procedure. Across all studies, the pooled mean difference was 23.6 points (95% CI: 19.2–28.0; $I^2=99\%$; $p=0$), indicating high heterogeneity. In the cohort study subgroup, the mean difference was 24.6 (95% CI: 16.2–33.1; $I^2=97\%$; $p<0.01$). Registry analyses yielded the mean difference

Table 3. Description of the Studies on the Quality-of-Life Changes following Atrial Fibrillation Ablation Procedures

Author's last name, year	Country	Study name	Study design	Procedure	Age	BMI	Total	Women	Paroxysmal AF
Potter, 2018 (23)	Europe, Australia, and Canada	no name	Cohort study	Catheter ablation	58.8 ± 11.3		242	71	242
Osmancik, 2020 (24)	Czech Republic	no name	Cohort study	Hybrid ablation	62.9 + 8.6 62.9 + 7.9 63.0 + 9.8	31.3 + 5.2	75	26	0
Gupta, 2021 (25)	UK	VISTAX	Cohort study	Catheter ablation	61.4±10.0	27.6±4.2	329	129	329
Chen, 2023 (26)	China	LAAC ablation	Cohort study	RFA and LAAC procedures	71.3 ± 7.4 68.7 ± 8.1	25.1 ± 3.5 25.3 ± 3.4	931	402	437
Aker, 2024 (27)	Ukraine	no name	Cohort study	PVI of RFA of CTI or RFA of CTI	64 (54–68) 54 (52–60)		43	15	43
Kiankhooy, 2024 (28)	USA	no name	Cohort study	Hybrid ablation	68±9.7	32±6.6	74	16	4
Vos, 2024 (29)	Netherlands	no name	Cohort study	Thorascopic ablation	63.9 (8.6) this is for total	27.7 [5.4]	191	61	42
Boersma, 2020 (30)	Europe UK, Georgia, Israel, and South Korea	GOLD AF Registry	Registry analysis	PVI catheter GOLD duty-cycled phased radiofrequency ablation catheter	60.6 ± 10.9	27.8 ± 4.5	1054	341	740
Ikemura, 2021 (31)	Japan	KiCS-AF	Registry analysis	Catheter ablation	64 (56–70)	23.6 (21.5–26.0)	1097	261	662
Vermeer, 2024 (32)	Netherlands	real world data	Registry analysis	PVI	64 [56; 70] 63 [56; 69] 62 [55; 68]	23.4 [22.2; 24.3] 27.2 [26.0; 28.4] 32.4 [30.9; 34.3]	20725	6926	14772
Risom, 2020 (33)	Denmark	CopenHeartRFA	RCT	Catheter ablation	59	n/a	210	45	155
Pavlovic, 2021 (34)	Europe, Australia and Argentina	Cryo-FIRST	RCT	Cryoballoon catheter ablation	50.5 (13.1)		107	31	107
Safarikova, 2024 (35)	Czech Republic	SURHYB Trial	RCT	Hybrid ablation	68.5 ± 7.2 68.6 ± 7.1	30.8 ± 4.9 31.2 ± 5.3	229	70	125
Meretz, 2025 (36)	Germany	BE-ACTION	RCT	PVI	67 (61–74) 66 (61–71)	28.4 (25.5–32.4) 27.8 (25.8–31.1)	200	67	105

Abbreviations: AF – atrial fibrillation; BMI – body mass index; LAAC – left-atrial appendage closure; RCT – randomized controlled trial; PVI of RFA of CTI – pulmonary vein isolation and radiofrequency ablation of the cavotricuspid isthmus; RFA of CTI – radiofrequency ablation of the cavotricuspid isthmus; RFCA – radiofrequency catheter ablation; USA – United States of America.

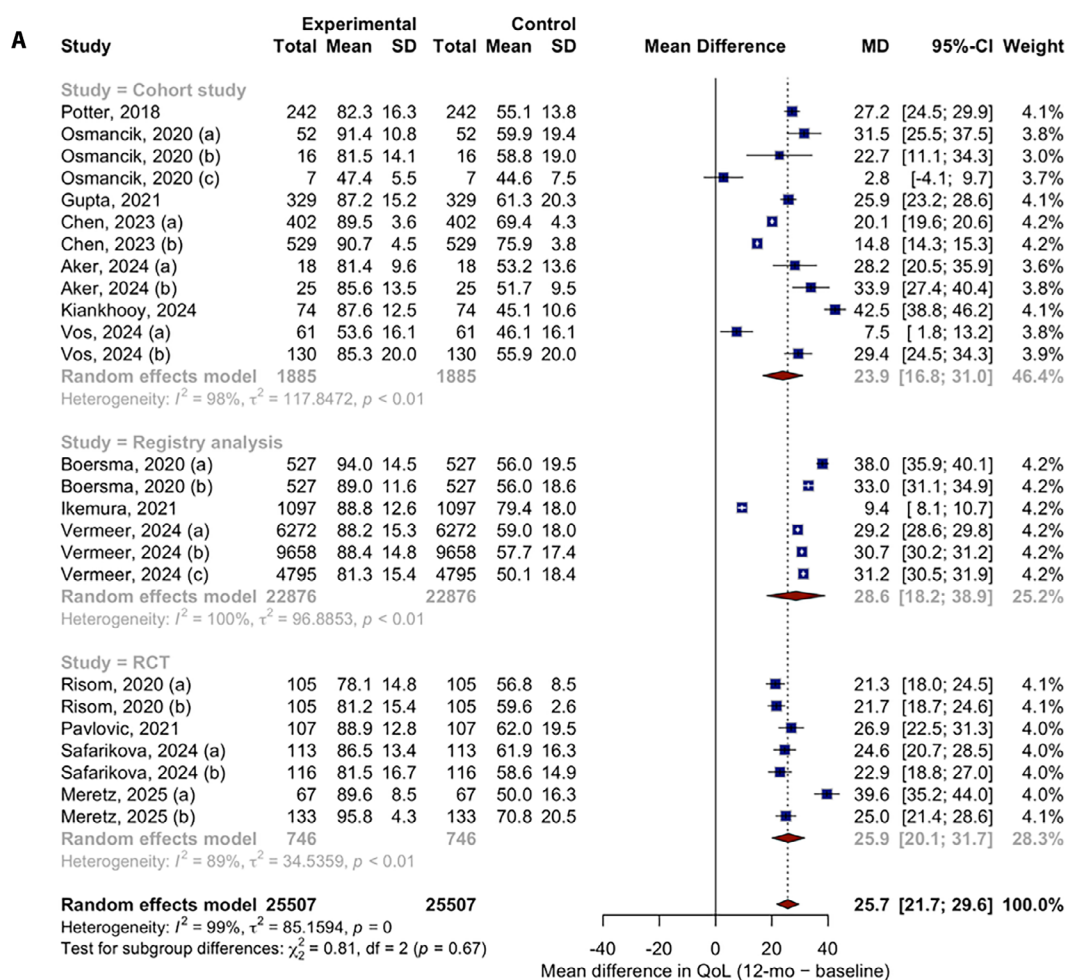


Figure 2. Meta-analysis of the Quality-of-Life Changes following Atrial Fibrillation Ablation Procedures: A) AFEQT Overall Score; B) AFEQT Symptoms Domain; C) AFEQT Daily Activities Domain; D) AFEQT Concern Domain; E) AFEQT Treatment Satisfaction Domain. *Abbreviations:* AFEQT – Atrial Fibrillation Effect on QualiTy-of-life questionnaire; CI – confidence interval; MD – mean difference; SD – standard deviation. Group definitions: Boersma, 2020 (a) (30) – no episode of AF or AT during follow up; Boersma, 2020 (b) (30) – office visit follow up; Osmancik, 2020 (a) (24) – no episode of AF or AT during follow up; Osmancik, 2020 (b) (24) – reoccurrence of paroxysmal AF or AT; Osmancik, 2020 (c) (24) – reoccurrence of permanent AF; Risom, 2020 (a) (33) – rehabilitation group; Risom, 2020 (b) (33) – usual care group; Chen, 2023 (a) (26) – female patients; Chen, 2023 (b) (26) – male patients; Aker, 2024 (a) (27) – radiofrequency ablation; Aker, 2024 (b) (27) – pulmonary veins isolation and radiofrequency ablation; Safarikova, 2024 (a) (35) – hybrid ablation; Safarikova, 2024 (b) (35) – cryoablation; Vermeer, 2024 (a) (32) – normal weight; Vermeer, 2024 (b) (32) – overweight; Vermeer, 2024 (c) (32) – obese; Vos, 2024 (a) (29) – female; Vos, 2024 (b) (29,36) – male; Meretz, 2025 (a) (36) – female; Meretz, 2025 (b) (36) – male.

of 21.3 (95% CI: 13.4–29.2; $I^2=100\%$; $p=0$), while showed a mean difference of 23.2 (95% CI: 18.6–27.9; $I^2=61\%$; $p=0.04$). All subgroups exhibited high heterogeneity.

Panel E displays the AFEQT treatment satisfaction domain score change 12 months post-procedure.

Across all studies, the pooled mean difference was 24.9 points (95% CI: 18.9–31.0; $I^2=99\%$; $p=0$), indicating high heterogeneity. In the cohort study subgroup, the mean difference was 35.9 (95% CI: 26.7–45.2; $I^2=97\%$; $p<0.01$). Registry analyses yielded the mean difference of 19.8 (95% CI: 14.6–24.9; $I^2=99\%$; $p<0.01$), while

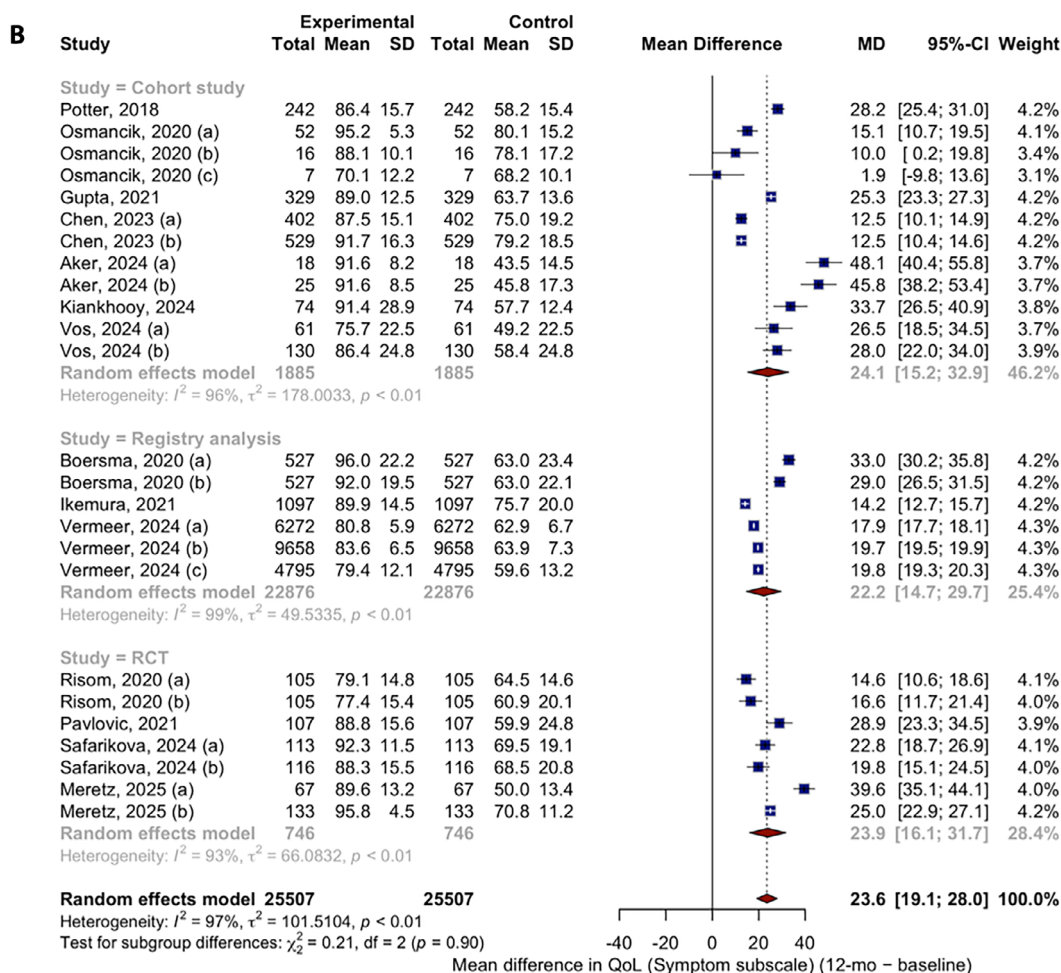


Figure 2. (Continued)

showed a mean difference of 15.7 (95% CI: 3.3–28.2; $I^2=94\%$; $p<0.01$). All subgroups exhibited high heterogeneity.

The results of the meta-regression examining the relationship between the proportion of paroxysmal AF patients in each study and the mean change in AFEQT total and domain scores are presented in Figure 3. Panel A shows the overall AFEQT score change at 12 months post-procedure. There was a statistically non-significant positive association between the proportion of paroxysmal AF participants and the overall AFEQT total score improvement ($p=0.3671$). Panel B displays the change in the AFEQT symptoms domain score at 12 months. The meta-regression demonstrated a significant positive association with the

proportion of paroxysmal AF participants ($p = 0.04$). In contrast, no significant associations were observed for the other domains: activities domain change ($p = 0.90$; Panel C), treatment concern domain change ($p = 0.66$; Panel D), or treatment satisfaction domain change ($p = 0.0638$; Panel E).

Sensitivity analyses are summarized in Figure 4. Panel A shows the leave-one-out results for the overall AFEQT total score change at 12 months. Omitting each study in turn produced pooled mean differences ranging narrowly from 25.0 to 26.4 points (versus the overall estimate of 25.2), and all recalculated 95 % confidence intervals overlapped the original interval (21.3–29.1) and remained statistically significant. This indicates that no single trial unduly

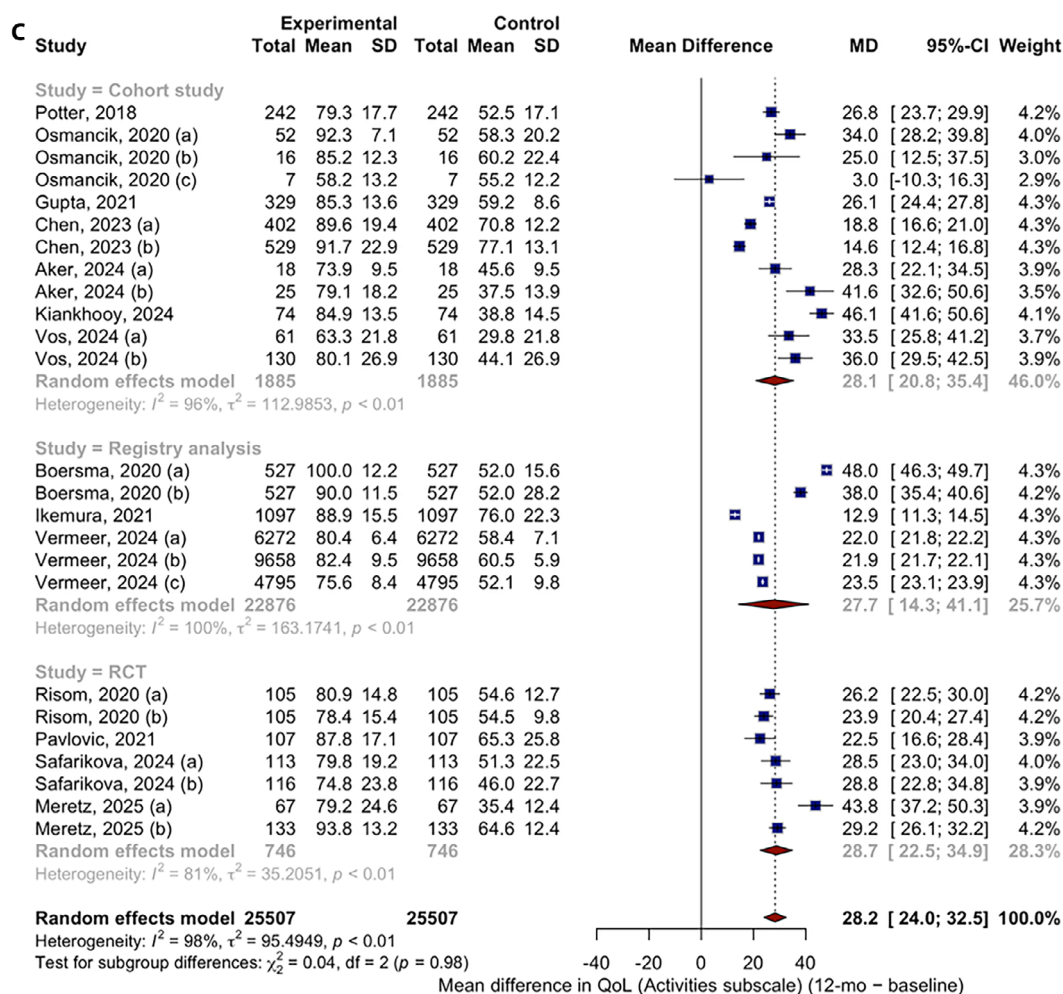


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influenced the overall effect. Panel B reports the same leave-one-out analysis for the AFEQT symptoms domain. Again, excluding any one study shifted the pooled mean difference only slightly, within the 22.9–24.2 range (versus the overall estimate of 23.6 for the AFEQT symptom domain), and all 95 % CIs continued to overlap the primary interval. This consistency confirms the robustness of the symptom-domain finding. Panel C displays results for the AFEQT activities domain. Sequential omission of each trial yielded minimal variation in the pooled mean difference, between 27.3 and 29.0 points (versus the overall estimate of 28.2 for the AFEQT activities domain),

with all updated CIs remaining within the original bounds and retaining significance. Panel D covers the AFEQT treatment concern domain. The leave-one-out estimates varied only modestly around the primary 23.6-point difference for the AFEQT treatment concern domain, with every recalculated CI overlapping the initial 19.2–28.0 interval. Panel E examines the AFEQT treatment satisfaction domain, where omitting individual studies shifted the pooled estimate by at most 1.3 points (range 23.6–26.1), and all CIs continued to include the original effect of 24.9 for the AFEQT treatment satisfaction domain. Across all panels, the leave-one-out analysis demonstrates that

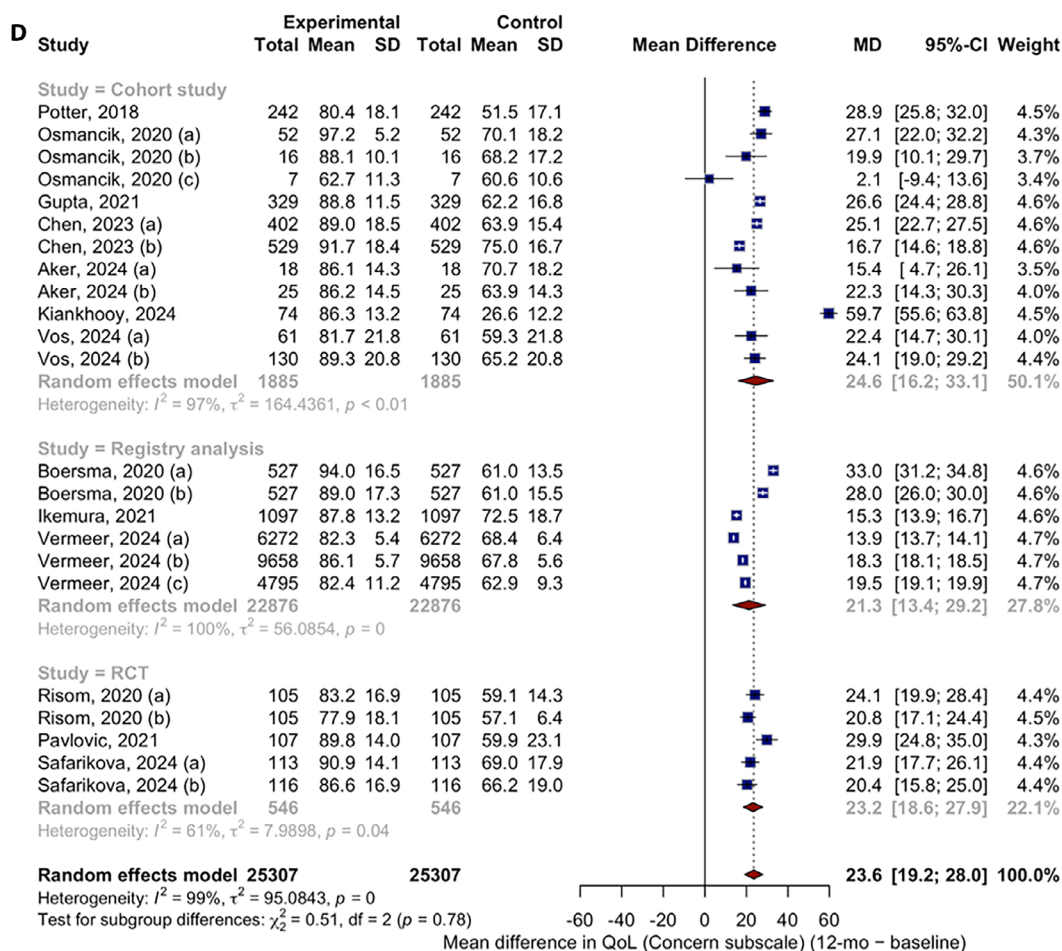


Figure 2. (Continued)

the observed improvements at 12 months are stable and not driven by any single study.

Publication-bias assessment results are shown in Figure 5 (Panels A–E) for the AFEQT overall score and each domain. In all five cases, the funnel plots appeared symmetrical, and Egger's test results yielded non-significant results, indicating no evidence of publication bias.

The certainty of evidence for all pooled estimates is detailed in Table 4, based on the GRADE framework. The five meta-analytic outcomes incorporated data from cohort studies, registry analyses, and RCT. Risk of bias was low across all outcomes. Inconsistency was judged “serious” for every outcome, whereas both

indirectness and imprecision were considered “not serious.” No publication bias was detected. Consequently, the overall certainty of evidence was rated as “low” for all five outcomes.

Discussion

This systematic review and meta-analysis demonstrate that AF ablation produces substantial, clinically meaningful improvements in health-related quality of life at 12 months, as measured by the AFEQT questionnaire. The pooled overall AFEQT score increased by 25.7 points (95% CI: 21.7–29.6; $I^2=99\%$), well above

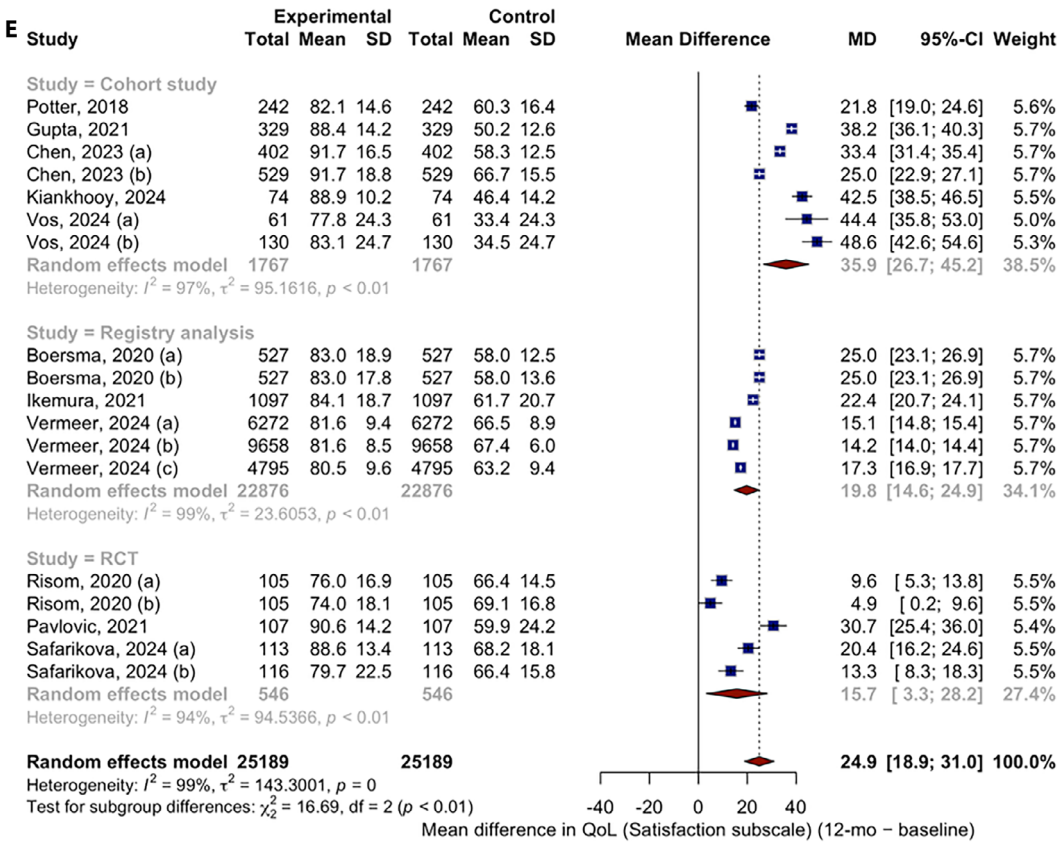


Figure 2. (Continued)

the 5 point minimal clinically important difference according to the Holmes and co-authors findings (50). Improvements spanned all four domains—symptom burden, daily activities, treatment concern, and treatment satisfaction—with gains of 23–28 points. The largest increase occurred in the activity’s domain (28.2 points), indicating significant restoration of physical and social function. Subgroup analyses revealed that for AFEQT total score cohort studies showed the smallest overall gain (23.9 points), registry analyses the smallest improvements in symptom (22.2 points), activities (27.7 points), and concern (21.3 points) domains, and RCTs the smallest change in treatment satisfaction (15.7 points), likely reflecting higher baseline satisfaction in trial participants. Our findings align with prior evaluations of the AFEQT instrument, which has demonstrated robust measurement properties across AF cohorts (51), and echo

earlier systematic reviews that underscored the importance of using disease-specific QoL tools to guide patient management (52). They also corroborate evidence that both rate and rhythm control interventions yield comparable QoL benefits in older AF populations (53), and extend those observations. According to the findings of Son and colleagues, health-related quality of life is commonly affected by anxiety and symptoms associated with AF (54). Our study further complements these results by demonstrating that the smallest improvements were observed in the symptom severity and treatment concern domains. Importantly, our findings are consistent with the 2024 European Society of Cardiology (ESC) recommendations for the management of AF. These guidelines highlight several AF-specific patient-reported outcome measures and note that the International Consortium for Health Outcomes Measurement (ICHOM) advises assessing

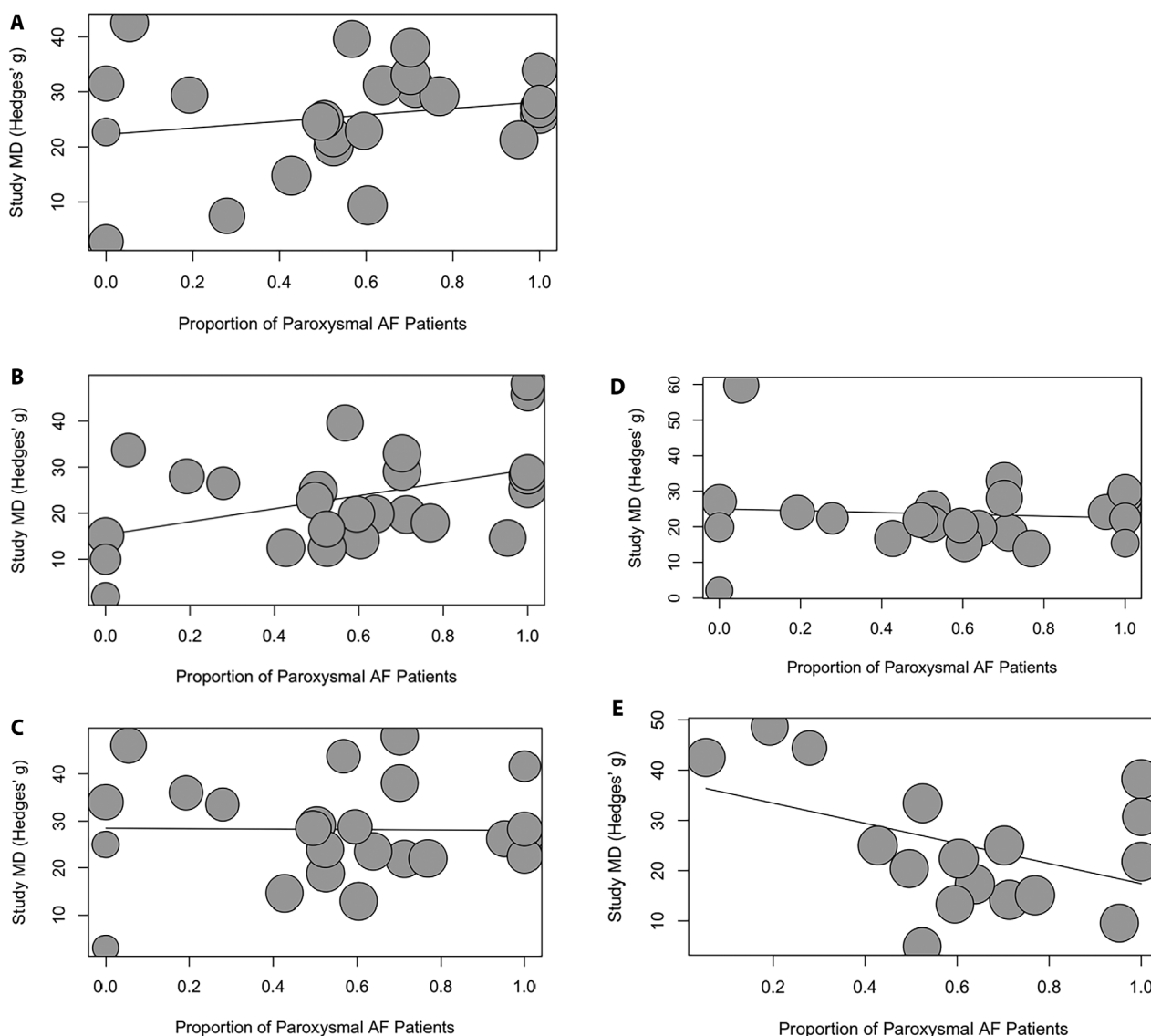


Figure 3. Meta-regression of the Quality-of-Life Changes following Atrial Fibrillation Ablation Procedures by the Proportion of Patients with Paroxysmal Atrial Fibrillation: A) AFEQT Overall Score; B) AFEQT Symptoms Domain; C) AFEQT Daily Activities Domain; D) AFEQT Concern Domain; E) AFEQT Treatment Satisfaction Domain.

exercise tolerance and symptom impact in AF using either the AFEQT or the Atrial Fibrillation Severity Scale (AFSS) (55). However, our analysis is limited to the 12-month post-ablation window and does not address the durability of QoL gains beyond one year. Indeed, some studies suggest attenuation of improvements over extended follow-up (e.g., 60 months) (6). A major limitation is the very high between-study

heterogeneity ($I^2 > 90\%$) across pooled analyses, reflecting variability in patient populations, ablation techniques, operator experience, and peri-procedural care. Although the random-effects model accounts for some differences, the residual heterogeneity reduces precision, so effect sizes should be viewed as average trends rather than universally applicable. The overall certainty of evidence is also low due to the

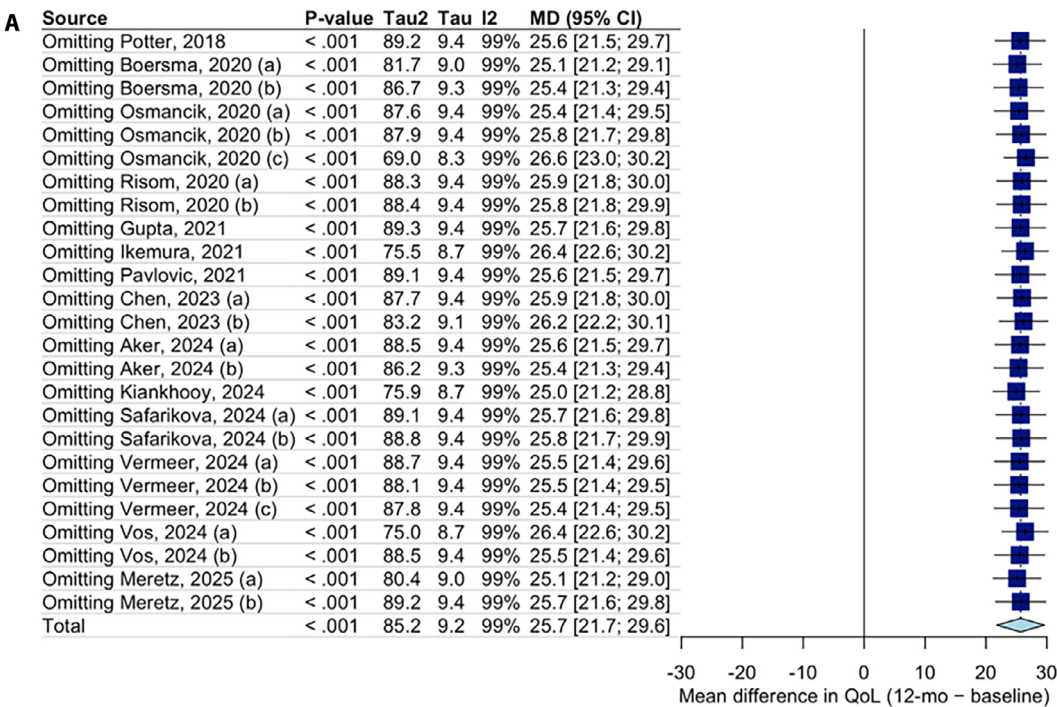


Figure 4. Sensitivity Analysis of Quality-of-Life Changes following Atrial Fibrillation Ablation Procedures by the Proportion of Patients with Paroxysmal Atrial Fibrillation: A) AFEQT Overall Score; B) AFEQT Symptoms Domain; C) AFEQT Daily Activities Domain; D) AFEQT Concern Domain; E) AFEQT Treatment Satisfaction Domain. *Abbreviations:* AFEQT – Atrial Fibrillation Effect on QualiTy-of-life questionnaire; CI – confidence interval; MD – mean difference; SD – standard deviation. Group definitions: Boersma, 2020 (a) (30) – phone call follow up; Boersma, 2020 (b) (30) – office visit follow up; Osmancik, 2020 (a) (24) – no episode of AF or AT during follow up; Osmancik, 2020 (b) (24)– reoccurrence of paroxysmal AF or AT; Osmancik, 2020 (c) (24) – reoccurrence of permanent AF; Risom, 2020 (a) (33) – rehabilitation group; Risom, 2020 (b) (33) – usual care group; Chen, 2023 (a) (26) – female patients; Chen, 2023 (b) (26) – male patients; Aker, 2024 (a) (27) – radiofrequency ablation; Aker, 2024 (b) (27) – pulmonary veins isolation and radiofrequency ablation; Safarikova, 2024 (a) (35) – hybrid ablation; Safarikova, 2024 (b) (35) – cryoablation; Vermeer, 2024 (a) (32) – normal weight; Vermeer, 2024 (b) (32) – overweight; Vermeer, 2024 (c) (32) – obese; Vos, 2024 (a) (29) – female; Vos, 2024 (b) (29,36) – male; Meretz, 2025 (a) (36) – female; Meretz, 2025 (b) (36) – male.

predominance of observational studies, potential publication bias, and inconsistent results. Thus, while the direction of effect appears robust, the exact magnitude should be interpreted cautiously. Future studies should minimize heterogeneity through standardized patient selection, harmonized ablation protocols, and aligned follow-up and AFEQT assessment schedules. The consistent, large-magnitude improvements in AFEQT scores observed across all domains underscore the utility of AF ablation as a cornerstone of symptomatic patient management. Clinicians should incorporate

AFEQT assessments into routine practice to facilitate shared decision-making, ensuring that patients understand the potential gains in symptom relief, functional capacity, and treatment satisfaction. Recognizing that treatment-concern and symptom domains may improve less dramatically, providers ought to augment procedural planning with targeted education and psychosocial support to address patient anxieties and optimize engagement with post-ablation care. Moreover, the high heterogeneity across studies highlights the need for standardized ablation protocols and unified

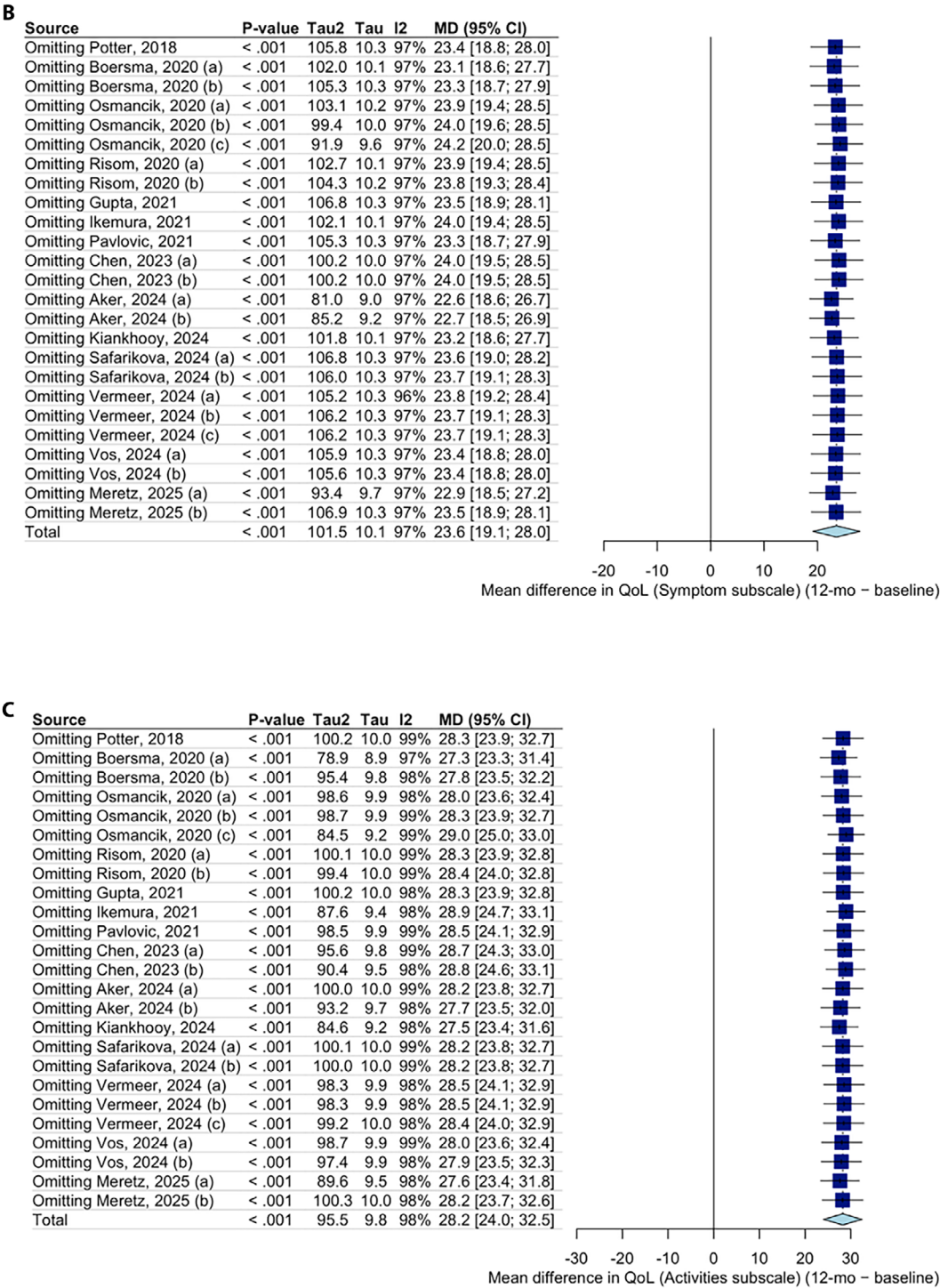


Figure 4. (Continued)

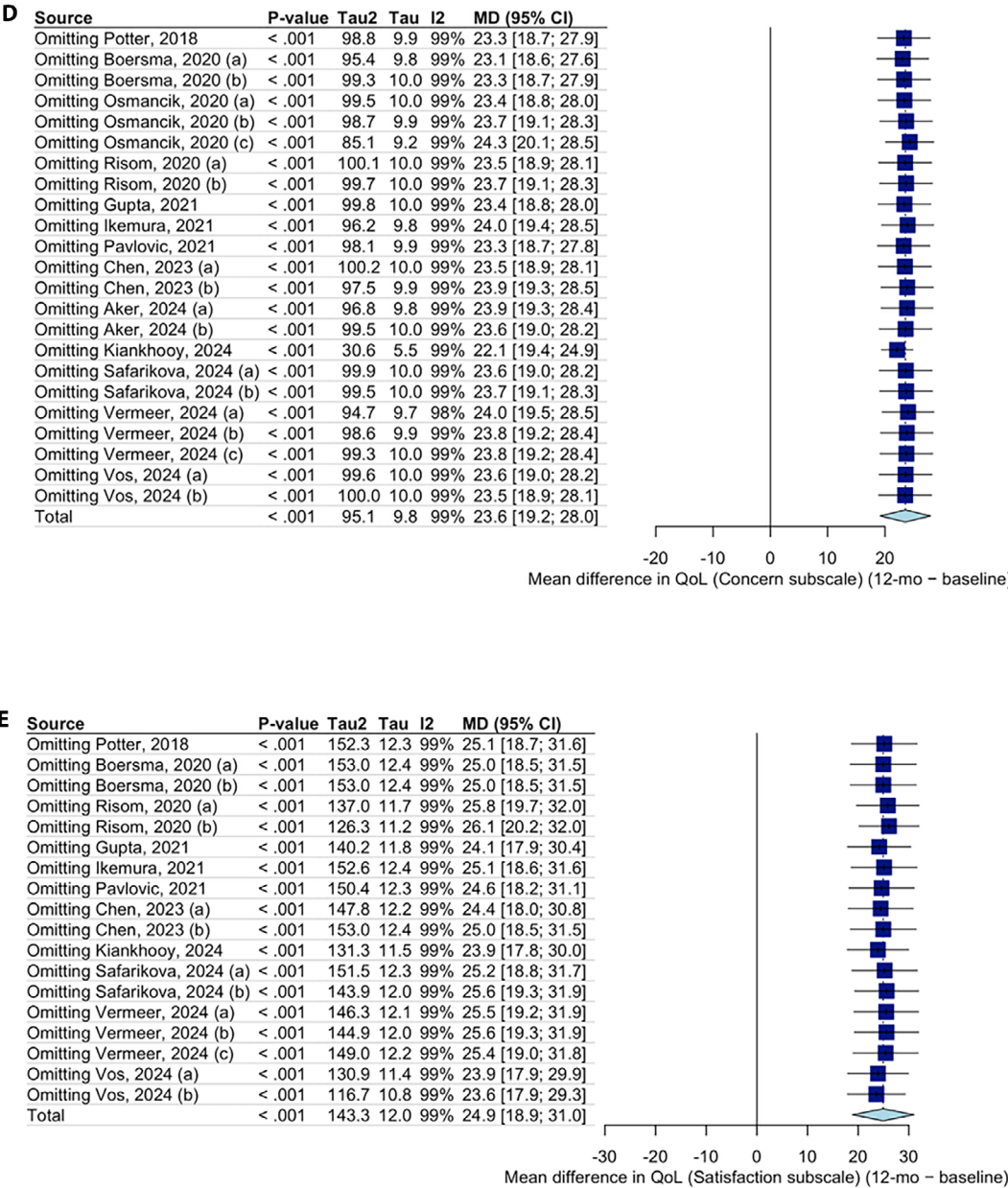


Figure 4. (Continued)

follow-up schedules; embedding AFEQT monitoring into long-term care pathways will enable timely identification of waning benefits and guide additional interventions. Finally, health systems should consider these findings when allocating resources and designing

patient education programs, emphasizing the establishment of dedicated QoL evaluation frameworks and multidisciplinary teams that can translate these quality-of-life enhancements into sustained improvements in patient well-being.

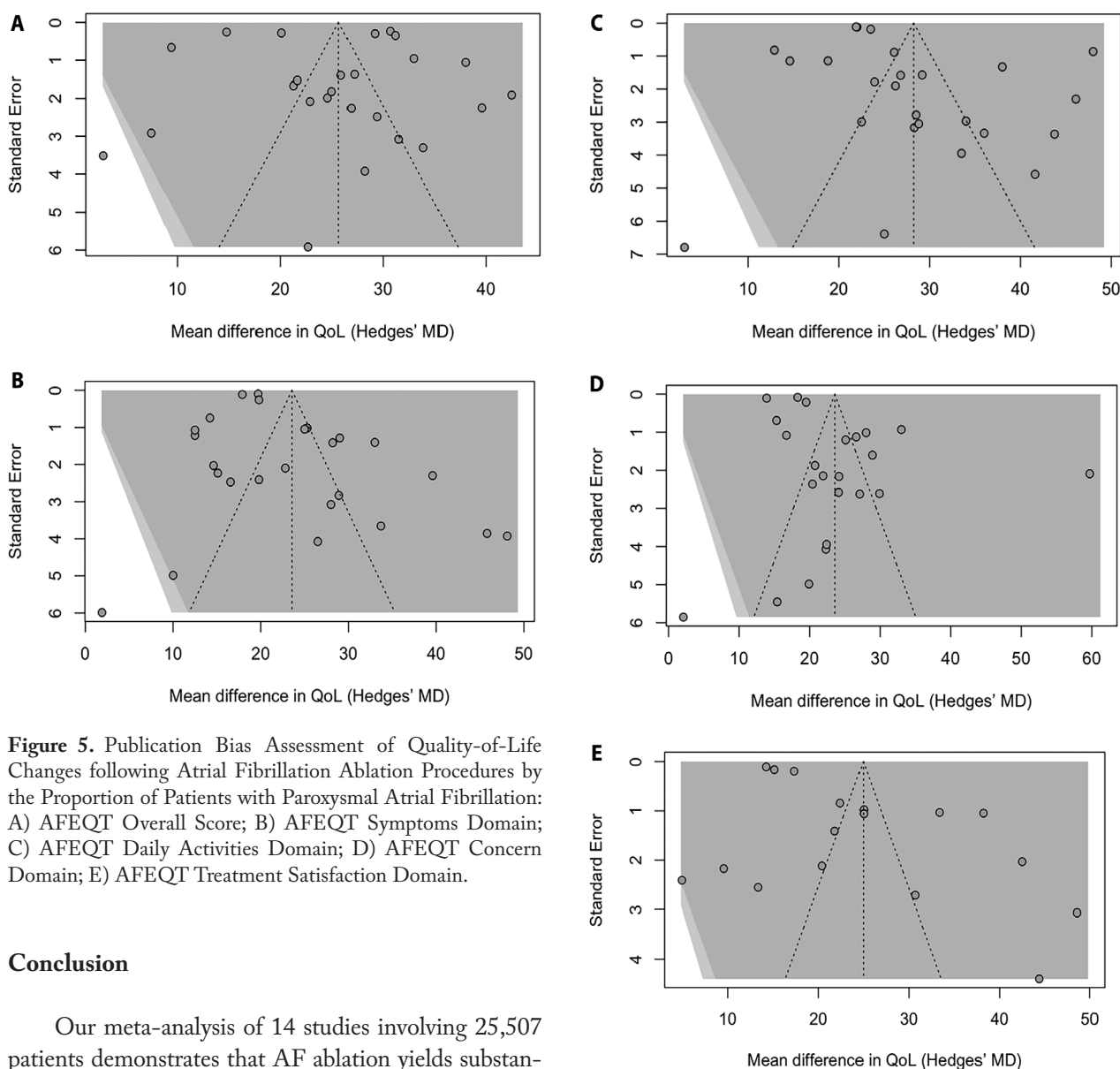


Figure 5. Publication Bias Assessment of Quality-of-Life Changes following Atrial Fibrillation Ablation Procedures by the Proportion of Patients with Paroxysmal Atrial Fibrillation: A) AFEQT Overall Score; B) AFEQT Symptoms Domain; C) AFEQT Daily Activities Domain; D) AFEQT Concern Domain; E) AFEQT Treatment Satisfaction Domain.

Conclusion

Our meta-analysis of 14 studies involving 25,507 patients demonstrates that AF ablation yields substantial and clinically meaningful quality-of-life gains at 12 months: the pooled overall AFEQT score improved by 25.7 points (95% CI: 21.7–29.6; $I^2=99\%$), with domain-specific increases of 23.6 points in symptoms (95% CI: 19.1–28.0; $I^2=97\%$); 28.2 points in daily activities (95% CI: 24.0–32.5; $I^2=98\%$), 23.6 points in treatment concern (95% CI: 19.2–28.0; $I^2=99\%$), and 24.9 points in treatment satisfaction (95% CI: 18.9–31.0; $I^2=99\%$). The greatest impact was observed on daily activities. These findings support the routine

use of ablation in symptomatic AF patients and the integration of AFEQT monitoring into clinical pathways. Future research should standardize ablation protocols, extend follow-up beyond one year to assess durability of benefit, and develop targeted interventions for domains with smaller improvements, thereby ensuring sustained quality-of-life enhancements for AF patients.

Table 4. Evaluation of the Certainty of Evidence Using GRADE Framework on the Success Rate of Primary Probing in Children

Outcome	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Certainty of Evidence
AFEQT total score changes following AF ablation procedures	Low	Serious	Not serious	Not serious	Not detected	Low
AFEQT symptoms domain score changes following AF ablation procedures	Low	Serious	Not serious	Not serious	Not detected	Low
AFEQT activities domain score changes following AF ablation procedures	Low	Serious	Not serious	Not serious	Not detected	Low
AFEQT treatment concerns domain score changes following AF ablation procedures	Low	Serious	Not serious	Not serious	Not detected	Low
AFEQT treatment satisfaction domain score changes following AF ablation procedures	Low	Serious	Not serious	Serious	Not detected	Low

Abbreviations: AF – atrial fibrillation; AFEQT – Atrial Fibrillation Effect on Quality-of-Life questionnaire.

Ethic Approval: Ethical review and approval were waived for this study as this is a systematic review of the published literature. Study protocol registration: PROSPERO ID: CRD420251087188.

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

Authors' Contribution: Conceptualization, K.Y.; methodology, K.Y.; software, K.Y.; validation, K.Y., M.K. and S.A.; formal analysis, K.Y.; investigation, K.Y., M.K. and S.A.; resources, K.Y., M.K. A.A., and M.R.; data curation, K.Y., M.K. and S.A.; writing—original draft preparation, K.Y. and M.K.; writing—review and editing, K.Y. M.K. M.R., A.A. and S.A.; visualization, K.Y.; supervision, K.Y., S.A., and M.K.; project administration, A.A., M.R., and S.A.; funding acquisition, M.K. All authors have read and agreed to the published version of the manuscript.

Declaration on the Use of AI: None.

Acknowledgments: The authors gratefully acknowledge Arai-lym Abilbay for assistance with reference management and image presentation.

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Received: 2 August 2025

Accepted: 3 September 2025

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