Carotid Stenosis and Gender: Systematic Review with ☸SAIMSARA.

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Abstract: The aim of this paper is to systematically review and synthesize the current evidence regarding the influence of gender on carotid stenosis, its associated clinical manifestations, treatment outcomes, and underlying pathophysiological mechanisms. The review utilises 228 studies with 756419 total participants (naïve ΣN). A single central value for the association between carotid stenosis and gender cannot be computed due to the heterogeneity of metrics and populations across studies; however, males generally exhibit a higher prevalence and severity of carotid artery stenosis compared to females. This generalizability is limited by the heterogeneous metrics and study designs, with the most significant limitation being the Heterogeneous Metrics, which prevented a unified quantitative synthesis. Clinicians should recognize that gender plays a distinct role in carotid stenosis presentation and outcomes, particularly in treatment-related risks for females, necessitating personalized approaches to screening, management, and post-procedural care.

Keywords: Carotid Stenosis; Sex Differences; Gender; Atherosclerosis; Ischemic Stroke; Risk Factors

Review Stats

- Generated: 2026-01-29 23:03:44 CET
- Plan: Pro (expanded craft tokens; source: Semantic Scholar)
- Source: Semantic Scholar
- Scope: All fields
- Keyword Gate: Fuzzy (≥60% of required terms, minimum 2 terms matched in title/abstract)
- Total Abstracts/Papers: 866
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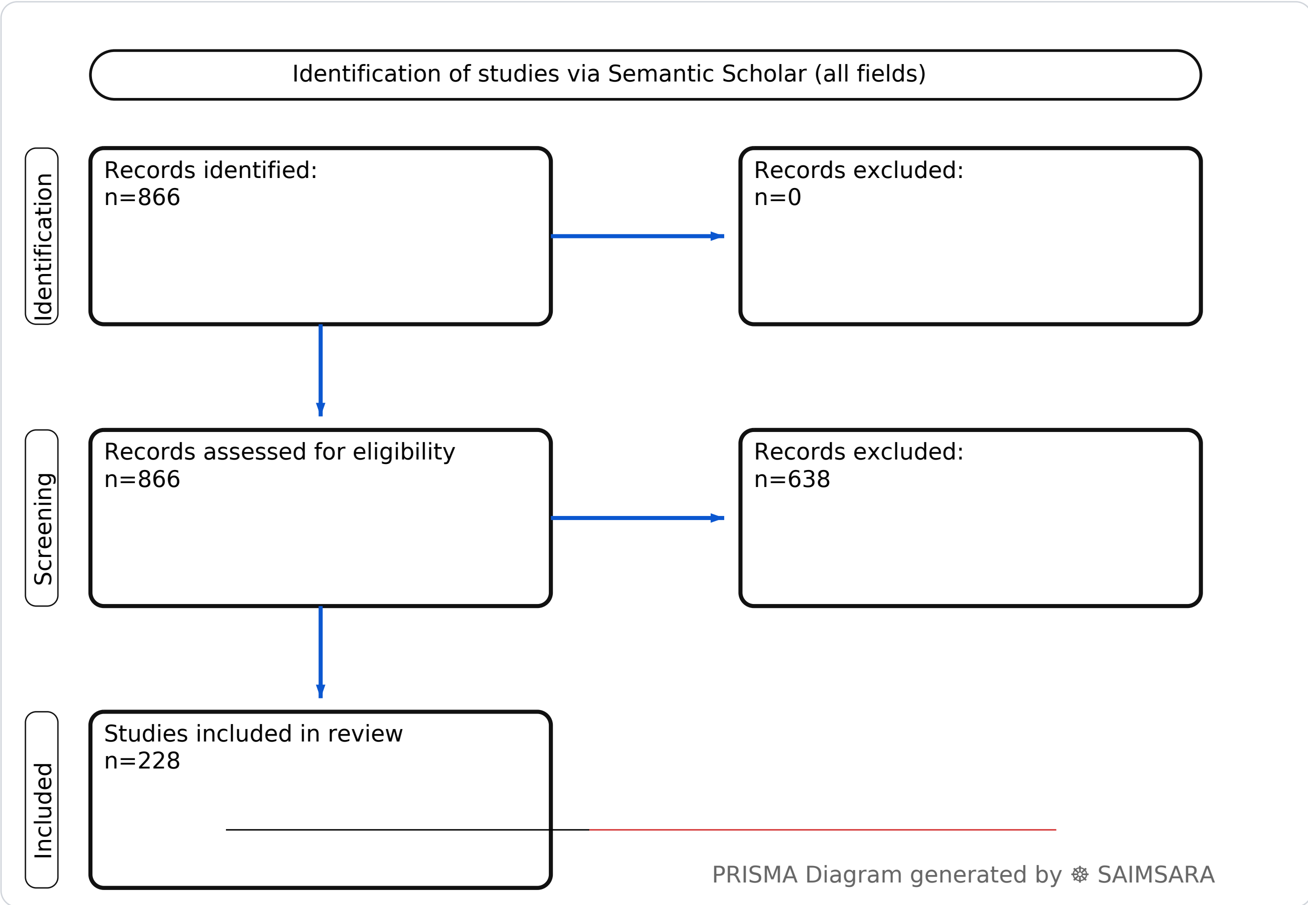
- Included original Abstracts/Papers: 228
- Total study participants (naïve ΣN): 756419



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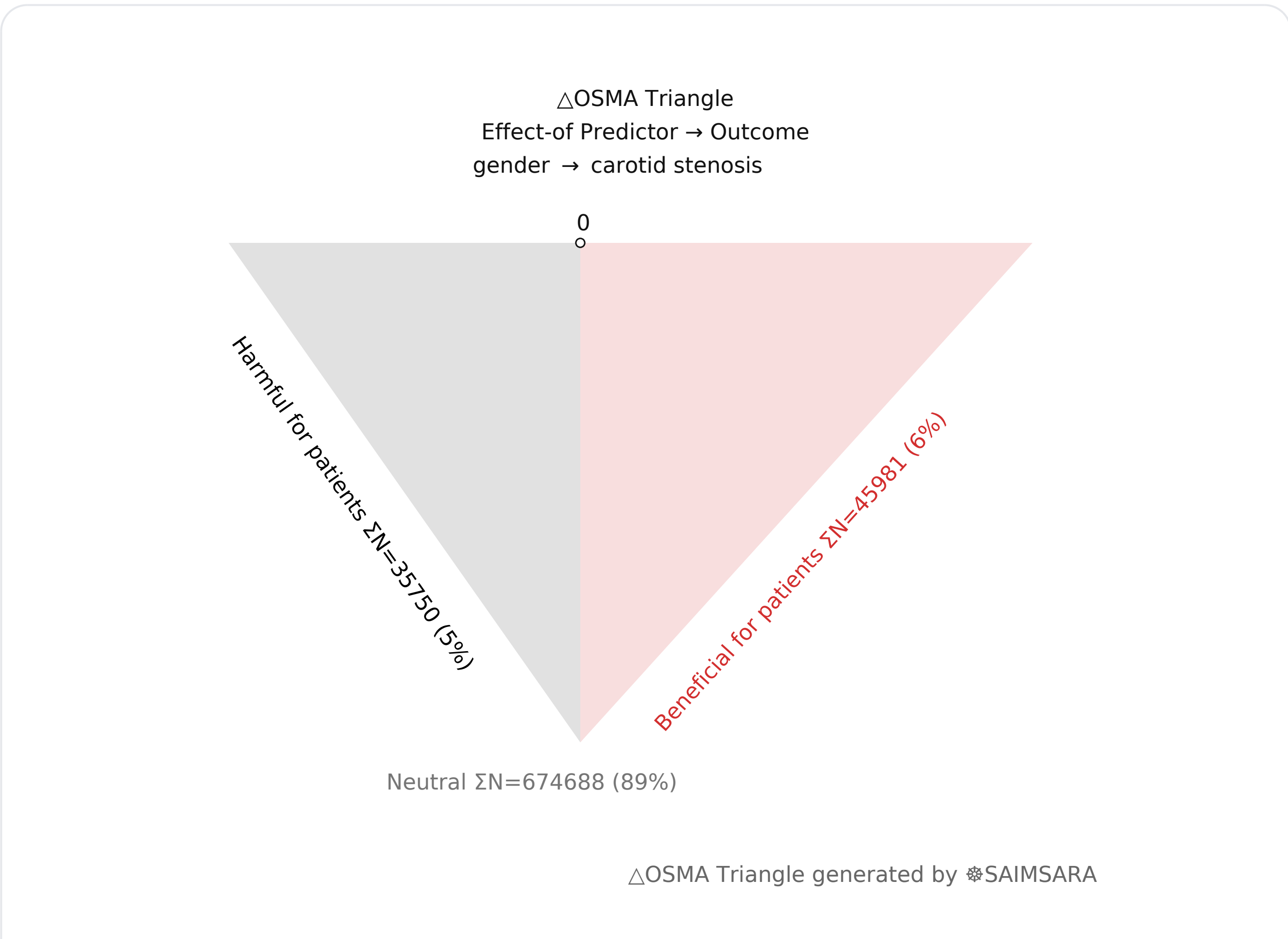
n=866
Records excluded:
n=0
Screening
Records assessed for eligibility
n=866
Records excluded:
n=638
Included
Studies included in review
n=228
PRISMA Diagram generated by ☸ SAIMSARA



△OSMA Triangle
Effect-of Predictor → Outcome
gender → carotid stenosis
0
Harmful for patients ΣN=35750 (5%)
Beneficial for patients ΣN=45981 (6%)
Neutral ΣN=674688 (89%)
△OSMA Triangle generated by ☸SAIMSARA

Outcome-Sentiment Meta-Analysis (OSMA): *(LLM-only)*

Frame: Effect-of Predictor → Outcome • *Source*: Semantic Scholar

Outcome: carotid stenosis Typical timepoints: peri/post-op, 10-y. Reported metrics: %, CI, p.

Common endpoints: Common endpoints: complications, mortality, functional.

Predictor: gender — exposure/predictor. Doses/units seen: 30 mg, 90 ml. Typical comparator: controls, male patients. female sex is, control, those without carotid artery….

- **1) Beneficial for patients** — carotid stenosis with gender — [21], [23], [131], [135], [142], [146], [172], [185], [186], [190], [213], [214], [219] — ΣN=45981
- **2) Harmful for patients** — carotid stenosis with gender — [4], [5], [8], [9], [14], [24], [34], [35], [50], [79], [84], [90], [99], [134], [139], [144], [145], [147], [152], [154], [155], [159], [161], [163], [165], [166], [169], [170], [180], [191], [203], [222], [226] — ΣN=35750
- **3) No clear effect** — carotid stenosis with gender — [1], [2], [3], [6], [7], [10], [11], [12], [13], [15], [16], [17], [18], [19], [20], [22], [25], [26], [27], [28], [29], [30], [31], [32], [33], [36], [37], [38], [39], [40], [41], [42], [43], [44], [45], [46], [47], [48], [49], [51], [52], [53], [54], [55], [56], [57], [58], [59], [60], [61], [62], [63], [64], [65], [66], [67], [68], [69], [70], [71], [72], [73], [74], [75], [76], [77], [78], [80], [81], [82], [83], [85], [86], [87], [88], [89], [91], [92], [93], [94], [95], [96], [97], [98], [100], [101], [102], [103], [104], [105], [106], [107], [108], [109], [110], [111], [112], [113], [114], [115], [116], [117], [118], [119], [120], [121], [122], [123], [124], [125], [126], [127], [128], [129], [130], [132], [133], [136], [137], [138], [140], [141], [143], [148], [149], [150], [151], [153], [156], [157], [158], [160], [162], [164], [167], [168], [171], [173], [174], [175], [176], [177], [178], [179], [181], [182], [183], [184], [187], [188], [189], [192], [193], [194], [195], [196], [197], [198], [199], [200], [201], [202], [204], [205], [206], [207], [208], [209], [210], [211], [212], [215], [216], [217], [218], [220], [221], [223], [224], [225], [227], [228] — ΣN=674688

1) Introduction

Carotid artery stenosis (CAS), a narrowing of the carotid arteries, is a significant risk factor for ischemic stroke and cognitive impairment. Its etiology is multifactorial, involving traditional cardiovascular risk factors such as age, hypertension, dyslipidemia, and smoking [12, 16, 48, 104]. The clinical presentation and prognosis of CAS can vary widely, from asymptomatic disease to acute ischemic stroke (AIS) [2, 5, 8]. Given the complex interplay of risk factors and outcomes, understanding the role of biological sex and gender-related factors in the development, progression, and management of CAS is crucial. This paper synthesizes current research on the relationship between carotid stenosis and gender, drawing insights from a comprehensive structured extraction.

2) Aim

The aim of this paper is to systematically review and synthesize the current evidence regarding the influence of gender on carotid stenosis, its associated clinical manifestations, treatment outcomes, and underlying pathophysiological mechanisms.

3) Methods

Systematic review with multilayer AI research agent: keyword normalization, retrieval & structuring, and paper synthesis (see SAIMSARA About section for details).

- **Bias:** Qualitatively inferred from study design fields. The included studies exhibit a range of designs, predominantly cross-sectional and retrospective cohort studies, with some prospective cohorts and randomized controlled trials (RCTs). This methodological heterogeneity, alongside varying sample sizes and populations, introduces potential for selection bias, confounding, and limited generalizability across different contexts. Many studies report associations without establishing causality, and some lack detailed statistical reporting for gender-specific findings.

4) Results

4.1 Study characteristics:

The included studies span from 2000 to 2025, employing diverse designs such as cross-sectional, retrospective, prospective cohort, and mixed-design studies. Populations investigated include ischemic stroke patients, asymptomatic carotid stenosis (ACS) patients, individuals undergoing cardiac or carotid surgery, and community-dwelling subjects. Sample sizes range from small cohorts (e.g., N=5 [15], N=20 [2]) to large registries (e.g., N=2,635,595 [105], N=52,023 [107]). Follow-up periods vary from short-term (e.g., 30 days [4, 14]) to long-term (e.g., 23.4 years [15], 10 years [51, 154]).

4.2 Main numerical result aligned to the query:

A single central value for the association between carotid stenosis and gender cannot be computed due to the heterogeneity of metrics (e.g., average stenosis percentage, prevalence of specific stenosis grades, odds ratios for various outcomes) and populations across studies. However, a consistent trend indicates that **males generally exhibit a higher prevalence and severity of carotid artery stenosis compared to females** [6, 23, 90, 118, 120, 146, 152, 180, 185, 186, 195]. For instance, average carotid stenosis was reported as 20.84% in males versus 16.92% in females in one study [146], and the prevalence of 90-99% stenosis was 14.3% in men compared to 7.8% in women in another [118]. Furthermore, carotid atherosclerosis was found to be more severe in males (5.08% vs. 3.04% for stenosis, 1.49% vs. 0.69% for moderate to severe stenosis) in a large cohort [120]. Conversely, female gender was significantly associated with carotid atherosclerotic plaques in one prospective study (odds ratio = 3.23, P = .001) [190], and with lower extremity arterial disease (LEAD) in Chinese diabetic patients (male OR=2.54, 95% CI 1.30–5.00, P=0.007) [99].

4.3 Topic synthesis:

- **Gender as a Determinant of Carotid Stenosis Prevalence and Severity:** Males consistently show higher prevalence and severity of carotid stenosis [23, 90, 118, 120, 146, 152, 180, 185, 186, 195]. For example, average stenosis was 20.84% in males vs. 16.92% in females [146], and 90-99% stenosis was 14.3% in men vs. 7.8% in women [118]. Male gender is an independent predictor of significant carotid stenosis [34, 37, 170].
- **Gender-Specific Risks in Post-Treatment Outcomes:** Female patients face higher risks of post-operative stroke (e.g., OR 3.8, CI95% 0.77–18.56, p: 0.05) [4], stroke recurrence [4], perioperative stroke/TIA and all-cause mortality after carotid surgery (female OR=1.4, 95%CI 1.0-4.7, P=0.041) [14], and long-term moderate restenosis after carotid endarterectomy (CEA) (16.3% in women vs. 7.6% in men) [35]. Female gender also increases the risk of adverse vascular events (AVE) after CEA by 4.762 times at 5 years [154] and is associated with higher rates of procedural complications after transcatheter aortic valve implantation (TAVI) [145].
- **Cognitive Impairment and Carotid Stenosis, with Gender Influence:** Carotid stenosis is linked to cognitive deficits [2, 9, 24], including lower MoCA scores [2] and worse memory/executive function [9]. While carotid stenosis is associated with thinner cerebral cortex and lower fluid cognitive abilities independent of gender [30], some studies suggest female gender is associated with less cognitive impairment [151]. No significant differences in white matter hyperintensity volumes were found in relation to gender in patients with internal carotid artery (ICA) stenosis [125].
- **Inflammation and Carotid Plaque Characteristics:** Systemic inflammation indices are higher in patients with irregular-ulcerated plaques [3]. Circulating chemerin is increased and correlates with inflammatory parameters in advanced carotid stenosis [28]. Pericarotid adipose tissue (PCAT) attenuation, an imaging biomarker of local inflammation, distinguishes different stages of carotid atherosclerotic disease [56]. Plaque stability in essential hypertension is significantly positively correlated with gender ($p < 0.05$) [168].
- **Associated Risk Factors and Gender Interactions:** Age, gender, carotid intima-media thickness (CIMT), plaque type, hypertension, dyslipidemia, and smoking are important factors affecting carotid stenosis [12, 16, 48, 104]. Male gender is an independent predictor

of significant carotid stenosis in patients undergoing coronary artery bypass grafting (CABG) [34] and in asymptomatic populations [37, 170]. Female gender is associated with increased arterial resistance [71] and subclavian artery stenosis or occlusion (P = .012) [58].

- **Treatment Modalities and Gender-Specific Considerations:** Gender influences treatment decisions for carotid artery stenosis [32, 33]. Women may experience longer endovascular revascularization procedures [136] and have differential outcomes in carotid revascularization procedures [46, 73]. Female gender was related to postprocedural neurological complications in univariate analysis (P = 0.046) [110].
- **Ocular and Cerebral Hemodynamic Manifestations:** Moderate or more ICA stenosis is significantly associated with ipsilateral choroidal thinning and ipsilateral subretinal drusenoid deposits (SDDs) [1]. Cerebral blood flow (CBF) measurements during cognitive tasks show gender differences, and chronic carotid stenosis patients exhibit autoregulation and vasoreactivity problems [224]. Male gender was associated with pathological cerebral vasomotor reactivity (VMR) ($p<0.05$) [50].

5) Discussion

5.1 Principal finding:

The principal finding of this review is that males consistently exhibit a higher prevalence and severity of carotid artery stenosis compared to females [6, 23, 90, 118, 120, 146, 152, 180, 185, 186, 195]. For instance, average stenosis was reported as 20.84% in males versus 16.92% in females in one study [146], highlighting a notable gender disparity in atherosclerotic burden.

5.2 Clinical implications:

- **Risk Stratification:** Clinicians should consider male gender as a significant independent risk factor for the presence and severity of carotid stenosis [34, 37, 170], potentially warranting earlier or more aggressive screening in high-risk male patients.
- **Post-Procedural Monitoring:** Female patients undergoing carotid revascularization procedures, such as carotid endarterectomy (CEA) or carotid artery stenting (CAS), may require enhanced post-operative monitoring due to a higher risk of perioperative stroke, stroke recurrence, and restenosis [4, 14, 35, 110, 145, 154, 203].
- **Tailored Treatment Approaches:** Treatment decisions and approaches for carotid stenosis should be individualized, taking into account gender-specific risks and outcomes, as women have shown reduced benefit from CEA in earlier trials [33] and higher rates of certain complications [145].
- **Cognitive Assessment:** Given the link between carotid stenosis and cognitive impairment [2, 9, 24], and potential gender differences in cognitive outcomes [151], comprehensive

cognitive assessments should be considered for all patients with CAS, with an awareness of gender-specific presentations.
- **Inflammation Management:** Recognizing the role of inflammation in carotid plaque stability and progression [3, 28, 56], and its potential correlation with gender [168], may inform targeted anti-inflammatory strategies in high-risk individuals.

5.3 Research implications / key gaps:

- **Standardized Gender-Specific Outcomes:** Future studies should standardize reporting of gender-specific prevalence, severity, and treatment outcomes for carotid stenosis across diverse populations using consistent metrics to allow for meta-analysis [118, 120, 146].
- **Mechanistic Basis for Gender Disparities:** Research is needed to elucidate the biological and physiological mechanisms underlying observed gender differences in carotid atherosclerosis development, plaque characteristics, and response to interventions [77, 168].
- **Long-Term Follow-up on Cognitive Impact:** Prospective cohort studies with long-term follow-up are required to definitively assess the gender-specific impact of carotid stenosis on cognitive decline, utilizing standardized cognitive batteries and advanced imaging [30, 83].
- **Optimized Treatment Protocols:** Randomized controlled trials are warranted to develop and evaluate gender-specific treatment protocols for carotid stenosis, aiming to minimize complications and improve long-term outcomes for both men and women [33, 35].
- **Role of Novel Biomarkers:** Further investigation into novel biomarkers (e.g., chemerin [28], carbamylated albumin [213], microRNAs [122]) and their gender-specific associations with carotid stenosis progression and treatment response is needed.

5.4 Limitations:

- **Heterogeneous Metrics** — The diverse metrics used to quantify carotid stenosis and gender-related outcomes across studies prevented a single meta-analytic summary, limiting quantitative synthesis.
- **Study Design Bias** — A predominance of cross-sectional and retrospective designs introduces potential for selection bias and limits the ability to infer causality regarding gender effects.
- **Incomplete Reporting** — Many studies reported gender as a demographic variable or adjusted for it, but did not consistently provide detailed gender-stratified analyses or specific effect sizes for gender.

- **Population Variability** — The wide range of populations (e.g., ischemic stroke patients, surgical candidates, asymptomatic individuals) and geographical settings restricts the generalizability of specific findings.
- **Lack of Mechanistic Detail** — While associations were noted, the underlying biological or social mechanisms contributing to observed gender differences were often not explored in depth.

5.5 Future directions:

- **Prospective Cohort Studies** — Conduct large, prospective cohort studies with standardized carotid imaging and gender-stratified analyses.
- **Gender-Specific Risk Models** — Develop and validate gender-specific risk prediction models for carotid stenosis progression and stroke.
- **Biomarker Validation Studies** — Investigate novel biomarkers in gender-balanced cohorts to understand their role in CAS pathophysiology.
- **Personalized Treatment Trials** — Design clinical trials evaluating personalized treatment strategies for CAS based on patient gender and risk profile.
- **Longitudinal Cognitive Assessment** — Implement longitudinal studies to track cognitive function in CAS patients, with detailed gender-specific analyses.

6) Conclusion

A single central value for the association between carotid stenosis and gender cannot be computed due to the heterogeneity of metrics and populations across studies; however, males generally exhibit a higher prevalence and severity of carotid artery stenosis compared to females [6, 23, 90, 118, 120, 146, 152, 180, 185, 186, 195]. This generalizability is limited by the heterogeneous metrics and study designs, with the most significant limitation being the **Heterogeneous Metrics**, which prevented a unified quantitative synthesis. Clinicians should recognize that gender plays a distinct role in carotid stenosis presentation and outcomes, particularly in treatment-related risks for females, necessitating personalized approaches to screening, management, and post-procedural care.

References

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Figure 1. Publication-year distribution of included originals

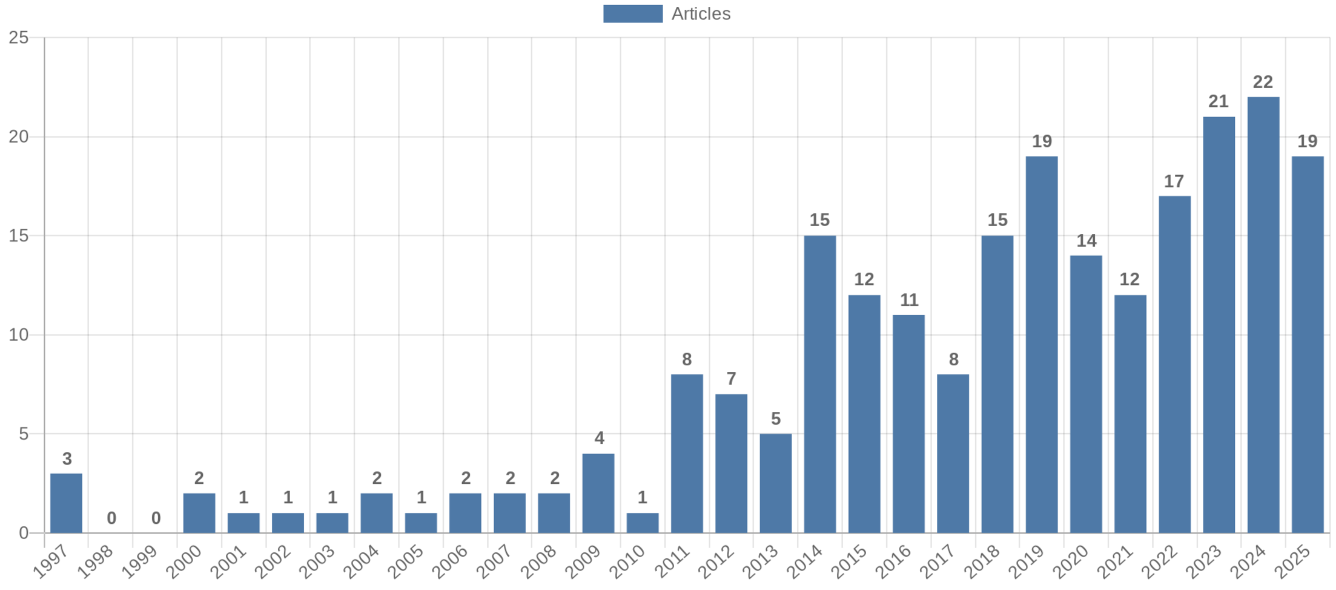

Figure 2. Study-design distribution of included originals

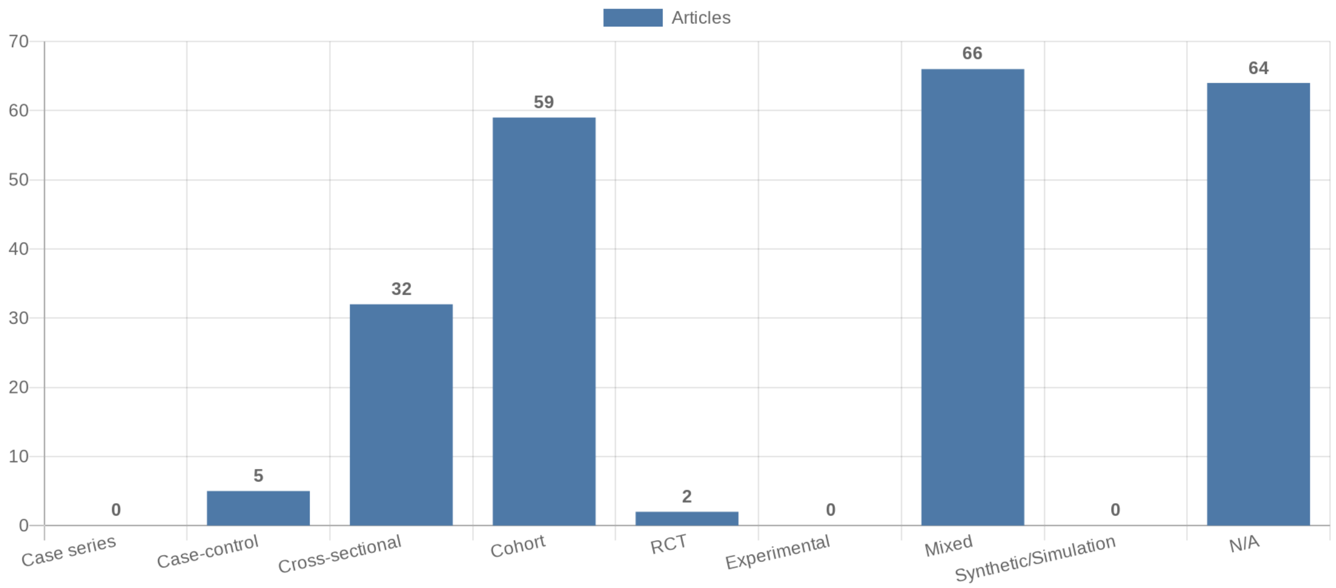

Figure 3. Study-type (directionality) distribution of included originals

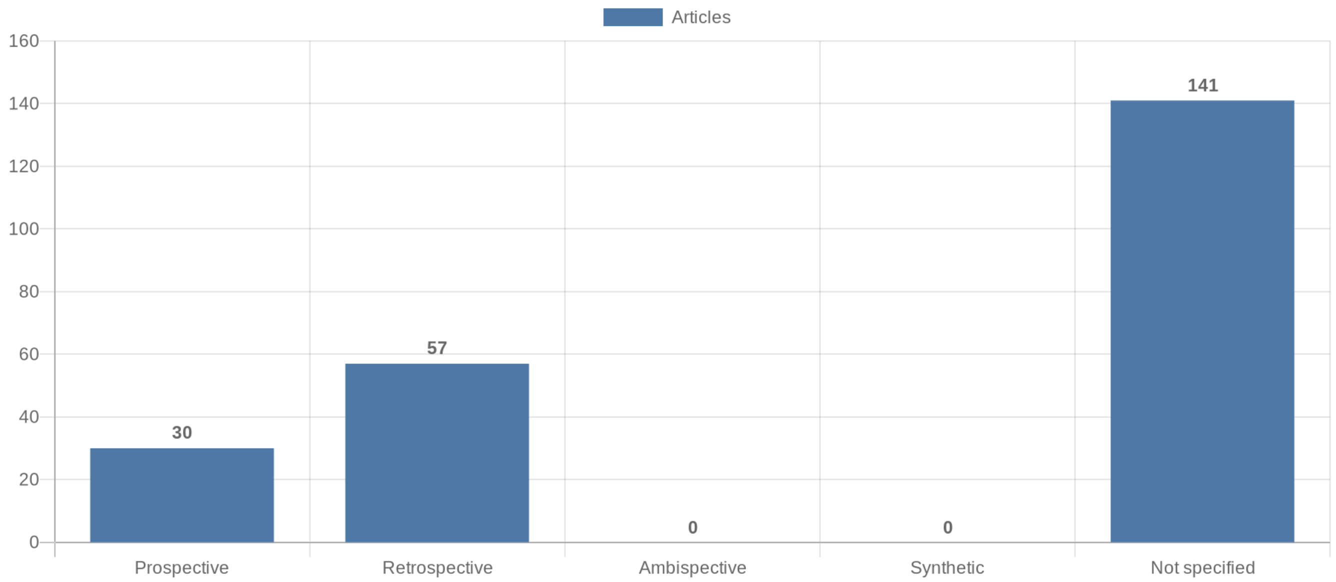

Figure 4. Main extracted research topics

- GENDER AS A DETERMINANT OF CAROTID STENOSIS
- GENDER-SPECIFIC RISKS IN POST-TREATMENT OUTCOMES
- COGNITIVE IMPAIRMENT AND CAROTID STENOSIS WITH GENDER
- INFLAMMATION AND CAROTID PLAQUE CHARACTERISTICS
- ASSOCIATED RISK FACTORS AND GENDER INTERACTIONS
- TREATMENT MODALITIES AND GENDER-SPECIFIC CONSIDERATIONS
- OCULAR AND CEREBRAL HEMODYNAMIC MANIFESTATIONS

Figure 5. Limitations of current studies (topics)

- HETEROGENEOUS METRICS
- STUDY DESIGN BIAS
- INCOMPLETE REPORTING
- POPULATION VARIABILITY
- LACK OF MECHANISTIC DETAIL

Figure 6. Future research directions (topics)

- STANDARDIZED GENDER-SPECIFIC OUTCOMES
- MECHANISTIC BASIS FOR GENDER DISPARITIES
- LONG-TERM FOLLOW-UP ON COGNITIVE IMPACT
- OPTIMIZED TREATMENT PROTOCOLS
- ROLE OF NOVEL BIOMARKERS
- PROSPECTIVE COHORT STUDIES
- GENDER-SPECIFIC RISK MODELS