Carotid Stenosis Prevalence: Systematic Review with ☸SAIMSARA.

Abstract: The aim of this paper is to systematically review and synthesize the reported prevalence of carotid stenosis from diverse studies, identify associated risk factors and clinical contexts, and outline the resulting clinical and research implications. The review utilises 289 studies with 452705 total participants (naïve ΣN). The prevalence of carotid stenosis (defined as ≥50% narrowing or significant stenosis) exhibits considerable heterogeneity across different populations and clinical settings, with a median of 13.5% and a range from 0.8% to 62.4%. This wide variability underscores that carotid stenosis is not a uniform entity but rather a condition whose occurrence is highly dependent on the specific population studied and the presence of underlying risk factors and comorbidities. The heterogeneous study populations and varied diagnostic criteria represent the most significant limitations to synthesizing a universal prevalence figure. Clinicians should recognize that while general population prevalence is low, the likelihood of significant carotid stenosis rises sharply in patients with cardiovascular risk factors or existing atherosclerotic disease, necessitating targeted screening and aggressive risk factor management in these vulnerable groups.

Keywords: Carotid Stenosis; Prevalence; Carotid Artery Disease

Review Stats

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- Source: Semantic Scholar
- Scope: All fields
- Keyword Gate: Fuzzy (≥60% of required terms, minimum 2 terms matched in title/abstract)
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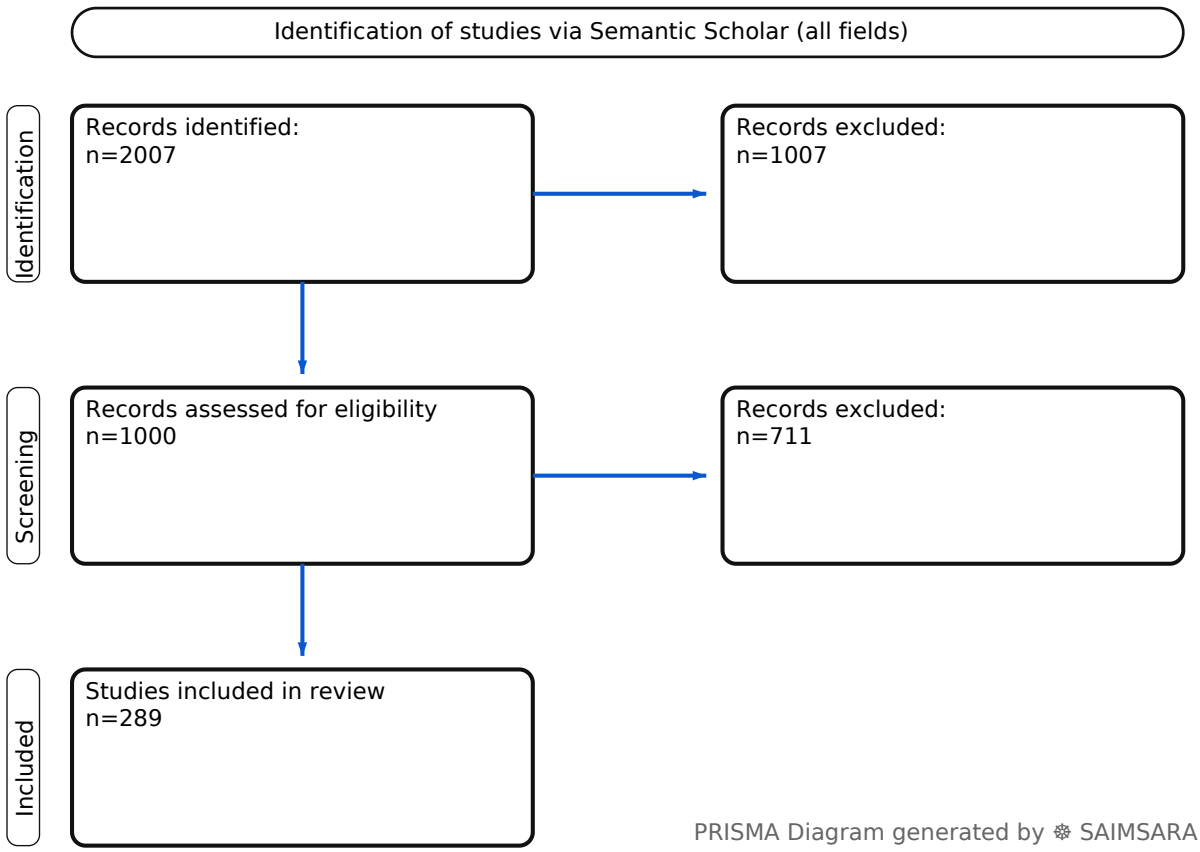
- Downloaded Abstracts/Papers: 1000
- Included original Abstracts/Papers: 289
- Total study participants (naïve ΣN): 452705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Screening
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Included
Studies included in review
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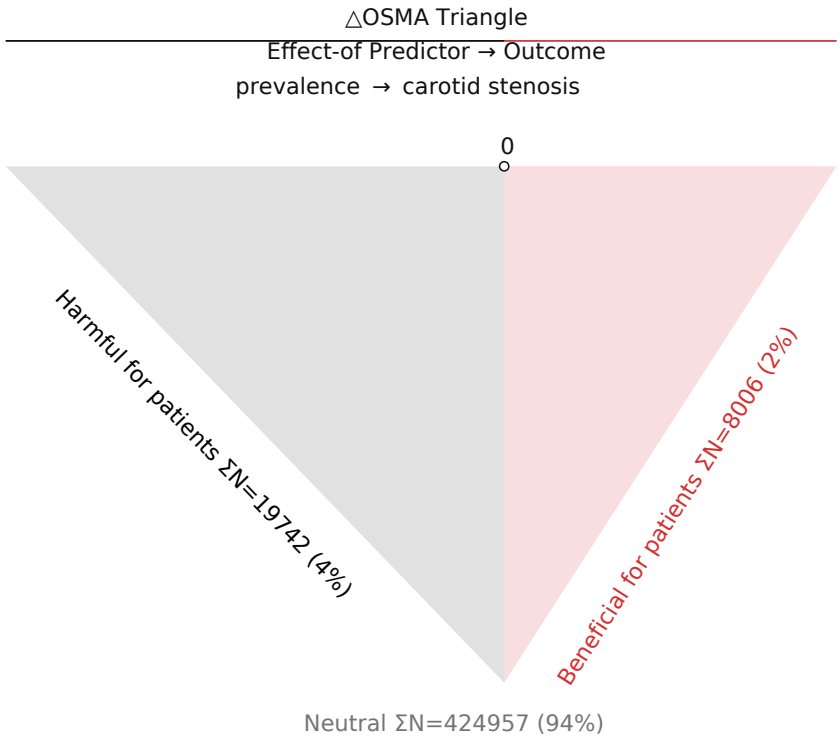
PRISMA Diagram generated by ☸ SAIMSARA


△OSMA Triangle
Effect-of Predictor → Outcome
prevalence → carotid stenosis
0
Harmful for patients ΣN=19742 (4%)
Beneficial for patients ΣN=8006 (2%)
Neutral ΣN=424957 (94%)
△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: 5-y, 55-y. Reported metrics: %, CI, p.

Common endpoints: Common endpoints: complications, occlusion, mortality.

Predictor: prevalence — exposure/predictor. Doses/units seen: 45 ml, 1.2 mg. Typical comparator: whites, asymptomatic ones, bilateral carotid stenosis or, control….

- **1) Beneficial for patients** — carotid stenosis with prevalence — [73] — ΣN=8006
- **2) Harmful for patients** — carotid stenosis with prevalence — [25], [77], [91], [127], [129], [130], [136], [137], [141], [148], [150], [177], [178], [181], [186], [188], [192], [194], [195] — ΣN=19742
- **3) No clear effect** — carotid stenosis with prevalence — [1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [26], [27], [28], [29], [30], [31], [32], [33], [34], [35], [36], [37], [38], [39], [40], [41], [42], [43], [44], [45], [46], [47], [48], [49], [50], [51], [52], [53], [54], [55], [56], [57], [58], [59], [60], [61], [62], [63], [64], [65], [66], [67], [68], [69], [70], [71], [72], [74], [75], [76], [78], [79], [80], [81], [82], [83], [84], [85], [86], [87], [88], [89], [90], [92], [93], [94], [95], [96], [97], [98], [99], [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], [128], [131], [132], [133], [134], [135], [138], [139], [140], [142], [143], [144], [145], [146], [147], [149], [151], [152], [153], [154], [155], [156], [157], [158], [159], [160], [161], [162], [163], [164], [165], [166], [167], [168], [169], [170], [171], [172], [173], [174], [175], [176], [179], [180], [182], [183], [184], [185], [187], [189], [190], [191], [193], [196], [197], [198], [199], [200], [201], [202], [203], [204], [205], [206], [207], [208], [209], [210], [211], [212], [213], [214], [215], [216], [217], [218], [219], [220], [221], [222], [223], [224], [225], [226], [227], [228], [229], [230], [231], [232], [233], [234], [235], [236], [237], [238], [239], [240], [241], [242], [243], [244], [245], [246], [247], [248], [249], [250], [251], [252], [253], [254], [255], [256], [257], [258], [259], [260], [261], [262], [263], [264], [265], [266], [267], [268], [269], [270], [271], [272], [273], [274], [275], [276], [277], [278], [279], [280], [281], [282], [283], [284], [285], [286], [287], [288], [289] — ΣN=424957

Introduction

Carotid artery stenosis (CAS), a narrowing of the carotid arteries, is a significant manifestation of

atherosclerosis and a leading cause of ischemic stroke. Its prevalence varies widely across different populations and clinical contexts, reflecting diverse risk factor profiles and diagnostic approaches. Understanding the epidemiology of CAS is crucial for identifying high-risk individuals, guiding screening strategies, and informing clinical management to prevent cerebrovascular events. This paper synthesizes findings on the prevalence of carotid stenosis across various patient cohorts and the general population, highlighting key associations and implications for clinical practice and future research.

Aim

The aim of this paper is to systematically review and synthesize the reported prevalence of carotid stenosis from diverse studies, identify associated risk factors and clinical contexts, and outline the resulting clinical and research implications.

Methods

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

- **Bias:** The included studies exhibit a range of designs, from cross-sectional and prospective cohort studies to retrospective analyses and randomized controlled trials (RCTs). Many studies are cross-sectional or retrospective, limiting the ability to infer causality or disease progression over time. Population selection bias is evident, with a heavy focus on patients with existing cardiovascular disease or stroke, potentially overestimating general population prevalence. Diagnostic criteria for stenosis also vary, contributing to heterogeneity.

Results

4.1 Study characteristics

The included studies comprise a diverse range of designs, predominantly cross-sectional and cohort studies, with some prospective and retrospective analyses. Populations studied span general community residents, patients undergoing various cardiac surgeries, individuals with chronic kidney disease (CKD), diabetes, peripheral arterial disease (PAD), and those presenting with acute ischemic stroke or transient ischemic attack (TIA). Follow-up periods, where reported, ranged from short-term (e.g., 30-day [25]) to several years (e.g., 5 years [16, 43, 44]).

4.2 Main numerical result aligned to the query

The prevalence of carotid stenosis (defined as ≥50% narrowing or significant stenosis) exhibits considerable heterogeneity across different populations and clinical settings. Across studies reporting

this metric, the median prevalence was 13.5% [7, 13, 20, 21, 184], with a wide range observed from 0.8% [221] to 62.4% [55]. For instance, in general health screening populations, prevalence was as low as 0.9% in Korea [42] and 1.87% in commercial vascular screening clinics [37]. In contrast, among patients with acute ischemic stroke, prevalence frequently ranged from 4.0% [16] to 62.4% [55]. Patients undergoing cardiac surgery also showed high prevalence, such as 18.7% in those undergoing elective myocardial revascularization [50] and 21.68% in coronary artery bypass grafting (CABG) patients [138].

4.3 Topic synthesis

- **General Population Prevalence:** Carotid stenosis prevalence is low in the general asymptomatic population, ranging from 0.56% in Chinese adults [14] to 3% generally [63, 67], but increases with age, reaching 6-15% in individuals aged 65 and older [132].
- **Association with Cardiovascular and Cerebrovascular Events:** The prevalence of carotid stenosis is markedly higher in patients with existing cardiovascular diseases or cerebrovascular events. For instance, it is 6.9% in patients with atrial fibrillation (AF) and acute ischemic stroke [4], 18.7% in acute ischemic stroke patients [10], and 60% in ischemic stroke/TIA patients [59]. Patients with peripheral arterial disease (PAD) show prevalence rates of 14% [24] to 19.6% for significant asymptomatic carotid artery stenosis [17].
- **Specific High-Risk Patient Groups:** Certain patient groups exhibit particularly elevated prevalence. This includes 33.9% in type 2 diabetes (T2D) patients [21], 51.2% in chronic kidney disease (CKD) patients undergoing dialysis [65], 75.0% in patients undergoing CABG [33], and 71% in patients undergoing cardiac surgery generally [9].
- **Plaque Characteristics and Risk:** Beyond stenosis degree, plaque features like intraplaque hemorrhage (IPH) are crucial. IPH was found in 24% of asymptomatic patients with <50% stenosis [64] and 7.2% of carotid arteries overall [148], with a higher prevalence in symptomatic arteries [205]. High-risk plaque (HRP) was nearly 1.5 times more prevalent than severe stenosis in Chinese patients with cerebrovascular symptoms [47].
- **Risk Factors for Carotid Stenosis:** Age is a consistent risk factor, with prevalence increasing significantly in older populations [35, 58, 72]. Other common risk factors include hypertension [51, 55, 66, 263], diabetes mellitus [51, 60, 177, 178], smoking [58, 66, 71], male sex [35, 51, 57, 67, 70, 252, 235], and elevated lipid levels [39, 51, 73, 278].
- **Geographic and Racial Variations:** There are notable geographic and racial differences in prevalence. For example, general population prevalence in China ranges from 0.56% [14] to 6.7% [19], while in Korea, it is 1.1% [3]. Racial differences in high-grade stenosis were observed in the US, with Blacks and Hispanics having lower prevalence compared to Whites, and Native Americans having higher prevalence [35].

- **Prognostic Indicators:** Carotid stenosis, especially high-grade, is associated with adverse outcomes. It is an independent predictor of mortality in CABG patients [69] and is linked to increased 5-year mortality in acute ischemic stroke patients with high-grade stenosis, particularly with co-existing CKD (eGFR < 45 mL/min/1.73 m^2) [43] or coronary artery disease (CAD) [44]. Bilateral CAS is associated with an increased risk of stroke in transcatheter aortic valve implantation (TAVI) patients [25].

Discussion

5.1 Principal finding

The median prevalence of carotid stenosis (defined as ≥50% narrowing or significant stenosis) across diverse populations and clinical contexts is 13.5% [7, 13, 20, 21, 184], ranging from 0.8% [221] to 62.4% [55], underscoring its variable but often substantial presence in at-risk individuals.

5.2 Clinical implications

- **Targeted Screening:** Patients with existing cardiovascular conditions (e.g., CAD, PAD, AF) or risk factors (e.g., T2DM, hypertension, CKD) should be considered for carotid artery screening due to their significantly elevated prevalence of stenosis [10, 17, 21, 65].
- **Beyond Stenosis Degree:** Clinicians should consider plaque characteristics, such as intraplaque hemorrhage (IPH) and high-risk plaque (HRP) features, even in non-stenotic or mildly stenotic lesions, as these are independently associated with ischemic events [47, 64, 205].
- **Pre-Surgical Assessment:** Routine carotid artery assessment is critical before major cardiac surgeries (e.g., CABG, TAVI) given the high prevalence of CAS in these cohorts and its association with increased perioperative and long-term risks [9, 25, 58, 69].
- **Risk Factor Management:** Aggressive management of traditional cardiovascular risk factors like age, hypertension, diabetes, and smoking is paramount in reducing the incidence and progression of carotid stenosis and improving patient outcomes [51, 58, 66, 71].
- **Racial and Geographic Considerations:** Awareness of racial and geographic variations in carotid stenosis prevalence is important for tailoring screening programs and public health interventions to specific populations [3, 14, 35].

5.3 Research implications / key gaps

- **Standardized Diagnostic Criteria:** Future research should establish harmonized definitions and measurement protocols for carotid stenosis and plaque characteristics to enable more consistent comparisons across studies [45, 204].
- **Longitudinal Plaque Progression:** Prospective studies are needed to track the natural history of non-stenotic carotid plaques and their progression to significant stenosis or symptomatic events in diverse populations [38, 140].
- **Intervention Efficacy in High-Risk Cohorts:** Randomized controlled trials are warranted to evaluate the effectiveness of targeted screening and early interventions for carotid stenosis in specific high-risk groups such as patients with CKD, severe T2DM, or those undergoing complex surgeries [1, 21, 65].
- **Biomarkers for Plaque Instability:** Research should focus on identifying novel circulating biomarkers (e.g., PTX3, TNF-α, LDL-C, M2BPGi) that can reliably predict plaque instability and stroke risk, complementing imaging findings [39, 130].
- **Impact of Environmental Factors:** Further investigation into the influence of environmental factors (e.g., high altitude [254]) and lifestyle interventions on carotid stenosis prevalence and progression is needed across different global regions.

5.4 Limitations

- **Heterogeneous Study Populations** — The synthesis draws from highly varied populations, from general community screenings to specific disease cohorts, making a single, universally applicable prevalence difficult to ascertain.
- **Varied Diagnostic Criteria** — Definitions of "significant" or "severe" stenosis (e.g., ≥50%, ≥70%, 50-99%) and diagnostic modalities (ultrasound, CTA, MRA) differ across studies, impacting comparability.
- **Cross-Sectional Designs** — Many studies are cross-sectional, providing prevalence snapshots but limiting insights into disease incidence, progression, or the causal relationships between risk factors and stenosis.
- **Limited Long-Term Follow-up** — While some studies include follow-up, comprehensive long-term data on the natural history and outcomes of different stenosis degrees in diverse populations are often sparse.
- **Geographic and Racial Bias** — A significant portion of the data originates from Asian populations and specific clinical settings, potentially limiting generalizability to other ethnic groups or healthcare systems.

5.5 Future directions

- **Standardized Imaging Protocols** — Develop and implement uniform imaging protocols and stenosis grading systems for carotid artery assessment globally.
- **Population-Based Registries** — Establish large-scale, prospective population-based registries to track carotid stenosis incidence and progression over decades.
- **Multi-Omics Biomarker Discovery** — Investigate multi-omics data (genomics, proteomics, metabolomics) to identify novel biomarkers for early carotid disease detection and risk stratification.
- **AI-Driven Risk Prediction** — Utilize artificial intelligence and machine learning to integrate clinical, imaging, and biomarker data for more accurate carotid stenosis risk prediction.
- **Cost-Effectiveness Analyses** — Conduct studies to assess the cost-effectiveness of different carotid stenosis screening strategies in various high-risk populations.

Conclusion

The prevalence of carotid stenosis (defined as ≥50% narrowing or significant stenosis) exhibits considerable heterogeneity across different populations and clinical settings, with a median of 13.5% [7, 13, 20, 21, 184] and a range from 0.8% [221] to 62.4% [55]. This wide variability underscores that carotid stenosis is not a uniform entity but rather a condition whose occurrence is highly dependent on the specific population studied and the presence of underlying risk factors and comorbidities. The heterogeneous study populations and varied diagnostic criteria represent the most significant limitations to synthesizing a universal prevalence figure. Clinicians should recognize that while general population prevalence is low, the likelihood of significant carotid stenosis rises sharply in patients with cardiovascular risk factors or existing atherosclerotic disease, necessitating targeted screening and aggressive risk factor management in these vulnerable groups.

References

SAIMSARA Session Index — session.json

Figure 1. Publication-year distribution of included originals

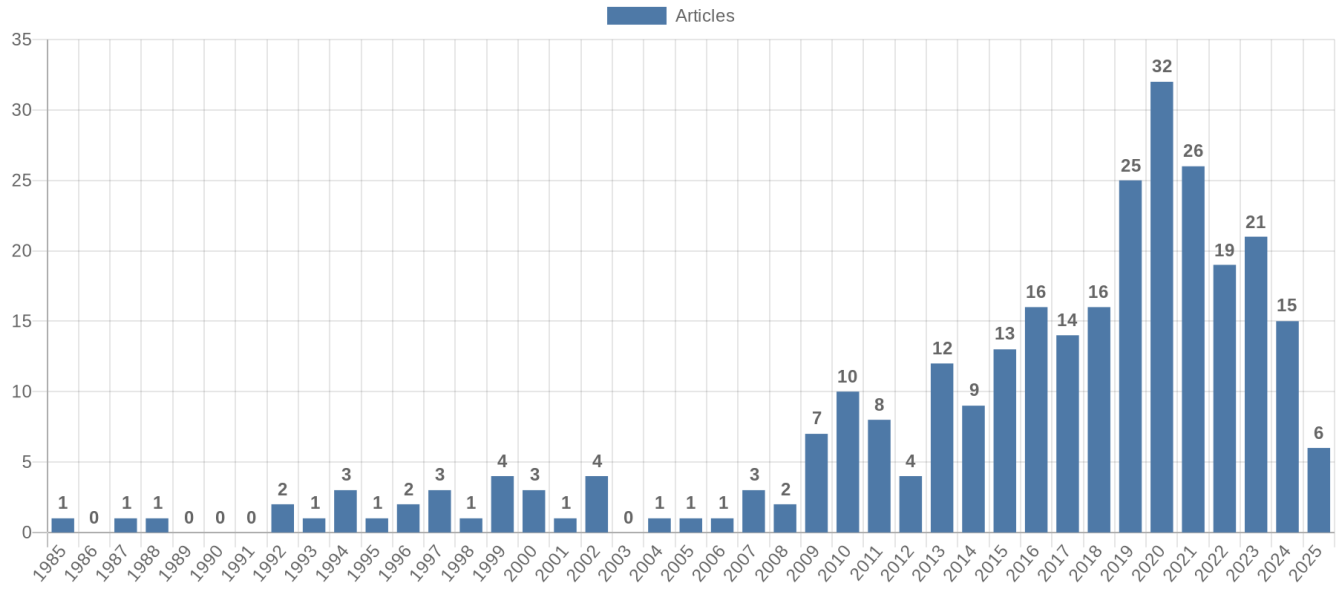


Figure 2. Study-design distribution of included originals

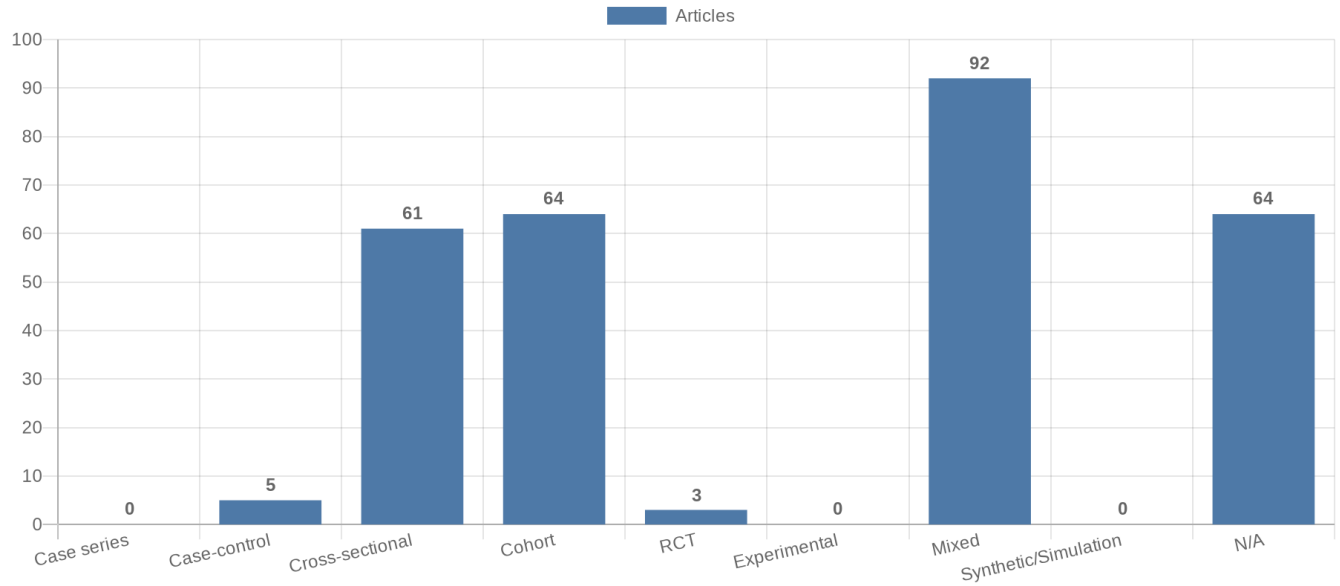


Figure 3. Study-type (directionality) distribution of included originals

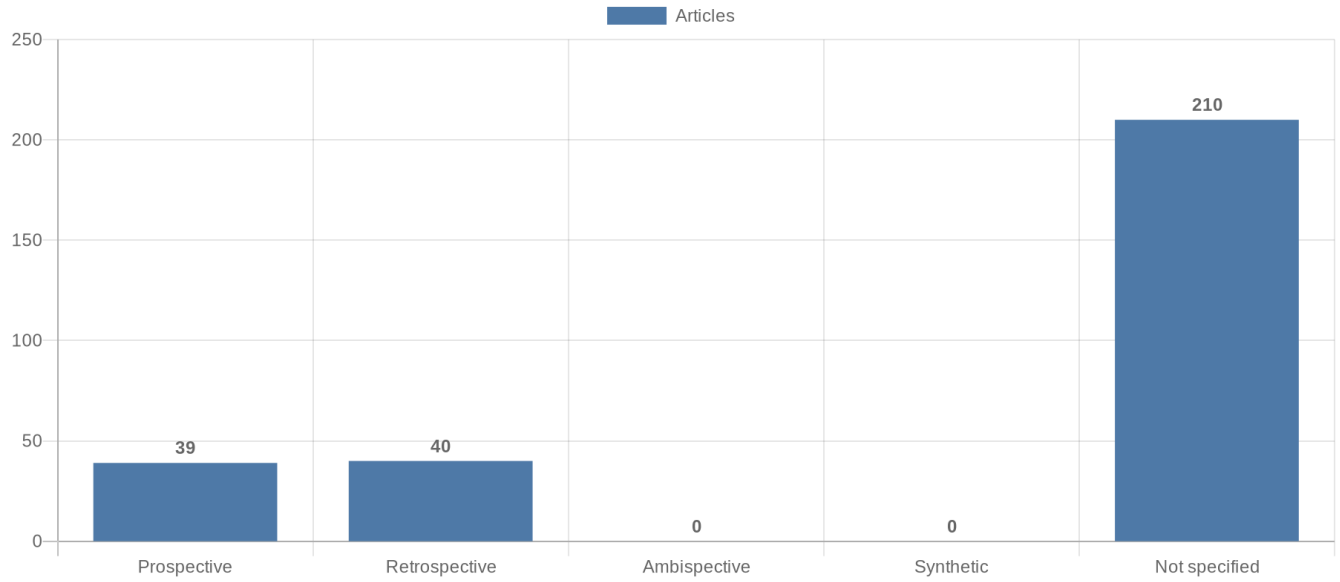


Figure 4. Main extracted research topics

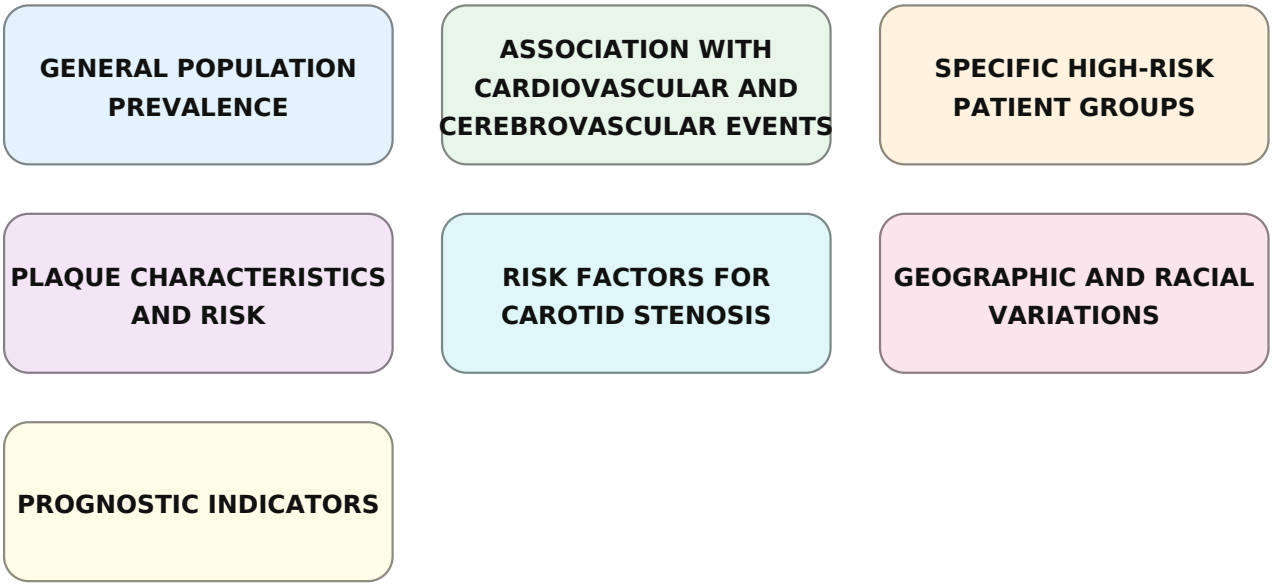


Figure 5. Limitations of current studies (topics)

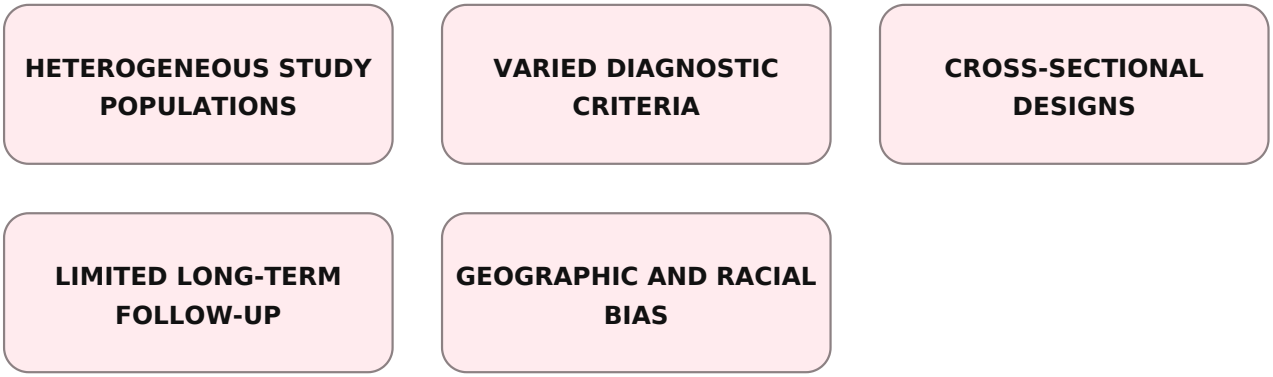


Figure 6. Future research directions (topics)