Abdominal Aortic Aneurysm and Gender: Systematic Review with ☸SAIMSARA.

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Abstract: This paper aims to systematically review and synthesize the current evidence on gender differences in the epidemiology, pathophysiology, clinical presentation, and outcomes of abdominal aortic aneurysm, identifying key research trends and implications for clinical practice. The review utilises 281 studies with 2287059 total participants (naïve ΣN). The pooled prevalence of abdominal aortic aneurysms (AAAs) in the general population showed a significant gender difference, with a median male prevalence of 5.16% (range 3.9–9.5%) compared to a median female prevalence of 1.6% (range 1.23–2.9%). While AAA is more prevalent in men, women often experience worse clinical outcomes, including higher mortality rates and reduced long-term survival after repair. The generalizability of some findings is limited by the retrospective nature and male predominance in many studies. A critical next step is to update national and international AAA guidelines to incorporate gender-specific recommendations for screening and management, ensuring equitable care for all patients.

Keywords: Abdominal aortic aneurysm; Gender differences; AAA rupture; Mortality; Endovascular repair; Open repair; Survival outcomes; Aortic anatomy; Screening practices; Pathophysiology

Review Stats

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- 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)
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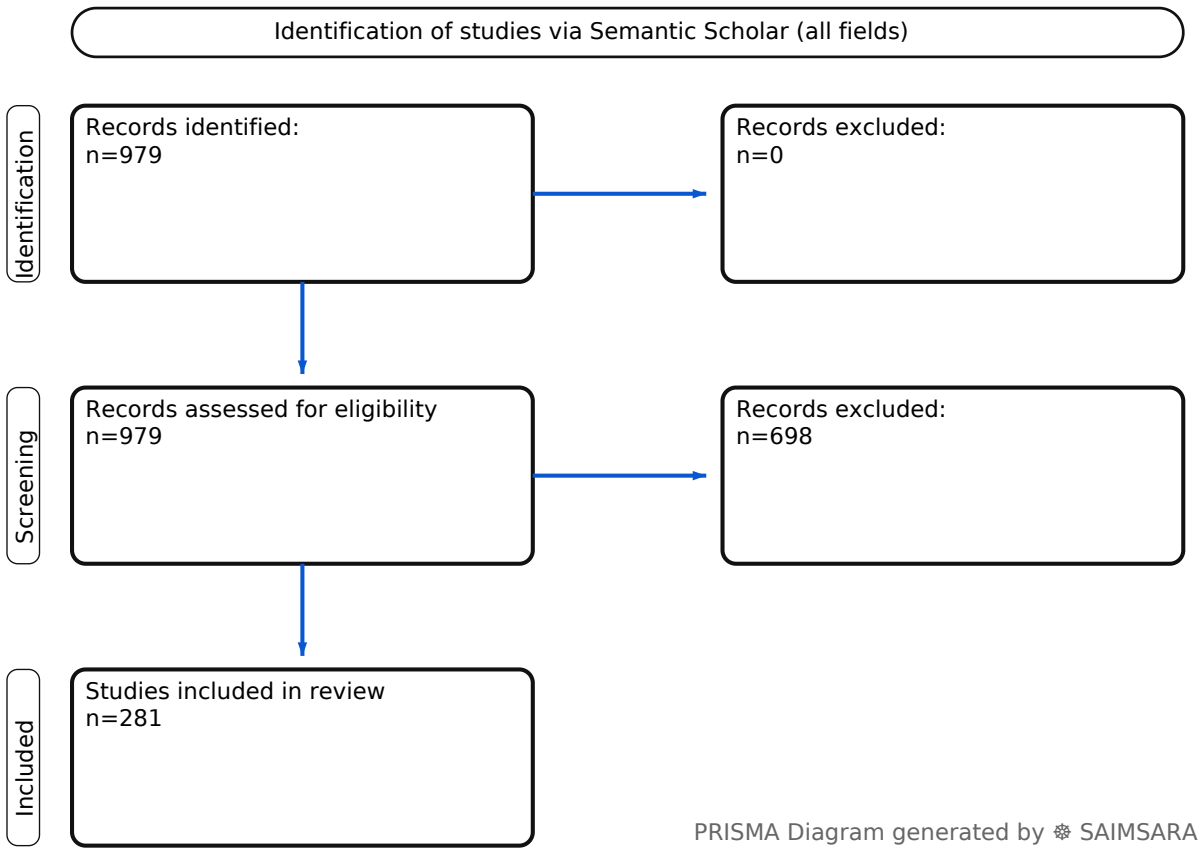
- Downloaded Abstracts/Papers: 979
- Included original Abstracts/Papers: 281
- Total study participants (naïve ΣN): 2287059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Records excluded:
n=0
Screening
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Records excluded:
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Included
Studies included in review
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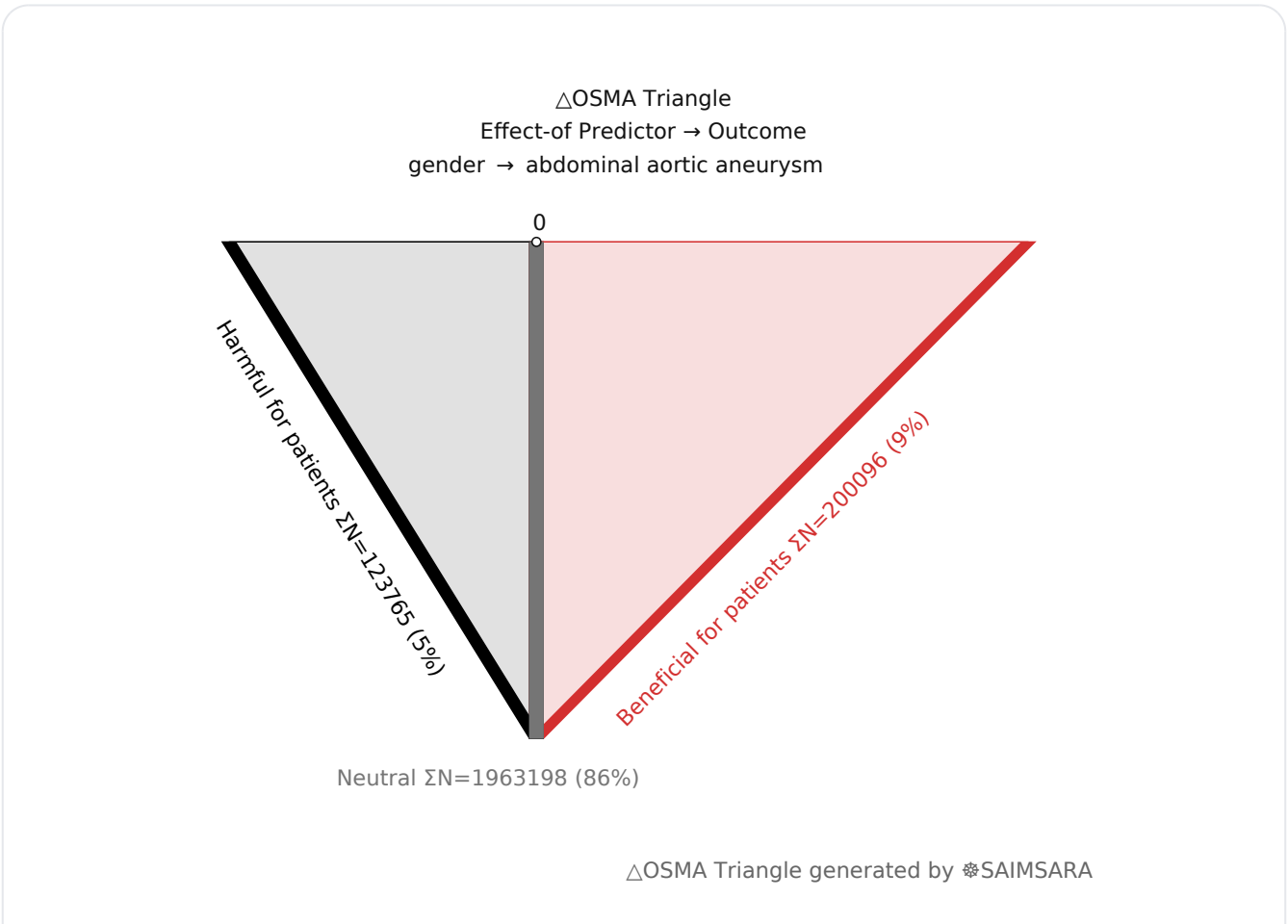
PRISMA Diagram generated by ☸ SAIMSARA


△OSMA Triangle
Effect-of Predictor → Outcome
gender → abdominal aortic aneurysm
0
Harmful for patients ΣN=123765 (5%)
Beneficial for patients ΣN=200096 (9%)
Neutral ΣN=1963198 (86%)
△OSMA Triangle generated by ☸SAIMSARA

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

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

Outcome: abdominal aortic aneurysm Typical timepoints: peri/post-op, 30-day. Reported metrics: %, CI, p.

Common endpoints: Common endpoints: mortality, survival, complications.

Predictor: gender — exposure/predictor. Doses/units seen: 100 ml. Routes seen: topical. Typical comparator: men, patients without aaa, aortic diameter in predicting, women….

- **1) Beneficial for patients** — abdominal aortic aneurysm with gender — [15], [112], [156] — ΣN=200096
- **2) Harmful for patients** — abdominal aortic aneurysm with gender — [1], [7], [9], [12], [50], [66], [68], [84], [92], [123], [154], [234], [237], [239], [240], [249], [251], [252], [253], [255], [257], [258], [260], [261], [265], [267] — ΣN=123765
- **3) No clear effect** — abdominal aortic aneurysm with gender — [2], [3], [4], [5], [6], [8], [10], [11], [13], [14], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30], [31], [32], [33], [34], [35], [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], [67], [69], [70], [71], [72], [73], [74], [75], [76], [77], [78], [79], [80], [81], [82], [83], [85], [86], [87], [88], [89], [90], [91], [93], [94], [95], [96], [97], [98], [99], [100], [101], [102], [103], [104], [105], [106], [107], [108], [109], [110], [111], [113], [114], [115], [116], [117], [118], [119], [120], [121], [122], [124], [125], [126], [127], [128], [129], [130], [131], [132], [133], [134], [135], [136], [137], [138], [139], [140], [141], [142], [143], [144], [145], [146], [147], [148], [149], [150], [151], [152], [153], [155], [157], [158], [159], [160], [161], [162], [163], [164], [165], [166], [167], [168], [169], [170], [171], [172], [173], [174], [175], [176], [177], [178], [179], [180], [181], [182], [183], [184], [185], [186], [187], [188], [189], [190], [191], [192], [193], [194], [195], [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], [235], [236], [238], [241], [242], [243], [244], [245], [246], [247], [248], [250], [254], [256], [259], [262], [263], [264], [266], [268], [269], [270], [271], [272], [273], [274], [275], [276], [277], [278], [279], [280], [281] — ΣN=1963198

1) Introduction

Abdominal aortic aneurysm (AAA) is a significant cardiovascular pathology characterized by a

localized dilatation of the abdominal aorta. While traditionally considered a disease predominantly affecting men, a growing body of research highlights critical gender-based differences in its prevalence, pathophysiology, anatomical presentation, clinical course, and treatment outcomes. These disparities underscore the necessity for gender-specific approaches in screening, diagnosis, and management strategies. This paper synthesizes current findings on the intricate relationship between abdominal aortic aneurysm and gender, drawing from a comprehensive structured extraction summary of recent academic literature.

2) Aim

This paper aims to systematically review and synthesize the current evidence on gender differences in the epidemiology, pathophysiology, clinical presentation, and outcomes of abdominal aortic aneurysm, identifying key research trends and implications for clinical practice.

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. Retrospective cohort studies and those without specified study designs or directionality may be prone to selection and reporting biases. Animal models and small case series limit generalizability to human populations. Studies focusing solely on male populations inherently limit the understanding of gender differences.

4) Results

4.1 Study characteristics: The included studies primarily comprised retrospective cohort analyses, mixed-design studies, and cross-sectional investigations, with some prospective cohorts and experimental animal models. Populations ranged from large national databases and screening programs to smaller cohorts of patients undergoing specific surgical repairs, dialysis patients, and animal models. Follow-up periods varied widely, from immediate perioperative outcomes to long-term surveillance extending up to 24 years.

4.2 Main numerical result aligned to the query:

The pooled prevalence of abdominal aortic aneurysms (AAAs) in the general population showed a significant gender difference, with a median male prevalence of 5.16% (range 3.9–9.5%) [40, 112, 245, 267] compared to a median female prevalence of 1.6% (range 1.23–2.9%) [40, 112, 245]. Among patients diagnosed with AAA, males consistently comprised the majority, with a median of 83% (range 66.7–92%) [7, 46, 76, 83, 106, 178, 217, 238, 244, 253, 257]. While perioperative

mortality for open AAA repair was similar between men (5.7%) and women (6.5%) in one large cohort [1], long-term survival after 9 years was significantly better in men (55.0%) than in women (43.8%) (P = .006) [1].

4.3 Topic synthesis:

- **Prevalence and Risk Factors:** Male gender is a consistently identified major risk factor for AAA development [28, 33, 39, 40, 42, 43, 45, 46, 64, 65, 68, 111, 112, 113, 154, 156, 213, 217, 220, 238, 242, 245, 251, 260, 267]. The pooled prevalence of AAA is significantly higher in males (median 5.16%, range 3.9–9.5%) compared to females (median 1.6%, range 1.23–2.9%) [40, 112, 245, 267]. Female gender was also identified as an independent predictor of AAA development in one study [20]. Other risk factors include age, smoking, hypertension, and family history [40, 42, 43, 45, 162, 256, 265, 270].
- **Anatomical and Morphological Differences:** Males generally have significantly larger abdominal aorta diameters than females [72, 82, 96, 98, 99, 101, 102, 112, 160, 161, 216, 242, 268]. The mean infrarenal aortic diameter is 21.4 mm in men and 18.7 mm in women [101]. Women with AAA tend to be older at operation [1, 116] and often present with more challenging anatomy for endovascular repair (EVAR), such as hostile proximal aortic neck features (e.g., shorter neck length, greater angulation) [9, 35, 97, 138, 140].
- **Rupture Risk and Presentation:** While AAA rupture incidence is higher in males [7], females often present with rupture at a significantly smaller aneurysm size (mean 7.4 cm vs. 8.2 cm in males, P=0.04) [7]. Morphological and hemodynamic features in female AAA models suggest a higher risk of rupture, exhibiting higher peak pressure and lower oscillatory shear stress index [8, 51, 249]. Gender, smoking, body size, and aneurysm geometry influence biomechanical rupture risk [29].
- **Mortality and Survival Outcomes:** Women generally experience worse outcomes after AAA repair. For ruptured AAA (rAAA), women have higher overall and postoperative mortality [7, 12, 53, 239]. In-hospital mortality for rAAA is higher in women (41.5%) vs. men (32.2%) [12], and 5-year survival is lower (29.1% vs. 40.7%, $p < 0.001$) [12]. Female gender is associated with an increased risk of 30-day mortality in both open (86% increased risk) and endovascular (50% increased risk) repair cohorts [9]. Long-term survival after open AAA repair is better in men (55.0% vs. 43.8% at 9 years, P=0.006) [1]. However, some studies found no significant difference in perioperative or 30-day mortality between genders after elective repair [1, 27, 208, 271]. Women also have a significantly lower rate of alive hospital discharge after infrarenal AAA repair [123].
- **Treatment Challenges and Complications:** Women are more likely to undergo open AAA repair than EVAR (33.5% vs. 20.9%) [23]. Female gender is a risk factor for endoleak type 1A [50] and aneurysmal sac enlargement after EVAR [66]. Women undergoing complex

endovascular aortic repair (f/b-EVAR, ch-EVAR) have more complications and worse in-hospital and long-term survival [234]. Female gender is also a significant risk factor for secondary intervention in Japanese patients after EVAR [92] and for higher intraoperative transfusion rates in open surgery for descending thoracic and abdominal aortic aneurysms [119].

- **Screening and Management Disparities:** There is a call for equitable screening practices regarding gender differences in AAA management [2]. Female gender is identified as a risk factor for being turned down for elective AAA repair, leading to lower survival rates in these patients [237, 240]. Guidelines for AAA management may need to include gender-specific considerations [163]. Large language models showed less accurate diagnoses for female patients with AAA compared to male patients [250].
- **Biological and Genetic Factors:** Gender-based features in histopathology of the abdominal aorta may determine differences in AAA anatomy and course [4]. Female sex hormones negatively regulate CD45+ fibroblast formation and IL-33 secretion, resulting in reduced Treg function in female mice during AAA development [17]. Increased PAI-1 in females compared with males was found to be protective for AAA formation in a rodent model [75]. Genetic factors like the IL-6 rs1800796 polymorphism show elevated AAA risk among males [33]. Differential mutational landscapes in the mitochondrial genome were identified in men with AAA [134]. Elimination of hepcidin demonstrated protective effects in male mice but deleterious effects in female mice with AAA, suggesting gender-specific clinical implications [170].
- **Predictive Factors:** Gender is considered a confounder or covariate in models predicting AAA rupture [21], prediction of AAA development [16, 37, 49], and long-term survival after repair [52, 54, 57, 69, 228]. Male gender and aortic aneurysm diameter ≥67 mm were predictors of postcontrast acute kidney injury (PC-AKI) after EVAR [11]. Female gender was a significant predictor of a greater than 20% drop in glomerular filtration rate (GFR) 5 years after EVAR [10, 109]. Elevated TMAO levels predict increased risk of AAA and fast growth [129, 130, 149, 150, 215]. Metformin's association with slower AAA growth was significantly influenced by male gender [147].

5) Discussion

5.1 Principal finding: This review highlights that while the pooled prevalence of abdominal aortic aneurysms is significantly higher in males (median 5.16%, range 3.9–9.5%) compared to females (median 1.6%, range 1.23–2.9%) [40, 112, 245, 267], women with AAA often face worse clinical outcomes, including higher mortality rates after both ruptured and elective repairs, and reduced long-term survival compared to men [1, 7, 9, 12, 123].

5.2 Clinical implications:

- **Targeted Screening:** Current screening guidelines, often focused on older men, should consider expanding to include women with specific risk factors or those presenting with smaller aneurysms, given their higher rupture risk at smaller sizes [2, 7, 8].
- **Personalized Management:** Treatment decisions for women with AAA should account for their distinct anatomical challenges, such as hostile neck anatomy for EVAR, and their increased risk of complications like endoleaks and sac enlargement [9, 35, 50, 66, 138, 140, 141].
- **Post-Procedural Monitoring:** Enhanced surveillance for renal function decline is warranted for female patients after EVAR, as female gender is a significant predictor of GFR drop [10, 109].
- **Awareness of Disparities:** Clinicians should be aware of the observed gender disparities in outcomes, particularly the higher mortality and lower survival rates in women, to ensure equitable care and address potential biases in treatment selection [7, 12, 123, 237, 240, 250].
- **Risk Factor Modification:** Given the influence of gender on AAA development and progression, targeted interventions for modifiable risk factors should consider gender-specific biological responses, such as the male-specific influence of metformin on AAA growth [147].

5.3 Research implications / key gaps:

- **Gender-Specific Rupture Thresholds:** Further research is needed to establish gender-specific aneurysm size thresholds for intervention, considering that women rupture at smaller diameters [7, 8, 249].
- **Mechanistic Differences:** Longitudinal studies are required to fully elucidate the biological and hormonal mechanisms underlying gender differences in AAA development, progression, and rupture risk, including the role of sex hormones and inflammatory pathways [4, 17, 75, 170].
- **Optimizing EVAR for Women:** Prospective studies are needed to develop and evaluate EVAR devices and techniques specifically tailored to the unique anatomical challenges presented by women, aiming to improve eligibility and reduce complications [9, 35, 138].
- **Impact of Bias on Outcomes:** Research should investigate the extent to which implicit biases in diagnosis, referral, and treatment decisions contribute to the observed poorer outcomes in women with AAA [2, 237, 240, 250].
- **Genetic and Biomarker Panels:** Future studies should integrate genetic and proteomic data with clinical risk factors to improve AAA prediction and identify gender-specific

biomarkers for early detection and personalized treatment strategies [16, 33, 126, 132, 134, 143].

5.4 Limitations:

- **Retrospective Study Designs** — Many studies are retrospective, limiting causal inference and increasing susceptibility to selection and reporting biases.
- **Heterogeneous Outcome Metrics** — Variability in reported mortality and survival endpoints across studies makes direct quantitative comparison challenging.
- **Limited Female-Specific Data** — The predominance of male patients in many cohorts means that data on women with AAA are often less extensive or analyzed as subgroups.
- **Lack of Mechanistic Detail** — While biological differences are noted, comprehensive mechanistic studies explaining gender disparities in AAA progression are limited.
- **Geographic and Population Specificity** — Some studies are confined to specific populations or regions, potentially limiting the generalizability of findings to diverse global populations.

5.5 Future directions:

- **Prospective Cohort Studies** — Conduct large, prospective, gender-balanced cohort studies to track AAA progression and outcomes.
- **Gender-Specific Imaging Criteria** — Develop and validate gender-specific imaging criteria for AAA risk assessment and treatment planning.
- **Biological Mechanism Research** — Investigate the role of sex hormones and genetic factors in AAA pathogenesis in both genders.
- **AI-Enhanced Diagnostics** — Benchmark AI models for equitable AAA diagnosis and risk prediction across genders.
- **Clinical Guideline Refinement** — Update national and international AAA guidelines to incorporate gender-specific recommendations for screening and management.

6) Conclusion

The pooled prevalence of abdominal aortic aneurysms (AAAs) in the general population showed a significant gender difference, with a median male prevalence of 5.16% (range 3.9–9.5%) [40, 112, 245, 267] compared to a median female prevalence of 1.6% (range 1.23–2.9%) [40, 112, 245]. While AAA is more prevalent in men, women often experience worse clinical outcomes, including higher

mortality rates and reduced long-term survival after repair. The generalizability of some findings is limited by the retrospective nature and male predominance in many studies. A critical next step is to update national and international AAA guidelines to incorporate gender-specific recommendations for screening and management, ensuring equitable care for all patients.

References

SAIMSARA Session Index — session.json

Figure 1. Publication-year distribution of included originals

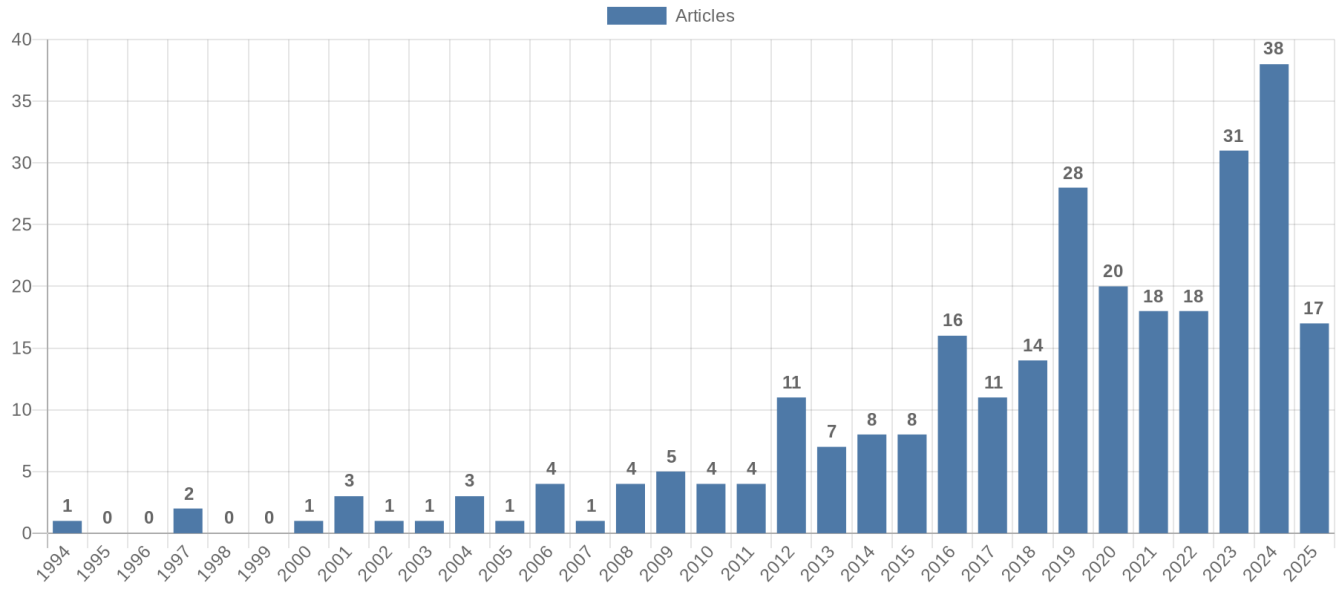


Figure 2. Study-design distribution of included originals

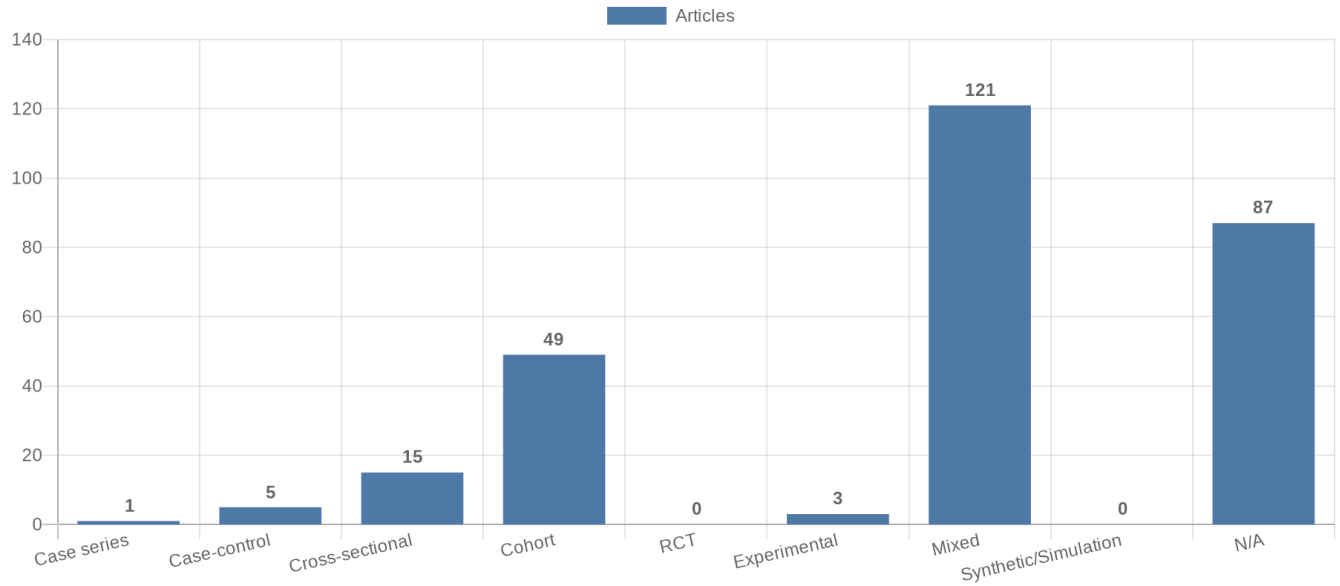


Figure 3. Study-type (directionality) distribution of included originals

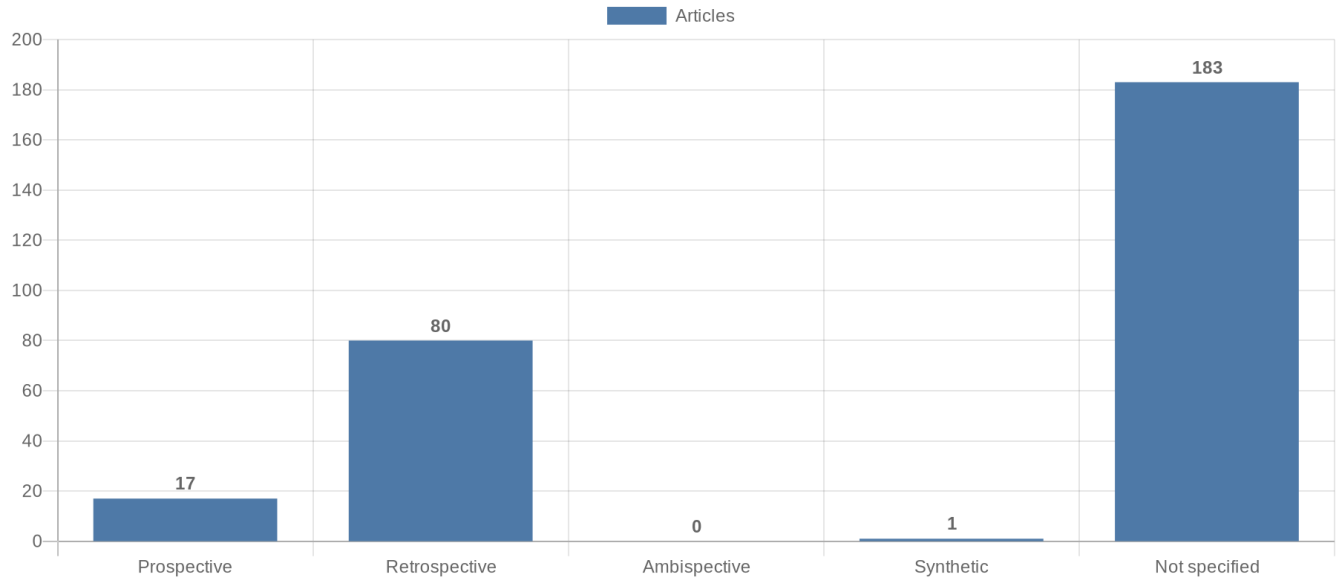


Figure 4. Main extracted research topics

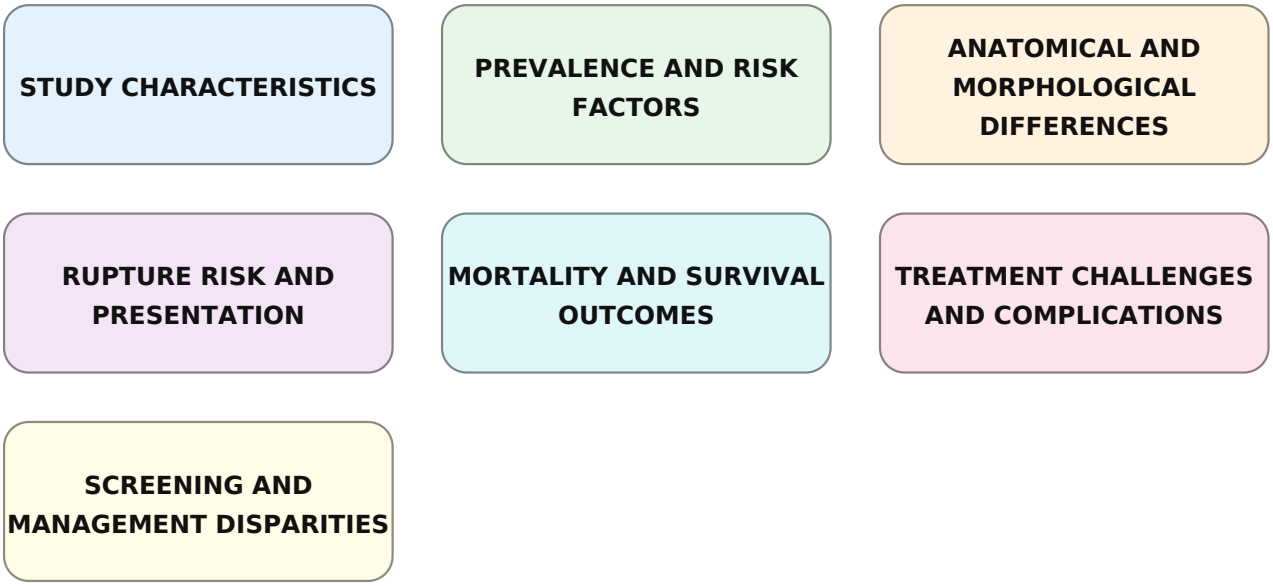


Figure 5. Limitations of current studies (topics)

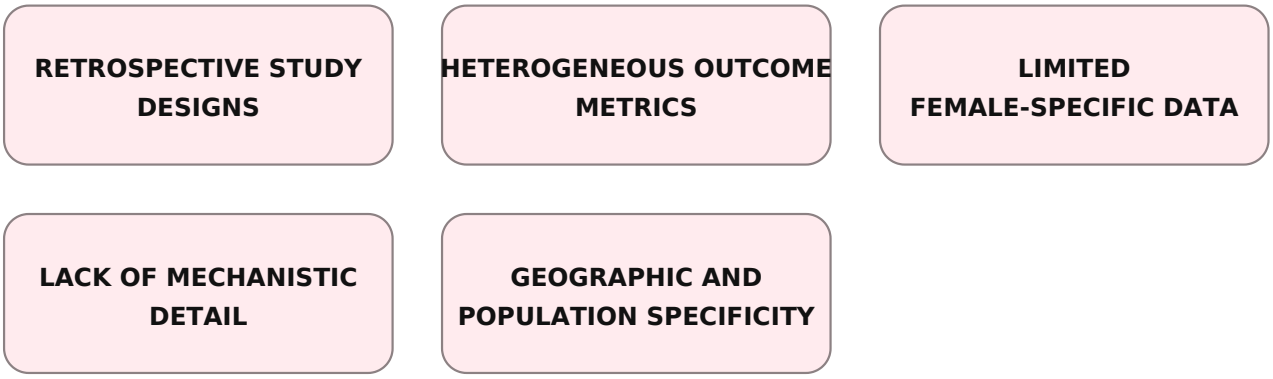


Figure 6. Future research directions (topics)

GENDER-SPECIFIC RUPTURE THRESHOLDS

MECHANISTIC DIFFERENCES

OPTIMIZING EVAR FOR WOMEN

IMPACT OF BIAS ON OUTCOMES

GENETIC AND BIOMARKER PANELS

PROSPECTIVE COHORT STUDIES

GENDER-SPECIFIC IMAGING CRITERIA