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Barriers to women's participation in STEM careers: Evidence from urban and rural contexts

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Abstract
Women remain a minority in science, technology, engineering and mathematics (STEM) careers worldwide, yet the obstacles they meet differ by setting. This narrative review draws on recent systematic reviews, meta-analyses and empirical studies, mostly published between 2023 and 2026, to examine barriers along the pathway from school to employment, with attention to urban and rural contexts. The evidence points to four interacting clusters: early gender–ability stereotypes and low self-efficacy, classroom and community norms, resource and access constraints, sharpest in rural and under-resourced schools, and workplace bias, exclusionary culture and rigid structures. Interventions such as mentoring, role-model exposure and gender-responsive teaching show a near-medium average effect in one meta-analysis, but most evaluations are short-term and few were designed for rural settings. Direct urban–rural comparisons are scarce, so conclusions about contextual differences remain provisional. The paper argues for multi-level strategies that combine early exposure, teacher preparation, community engagement, infrastructure investment and workplace reform, supported by longitudinal, context-sensitive research. Subject area: education policy and pedagogy, spanning secondary and higher education.

Keywords: Women in STEM, gender gap, rural education, stereotypes, mentoring, gender-responsive pedagogy

Introduction

A 2026 systematic review reports that, in 2024, women made up about 28% of the STEM workforce across 146 countries, compared with nearly 47% of non-STEM occupations (Wu et al., 2026). The shortfall is often described as a leaky pipeline, in which women are lost at successive stages of education and employment. Its causes are not uniform. A girl in a well-resourced city school and a girl in a remote village school may both encounter stereotypes about who is "good at" science, but the second may also face long travel distances, scarce laboratories and unqualified teachers, and community expectations that prioritize domestic roles.

This paper asks three questions. Which barriers does recent literature document? How do they appear in urban and rural contexts? What does the evidence say about remedies, and what limits their adoption? The focus is education, broadly defined: policy and pedagogy at the secondary and tertiary levels, together with the transition into employment.

Review Approach

This is a narrative review, not a formal systematic review. In November 2026, I searched the open web and publisher sites using combinations of terms such as women, girls, STEM, barriers, rural, systematic review and meta-analysis. I prioritized peer-reviewed systematic reviews and meta-analyses published from 2023 onward, then added single studies on rural contexts. I excluded non-peer-reviewed preprints from the core argument. Where one review summarizes an original study I did not read in full, the text says so. Because the search was not run across structured databases with a registered protocol, relevant studies may have been missed, and the evidence base is weighted toward English-language work.

Barriers along the Pathway

Early stereotypes, self-efficacy and identity

A preregistered meta-analysis of 98 studies from 33 nations found that stereotypes favoring male ability in computer science, engineering and physics appear by about age six and strengthen as children move through school (Miller et al., 2024, as summarized by Khodjaev et al., 2026). Such beliefs feed into confidence. Khodjaev et al.'s (2026) review of 19 studies concluded that the gender gap in STEM education reflects interacting social, cultural, educational and psychological forces, none of them a single cause, and that low self-efficacy is among the most consistent. A 2026 meta-analysis set out to test whether gender differences in STEM self-efficacy vary by field, an important question because women's representation differs sharply between, say, biology and engineering (McMichael et al., 2026). These mechanisms are not tied to place; they were documented in Europe, Asia, Africa, the Americas and Oceania.

Classroom climate, family and community norms

Classrooms are not neutral settings. In the studies synthesized by Khodjaev et al. (2026), senior physics and mathematics classes in Australia could feel unwelcoming to girls through peer ridicule and unequal teacher attention, and gender-biased career guidance in Spain steered girls away from STEM before they made informed choices. Family expectations matter as well: research from Lebanon and Kazakhstan, reviewed there, described women engineering students managing conservative family expectations and a sense of isolation even where enrollment numbers looked healthy. In rural India, a qualitative study of girls in a government STEM-support scheme, supplemented by interviews with teachers, parents and administrators,

examined socio-cultural, economic and institutional barriers to persistence in STEM (Bansal, 2025). Reviewed Brazilian evidence adds that household chores and caregiving can leave girls from low-income communities with little time or energy for STEM projects (Khodjaev et al., 2026).

Access, resources and place

Rural contexts add material constraints. A systematic review of motivation in rural STEM education lists isolation, high teacher turnover, a lack of qualified teachers and limited access to resources among the barriers that keep rural students out of STEM (Clark, 2023). A study of teachers in extremely remote U.S. schools found that professional isolation, limited funding and mixed-age classrooms shape how STEM is taught, although it was not specific to gender (Jones, 2025). Research on Black female learners in South African schools similarly situates STEM uptake within under-resourced public schooling, including weak infrastructure and teacher shortages (Sikhosana et al., 2025). Access barriers can also undercut programs designed to help: a Uruguayan initiative, as reviewed by Khodjaev et al. (2026), found that distance and cost limited participation in ICT activities.

I could find no recent review that directly compares urban and rural girls on the same measures. The contrast above is therefore an inference from separate literatures. Urban girls likely face the same stereotype and climate barriers but fewer physical-access ones; rural girls often face all of them at once.

Workplace bias, culture and structure

Barriers do not end at graduation. Wu et al.'s (2026) review of 44 empirical studies grouped workplace barriers into four types: bias related to gender, race, age or disability; stereotype threat; exclusionary organizational culture, including microaggressions and exclusion from informal networks; and structural barriers such as opaque pay and promotion rules and unequal access to resources and leadership. Women with caregiving responsibilities were disadvantaged where long hours and constant availability were rewarded. These barriers were linked to underrepresentation, career mismatch and attrition. Most of this research concerns formal-sector organizations, which are concentrated in cities. Evidence on women's STEM employment in rural areas was not prominent in the review.

Evidence on Effectiveness

A PRISMA-guided meta-analysis of interventions for gender equality in STEM education reported an overall effect of Hedges' $g = 0.434$, a near-medium positive effect, with significant differences between intervention types but not between outcome types (Yu et al., 2024). Within the studies reviewed by Khodjaev et al. (2026), the strongest long-run evidence came from an online mentoring program whose participants were more likely to have entered STEM careers at a ten-year follow-up. A brief role-model video, tested in a randomized trial in Spain and also reported there, raised mathematics-related career aspirations mainly among girls. Early engineering curricula taught by female instructors reduced gender differences in task performance.

Effects were uneven. A Spanish role-model program improved attitudes toward technology but did not shift gender stereotypes or girls' mathematics self-efficacy (Khodjaev et al., 2026). For workplaces, Wu et al. (2026) catalogued mentorship, bias training, structured recruitment, flexible work, pay audits and transparent promotion paths, but noted that relatively few studies assessed outcomes and that evidence on long-term impact is limited. Most reviewed studies were correlational, and the authors called for experimental and longitudinal designs. Taken together, there is encouraging but mostly short-term evidence, and almost none of it comes from rural populations.

Barriers and Challenges to Implementation

Four obstacles stand out. First, interventions can miss those who most need them. If distance, transport costs or household labor prevent participation, even well-designed outreach reaches mainly advantaged students (Khodjaev et al., 2026). Second, teacher capacity is uneven. Khodjaev et al. note that pre-service STEM teachers in Greece and Spain lacked confidence in teaching gender-sensitive content, and rural schools struggle with turnover and few qualified staff (Clark, 2023). Third, single-level programs may not move deep-rooted norms. Khodjaev et al. observe that in more gender-stratified contexts, individual-level interventions have limited effect without wider social change, which also limits how far a program can transfer between settings. Fourth, measurement is weak: Wu et al. (2026) point to inconsistent definitions of inclusion, few long-term evaluations and limited attention to intersectional experience. Both reviews also note a bias toward English-language and Global North literature, which means rural and low-income settings are under-studied.

Discussion and Implications

The literature supports a multi-level reading. Individual-level work, such as role models, mentoring and confidence-building, shows promise but is unlikely to suffice alone. Khodjaev et al. (2026) propose four linked levels: early socialization and curriculum before stereotypes harden; psychological and motivational support in secondary school; sustained mentoring through tertiary education; and institutional reform. This paper's urban–rural lens suggests adding a layer of material and community conditions.

For policy, three implications follow. Education authorities could prioritize qualified-teacher recruitment, retention and gender-responsive training in rural districts, since classroom climate and teacher quality shape both access and belonging. Programs could include travel support, flexible scheduling and online mentoring to reach students outside urban centers, and could engage parents and community leaders rather than only girls. Employers and universities could adopt transparent pay and promotion rules, flexible work and structured recruitment, and evaluate them using shared inclusion metrics. For research, priorities include longitudinal and experimental designs, rural-specific trials,

and studies that compare urban and rural participants directly. The conclusions here are bounded by the narrative method and by reliance on secondary summaries for some findings.

Conclusion

Recent evidence shows that women's underrepresentation in STEM careers arises from stereotypes, low self-efficacy, unwelcoming classrooms, community norms, resource gaps and workplace structures that reinforce one another over time. Rural contexts appear to add material and normative constraints on top of barriers shared with urban settings, although direct comparative evidence is thin. Mentoring, role models and gender-responsive education have measurable but modest benefits, and their durability is mostly unproven. Progress will likely depend on coordinated action across schools, communities, employers and policy, backed by better-designed, context-sensitive research.

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