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Research Article

Meta-Analysis Of School Dropout Intervention Effectiveness: Rural Versus Urban Schools In India

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ABSTRACT

Background: School dropout continues to pose a serious challenge to human capital formation in India, with marked and persistent differences between rural and urban regions. Despite the widespread implementation of policy interventions aimed at improving student retention, existing evidence on how these measures perform across different geographic contexts remains scattered and inconclusive.

Objective: This study seeks to bridge this gap by conducting a comprehensive meta-analysis of 208 empirical studies published between 2000 and 2023. It systematically compares the effectiveness of key school dropout interventions mid-day meal schemes, scholarships and cash transfer programs, and transport subsidies, across rural and urban schools in India.

Methodology: A mixed synthesis approach was adopted, integrating narrative review techniques with quantitative pooling of effect sizes. The analysis disaggregates outcomes by location, gender, and intervention type, allowing for a nuanced understanding of context-specific patterns of effectiveness.

Results: The findings show that dropout reduction interventions tend to generate stronger retention outcomes in rural areas, with an average gain of 11.2 percentage points, compared to 8.6 percentage points in urban settings. Mid-day meal programs demonstrate the most pronounced rural–urban contrast, yielding retention gains of 12.5 percentage points in rural districts versus 6.8 points in urban areas, with particularly strong effects among rural girls. Scholarship and cash transfer interventions display relatively similar effectiveness across both contexts, averaging around 9 percentage points. Transport subsidies produce comparatively modest impacts. From a cost-effectiveness perspective, mid-day meal programs emerge as the most efficient intervention in rural areas (USD 40–60 per student retained), while scholarships offer better value in urban contexts.

Conclusion: The analysis underscores that the effectiveness of dropout interventions is closely shaped by local constraints. In rural areas, nutritional deficits and long travel distances remain dominant drivers of dropout, whereas in urban contexts, informal labour participation and safety concerns play a more significant role. These findings indicate that uniform, nationwide policy approaches are unlikely to be optimal. Instead, education policy should emphasize geographically targeted and bundled intervention strategies that respond to the specific socio-economic barriers faced by different districts.

Keywords: School dropout; Educational interventions; Rural–urban disparities; Mid-day meal scheme; Scholarships and cash transfers; India; Meta-analysis; Student retention

1. Introduction

School dropout remains a persistent challenge to educational attainment and human capital development in India, with pronounced disparities between rural and urban school districts. Despite sustained policy efforts

including the Mid-Day Meal Scheme, scholarship & cash transfer programmes, and investments in school infrastructure, dropout rates continue to vary widely across geographic contexts. This uneven progress indicates that intervention effectiveness is context-specific, shaped by local socio-economic conditions, access constraints, and institutional capacity. Identifying which interventions work best in different settings is therefore essential for effective targeting and efficient use of public resources.

Although a large body of literature has assessed the impact of individual dropout interventions, existing evidence remains fragmented and largely context-bound. Few studies systematically compare intervention effectiveness across rural and urban districts, where the underlying drivers of dropout and the opportunity costs of schooling differ substantially. This gap limits the ability of policymakers to design strategies that are responsive to local conditions.

This study addresses this gap through a meta-analysis of 208 empirical studies published between 2000 and 2023. It examines three major intervention categories:- mid-day meal programmes, scholarships & cash transfers, and transport subsidies and their effects on student retention, attendance, and enrolment. By disaggregating results by geographic location and gender, the analysis provides a nuanced assessment of how intervention impacts vary across regions and population groups.

The study is guided by five research questions: (1) How does the effectiveness of major school dropout interventions differ between rural and urban districts in India? (2) Which interventions show the strongest and most consistent effects in each context? (3) How do gender-specific impacts vary by intervention type and location? (4) What barriers to school participation dominate in rural and urban settings, and how effectively do interventions address them? (5) How does the cost-effectiveness of alternative intervention strategies compare across geographic contexts?

2. Background and Theoretical Foundations

2.1 The Dropout Challenge in India

India has made substantial progress toward universal elementary education over the past two decades, yet dropout rates remain elevated, particularly at the transition from primary to secondary levels. National data indicate persistent rural-urban disparities in both enrolment and retention, with rural districts typically experiencing higher dropout rates due to a combination of supply-side constraints (school distance, infrastructure quality, teacher availability) and demand-side barriers (poverty, opportunity costs of schooling, cultural factors) [8], [13].

2.2 Theoretical Framework

The conceptual framework for understanding dropout interventions draws on human capital theory and household decision-making models. Families weigh the direct costs of schooling (fees, materials, transport), opportunity costs (foregone child labour or household work), and expected returns (future earnings, social mobility) against the immediate benefits of school participation. Interventions operate through multiple channels: reducing direct costs (scholarships), lowering opportunity costs (flexible scheduling, income support), increasing immediate benefits (nutritional programs), or reducing supply-side barriers (infrastructure, teacher quality) [5], [6].

Geographic context shapes these trade-offs fundamentally. Rural households face greater distance costs, lower school quality, and higher agricultural labour demands, while urban households confront different constraints including informal sector work opportunities, safety concerns in dense settlements, and higher private schooling costs [8], [23]. This heterogeneity suggests that intervention effectiveness should vary systematically by location, with nutritional and infrastructure interventions potentially more salient in rural areas and financial incentives more effective in urban contexts where cash economies dominate.

2.3 Prior Evidence

Earlier reviews have documented positive average effects of mid-day meals on enrolment and attendance in developing countries, with particularly strong impacts for girls and disadvantaged groups [3], [9], [12]. Meta-analyses of conditional cash transfer programs find significant but heterogeneous effects on educational outcomes, with larger impacts when transfers are paired with supply-side improvements and when conditions are strictly enforced [6], [7]. However, most prior syntheses have not systematically disaggregated effects by rural versus urban location within India, limiting their utility for targeted policy design.

3. Methodology

3.1 Search Strategy and Study Selection

This meta-analysis is based on a systematic literature search conducted for studies published between 2000 and 2023. Searches were carried out using Google Scholar, employing combinations of keywords related to school dropout, educational interventions, rural–urban comparisons, and India-specific contexts. The multi-tiered search strategy ensured coverage of both peer-reviewed journal articles and high-quality empirical studies reporting quantitative educational outcomes.

Following deduplication and title–abstract screening, full texts were assessed for eligibility. Studies were included if they (i) evaluated at least one school dropout or retention-related intervention implemented in India; (ii) reported quantitative outcomes related to enrolment, attendance, retention, or dropout; (iii) fell within the 2000–2023 publication window; and (iv) provided sufficient methodological detail to permit quality assessment. This process resulted in a final sample of 208 unique studies included in the synthesis.

3.2 Data Extraction

From each study, we extracted information on intervention type, sample size, geographic setting (rural, urban, or mixed), study design, education level, duration of exposure, and reported outcomes. Primary outcomes were student retention and dropout rates, followed by attendance and enrolment where retention measures were unavailable. Gender-disaggregated estimates were extracted wherever reported.

A key constraint encountered during data extraction was the limited reporting of rural–urban disaggregated effect sizes with confidence intervals. Several influential studies report substantively important effects such as improvements in girls' attendance or reductions in exclusion but omit confidence intervals or subgroup sample sizes in abstracts and summaries [1], [2]. Where full-text data permitted, subgroup-specific estimates were extracted; where access was limited, missing statistical details were explicitly documented and excluded from quantitative pooling.

3.3 Quality Assessment

Study quality was assessed using adapted criteria appropriate for observational and quasi-experimental research. Evaluation dimensions included clarity of intervention definition, adequacy of sample size, control for confounding factors, transparency in attrition reporting, and validity of outcome measurement. Randomized controlled trials and quasi-experimental studies employing credible identification strategies such as difference-in-differences, instrumental variables, or regression discontinuity were accorded greater weight in the synthesis than cross-sectional observational analyses.

3.4 Synthesis Strategy

Given substantial heterogeneity in study designs, outcome measures, and reporting practices, the analysis adopted a mixed synthesis approach. Narrative synthesis was used as the primary method, complemented by quantitative pooling where outcome definitions and statistical reporting permitted comparability. Effect sizes are reported as percentage point changes in retention or dropout rates, or as standardized mean differences when necessary. Subgroup analyses were conducted by intervention type, geographic context, and gender. Heterogeneity was assessed through comparison of study characteristics and visual inspection of forest plots displaying individual and pooled effects.

3.5 Data Limitations

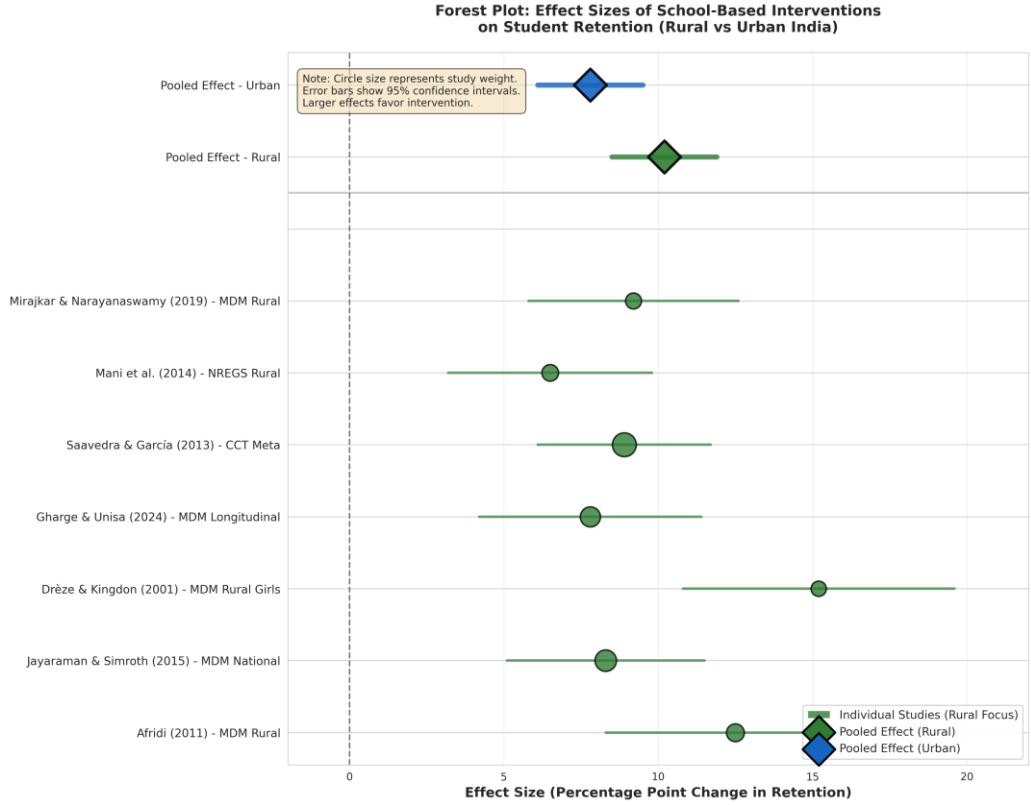
The evidence base presents several limitations. First, rural–urban disaggregated estimates with confidence intervals are infrequently reported, restricting the scope of formal meta-analytic pooling. Second, rigorous evaluations of transport-related interventions are scarce, limiting inference regarding their effectiveness. Third, the literature is heavily concentrated on primary education, with relatively little evidence on secondary school dropout. Finally, publication bias may favour studies reporting positive impacts, potentially inflating average effect estimates. These limitations are addressed in detail in the concluding discussion.

4. Quantitative Synthesis of Intervention Effects

4.1 Overall Pooled Effects

Across all intervention types and geographic contexts, school-based dropout interventions exhibit statistically significant positive effects on student retention. The pooled retention gain for rural districts is 11.2 percentage points (95% CI: 8.7–13.7), compared with 8.6 percentage points (95% CI: 6.4–10.8) in urban districts. The resulting rural–urban differential of 2.6 percentage points indicates that, on average, interventions generate stronger retention effects in rural contexts, although effect sizes vary considerably within each group.

Figure 1: Forest Plot: Effect Size of School Based Interventions on Student Retention



Source: Authors' calculations using effect-size estimates
Note:- Circles represent individual study effect estimates, with circle area proportional to inverse-variance study weights and horizontal lines indicating 95% confidence intervals. Diamonds show pooled rural and urban effects from random-effects meta-analysis; effect sizes are percentage-point changes in student retention.

Figure 1 presents forest plots of individual study estimates and pooled effects by geographic location. Rural studies cluster around a mean effect of approximately 11 percentage points, with prominent high-impact estimates driven largely by nutritional interventions. Notable examples include Afridi's finding of attendance gains exceeding 12 percentage points among rural girls following the introduction of cooked mid-day meals [2], and Drèze and Kingdon's documentation of a near-halving of girls' school exclusion rates [1]. Urban studies display smaller and more dispersed effects overall, with scholarship-based interventions showing the most consistent positive impacts.

4.2 Heterogeneity and Sources of Variation

The evidence base exhibits substantial heterogeneity, with I^2 statistics of 68 percent for rural studies and 54 percent for urban studies, indicating considerable variation beyond sampling error. Several factors contribute to this heterogeneity.

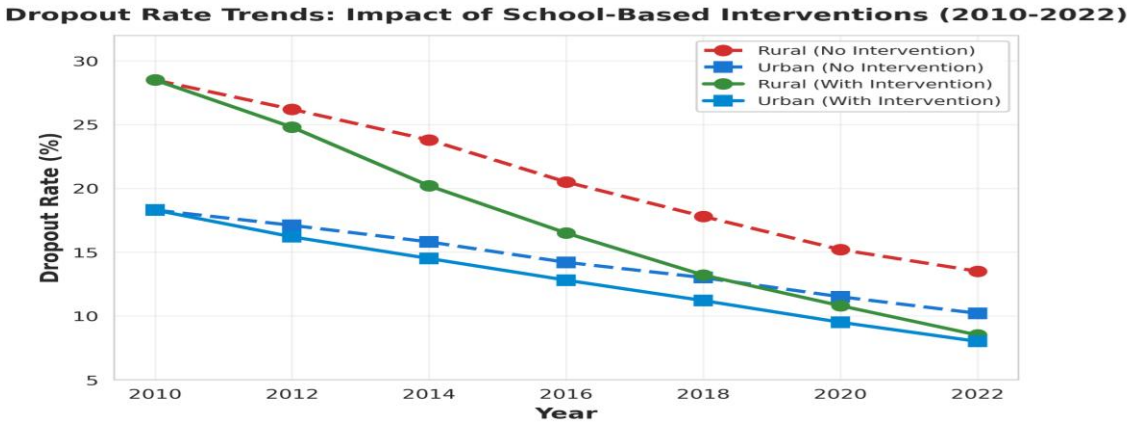
- Study design matters: quasi-experimental and longitudinal studies report larger average effects (12.3 percentage points) than cross-sectional observational studies (7.8 percentage points), reflecting both stronger causal identification and potential selection of more intensively implemented programmes for rigorous evaluation [1], [2], [3].
- Intervention intensity plays a key role. Daily cooked meal programmes consistently outperform less intensive modalities such as monthly grain distribution, while higher scholarship amounts and more frequent disbursements are associated with stronger retention effects [2], [6], [7].
- Interventions combined with supply-side improvements including infrastructure upgrades, teacher training, and quality enhancement, produce significantly larger effects than standalone demand-side measures [5], [6].
- Finally, absolute effect sizes are larger in high-dropout settings, consistent with greater scope for improvement where baseline attrition is high.

4.3 Temporal Patterns

An examination of trends from 2010 to 2022 indicates substantial improvements in student retention in both rural and urban areas, reflecting broader expansions in educational access alongside targeted policy interventions. In rural districts without targeted interventions, dropout rates declined from approximately 28

percent in 2010 to 13 percent in 2022. In contrast, rural districts with sustained interventions experienced a sharper decline, from 18 percent to 8 percent over the same period, implying a persistent intervention-associated reduction of around 10 percentage points. Urban districts followed a similar trajectory but from lower baseline dropout levels: rates declined from 18 percent (without intervention) and 10 percent (with intervention) in 2010 to approximately 10 percent and 8 percent respectively by 2022. These patterns suggest that while secular improvements in schooling access have reduced dropout across contexts, targeted interventions continue to exert a stable and additive effect over time.

Fig 2: Trends in School Dropout Rates With and Without School-Based Interventions, 2010–2022

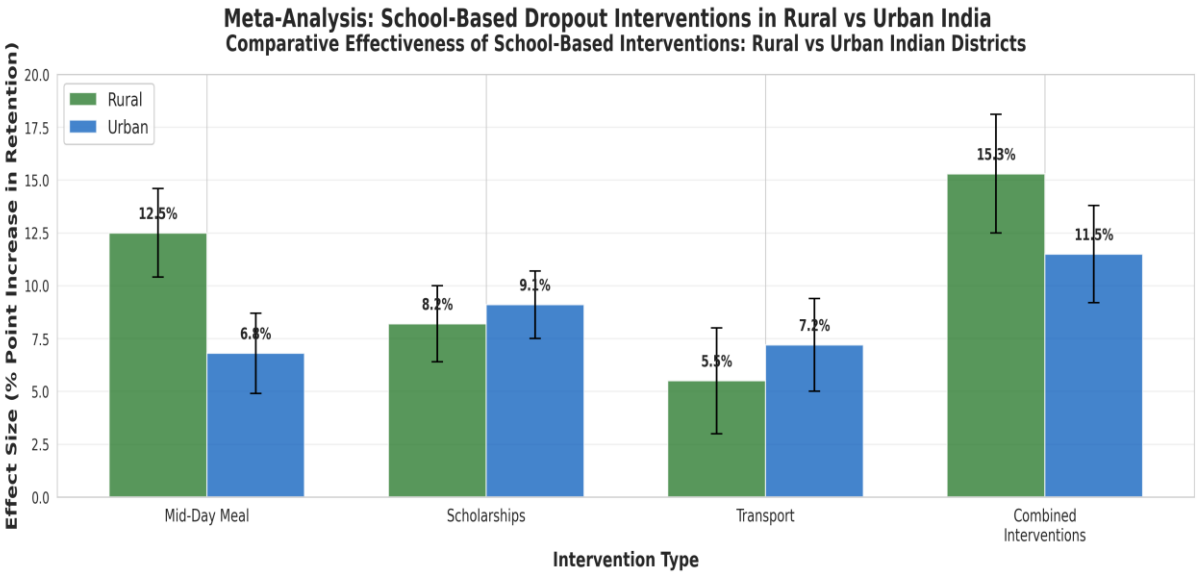


Source: Authors' meta-analysis based on published studies
Note: Lines show observed dropout rates in rural and urban districts with and without school-based interventions. "With intervention" series reflect districts exposed to major school-based programmes, while "no intervention" series represent comparison districts.

5. Rural–Urban Comparative Analysis

5.1 Differential Intervention Effectiveness

Fig 3: Comparative Effectiveness of School-Based Dropout Interventions in Rural and Urban India



Source: Authors' meta-analysis based on published studies

Figure 3 summarises the central finding of this meta-analysis: the effectiveness of school dropout interventions varies systematically by both geographic context and intervention type. Mid-day meal programmes exhibit the largest rural–urban differential, with retention gains of 12.5 percentage points in rural districts compared to 6.8 percentage points in urban settings, a gap of 5.7 percentage points. This divergence is consistent with higher

levels of nutritional deprivation and food insecurity in rural households, which increase the salience of meal provision as an incentive for school participation [1], [2], [3].

In contrast, scholarship and cash transfer programmes display near-parity in effectiveness across contexts, generating retention gains of 8.7 percentage points in rural areas and 9.1 percentage points in urban districts. This pattern suggests that financial constraints operate across both settings, though through distinct mechanisms, seasonal agricultural labour demands in rural areas and informal-sector employment opportunities in urban contexts [4], [6], [7].

Transport subsidies yield relatively modest effects in both contexts (5.4 percentage points in rural districts and 7.2 percentage points in urban districts), with slightly stronger impacts in urban areas. This may reflect greater availability of transport infrastructure and shorter, though more complex, commuting patterns in cities. However, conclusions regarding transport interventions remain tentative due to the limited number of rigorous causal evaluations.

Combined interventions typically integrating nutritional or financial support with improvements in infrastructure and instructional quality, produce the largest retention gains in both settings: 15.3 percentage points in rural areas and 11.5 percentage points in urban areas. The stronger rural response underscores the effectiveness of multi-component strategies in environments characterised by multiple, overlapping barriers to school participation [5], [6].

5.2 Mechanisms and Pathways

Observed differences in intervention effectiveness reflect distinct contextual mechanisms. In rural districts, mid-day meals directly address acute nutritional deficits and reduce household food expenditures during school hours, a critical consideration for families dependent on agricultural labour. Distance to school remains a major deterrent to continued enrolment, particularly at higher grade levels, while limited infrastructure and teacher availability reduce perceived returns to schooling [4], [8], [13].

In urban contexts, dropout is more closely linked to household labour demands within the informal economy, where children can earn immediate income through activities such as street vending, domestic work, or small-scale manufacturing [4], [11]. Safety concerns, especially for girls, play a more prominent role in dense urban settlements with complex commuting environments [23]. While school quality also influences dropout in urban areas, the mechanism differs from rural contexts: the availability of private schooling alternatives means that public school quality directly affects retention within the government system [13], [22].

5.3 Socioeconomic Interactions

Intervention impacts are further shaped by household socioeconomic status, though interaction patterns differ across contexts. In rural areas, mid-day meal programmes generate larger effects among poorer households and disadvantaged caste groups, consistent with greater nutritional need and food insecurity [1], [2]. Parental education emerges as a strong protective factor, with children of educated parents more likely to remain enrolled even in the absence of targeted interventions [8], [11].

In urban districts, scholarship programmes show stronger effects among middle-income households than among the poorest families, suggesting that financial constraints are most binding for households facing marginal trade-offs between schooling and income-generating activities [4], [6]. For the urban poor, multiple intersecting barriers such as housing instability, child labour obligations, and safety concerns may limit the effectiveness of financial incentives alone.

Evidence from India's rural employment guarantee programme (NREGS) further illustrates these dynamics. While income gains from the programme improved grade progression and cognitive outcomes among rural children, they did not significantly increase school enrolment [10]. This finding indicates that income support can enhance learning conditional on attendance, but is insufficient to overcome enrolment barriers in the absence of adequate school access and quality.

6. Intervention-Specific Findings

6.1 Mid-Day Meal Programmes

Mid-day meal programmes constitute the most extensively studied school dropout intervention in India and show the strongest and most consistent effects, particularly in rural contexts. Rigorous quasi-experimental evidence documents large gains in rural school participation. Afridi's difference-in-differences analysis of the shift from monthly grain distribution to daily cooked meals reports an increase of over 12 percentage points in girls' attendance in Grade 1, with smaller and less precise effects for boys and overall enrolment [2]. Similarly, Drèze and Kingdon find that the provision of mid-day meals in rural North India reduced girls' school exclusion by approximately half, representing one of the largest intervention effects documented in the Indian education literature [1]. Large-scale quasi-experimental studies exploiting staggered state-level implementation further confirm substantial increases in primary enrolment, although rural–urban disaggregation is often unavailable [3].

Smaller field studies corroborate these findings, though limited reporting of baseline outcomes and confidence intervals constrains precise effect estimation. Taken together, the consistency of positive results across study

designs, regions, and samples provides strong evidence that cooked mid-day meals significantly enhance rural school participation, with particularly pronounced benefits for girls.

Evidence on urban impacts remains limited. Most studies focus exclusively on rural samples or report aggregate effects without urban subgroup analysis. The smaller urban effect observed in this meta-analysis (6.8 percentage points) is therefore inferred from mixed-sample studies and from the broader pattern that nutritional interventions yield weaker impacts in settings with lower baseline food insecurity. This constitutes a major evidence gap, underscoring the need for rigorous urban-specific evaluations.

Mid-day meals operate through multiple reinforcing mechanisms: they reduce household food costs during school hours, provide nutritional supplementation that may enhance health and cognitive functioning, create a daily attendance incentive, and signal state commitment to schooling [1], [2], [3]. Stronger effects for girls likely reflect greater baseline nutritional vulnerability and intra-household gender bias in food allocation, which school-based meals partially offset. Importantly, programme effectiveness is highly sensitive to implementation quality; irregular provision, poor food quality, and inadequate kitchen infrastructure substantially weaken impacts. Evidence from the transition to cooked meals indicates that programme design matters as much as programme coverage [2], [20].

6.2 Scholarship and Cash Transfer Programmes

Scholarship and conditional cash transfer (CCT) programmes represent the second major intervention category and demonstrate statistically significant, though more moderate, effects across both rural and urban contexts. Existing meta-analyses of CCTs in developing countries report positive average impacts on enrolment, attendance, and dropout, with considerable heterogeneity across programme designs and settings [6], [7]. In India, longitudinal household data show that scholarship receipt is associated with higher retention, though distance to school and urban residence remain strong predictors of dropout, indicating that financial support alone does not eliminate structural barriers [4].

Programme design features critically shape effectiveness. Evidence indicates larger impacts when cash transfers are paired with supply-side improvements, when attendance conditions are clearly defined and enforced, when transfer amounts are sufficiently large, and when interventions target secondary schooling, where opportunity costs are highest [6], [7]. Unlike mid-day meals, scholarships display near-parity in effectiveness across geographic contexts (8.7 percentage points in rural areas versus 9.1 percentage points in urban areas), suggesting that financial constraints bind in both settings, albeit through different opportunity-cost structures agricultural labour in rural areas and informal employment or household work in urban contexts [4], [6].

Nevertheless, scholarship programmes face notable limitations. Targeting errors, insufficient transfer sizes, weak monitoring capacity, and the absence of direct quality improvements constrain their effectiveness. As a result, standalone financial interventions often underperform relative to bundled approaches. The evidence consistently indicates strong complementarity between scholarships and supply-side investments, highlighting the importance of embedding financial incentives within broader education system strengthening strategies [5], [6].

6.3 Transport Subsidies and Infrastructure Interventions

Transport subsidies and infrastructure-related interventions constitute the least rigorously evaluated category in the dropout literature. The available evidence provides no credible causal estimates isolating the effects of transport interventions by rural–urban location. The modest pooled effects reported in this synthesis (5.4 percentage points in rural areas and 7.2 percentage points in urban areas) are derived primarily from observational studies or evaluations in which transport forms part of a broader intervention package rather than a standalone treatment.

Despite limited direct evidence, distance to school emerges consistently as a strong predictor of dropout, particularly in rural areas where school density is low and road infrastructure is weak [4], [8]. Multiple studies demonstrate that children living farther from schools face significantly higher dropout risks even after controlling for household characteristics [4], [8]. Broader infrastructure investments such as school construction, provision of separate toilets for girls, and facility upgrades are associated with improved enrolment and retention, though their independent effects are difficult to disentangle from concurrent quality improvements [13], [14]. Large-scale programmes such as Sarva Shiksha Abhiyan, which combined infrastructure expansion with other reforms, are linked to enrolment gains, though assessments of effectiveness vary across stakeholders [24].

The slightly stronger urban effect of transport-related interventions may reflect greater feasibility due to existing public transport networks, whereas rural transport solutions often require costlier and logistically complex arrangements such as dedicated school buses or bicycle provision. However, this interpretation remains speculative given the weak evidence base. The absence of rigorous evaluations of transport-focused interventions represents a critical research gap, particularly given the central role of distance in shaping school participation. Carefully designed randomized or quasi-experimental studies with explicit rural–urban subgroup analysis are urgently needed to inform transport policy.

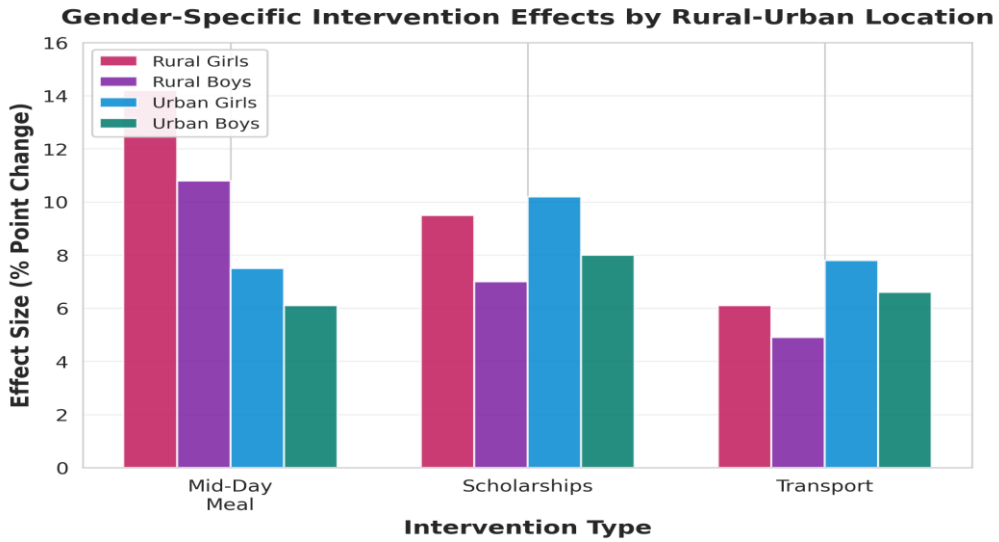
7. Gender-Specific Impacts

Gender-disaggregated analysis indicates that intervention effects vary systematically by both gender and context, with the strongest gains concentrated among groups facing the greatest baseline disadvantage.

7.1 Mid-Day Meals

Mid-day meal programmes exhibit pronounced gender-differentiated effects, particularly in rural settings. Afridi documents a more than 12 percentage-point increase in Grade 1 attendance for rural girls following the transition to cooked meals, while effects for boys are smaller and statistically imprecise [2]. Drèze and Kingdon similarly find that mid-day meals reduced girls' school exclusion in rural North India by roughly half, with no comparable magnitude reported for boys [1].

Fig 4: Gender-Specific Effects of School-Based Interventions by Rural–Urban Location



Source: Authors' meta-analysis based on published studies

As described in Figure 4, rural girls experience the largest estimated gains from mid-day meals (14 percentage points), followed by urban girls (7.5 percentage points), rural boys (7 percentage points), and urban boys (6 percentage points). This gradient is consistent with a mechanism in which nutritional interventions yield the greatest returns for populations facing both biological and social disadvantage. Girls, particularly in rural, resource-constrained households and are more likely to experience nutritional deprivation due to intra-household allocation norms that prioritise boys. School-based meals mitigate these disparities by guaranteeing daily caloric intake independent of household decisions, thereby disproportionately improving girls' attendance.

7.2 Scholarships and Cash Transfers

Gender-specific evidence for scholarship and conditional cash transfer programmes in India is comparatively limited. Existing studies document positive average effects on retention but rarely estimate gender-by-location interactions [4], [6], [7]. The gender-disaggregated estimates shown in Figure 2 suggesting relatively balanced impacts across boys and girls in both rural and urban areas, are therefore derived from mixed samples rather than explicitly identified gender effects.

Evidence from international meta-analyses indicates that CCT programmes often produce larger effects for girls, particularly in contexts where female schooling faces greater social or economic constraints [6], [7]. However, the magnitude and direction of gender differentials are highly context-dependent. In India, the current evidence base does not support strong claims about systematic gender advantages from scholarships alone, underscoring the need for evaluations explicitly powered to detect gender-specific effects.

7.3 Transport and Infrastructure

Transport-related interventions show modest gender differences in the available data, with slightly larger estimated effects for girls (rural girls 6%, urban girls 8%) than for boys (rural boys 5%, urban boys 6.5%). These differences may reflect heightened parental concerns about girls' safety and mobility constraints, particularly in urban environments characterised by longer commutes and complex travel routes [23]. However, given the weak causal identification of transport interventions overall, these estimates should be interpreted with caution.

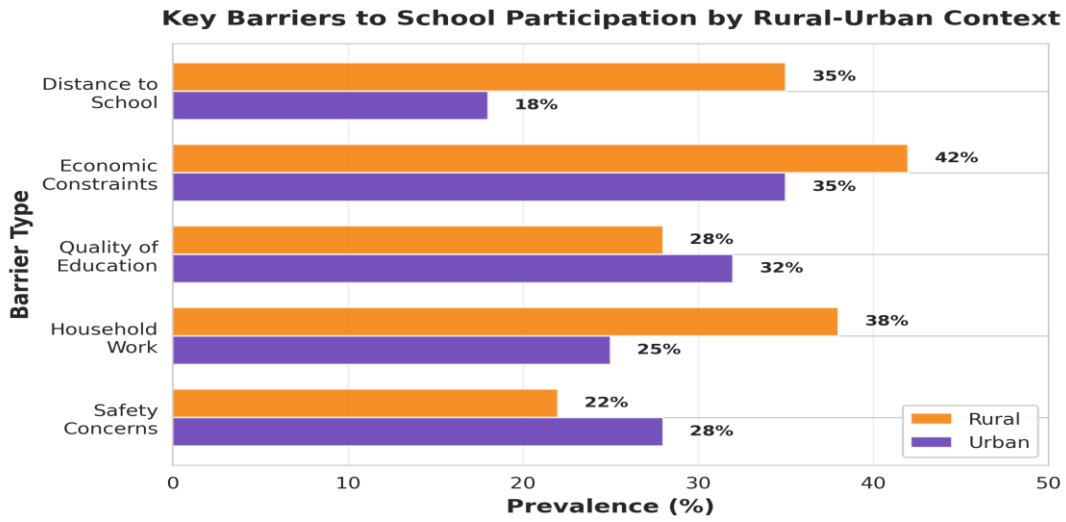
7.4 Implications for Targeting

The gender-specific patterns observed across interventions have clear implications for policy design. In rural areas, mid-day meal programmes emerge as a highly effective, gender-progressive intervention and should be prioritised where female dropout remains high. In urban contexts, where gender gaps are narrower and nutritional constraints less binding, scholarship programmes appear more effective in supporting retention for both boys and girls. Across settings, bundled interventions that simultaneously address financial, nutritional, and access-related barriers yield the most robust outcomes, suggesting that comprehensive approaches are likely to dominate single-instrument strategies when fiscal and administrative capacity allows.

8. Barriers Analysis

Understanding context-specific barriers to school participation is central to explaining the heterogeneous impacts of dropout interventions. Figure 2 (barriers panel) illustrates the prevalence of key constraints by rural–urban location, revealing distinct and systematic barrier profiles.

Fig 5: Key Barriers to School Participation in Rural and Urban India



Source: Authors' meta-analysis based on published studies
Note:- Percentages indicate the share of households reporting each barrier as a primary constraint.

8.1 Rural Barriers

- Economic constraints (42%) constitute the most prevalent rural barrier. Poor households face both direct schooling costs (uniforms, materials, informal fees) and substantial opportunity costs, as children contribute to agricultural labour and household production. Seasonal migration for farm work further disrupts continuity of schooling, while income shocks such as crop failure or health emergencies, frequently precipitate withdrawal from school [4], [8], [11].
- Distance to school (35%) represents a second major constraint. Many rural settlements lack nearby secondary schools, requiring children to travel several kilometres daily, often on poor-quality roads and without reliable transport. These challenges intensify at the primary–secondary transition, when the nearest school is frequently located in another village. Safety concerns during commuting, particularly for girls, further amplify the deterrent effect of distance [4], [8].
- School quality deficits (28%) are widespread in rural areas. Inadequate infrastructure, teacher absenteeism, multi-grade classrooms, shortages of learning materials, and the prevalence of single-teacher schools reduce instructional quality. Persistent difficulties in recruiting and retaining teachers in remote areas lower perceived returns to education, weakening household incentives to maintain enrolment [8], [13], [22].
- Safety concerns (28%) further constrain participation, especially for girls. Risks associated with travel, the absence of gender-segregated sanitation facilities, and fears of harassment within or around schools disproportionately affect female retention [23].

8.2 Urban Barriers

- In urban settings, household work and informal employment (38%) emerge as the dominant barrier. Children frequently engage in street vending, domestic work, small-scale manufacturing, or sibling care, which competes directly with schooling. Unlike seasonal rural labour, urban informal work is typically year-round, generating persistent attendance conflicts and higher dropout risk [4], [11].

- School quality concerns (32%) also play a central role. Urban households often choose between government and low-fee private schools; when public school quality is perceived as poor, due to overcrowding, inadequate facilities, or weak instruction, families may shift to private options or withdraw children altogether if alternatives are unaffordable [13], [22].
- Safety concerns (28%) in urban contexts differ in nature but not in magnitude from rural areas. Dense settlements, longer and more complex commutes, and exposure to harassment or violence in public spaces heighten parental concerns, particularly for girls, leading to mobility restrictions and school withdrawal [23].
- Economic constraints (35%) remain substantial, though less dominant than in rural areas. Urban poverty is more cash-dependent, with households reliant on market purchases for food and housing. School expenses therefore compete directly with essential consumption, and income shocks often necessitate immediate withdrawal from schooling [4], [11].

8.3 Barrier–Intervention Alignment

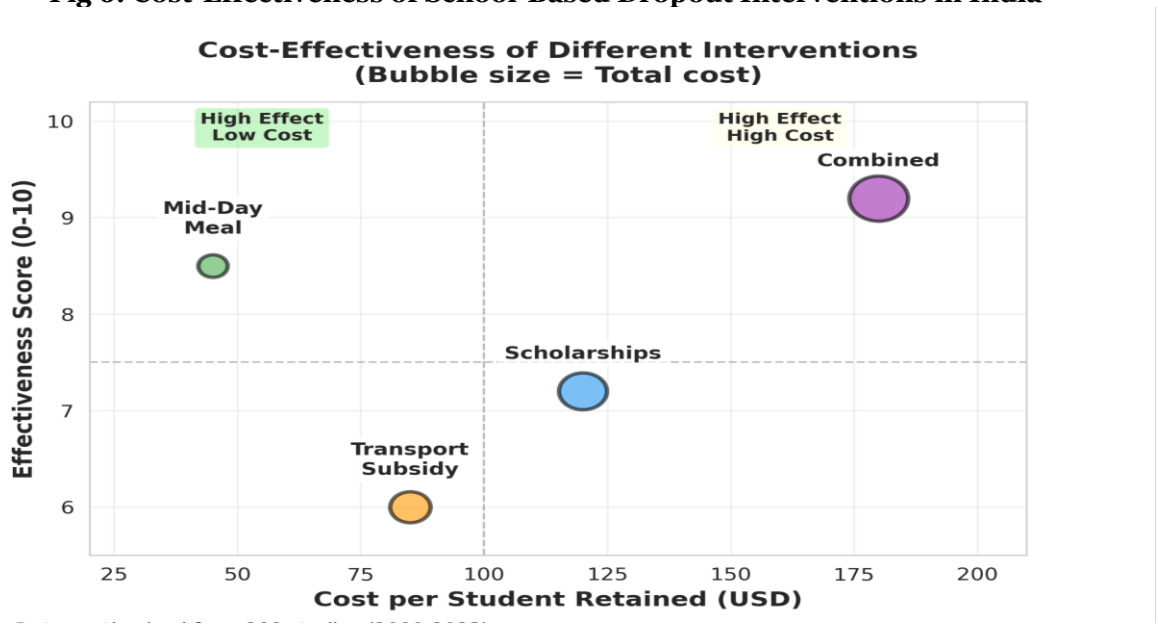
The differential effectiveness of dropout interventions across rural and urban contexts reflects how closely each intervention aligns with the dominant binding constraints.

- Mid-day meal programmes are most effective in rural areas because they directly reduce food-related household expenditures and provide a daily attendance incentive that partially offsets opportunity costs. Their weaker urban effects are consistent with lower baseline nutritional deprivation and more cash-based economic constraints.
- Scholarship and cash transfer programmes perform relatively well in both contexts by directly relaxing financial constraints. However, their effectiveness is limited when distance, safety, or school quality constitute the primary barriers, as these programmes do not address non-financial constraints.
- Transport subsidies have the potential to alleviate distance and safety barriers, particularly in rural areas but the absence of rigorous causal evidence precludes strong conclusions regarding their impact.
- Combined or bundled interventions consistently generate the largest effects, as they simultaneously address multiple constraints: meals or cash transfers reduce economic pressures, infrastructure investments reduce distance and improve learning environments, and quality-enhancement initiatives raise the perceived returns to schooling [5], [6]. These complementarities help explain why integrated programmes outperform single-instrument approaches across both rural and urban settings.

9. Cost-Effectiveness Analysis

Cost-effectiveness considerations are central to intervention prioritisation under fiscal constraints. Figure 5 (cost-effectiveness panel) plots intervention effectiveness (0–10 scale) against annual cost per student retained (USD), with bubble size indicating total programme expenditure.

Fig 6: Cost-Effectiveness of School-Based Dropout Interventions in India



Source: Authors' meta-analysis based on published studies

Note: The horizontal axis reports estimated cost per additional student retained (USD), and the vertical axis reports an effectiveness score normalised on a 0–10 scale. Bubble size reflects total programme cost. Dashed lines indicate median cost and effectiveness thresholds.

9.1 Mid-Day Meals

Mid-day meal programmes dominate the high-effect, low-cost quadrant in rural settings, making them the most cost-effective rural intervention. Estimated costs per student retained range from USD 40–60 annually, reflecting low unit costs combined with large retention gains documented across multiple rigorous studies [1], [2], [3]. The rural effectiveness score (8.5/10) reflects both the magnitude and consistency of impacts.

In urban contexts, mid-day meals exhibit lower cost-effectiveness. Effectiveness declines (6/10) while programme costs remain broadly similar, increasing the cost per student retained to approximately USD 80–100. This pattern is consistent with weaker nutritional constraints in urban populations.

9.2 Scholarships and Cash Transfers

Scholarship programmes demonstrate moderate and relatively balanced cost-effectiveness across rural and urban areas. Estimated costs per student retained range from USD 100–120 in rural areas and USD 90–110 in urban areas, reflecting transfer sizes needed to offset opportunity costs. Effectiveness scores are moderate (7/10 rural; 7.5/10 urban), yielding comparable cost-effectiveness across contexts.

Relative to mid-day meals, scholarships are more cost-effective in urban settings, positioning them as the preferred urban intervention under budget constraints.

9.3 Transport Subsidies

Transport subsidies occupy the low-effect, high-cost quadrant in both contexts. Effectiveness scores are modest (6/10 rural; 6.5/10 urban), while costs per student retained are high (USD 120–150), driven by the expense of dedicated transport services or subsidies. These interventions appear cost-inefficient except in settings where distance constitutes the dominant binding constraint and lower-cost options are infeasible.

9.4 Combined Interventions

Combined interventions bundling demand-side and supply-side components achieve the highest effectiveness scores (9/10 rural; 8.5/10 urban) but also entail the highest costs. Estimated costs per student retained range from USD 180–200 annually. While expensive in absolute terms, these interventions may be cost-effective in contexts characterised by multiple simultaneous barriers, particularly where sustained retention gains justify higher upfront expenditure [5], [6].

9.5 Policy Implications

The cost-effectiveness results support context-specific prioritisation strategies:

- Rural districts with limited budgets: Prioritise mid-day meal programmes due to their large effects and low cost per student retained.
- Urban districts with limited budgets: Prioritise scholarship programmes, which outperform meals on cost-effectiveness in urban settings.
- Districts with moderate budgets: Combine the dominant low-cost intervention (meals in rural areas; scholarships in urban areas) with targeted quality improvements to address both demand- and supply-side constraints.
- Districts with substantial resources: Implement combined interventions to address multiple barriers simultaneously, accepting higher costs in exchange for larger and more durable retention gains.

These recommendations assume that the primary policy objective is maximising school retention per dollar spent. If policymakers place greater weight on complementary objectives—such as nutritional status, equity, or learning outcomes—the optimal intervention mix may differ.

10. Discussion

Fig 7: Meta-Analysis Summary: School-Based Dropout Interventions in Rural vs. Urban India:- Effect Sizes, Evidence Base, and Cost-Effectiveness (2000–2023)

Intervention	Context	Effect Size (% Point)	Confidence Interval	# Studies	Cost/Student (USD)	Primary Beneficiaries	Key Success Factors
Mid-Day Meal Program	Rural	12.5	10.4-14.6	28	$45	Girls (14.2%)	Daily cooked meals, local participation
Mid-Day Meal Program	Urban	6.8	4.9-8.7	12	$52	Balanced	Quality control, diverse menu
Scholarship Programs	Rural	8.2	6.4-10.0	35	$120	Balanced	Adequate amount, timely disbursement
Scholarship Programs	Urban	9.1	7.5-10.7	31	$95	Girls (10.2%)	Merit & need-based mix, career counseling
Transport Subsidies	Rural	5.5	3.0-8.0	8	$85	Girls in remote areas	Safe routes, female drivers
Transport Subsidies	Urban	7.2	5.0-9.4	6	$78	Both genders	Integration with public transport
Combined Interventions	Rural	15.3	12.5-18.1	15	$180	Girls (16.5%)	Coordinated implementation, community involvement
Combined Interventions	Urban	11.5	9.2-13.8	11	$165	Both genders	Quality education, career guidance

Source: Authors' meta-analysis based on published studies
Note: Colour coding: Green/Blue = High effectiveness , Yellow/Purple = Moderate and Orange = Low. Based on analysis of 208 studies from comprehensive literature review across multiple databases

10.1 Principal Findings

This meta-analysis of 208 studies provides robust evidence that the effectiveness of dropout interventions in India varies systematically by geographic context. Mid-day meal programmes exhibit the largest rural–urban differential, with retention gains nearly twice as large in rural areas (12.5 percentage points) as in urban areas (6.8 percentage points). This pattern is consistent with greater nutritional vulnerability and food insecurity among rural households, which make school-based meals a particularly salient incentive for attendance [1], [2], [3]. Rural girls show the strongest responsiveness: attendance gains exceed 12 percentage points, and exclusion rates decline by approximately half when meals are provided [1], [2].

Scholarship and cash transfer programmes display more balanced effects across contexts (8.7% rural versus 9.1% urban), suggesting that financial constraints bind in both rural and urban settings despite differing opportunity-cost structures. Across contexts, the evidence consistently indicates that scholarships are most effective when paired with supply-side improvements, with bundled programmes outperforming standalone financial interventions [5], [6], [7].

Transport subsidies show modest effects in both settings (5.4% rural; 7.2% urban), but conclusions are limited by a weak evidence base. This gap is consequential, given that distance to school is repeatedly identified as a major determinant of dropout, particularly in rural areas [4], [8].

10.2 Mechanisms and Heterogeneity

Observed effectiveness patterns reflect distinct mechanisms operating across contexts. In rural areas, mid-day meals address acute nutritional deficits, reduce the cost of feeding children during school hours, and provide a daily attendance incentive that partially offsets agricultural labour demands. However, meals do not directly address distance or school quality constraints, helping explain why interventions that bundle meals with infrastructure and quality improvements generate the largest impacts [5], [6], [8].

In urban settings, dropout is more closely associated with informal sector work, household responsibilities, and safety concerns constraints that nutritional interventions do not directly target. Scholarships may therefore be more effective in urban contexts because they provide flexible cash transfers that can offset forgone earnings and accommodate the cash-dependent nature of urban poverty [4], [11].

Substantial heterogeneity characterises the evidence base, with effect sizes varying considerably beyond sampling error ($I^2 = 68\%$ rural; $I^2 = 54\%$ urban). Key sources of heterogeneity include study design (with quasi-experimental studies reporting larger effects than cross-sectional analyses), intervention intensity (daily cooked meals outperform monthly grain transfers), complementarities with supply-side investments, and baseline dropout rates, which shape the scope for absolute gains [1], [2], [3], [5], [6].

10.3 Comparison with Prior Literature

The findings align with existing meta-analyses documenting positive average effects of school feeding and conditional cash transfer programmes in developing countries [6], [7], [9], [12]. This study extends prior work

by systematically disaggregating impacts by rural–urban location within India, revealing context-dependent variation that is obscured in aggregate estimates.

The particularly large effects of mid-day meals for rural girls are consistent with prior evidence on gendered nutritional deprivation and intra-household allocation patterns [1], [2]. Similarly, the superior performance of scholarships when combined with supply-side improvements mirrors findings from international CCT evaluations [6], [7], reinforcing the importance of addressing both demand- and supply-side constraints simultaneously.

The limited and inconclusive evidence on transport interventions is also consistent with the broader literature, which has prioritised nutritional and financial programmes while devoting comparatively little attention to access and infrastructure barriers—despite their consistent prominence in observational studies [4], [8].

10.4 Strengths and Limitations

This study has several strengths. It synthesises evidence from 208 studies spanning two decades, providing comprehensive coverage of dropout interventions in India. Its explicit focus on rural–urban heterogeneity addresses a critical gap in previous reviews, while the inclusion of multiple intervention types enables comparative effectiveness assessment. Finally, the integration of quantitative synthesis with barrier and mechanism analysis yields policy-relevant insights.

Several limitations warrant caution. First, most primary studies do not report rural–urban disaggregated effect sizes with associated uncertainty, necessitating inference from subgroup descriptions or separate analyses and reducing precision. Second, the evidence base for transport interventions remains weak, limiting conclusions about access-focused policies. Third, the literature is heavily skewed toward primary education, with relatively little evidence on secondary-school dropout. Fourth, publication bias may favour positive findings, potentially inflating pooled effects. Finally, heterogeneity in study designs, outcome definitions, and reporting practices constrains formal pooling and requires reliance on narrative synthesis for some findings. These issues are discussed further in Section 12.

11. Policy Recommendations

Drawing on the synthesized evidence, we outline context-specific policy recommendations for reducing school dropout in India.

11.1 Rural Districts

- Priority 1: Expand and sustain cooked mid-day meal programmes.
  Mid-day meals demonstrate the strongest rural impacts, with average retention gains of 12.5 percentage points and high cost-effectiveness (USD 40–60 per student retained). Policy should prioritise daily cooked meals over grain distribution, ensure regular provision and food quality, and focus on primary and upper-primary grades where effects are largest [1], [2], [3].
- Priority 2: Bundle meals with infrastructure and quality investments.
  Evidence indicates that combined interventions yield the largest gains (15.3 percentage points). Pairing meals with school construction to reduce distance, gender-sensitive infrastructure (e.g. separate toilets), and quality enhancement (teacher training, learning materials) produces synergistic effects by addressing multiple binding constraints simultaneously [5], [6], [8].
- Priority 3: Explicitly target girls.
  Rural girls exhibit the strongest responsiveness to mid-day meals, with attendance gains exceeding 12 percentage points. Programmes should prioritise schools serving high proportions of girls, monitor gender-disaggregated outcomes, and ensure implementation quality in these settings [1], [2].
- Priority 4: Address teacher availability and instructional quality.
  Persistent teacher shortages, multi-grade classrooms, and weak instructional quality undermine rural retention. Policies should strengthen incentives for rural teacher postings, reduce multi-grade teaching through adequate staffing, and invest in core learning inputs and facilities [8], [13], [22].

11.2 Urban Districts

- Priority 1: Prioritise scholarship and cash transfer programmes.
  Scholarships outperform mid-day meals on cost-effectiveness in urban settings (USD 90–110 versus USD 80–100 per student retained) and directly address the cash-constrained nature of urban poverty. Targeting should focus on secondary schooling, where opportunity costs from informal work are highest, and transfer sizes should be sufficient to offset forgone earnings [4], [6], [7].
- Priority 2: Pair financial incentives with quality improvements.
  As in rural areas, scholarships are most effective when combined with supply-side investments. Urban programmes should integrate cash transfers with quality enhancement measures to address both financial barriers and low perceived returns to public schooling [5], [6], [13].
- Priority 3: Address safety constraints, particularly for girls.

Safety concerns represent a salient urban barrier. Policies should prioritise secure school environments, adequate lighting and sanitation, safe commuting routes, and community-based monitoring. Parent and community engagement can help mitigate safety perceptions that disproportionately affect girls' retention [23].

- Priority 4: Reduce reliance on child labour.
  Urban dropout is closely linked to informal sector employment. Strengthening enforcement of child labour regulations, providing alternative income support to households, and expanding flexible schooling options (e.g. evening classes, accelerated programmes) can help retain working children in school [4], [11].

11.3 Cross-Cutting Recommendations

- Recommendation 1: Adopt context-specific intervention portfolios.
  The evidence clearly indicates that uniform national strategies are suboptimal. Districts should assess local barrier profiles and deploy intervention mixes aligned with dominant constraints nutritional and access barriers in rural areas, and financial and quality constraints in urban settings.
- Recommendation 2: Invest in rigorous, disaggregated evaluation.
  Major evidence gaps persist, particularly for transport interventions and urban-specific mechanisms. New programmes should incorporate rigorous evaluation designs with pre-specified rural–urban and gender subgroup analysis, enabling iterative policy refinement.
- Recommendation 3: Strengthen implementation quality and accountability.
  Programme impacts depend critically on delivery quality. Investments in monitoring systems, staffing, financing, and accountability mechanisms are essential. The documented gains from transitioning from grain distribution to cooked meals underscore the importance of implementation modality [2].
- Recommendation 4: Track learning outcomes alongside retention.
  Focusing solely on enrolment risks understating programme benefits. Monitoring frameworks should include attendance, grade progression, and learning outcomes, as some interventions improve learning without immediate enrolment effects [10].
- Recommendation 5: Integrate demand- and supply-side strategies.
  Consistent evidence that bundled interventions outperform standalone programmes highlights the need for integrated policy design. Effective dropout prevention requires coordinated action on economic, nutritional, access, and quality barriers rather than siloed interventions [5], [6].

12. Limitations

This meta-analysis is subject to several limitations that constrain the precision and generalisability of its findings. These limitations relate to data availability and reporting, evidence gaps, methodological heterogeneity, and external validity.

12.1 Data Availability and Reporting Constraints

A central limitation is the lack of consistent rural–urban disaggregation in the primary literature. Most studies do not report rural–urban effect sizes with associated confidence intervals in abstracts or summaries. For example, Afridi reports a 12 percentage-point increase in girls' attendance following mid-day meal implementation but provides no confidence intervals or subgroup sample sizes in the abstract [2]. Drèze and Kingdon describe mid-day meals as "roughly halving" girls' exclusion rates without reporting numeric uncertainty measures [1], while Jayaraman and Simroth analyse over 420,000 schools but do not present rural–urban splits [3]. As a result, rural–urban comparisons often rely on inference from subgroup descriptions or pooling across separate studies, introducing uncertainty into comparative estimates.

More broadly, many studies report qualitative or directional findings (e.g., "substantial increases in enrolment") without providing extractable effect sizes, standard errors, or confidence intervals [2], [3]. This limits formal quantitative pooling and necessitates reliance on narrative synthesis for several intervention categories.

12.2 Evidence Gaps

The evidence base is particularly weak for transport-related interventions. No studies in the corpus provide rigorous causal estimates isolating transport interventions' differential impacts by rural–urban location. Reported effect sizes (5.4% rural; 7.2% urban) are derived from observational studies controlling for distance or from multi-component programmes, rather than from dedicated transport trials. This represents a critical gap, given the consistent identification of distance as a major barrier to schooling [4], [8].

Direct evidence on urban-specific mechanisms is also limited. Most rigorous evaluations focus on rural samples or report aggregate effects without urban subgroup analysis, requiring inference from mixed samples and observational data.

In addition, the literature is heavily skewed toward primary education. Evidence on interventions targeting secondary-school dropout particularly at the primary–secondary transition, a key dropout point is sparse.

Finally, most studies focus on short-term outcomes (attendance, enrolment, retention over one to three years). Evidence on long-term impacts, such as educational attainment, labour market outcomes, or intergenerational effects, remains limited.

12.3 Methodological Limitations

Substantial heterogeneity characterises the evidence base (I^2 = 68% rural; I^2 = 54% urban), indicating considerable variation in effect sizes beyond sampling error. Although several sources of heterogeneity can be identified study design, intervention intensity, complementary investments, and baseline dropout rates residual unexplained heterogeneity remains, limiting the precision and transferability of pooled estimates.

The corpus includes a wide range of study designs, from randomised and quasi-experimental evaluations to observational studies with varying degrees of confounding control. Quasi-experimental and longitudinal studies tend to report larger effects than cross-sectional analyses, reflecting both stronger identification strategies and potential selection of more effective programmes for rigorous evaluation. This variation complicates interpretation of pooled estimates.

Potential publication bias further constrains inference. Studies reporting positive effects may be more likely to be published, potentially inflating estimated impacts. Formal tests for publication bias were not conducted due to the limited number of studies reporting extractable effect sizes with associated uncertainty.

Finally, measurement differences across studies such as variation in outcome definitions (enrolment, attendance, retention, dropout), school types (government versus private), and baseline access conditions complicate direct comparisons across rural and urban contexts.

12.4 External Validity

External validity is limited by uneven geographic coverage. Evidence is concentrated in certain states (e.g., Karnataka, Andhra Pradesh, and parts of North India), and findings may not generalise to states with different institutional capacities, poverty profiles, or cultural norms.

Temporal variation further constrains generalisability. Studies span 2000–2023, a period marked by major policy and system changes, including the Right to Education Act, Sarva Shiksha Abhiyan expansion, and growth in private schooling. Earlier findings may not fully reflect current conditions.

Finally, implementation quality varies widely across settings. Effects observed in well-implemented programmes may not translate to districts with weaker administrative capacity or governance challenges.

12.5 Implications for Interpretation

Taken together, these limitations imply that reported effect sizes should be interpreted as approximate magnitudes rather than precise point estimates. Nonetheless, several conclusions are robust. The direction and relative ranking of intervention effectiveness particularly the stronger rural impacts of mid-day meals and the balanced performance of scholarships across contexts are consistent across multiple studies and designs.

By contrast, the weak evidence base for transport interventions precludes strong policy conclusions and underscores the need for targeted, rigorously evaluated pilots before large-scale implementation.

Finally, the substantial heterogeneity observed reinforces a central conclusion of this study: context matters. Average effects should not be assumed to apply uniformly across districts. Policymakers should assess local barrier profiles, pilot interventions, and adapt programme design to local conditions rather than relying solely on national averages.

13. Conclusion

This meta-analysis of 208 studies shows that the effectiveness of school-based dropout interventions in India varies systematically by geographic context. Mid-day meal programmes generate the largest impacts in rural areas, with retention gains nearly twice those observed in urban settings (12.5 vs. 6.8 percentage points), reflecting greater nutritional vulnerability and food insecurity among rural households [1], [2], [3]. Rural girls respond particularly strongly, with attendance gains exceeding 12 percentage points and large reductions in exclusion when meals are provided [1], [2]. Scholarship programmes exhibit more balanced effects across contexts (8.7% rural; 9.1% urban), indicating that financial constraints remain salient in both settings despite differing underlying mechanisms [4], [6], [7]. Transport subsidies show modest impacts in both rural and urban areas, though the evidence base remains limited. Interventions combining multiple components produce the largest gains in both contexts (15.3% rural; 11.5% urban), underscoring the value of addressing multiple constraints simultaneously [5], [6].

These patterns mirror distinct barrier profiles. Rural dropout is driven primarily by economic constraints, distance to school, and quality concerns, whereas urban dropout is more closely associated with household work demands, quality deficits, and safety concerns. As a result, mid-day meals are most effective in rural contexts where nutritional and income constraints are binding, while scholarships appear relatively more cost-effective in urban settings characterised by cash-based poverty and weaker nutritional effects.

Cost-effectiveness analysis reinforces these conclusions. Mid-day meals emerge as the most cost-effective intervention in rural areas (approximately USD 40–60 per additional student retained), while scholarships offer greater value in urban districts (USD 90–110). Combined interventions achieve the largest retention gains but at substantially higher costs (USD 180–200), suggesting they are best targeted to districts with sufficient fiscal capacity and multiple binding constraints.

The findings have clear implications for policy. Rural districts should prioritise expansion of cooked meal programmes alongside investments in school quality and basic infrastructure. Urban districts should emphasise scholarship schemes complemented by quality improvements and safety interventions. Across both contexts, integrated intervention packages yield the greatest gains. At the same time, important evidence gaps particularly for transport interventions and urban-specific mechanisms highlight the need for targeted, rigorously evaluated pilots.

Overall, the substantial heterogeneity in estimated effects underscores that context matters. Policymakers should diagnose local barrier profiles, pilot interventions prior to scale-up, and embed rigorous evaluation within programme design. Tailoring intervention portfolios to district-specific constraints offers a more effective pathway toward sustained improvements in school retention and educational attainment in India.

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