Quality Education for All

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Educational inequality trajectories and SDG4 achievement: a comparative analysis of global trends (2010–2024)

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Abstract

Purpose – This study aims to assess global trends in educational inequality from 2010 to 2024, with a particular focus on measuring progress toward Sustainable Development Goal 4 (SDG4). It investigates how educational disparities evolve across regions and human development levels, identifying both structural patterns and notable deviations.

Design/methodology/approach – The research uses UNDP's educational inequality index data, covering 195 countries over a 14-year period. Through quantitative analysis of this data set, the study examines regional trajectories, evaluates correlations with Human Development Index (HDI) categories and projects inequality patterns through 2024.

Findings – The results reveal a global decline in educational inequality – from 20.7 in 2010–18.0 in 2021 – with continued improvement projected. However, large regional disparities persist: Sub-Saharan Africa and South Asia show the highest inequality (32.9 and 33.2 in 2021), while Europe and Central Asia exhibit the lowest (5.8). A strong correlation ($r = 0.80$) between HDI and inequality is observed, though exceptions such as Uzbekistan, Kyrgyzstan and Tajikistan demonstrate successful low-inequality outcomes despite economic constraints.

Originality/value – By integrating global trend analysis with regional and developmental classifications, this study offers a rare synthesis of theoretical and empirical insights. It highlights transferable policy models like the "Central Asian model" and supports cross-sectoral strategies targeting persistent disparities. The study provides timely evidence for designing equity-focused education policies to achieve SDG4 by 2030.

Keywords Educational inequality, Sustainable development goals, Regional disparities, Human capital theory, Social justice theory, Education policy

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1. Introduction

Educational equity has emerged as a defining concern of global development in the 21st century. As underscored by Ban (2016), education is not only a standalone Sustainable Development Goal (SDG4) but a foundational enabler of broader social and economic transformation. Yet, despite measurable progress in access, educational inequality remains deeply entrenched – especially across regions marked by conflict, poverty and structural exclusion (Chowdhury *et al.*, 2025). The persistence of educational inequality represents a fundamental challenge to achieving SDG4's vision of inclusive and equitable quality education for all. While global commitment to this goal has strengthened since its adoption in 2015, progress remains uneven across regions and countries.

The complexity of educational injustice has led scholars to explore diverse theoretical frameworks that inform contemporary understanding of educational equity. Human capital theory emphasizes the economic imperative of education for productivity and national growth (Gillies, 2015; Galor, 2011), positioning educational equity as both a moral imperative and strategic necessity for development. Complementing this economic perspective, capability-based approaches foreground individual agency, meaningful opportunity and justice beyond access (Sen, 1999; Robeyns, 2017; Walker and Unterhalter, 2007; Merry, 2008). These frameworks collectively emphasize that educational justice requires not only universal access but also the transformation of educational environments to accommodate diverse backgrounds and enable learners to develop capabilities they value.

Despite the importance of educational equity for sustainable development, significant research gaps exist in understanding the dynamic patterns of inequality across different contexts, the relationship between human development and educational disparities and the policy factors that enable some countries to achieve exceptional progress. Previous studies often focus on national averages or singular equity dimensions, which may obscure local disparities and mask stagnation in the most vulnerable contexts. Moreover, few studies systematically compare successful country-level models to identify transferable strategies for advancing SDG4 with justice and precision.

This study addresses these critical gaps by providing a comprehensive empirical analysis of educational access inequality trends from 2010 to 2024 across 195 countries, informed by insights from both the human capital theory and capability-based approaches. The research offers a global, multi-scalar analysis informed by regional prioritization, cross-sectoral integration (Boas *et al.*, 2016) and community-centered policy logic (Osborne *et al.*, 2022). In particular, this study responds to recent calls for nuanced, data-informed educational policy that accounts for both inter- and intra-national disparities (Hák *et al.*, 2016; Head, 2008). By integrating theoretical insights from human capital and capability-based frameworks with empirical trend data, this research contributes a valuable synthesis that is both globally comprehensive and normatively grounded.

Specifically, this research seeks to answer the following questions:

Q1. How have patterns of educational inequality evolved globally between 2010 and 2024, and what trajectories are projected through 2024 across different human development groups and geographic regions?

Q2. To what extent does human development status correlate with educational inequality, and what factors explain anomalous cases where countries achieve higher or lower inequality than their development level would predict?

Q3. Which countries have demonstrated the most significant improvement or deterioration in educational inequality, and what policy approaches might explain these divergent outcomes in the context of SDG4 implementation?

Ultimately, this analysis aims to inform policy architectures that not only meet technical benchmarks, but also honor the deeper ethical commitments embedded in the SDG4 vision of inclusive, equitable and quality education for all, providing timely evidence for designing access-focused education policies as a foundational step toward achieving SDG4 by 2030.

2. Literature review

This section explores the theoretical foundations that inform the analysis of educational inequality and progress toward SDG4. The literature reveals two dominant perspectives shaping contemporary debates on educational equity. The first, grounded in human capital theory, positions education as a driver of economic development and national competitiveness, emphasizing the importance of reducing inequality to enhance productivity and growth. The second perspective draws on social justice and capability-based approaches, which conceptualize educational equity as a matter of enabling all individuals to develop their capabilities and lead lives they have reason to value. These approaches expand the focus from access to the substantive quality and relevance of education. By drawing on insights from both economic and ethical paradigms, this literature review provides a conceptual framework for interpreting cross-national patterns of inequality, identifying successful national models and informing policy responses. The following subsections examine these perspectives in detail and assess their implications for understanding educational disparities globally.

2.1 Educational equity and human capital formation

Human capital theory posits that investments in education enhance individual productivity and contribute to broader economic development (Gillies, 2015). Within this framework, educational equity is not only a moral imperative but a strategic necessity for national growth and competitiveness. As such, disparities in access to education reflect inefficiencies in human capital accumulation, which directly undermines efforts to achieve SDG4. Countries with persistent educational inequality are often unable to fully realize the productive potential of their populations, particularly in low- and middle-income regions (Xu *et al.*, 2023).

The link between human capital and educational access is well documented. Duflo (2001) demonstrated through a natural experiment in Indonesia that investments in school infrastructure significantly increased educational attainment and, subsequently, labor market outcomes. This reinforces the idea that targeted educational investment can catalyze long-term socioeconomic benefits. Yet, as the findings of the present study illustrate, improvements in infrastructure must be accompanied by deliberate equity-focused policies to prevent the deepening of disparities among disadvantaged groups.

Human capital development also hinges on the distributional fairness of educational opportunities. Dardanoni *et al.* (2007) emphasize that unequal opportunities in early education can entrench structural disadvantages, limiting intergenerational mobility and reinforcing cycles of poverty. In countries where educational inequality remains high – such as those in Sub-Saharan Africa and South Asia – this translates into a significant barrier to inclusive development. Our findings reveal that although global educational inequality is gradually declining, progress remains uneven, and without equitable distribution, human capital gains are likely to be concentrated among already privileged groups.

Hung and Ramsden (2021) expand this argument by illustrating how familial and societal investment in education, influenced by human capital expectations, drives social mobility in rapidly developing contexts. Their research on China underscores the importance of aligning educational policy with long-term capital development strategies. In this regard, countries such as Uzbekistan and Fiji – identified in our study as success cases – provide compelling evidence that even resource-constrained nations can achieve substantial gains in human capital through equitable education systems. Thus, human capital theory offers a vital lens for interpreting the relationship between educational equity and sustainable development. By reducing inequality in access and attainment, countries not only move closer to achieving SDG4, but also strengthen their foundations for inclusive and resilient economic growth (Xu *et al.*, 2023; Dardanoni *et al.*, 2007). Galor (2011) emphasizes that initial income and educational inequality can severely constrain human capital formation, creating long-term barriers to economic development. His framework shows that unequal access to education reinforces intergenerational poverty traps, hindering inclusive growth. From a human capital theory perspective, this underscores the developmental costs of educational disparity and highlights the necessity of early, equitable investment in education systems to achieve sustained national progress and meet SDG4 targets effectively.

Recent scholarship has further emphasized the economic rationale for reducing educational inequality through the lens of human capital theory. Hanushek and Woessmann (2015) argue that the cognitive skills acquired through equitable education systems form the "knowledge capital" essential for sustained national growth. Complementing this, Psacharopoulos and Patrinos (2018) provide robust empirical evidence that investments in education yield substantial economic returns, particularly when directed toward disadvantaged populations. However, critics like Marginson (2019) caution against a narrow interpretation of human capital theory that overlooks broader social purposes of education. These perspectives suggest that while education is a critical engine for economic productivity, its transformative potential depends on equitable access. Therefore, efforts to meet SDG4 must incorporate both efficiency- and equity-based rationales, ensuring that all individuals, regardless of socioeconomic background, contribute to and benefit from national development.

2.2 Educational justice and capability-based approaches

The pursuit of educational equity cannot be adequately addressed through access metrics alone. Capability-based theories of justice, particularly those developed by Amartya Sen and Martha Nussbaum, offer a richer and more comprehensive framework for understanding educational inequality as a multidimensional form of deprivation – one that constrains individuals' freedom to achieve valued life outcomes (Saito, 2003). From this perspective, the key concern is not merely school attendance, but whether learners are acquiring substantive capabilities – such as literacy, critical reasoning and agency – that enable meaningful participation in society.

Robeyns (2006) outlines three major models of education: rights-based, human capital and capability-based. While the first two prioritize access and economic productivity, the capability approach centers on the expansion of real freedoms and aligns directly with SDG4's vision of "inclusive and equitable quality education." As such, educational justice requires not only universal access but also the transformation of educational environments to accommodate the diverse backgrounds and needs of learners.

Terzi (2005) extends this notion by applying the capability approach to disability and special education, arguing that justice in education entails recognizing and responding to learners' differing starting points. In contexts of entrenched inequality – such as Sub-Saharan

Africa and South Asia, as our findings indicate – this calls for compensatory strategies that enhance real opportunities for marginalized populations. Chowdhury *et al.* (2025) highlight that students with disabilities face compounded barriers in accessing primary education during and after environmental disasters, particularly in marginalized regions. Their study in Jashore, Bangladesh, reveals that without inclusive infrastructure and responsive policy measures, educational equity remains out of reach for the most vulnerable groups.

Walker (2006) similarly emphasizes that capability-informed policy-making is particularly effective in addressing structural and intersectional forms of disadvantage, including those related to gender, geography and socioeconomic status. This insight is especially relevant to our analysis, which uncovered stark disparities not only between but also within countries. National averages may obscure significant intra-national inequalities, leaving vulnerable populations educationally excluded.

Unterhalter and Brighouse (2007) further stress that educational justice must consider not only "how much" is distributed, but also "what" is distributed – highlighting the crucial role of curriculum, pedagogy and voice in fostering capabilities. Accordingly, achieving SDG4 requires justice-oriented frameworks that move beyond access to emphasize relevance, empowerment and participation.

Building on this foundation, some scholars have called for a broader conceptualization of equity that includes the needs of all learners – both disadvantaged and exceptionally capable. Merry (2008) argues that educational justice must not only remove barriers for marginalized students but also provide meaningful challenges for those with advanced capabilities. From a capability perspective, justice entails enabling all learners – regardless of where they fall on the ability spectrum – to develop their full potential and pursue lives they have reason to value. This broadens the equity agenda beyond compensatory justice to include *aspirational equity*, where educational systems promote excellence without reinforcing privilege. In this view, justice in education requires balancing inclusive access with differentiated provision, ensuring that neither underachievement nor unrecognized talent perpetuates structural inequality.

Recent scholarship has further clarified the conceptual diversity underlying educational equity discourses. Levinson, Geron and Brighouse (2022) identify and differentiate among four key normative frameworks: equality of opportunity, equality of outcomes, adequacy and the capability approach. Each conception implies a distinct threshold for what counts as "just" in education. Of these, the capability framework offers a particularly holistic vision, emphasizing not just access or achievement, but the real freedoms learners have to convert educational inputs into meaningful life opportunities. This aligns with the view that justice in education is not fulfilled by resource distribution alone, but by enabling all learners to flourish. Integrating this conceptual taxonomy into educational policymaking can help clarify competing goals and ensure that interventions are guided by transparent and ethically coherent understandings of equity (Levinson *et al.*, 2022).

Further, recent scholarship has reinforced the theoretical foundation of the capability approach in education by addressing how structural conditions constrain real opportunities. Calitz (2018) analyzes how systemic inequality in higher education limits students' agency, calling for policy frameworks that expand inclusiveness. Robeyns (2017) re-examines the normative roots of the capability approach, advocating for its relevance in evaluating justice beyond mere resource distribution. Likewise, Walker and Unterhalter (2007) emphasize that educational justice should be assessed by whether learners can develop capabilities they truly value – such as agency, self-determination and voice.

In sum, the capability perspective urges a shift from standardized educational outputs toward meaningful, context-sensitive learning experiences. Educational equity, from this

standpoint, is not simply a matter of equal inputs, but of ensuring that all learners are genuinely empowered to lead lives they have reason to value. This lens is essential for recognizing and addressing the deeper injustices embedded in global educational inequality.

2.3 Educational access versus educational quality: the input–output challenge

A critical distinction in educational equity research concerns the relationship between educational inputs (such as years of schooling, enrollment rates and participation) and educational outputs (learning outcomes, skill development and quality education). Pritchett (2020) demonstrates that dramatic increases in educational participation globally have not been accompanied by corresponding improvements in learning outcomes, particularly in developing countries. This "schooling ain't learning" phenomenon highlights that access equity – while necessary – is insufficient for achieving comprehensive educational equity.

This distinction is fundamental to interpreting inequality measures. Years of schooling inequality captures disparities in educational participation but cannot assess whether students with equal schooling duration receive comparable educational quality or achieve similar learning outcomes (Pritchett 2020). Students may attend school for similar periods while experiencing vastly different teacher quality, infrastructure, curriculum relevance and learning environments.

Therefore, this study's focus on years of schooling inequality addresses one critical dimension of educational equity – access – while acknowledging that achieving SDG4's vision of "inclusive and equitable quality education" requires addressing both access and quality dimensions. Our analysis provides insights into the foundational prerequisite of educational access while recognizing that quality equity remains a distinct and equally important challenge for future research and policy development.

While this study uses quantitative analysis of educational access inequality data rather than directly operationalizing these theoretical frameworks methodologically, both human capital theory and capability-based approaches provide essential interpretive lenses for understanding the significance and implications of our findings. Human capital theory informs our interpretation of why reducing educational access inequality matters for economic development and helps explain the strong correlation observed between Human Development Index (HDI) rankings and educational access patterns. Capability-based approaches inform our understanding of why access equity, while foundational, represents only one dimension of comprehensive educational justice, and guide our recognition that years of schooling inequality reduction, while necessary, is insufficient for achieving SDG4's vision of inclusive and equitable quality education. These frameworks collectively provide the normative foundation for interpreting our empirical findings within broader debates about educational equity and sustainable development while acknowledging that access measurement represents only one component of the multidimensional educational equity agenda these theories envision.

3. Methodology

3.1 Data sources and sample

This study used data from the United Nations Development Program's (UNDP) inequality data set, which provides educational inequality measures for 195 countries from 2010 to 2024. The data set includes comprehensive information on human development classification, geographic region, HDI ranking and yearly educational inequality indices. The

complete data set captures approximately 96% of UN member states, providing a robust foundation for global analysis.

Educational inequality data was analyzed in conjunction with country classifications including:

- Human Development Groups (Low, Medium, High and Very High).
- UNDP Developing Regions (Sub-Saharan Africa, Latin America and the Caribbean, East Asia and the Pacific, Arab States, Europe and Central Asia and South Asia).
- HDI rankings for 2024.

3.2 Measures and variables

The primary dependent variable represents the percentage of inequality in the distribution of years of schooling based on data from household surveys and censuses. This measure specifically captures disparities in quantitative educational access across the population – that is, how many years individuals have spent in formal educational institutions – with higher values indicating greater inequality in educational participation duration.

Critical distinction: This study measures years of schooling (an input indicator reflecting educational participation) rather than educational attainment in terms of learning outcomes, skills acquisition or quality of education received. Following Pritchett (2020) and other scholars who have demonstrated that increased educational participation does not automatically translate to improved learning outcomes or educational quality, we explicitly limit our analysis to inequalities in access to education rather than inequalities in educational achievement or quality.

The index is calculated using the Atkinson inequality measure, with an inequality aversion parameter of 1, making it particularly sensitive to inequalities at the lower end of the distribution.

Methodological limitation: This approach assumes that years of schooling provide a meaningful indicator of educational access but makes no claims about the relationship between time spent in school and educational quality, learning outcomes or capability development. As extensive research has shown, equal years of schooling can mask significant disparities in educational quality, teacher effectiveness, infrastructure and learning achievement.

3.2.1 Independent variables include

- Time (historical data for 2010–2021 and projections for 2022–2024).
- Human development classification.
- Geographic region.
- HDI rank (2024).

3.3 Analytical approach

The analysis proceeded in four sequential phases:

3.3.1 Phase 1: descriptive trend analysis. Annual mean educational inequality values were calculated globally, by human development group and by geographic region to establish baseline trends from 2010 to 2024. Percentage changes and compound annual growth rates were calculated to quantify improvement or deterioration rates.

3.3.2 Phase 2: correlation analysis. Pearson correlation coefficients were calculated to examine the relationship between 2024 HDI rankings and educational inequality values. This

analysis tested the hypothesis that lower human development correlates with higher educational inequality.

3.3.3 Phase 3: projection modeling. For projections to 2024, a linear extrapolation model was applied based on country-specific trends from 2017 to 2021. The model formula was:

$$\text{Inequality}_{2024} = \text{Inequality}_{2021} + (\text{Annual Change Rate} \times 3).$$

Where annual change rate was calculated as: $(\text{Inequality}_{2021} - \text{Inequality}_{2017}) \div 4$.

When insufficient recent data was available (fewer than two data points during 2017–2021), the 2021 value was carried forward for projections.

Critical limitation regarding the COVID-19 pandemic: These projections assume continuation of pre-2021 trends and do not account for the unprecedented disruptions caused by the COVID-19 pandemic, which began affecting educational systems globally in 2020. The pandemic has had differential impacts across countries and regions, with evidence suggesting significant disruptions to educational access, particularly affecting marginalized populations. UNESCO data indicates that over 1.6 billion students were affected by school closures, with disproportionate impacts on disadvantaged groups who lacked access to remote learning technologies. Additionally, economic pressures from the pandemic have led many countries to redirect funding from education to health and economic recovery, potentially reversing previous progress in educational access equity.

Projection validity concerns: Given these unprecedented disruptions, the 2021–2024 projections should be interpreted as illustrative scenarios based on pre-pandemic trends rather than reliable predictions. The actual trajectory of educational access inequality through 2024 may deviate significantly from these projections due to pandemic-related disruptions that are not captured in the linear extrapolation model.

3.3.4 Phase 4: comparative anomaly analysis. Countries were identified as statistical anomalies if their educational inequality values deviated significantly from the expected value based on their HDI rank. Specifically, countries were classified as anomalous if:

- High or Very High HDI countries with inequality values exceeding 15%.
- Low or Medium HDI countries with inequality values below 10%.

3.4 Methodological limitations

Several critical limitations should be acknowledged in interpreting the findings of this study, with the most significant relating to pandemic-related disruptions and data constraints.

3.4.1 COVID-19 pandemic disruption and projection validity. The most significant limitation concerns the validity of 2021–2024 projections given the unprecedented global disruption caused by the COVID-19 pandemic. The linear extrapolation method assumes continuation of pre-pandemic trends and cannot account for the differential impacts of school closures, economic recession and shifting government priorities that have affected educational systems since 2020. UNESCO data indicates that over 1.6 billion students worldwide were affected by school closures, with disproportionate impacts on disadvantaged groups who lacked access to remote learning technologies. Additionally, economic pressures from the pandemic have led many countries to redirect funding from education to health and economic recovery, potentially reversing previous progress in educational access equity.

The pandemic's effects have varied dramatically across countries and regions, making uniform extrapolation particularly problematic. Low-income countries and regions with limited digital infrastructure have experienced more severe disruptions to educational access, while countries with robust remote learning capabilities may have maintained or even improved educational participation during closures. These differential impacts mean that global and regional projections based on pre-2021 trends may significantly misrepresent

actual post-pandemic trajectories. Therefore, the 2021–2024 projections should be interpreted as illustrative scenarios based on pre-pandemic trends rather than reliable predictions, and the actual trajectory of educational access inequality through 2024 may deviate significantly from these projections.

3.4.2 Data availability and coverage limitations. Data availability varied across countries and years, with approximately 70% of countries having complete data for all years from 2010 to 2021. Missing data points may affect trend analysis for some countries, particularly those with the highest educational inequality where robust monitoring systems are often lacking. The complete data set captures approximately 96% of UN member states, providing a robust foundation for global analysis, but gaps remain in countries where data collection capacity is limited.

3.4.3 Measurement and scope limitations. The educational inequality index captures disparities in years of schooling based on household surveys and censuses but represents only one dimension of educational equity. This measure specifically reflects quantitative educational access across the population rather than educational attainment in terms of learning outcomes, skills acquisition or quality of education received. Following Pritchett (2020) and other scholars who have demonstrated that increased educational participation does not automatically translate to improved learning outcomes or educational quality, this analysis explicitly limits focus to inequalities in access to education rather than inequalities in educational achievement or quality. The approach assumes that years of schooling provide a meaningful indicator of educational access but makes no claims about the relationship between time spent in school and educational quality, teacher effectiveness, infrastructure or learning achievement.

3.4.4 Analytical and causal inference limitations. The linear projection method assumes continuation of recent trends and does not account for potential policy changes, economic shocks or other factors that might accelerate or reverse progress through 2024 beyond the pandemic disruption already noted. While the analysis identifies correlations between development status and educational inequality, as well as anomalous cases, it cannot definitively establish causal relationships without more detailed country-specific policy analysis. The methodology can identify patterns and associations but cannot determine whether observed improvements result from specific policy interventions, broader socioeconomic changes or other factors.

Despite these limitations, the comprehensive nature of the data set covering 195 countries over a 14-year period and the methodological approach provide a robust foundation for understanding educational inequality patterns and trajectories in relation to SDG4 targets while acknowledging that the findings represent only one component of the multidimensional educational equity agenda.

COVID-19 pandemic disruption: The most significant limitation concerns the validity of 2021–2024 projections, given the unprecedented global disruption caused by the COVID-19 pandemic. The linear extrapolation method assumes continuation of pre-pandemic trends and cannot account for the differential impacts of school closures, economic recession and shifting government priorities that have affected educational systems since 2020. Evidence from UNESCO and other sources indicates that the pandemic has disproportionately impacted educational access for marginalized populations, potentially reversing progress in educational access equity. Furthermore, global trends toward increased defense spending and reduced education investment in the post-pandemic period suggest that the assumed continuation of previous improvement trajectories is highly questionable.

Differential pandemic impacts: The pandemic's effects have varied dramatically across countries and regions, making uniform extrapolation particularly problematic. Low-income countries and regions with limited digital infrastructure have experienced more severe disruptions to educational access, while countries with robust remote learning capabilities may have maintained or even improved educational participation during closures. These differential impacts mean that global and regional projections based on pre-2021 trends may significantly misrepresent actual post-pandemic trajectories.

4. Results

4.1 Global trends in educational inequality (2010–2024)

The analysis of educational inequality data from 2010 to 2021, with projections to 2024, reveals a consistent global improvement trend. The global average educational inequality index decreased from 20.65 in 2010–18.01 in 2021, representing a 12.8% reduction. The projections for 2022–2024 indicate a continued decline to 17.50 by 2024, suggesting a gradual progression toward greater educational equity at the global level.

However, this overall improvement masks significant disparities across regions and human development groups. When examining patterns by HDI categories (Table 1), a stark contrast emerges between development levels. Very High HDI countries have maintained consistently low inequality levels throughout the period, achieving an 18.4% reduction from 8.61 in 2010–7.03 in 2021, with further improvement projected to 6.66 by 2024. By contrast, Low HDI countries have shown minimal progress, experiencing a slight increase in inequality from 37.94 in 2010–38.57 in 2021 (a 1.7% increase), before modest projected improvements to 38.32 by 2024.

This divergent pattern has resulted in a widening gap between the most and least developed countries. By 2024, the data indicates that Low HDI countries are projected to have inequality levels more than 5.7 times higher than Very High HDI countries (38.32 vs 6.66). The rate of progress also varies substantially, with some countries achieving rapid improvements while others stagnate or deteriorate, highlighting the uneven nature of progress toward SDG4 targets across different development contexts.

4.2 Regional and development group analysis

Regional analysis reveals distinctive patterns in educational inequality across different parts of the world, with some regions making substantial progress while others face persistent challenges.

The regional trends illustrated in Figure 1 reveal several key patterns:

Table 1. Educational inequality by human development group (2010–2024)

Human Development Group	2010	2015	2021	2024	Change 2010–2021 (%)	Change 2021–2024 (%)
Low	37.94	39.10	38.57	38.32	+1.7	−0.6
Medium	28.72	26.48	26.31	26.11	−8.4	−0.8
High	15.82	14.32	12.34	12.09	−22.0	−2.0
Very High	8.61	7.91	7.03	6.66	−18.4	−5.3
Global Average	20.65	19.13	18.01	17.50	−12.8	−2.8

Source(s): Authors' own creation based on UNDP inequality data set (2010–2024)

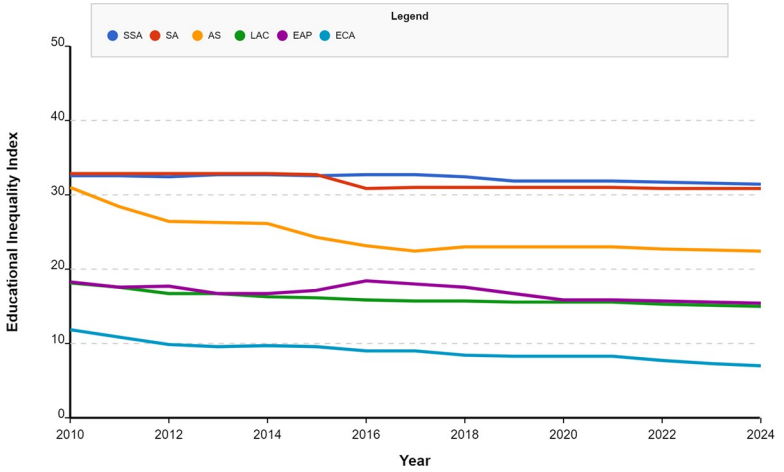

Figure 1. Regional trends in educational inequality (2010–2024)
Source(s): Authors' own creation based on UNDP inequality data set (2010–2024)

- *Sub-Saharan Africa (SSA)* and *South Asia (SA)* consistently show the highest inequality levels throughout the period. While South Asia demonstrates more substantial improvement (reduction from 37.77 in 2010–33.19 in 2021), both regions maintain similarly high inequality levels through 2024 according to the data.
- *Arab States (AS)* showed the most dramatic improvement among all regions, decreasing from 33.16 in 2010–23.90 in 2021, a 27.9% reduction.
- *Europe and Central Asia (ECA)* maintained the lowest inequality levels throughout the period, improving from an already low 9.47 in 2010–5.79 in 2021.
- *Latin America and Caribbean (LAC)* and *East Asia and Pacific (EAP)* followed comparable moderate trajectories, with both achieving substantial reductions over the period.

The strong correlation between HDI ranking and educational inequality ($r = 0.80$) confirms that countries with lower human development typically face greater educational disparities. However, the analysis identified notable exceptions to this pattern, which present important insights for policy development.

4.3 Country-level analysis of exceptional cases

Despite the strong correlation between human development and educational inequality, several countries deviate significantly from expected patterns. Table 2 presents two categories of exceptional cases: high HDI countries with unexpectedly high inequality and low HDI countries with unexpectedly low inequality.

These anomalous cases highlight that while development level strongly influences educational inequality, policy choices and historical factors can significantly modify this relationship. The Central Asian countries (Uzbekistan, Kyrgyzstan, Tajikistan) demonstrate particularly notable achievements in maintaining low educational inequality despite development challenges.

Table 2. Anomalous cases in the HDI–inequality relationship (2021)

Category	Country	HDI rank (2021)	HDI group	Educational inequality (2021)	Regional avg	Deviation from HDI group avg
High HDI with high inequality	Kuwait	50	Very High	22.11	23.90	+15.08
	Saudi Arabia	35	Very High	18.12	23.90	+11.09
	Spain	27	Very High	15.73	N/A	+8.70
Low HDI with low inequality	Uzbekistan	101	High	0.55	5.79	−11.79
	Kyrgyzstan	118	Medium	3.36	5.79	−22.95
	Marshall Islands	131	Medium	4.78	15.54	−21.53
	Tajikistan	122	Medium	6.04	5.79	−20.27
	Lebanon	112	High	6.18	23.90	−6.16

Source(s): Authors' own creation based on UNDP inequality data set (2010–2024)

4.4 Recent trends and SDG4 implications (2021–2024)

The data for 2022–2024 provides insights into countries with the most substantial progress or deterioration in educational equality in recent years (Figure 2). The data for 2021–2024 identifies Madagascar (−4.25, −14.5%), Tunisia (−2.91, −9.5%), Bahrain (−2.48, −19.7%), Luxembourg (−2.46, −52.3%) and Bolivia (−2.07, −12.5%) as the countries achieving the most substantial improvements in educational equality. Conversely, Mauritania (+2.40, +5.5%), Nigeria (+1.74, +4.3%), Guinea (+1.39, +2.8%), Cuba (+0.96, +10.6%) and Senegal (+0.86, +1.8%) show concerning trends of increasing inequality.

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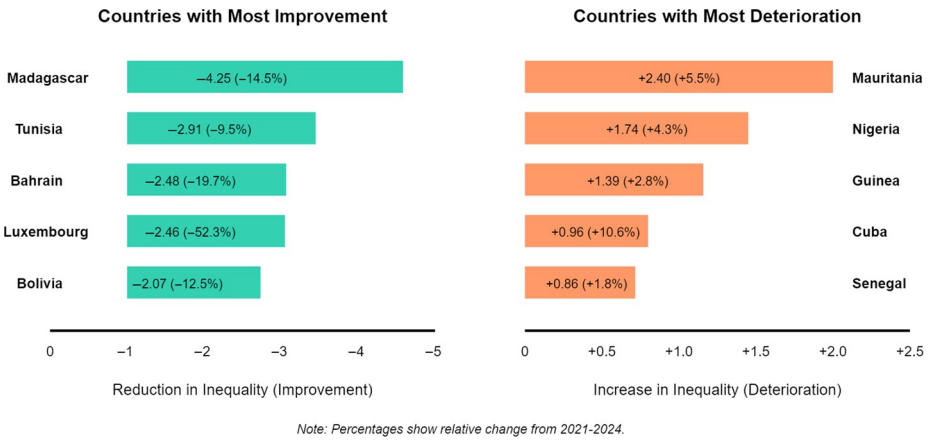

Figure 2. Countries with the most significant change in educational inequality (2021–2024)
Source(s): Authors' own creation based on UNDP inequality data set (2010–2024)

Among the most impressive long-term success stories, several countries achieved remarkable improvements from 2010 to 2021:

- Oman (–18.59, –60.9%).
- Kiribati (–11.74, –54.9%).
- Maldives (–10.65, –26.7%).
- Bahrain (–9.59, –43.3%).
- Fiji (–9.22, –77.8%).

These countries provide important case studies of successful policy interventions, particularly Fiji's achievement of 77.8% reduction in educational inequality over just 11 years – the most substantial improvement globally.

The analysis also examined progress toward SDG4 targets by calculating the gap between current inequality levels and an illustrative target of 5% educational inequality. While Very High HDI countries are approaching this target with an average gap of 1.66 percentage points, Low HDI countries face a substantially larger challenge with an average gap of 33.32 percentage points.

Based on current improvement rates, only 12 countries globally are on track to reach a 5% educational inequality target by 2030, all of them from the Very High and High HDI groups. This finding underscores the need for accelerated and targeted interventions in high-inequality regions to achieve SDG4 goals of equitable quality education for all.

5. Discussion

5.1 Regional disparities in educational inequality: global patterns and implications for SDG4

The analysis of educational inequality trends from 2010 to 2024 reveals significant regional disparities that present substantial challenges to achieving SDG4 targets. Sub-Saharan Africa and South Asia consistently demonstrate the highest levels of educational inequality throughout the study period, with 2024 data indices of 32.7 and 33.1, respectively . These regions represent approximately 55% of children globally but account for more than 75% of children not enrolled in school. The persistent educational inequality in these regions is particularly concerning, as they are most at risk of not meeting the SDG target of universal access to quality education by 2030. By contrast, Europe and Central Asia maintain the lowest regional inequality levels, with the ECA region showing continuous improvement from 9.5 in 2010–5.8 in 2021. This regional disparity indicates the need for tailored approaches to address the unique challenges facing different geographical areas. As Rahman *et al.* (2023) note, regional differences in intervention coverage are significant, with some regions making substantial progress toward targets, while others lag behind.

The regional disparities in educational inequality align with broader socioeconomic development patterns. Niessen *et al.* (2018) highlight how socioeconomic inequalities significantly impact access to services, with "strong scientific evidence suggesting an increase in the clustering of non-communicable conditions with low socioeconomic status in low-income and middle-income countries since 2000." This pattern is mirrored in educational inequalities, where poverty reduction, health promotion and educational access are deeply interconnected. The achievement of SDG4 targets requires acknowledging these regional disparities and developing context-specific interventions. As our data reveals, the global average educational inequality index has decreased from 20.7 in 2010–18.0 in 2021, representing progress but still short of targets in many regions. Rahman *et al.* (2023) project

that only 18 countries will reach the 80% composite coverage index target by 2030, underscoring the need for accelerated action in lagging regions.

5.2 Socioeconomic and development determinants of educational inequality

The strong correlation between human development status and educational inequality ($r = 0.80$) provides compelling evidence that educational equity cannot be addressed in isolation from broader development concerns. This relationship manifests in a clear hierarchy among Human Development Groups, with Low HDI countries consistently showing the highest educational inequality levels (38.6 in 2021), while Very High HDI countries maintain the lowest levels (7.0 in 2021). Niessen *et al.* (2018) explain this pattern through the lens of socioeconomic determinants, noting that "five Sustainable Development Goals set targets that relate to the reduction of health inequalities nationally and worldwide. These targets are poverty reduction, health and wellbeing for all, equitable education, gender equality, and reduction of inequalities within and between countries." The interaction between inequalities and education is complex: better economic outcomes enhance educational access, while low socioeconomic status leads to educational disadvantages, creating a cycle that can trap communities in persistent inequality. The analysis of educational inequality by Human Development Groups reveals that progress has been uneven. While High HDI countries achieved a 22.0% reduction from 2010 to 2021, Low HDI countries saw a 1.7% increase during the same period. This growing gap underscores how educational inequality can reinforce existing socioeconomic divides. This aligns with observations from Zhou *et al.* (2024), who found that "socioeconomic inequalities are associated with the progression of chronic conditions… with lower SES groups having both an earlier time to and a higher incidence" of multimorbidities. The parallels between health and educational inequalities reflect their shared socioeconomic determinants. At a national level, countries exhibit significant variation in educational inequality even within the same HDI category. For example, the analysis identified notable exceptions to the HDI-inequality relationship, especially in Central Asian countries. Uzbekistan (HDI: 101, inequality: 0.55), Kyrgyzstan (HDI: 118, inequality: 3.36) and Tajikistan (HDI: 122, inequality: 6.04) achieved remarkably low educational inequality despite medium to high HDI rankings. These exceptions offer valuable policy insights, suggesting that targeted educational strategies can overcome structural barriers even in resource-constrained environments.

5.3 Success stories and policy lessons from educational inequality reduction

The analysis of countries that have achieved significant reductions in educational inequality provides valuable policy insights for accelerating progress toward SDG4 targets. Both the long-term success stories from 2010 to 2021 and countries projected to make substantial improvements by 2024 offer important lessons for policy development.

5.3.1 Central Asian model. Perhaps the most remarkable success stories emerge from Central Asian countries, which have achieved and maintained exceptionally low educational inequality despite development challenges. Uzbekistan, with an HDI rank of 101, achieved an educational inequality index of just 0.55 in 2021 – the lowest among all analyzed countries. Similarly, Kyrgyzstan (HDI: 118, inequality: 3.36) and Tajikistan (HDI: 122, inequality: 6.04) demonstrated that equitable education is possible despite resource constraints.

Several key policy factors contribute to this "Central Asian model" of educational equity:

- *Strong public education systems*: These countries have maintained high public investments in education as a percentage of GDP, prioritizing universal access.

- *Cultural value of literacy*: The Soviet-era emphasis on universal literacy created a strong educational foundation that these countries have preserved post-independence.
- *Educational continuity during transitions*: Despite economic challenges following the collapse of the Soviet Union, these countries prioritized maintaining educational infrastructure and access.
- *Gender equity in education*: Central Asian countries have largely achieved gender parity in educational enrollment, removing a key barrier to educational equity.

This model provides important evidence that targeted educational policies can achieve equity despite broader development challenges, offering valuable lessons for other low and middle-income countries.

5.3.2 Resource-rich countries with effective policies. Several countries with resource wealth have effectively leveraged these resources toward educational equity. Oman and Bahrain stand out, achieving reductions in educational inequality of 18.59 (60.9%) and 9.59 (43.3%), respectively, from 2010 to 2021. These countries have implemented several key strategies:

- *Substantial investment in universal education infrastructure*: Allocating resource wealth toward comprehensive educational facilities across all regions.
- *Scholarship programs for disadvantaged populations*: Targeted financial support to overcome economic barriers to education.
- *Prioritizing rural and marginalized communities*: Directing resources to traditionally underserved areas to reduce geographic disparities.

As Rahman *et al.* (2023) note, "governments of countries where the universal target has not yet been reached must develop evidence-based policies aimed at enhancing coverage. Additionally, they should focus on reducing the extent of existing inequalities within their populations."

5.3.3 Latin American progress. Several Latin American countries have made substantial progress in reducing educational inequality. Bolivia demonstrated a reduction of 7.13 (30.1%) from 2010 to 2021, with projections for continued improvement by 2024. Key policy approaches in this region include:

- *Conditional cash transfer programs*: Linking financial support to school attendance, which has proven effective in increasing educational participation among marginalized groups.
- *Educational reforms prioritizing indigenous and rural populations*: Targeted interventions addressing the specific needs of traditionally excluded communities.
- *Progressive funding formulas*: Directing resources disproportionately to disadvantaged regions to overcome historical inequities.

These success stories demonstrate that policy choices significantly influence educational equity outcomes, even within similar development contexts. The experiences of these countries provide a valuable knowledge base for policy development in regions still struggling with high educational inequality.

5.4 Barriers to progress: persistent challenges in reducing educational inequality

Despite overall progress in reducing educational inequality globally, significant barriers continue to impede advancement toward SDG4 targets in many countries. Understanding these challenges is crucial for developing effective interventions to accelerate progress.

5.4.1 Structural and economic constraints. Persistent poverty remains a fundamental barrier to educational equity in many regions. In Sub-Saharan Africa, where educational inequality remains high (32.9 in 2021), economic constraints limit educational infrastructure investment and household capacity to support children's education. Economic insecurity leads to higher opportunity costs for education, particularly in rural areas where children's labor may be essential for household survival.

Limited public resources for education in many low-income countries create significant challenges. As data from our analysis shows, Low HDI countries experienced minimal improvement in educational inequality from 2010 to 2021 (1.7% increase), while Very High HDI countries achieved a 18.4% reduction. This resource gap reflects broader economic inequalities between countries that are difficult to overcome without substantial international support.

Infrastructure deficits further exacerbate educational inequality, particularly in rural areas. The rural-urban divide remained significant across most countries in the analysis, with many rural areas lacking adequate educational facilities, qualified teachers and digital connectivity.

5.4.2 Social and cultural barriers. Gender-based discrimination continues to impact educational equity in many regions. Idowu *et al.* (2024) emphasize that "women's empowerment indices, such as the Gender Inequality Index (GII), employment, and literacy" are critical factors in addressing disparities. In contexts where gender norms restrict women's education and participation, educational inequality is perpetuated across generations. Osborne *et al.* (2022) highlight how "people's health awareness and behaviours are linked to lifelong experiences and social practices, which may be multilayered, hidden and beyond their control." The same applies to educational engagement, where cultural attitudes toward education and societal expectations significantly influence educational participation and outcomes. Conflict and political instability disrupt educational systems, with Niessen *et al.* (2018) noting how these factors contribute to "clustering of non-communicable conditions with low socioeconomic status in low-income and middle-income countries." Similar patterns emerge in educational inequality, where conflict-affected regions show persistently high inequality indices.

5.4.3 Policy and implementation gaps. Many countries face challenges in policy implementation, even when appropriate policies are in place. As Rahman *et al.* (2023) observe, "regionally, CCI is projected to increase in all regions… [but] only 18 countries are projected to reach the 80% CCI target by 2030," indicating gaps between policy intentions and outcomes. Siloed approaches to development challenges limit effectiveness, with Osborne *et al.* (2022) advocating for avoiding "deficit approaches and siloed health system and policy responses… focusing instead on integrating community-based solutions through co-design, cognisant of people's daily experiences and social practices." Similarly, educational inequality requires integrated approaches that address its multidimensional nature. Limited monitoring and evaluation capacity hampers evidence-based policy development in many contexts. Our analysis revealed significant data gaps, particularly for countries with the highest educational inequality, making it difficult to track progress and adjust interventions.

5.5 Pandemic-related disruptions and projection validity concerns

The COVID-19 pandemic represents an unprecedented disruption to global educational systems that fundamentally challenges both the validity of pre-2021 trend extrapolations and the projected trajectories presented in this analysis. This disruption has created what UNESCO terms a "learning crisis," with implications that extend far beyond temporary school closures to encompass fundamental shifts in educational access patterns, resource allocation and policy priorities that were not anticipated in pre-pandemic planning frameworks.

5.5.1 Scale and scope of educational disruption. UNESCO data indicates that over 1.6 billion students worldwide were affected by school closures, with the longest closures occurring in countries that were already struggling with high levels of educational access inequality. The magnitude of this disruption is unprecedented in modern educational history, affecting educational systems across all regions and development levels simultaneously. However, the impact has been far from uniform, creating differential effects that compound existing inequalities in educational access.

The pandemic has disproportionately affected marginalized populations who lacked access to remote learning technologies, digital infrastructure and supportive home learning environments. While some high-income countries successfully transitioned to digital learning platforms and maintained or even improved educational access during closures, many low-income countries experienced complete educational disruption for extended periods. This differential capacity to maintain educational continuity during crisis periods has likely exacerbated existing inequalities in educational access, with the most disadvantaged populations bearing the greatest burden of learning losses and interrupted schooling.

5.5.2 Economic and resource allocation impacts. The economic consequences of the pandemic have forced many countries to redirect public spending from education to health and economic recovery priorities, contradicting the assumed continuation of improvement trends embedded in the 2021–2024 projections presented in this study. UNESCO reports indicate declining global investment in education since 2020, representing a significant departure from the pre-pandemic trajectory of gradual improvement in educational resource allocation. Many countries have simultaneously increased defense spending in response to geopolitical instability, further constraining resources available for educational development and equity initiatives.

These resource constraints have particular implications for countries that were making progress in reducing educational inequality through targeted investments in infrastructure, teacher training and support for disadvantaged populations. The redirection of funds away from these equity-focused interventions may have disrupted progress trajectories that had been sustained over the previous decade, potentially reversing gains that took years to achieve.

5.5.3 Implications for projection validity and future research. The projections presented for 2022–2024 in this analysis are based on linear extrapolation of pre-pandemic trends and should be interpreted with significant caution, given these unprecedented disruptions. The assumption of trend continuation that underlies these projections cannot account for the complex, differential impacts that have affected educational systems since 2020. Rather than continued improvement, many regions may have experienced reversals in progress toward SDG4 targets, particularly affecting the most vulnerable populations who were already at risk of educational exclusion.

These pandemic-related disruptions suggest that the projections should be viewed as conditional scenarios based on pre-2021 patterns rather than reliable forecasts of actual

educational access inequality through 2024. The actual trajectory of educational access inequality may deviate significantly from these projections, potentially requiring more urgent and targeted interventions than originally anticipated to achieve SDG4 targets by 2030.

Future research priorities must therefore include gathering comprehensive post-pandemic data to assess the true impact of COVID-19 on global educational access equity patterns. This assessment should examine not only aggregate national trends but also differential impacts across population groups, with particular attention to how the pandemic has affected progress toward educational equity for marginalized communities. Only through such systematic post-pandemic analysis can researchers and policymakers develop accurate understanding of current educational inequality trajectories and recalibrate intervention strategies accordingly to meet SDG4 commitments in the remaining years before 2030.

5.6 Implications for SDG4 and recommendations for policy and practice

The findings of this study have significant implications for advancing progress toward SDG4 targets and reducing educational inequalities globally. Based on the analysis of trends from 2010 to 2024 and identified success factors, we propose the following recommendations for policy and practice.

5.6.1 Regional prioritization for achieving sustainable development goals in education. Given the substantial regional disparities in educational inequality, international efforts should prioritize Sub-Saharan Africa and South Asia, where educational inequality remains highest. These regions have shown the least improvement over the study period and are at greatest risk of missing SDG4 targets. Targeted international support, including financial resources and technical assistance, should focus on countries with persistent high inequality indices. Special attention should be directed to countries facing multiple development challenges, including conflict, climate vulnerability and extreme poverty. The analysis identified several countries where multiple factors contribute to persistent educational inequality, requiring comprehensive approaches that address these intersecting challenges.

The effectiveness of SDGs depends not only on their aspirational targets but also on the robustness and relevance of the indicators used to measure progress. Hák, Janoušková and Moldan (2016) emphasize that for the SDGs to be meaningfully implemented, particularly in complex domains such as education, the selected indicators must reflect both the quantitative and qualitative dimensions of development. In the context of SDG4, this reinforces the importance of moving beyond aggregate averages to capture disparities in educational access, attainment and learning outcomes. As our study shows, while global averages suggest progress in reducing educational inequality, disaggregated indicators reveal stark intra- and inter-regional differences that risk being overlooked by overly simplified measurement frameworks. Therefore, educational inequality indicators must be refined to reflect multidimensional aspects of equity – including gender, geographic and socioeconomic disparities – in alignment with the call for relevant, context-sensitive metrics (Hák *et al.*, 2016). The SDGs represent a global consensus on the need for inclusive, equitable and transformative development by 2030. As Ban (2016) emphasized in his reflections on the SDG agenda, education is not only a standalone goal but a critical enabler of all other development targets. SDG4's emphasis on inclusive and equitable quality education underscores its dual function: as both a human right and a catalyst for sustainable societies. The findings of this study align with this vision, demonstrating that educational inequality is deeply interconnected with broader structural conditions such as poverty, gender inequality and regional disparities. Consequently, reducing educational disparities is

central not only to the realization of SDG4, but also to advancing the entire sustainable development agenda (Ban, 2016).

5.6.2 Cross-sectoral approaches. As Niessen *et al.* (2018) emphasize, "strong evidence from 283 studies overwhelmingly supports a positive association between low-income, low socioeconomic status, or low educational status" and adverse development outcomes. This highlights the urgent need for integrated approaches that address educational inequality in tandem with broader development challenges. Educational policy should therefore be linked to strategies aimed at poverty reduction, health-care access and gender equity. In this context, Osborne *et al.* (2022) stress the importance of "integrating community-based solutions through co-design, cognisant of people's daily experiences and social practices," cautioning against siloed development responses. Similarly, Idowu *et al.* (2024) argue that enhancing women's empowerment indicators – such as the GII, employment and literacy – offers a promising pathway to improved well-being, as seen in efforts to reduce neonatal mortality in Sub-Saharan Africa. These insights suggest that aligning educational equity with women's empowerment initiatives could significantly advance SDG4 goals.

Building on this, Boas, Biermann and Kanie (2016) propose a nexus approach to global sustainability governance, emphasizing that fragmented, sector-specific interventions are inadequate for addressing complex, interconnected development challenges. Our findings strongly support this view: regions burdened by persistent educational inequality often contend with overlapping disadvantages – including inadequate health systems, climate vulnerability and gender-based exclusion – that exacerbate educational disparities. Addressing these issues through cross-sectoral, nexus-informed strategies enables countries to craft more resilient and inclusive policies that simultaneously advance multiple SDG targets (Boas *et al.*, 2016).

5.6.3 Evidence-based policy development. Successful examples from Central Asia, the Middle East and Latin America offer valuable policy models that can be adapted to diverse development contexts. Notably, the "Central Asian model" demonstrates that equitable education can be achieved even under resource constraints. These countries combine targeted investments with strong public systems and social norms that prioritize educational continuity and inclusiveness.

As Zhou *et al.* (2024) note in a parallel context, "more effective equity-oriented policies and practices" are essential to address persistent inequalities. In the field of education, this translates to designing targeted interventions for marginalized populations while upholding the principle of universal access. Equally important is the role of community ownership and participation. Osborne *et al.* (2022) emphasize that "meaningful community engagement, local ownership and locally driven actions are needed to identify strengths, challenges and preferences to build locally fit-for-purpose and implementable actions." Educational policies must therefore be co-designed with local stakeholders to enhance relevance, sustainability and impact.

Developing effective educational equity strategies further requires more than descriptive data or normative aspirations – it demands a pluralistic, evidence-based framework. Head (2008) identifies three complementary "lenses" in evidence-informed policymaking: scientific research, practitioner expertise and political judgment. In the context of SDG4, this suggests that successful reforms must be grounded in rigorous data (such as inequality indices), responsive to field-level realities and politically viable. Our analysis indicates that countries with notable progress in reducing educational inequality – such as those in Central Asia – effectively integrate these dimensions. They draw on empirical performance evidence, experienced public institutions and equity-oriented societal values. Thus,

achieving meaningful and sustainable progress toward SDG4 requires policy frameworks that blend empirical rigor with social inclusion and political pragmatism (Head, 2008).

5.6.4 Improved monitoring and accountability. Enhanced data collection and monitoring systems are essential for tracking progress toward SDG4 targets, particularly in countries with limited statistical capacity. The analysis revealed significant data gaps in countries with high educational inequality, hampering effective policy development. International accountability mechanisms should be strengthened to ensure continued progress toward educational equity goals. As Rahman *et al.* (2023) note, monitoring progress in intervention coverage "is crucial to evaluate the advancement of low-income and middle-income countries towards the attainment of Sustainable Development Goal targets." Regular equity analyses are needed to identify and address disparities within countries, as national averages can mask significant internal inequalities. Our analysis demonstrated substantial within-country disparities based on urban–rural divisions, gender and socioeconomic status. By implementing these recommendations, countries can accelerate progress toward the SDG4 target of inclusive and equitable quality education for all. The experiences of countries that have achieved significant reductions in educational inequality provide valuable guidance for policy development, while the identification of persistent barriers highlights areas requiring intensified attention.

5.7 Research gaps and future directions

While this study provides comprehensive analysis of educational inequality trends from 2010 to 2024 and their implications for SDG4, several important research gaps remain that should be addressed in future work.

5.7.1 Methodological limitations and data gaps. The current analysis relies on available national-level data, which may not fully capture subnational disparities or the experiences of the most marginalized populations. Future research should aim to incorporate more granular data on educational inequality within countries, particularly for marginalized groups that may be underrepresented in national surveys.

As Blanchard *et al.* (2024) observe in another context, "there are striking inequities in the origin, scope, and design of these studies, suggesting that research capacity and funding lies in the hands of a few expert teams worldwide." Similar research capacity disparities exist in educational inequality research, leading to knowledge gaps for countries with limited research infrastructure.

The educational inequality index captures disparities in educational attainment but does not directly measure quality of education or learning outcomes. Future research should incorporate measures of educational quality alongside quantitative access metrics to provide a more comprehensive picture of educational equity.

5.7.2 Emerging research priorities. More research is needed on the impact of digital technologies on educational inequality, particularly following the COVID-19 pandemic. The increasing reliance on digital learning platforms may exacerbate existing inequalities in contexts where digital access is limited. Climate change impacts on educational systems and inequalities represent an emerging research priority. As climate-related disruptions increase, understanding their differential impacts on educational access across socioeconomic groups will be essential for developing resilient educational systems. Blanchard *et al.* (2024) emphasize the need for research to "consider impacts on equity more consistently." Future educational inequality research should more systematically examine intersectional dimensions of inequality, including the combined effects of gender, disability, ethnicity and socioeconomic status.

5.7.3 Policy-oriented research needs. Implementation science approaches are needed to better understand how successful policies from high-performing countries can be effectively adapted to different contexts. The successful examples from Central Asia, for instance, require careful analysis to identify transferable elements that could benefit other regions. Idowu *et al.* (2024) note that while women's empowerment represents "potentially a long-term solution, short and medium-term recommendations were also proffered." Similarly, research on educational inequality should focus on both short-term interventions to address immediate disparities and longer-term structural changes to achieve sustainable equity. As Osborne *et al.* (2022) argue, "health literacy development needs to underpin local and national policy, laws and regulations to create enabling environments." Comparable research on educational literacy and its role in policy development could enhance the effectiveness of educational equity initiatives. By addressing these research gaps, future studies can contribute to more effective policies and interventions to reduce educational inequality and accelerate progress toward SDG4 targets.

5.7.4 Recommendations for accelerating progress toward SDG4 targets. 5.7.4.1 Regional prioritization for high-inequality contexts. International efforts must strategically prioritize Sub-Saharan Africa and South Asia, where educational inequality remains persistently high (32.9 and 33.2, respectively, in 2021) and progress has been the slowest. These regions require targeted financial resources, technical assistance and capacity-building support that addresses their specific contextual challenges. Priority should be given to countries facing multiple development constraints, including conflict-affected states, climate-vulnerable nations and those experiencing extreme poverty. Specifically, international donors and development agencies should establish dedicated funding mechanisms for educational equity initiatives in these regions, provide technical expertise for policy development and implementation and create knowledge-sharing platforms that connect high-performing countries with those facing similar challenges. The analysis demonstrates that without accelerated intervention, these regions risk missing SDG4 targets by substantial margins, with current trajectories suggesting that Low HDI countries face an average gap of 33.32 percentage points from illustrative equity targets. This regional focus should also include South-South cooperation initiatives that leverage successful models from countries with similar development profiles, such as the Central Asian countries that have achieved remarkable equity outcomes despite resource constraints.

5.7.4.2 Cross-sectoral integration and holistic development approaches. Educational inequality cannot be addressed in isolation from broader development challenges, as evidenced by the strong correlation (r = 0.80) between HDI rankings and educational inequality in this study. Effective interventions must therefore integrate educational policy with poverty reduction strategies, health-care access improvements, gender equity initiatives and economic development programs. This requires establishing inter-ministerial coordination mechanisms that ensure educational investments are aligned with broader development goals, such as linking conditional cash transfer programs to educational participation while simultaneously addressing health-care and nutrition needs. Countries should develop integrated policy frameworks that recognize education as both a driver and outcome of sustainable development, incorporating lessons from successful cross-sectoral approaches observed in Latin American countries like Bolivia, which achieved a 30.1% reduction in educational inequality through comprehensive social programs. Implementation should involve joint planning processes between education, health, social protection and economic development ministries, with shared performance indicators that capture the interconnected nature of these challenges. Community-level interventions should address multiple deprivations simultaneously, such as providing educational infrastructure alongside

health-care facilities and economic opportunities, recognizing that families' educational decisions are influenced by their broader socioeconomic circumstances.

5.7.4.3 Evidence-based policy development and adaptation of successful models. The identification of successful models, particularly the "Central Asian model" demonstrated by Uzbekistan, Kyrgyzstan and Tajikistan, provides valuable blueprints for policy development that can be adapted to diverse contexts. These countries achieved remarkably low educational inequality (0.55, 3.36 and 6.04, respectively) despite medium HDI rankings through strong public education systems, cultural emphasis on literacy and prioritization of educational continuity during economic transitions. Countries seeking to improve educational equity should systematically study and adapt these approaches, focusing on universal public education investment, teacher training and deployment to underserved areas and maintaining educational infrastructure during economic or political transitions. Policy development should also draw from successful interventions in resource-rich countries like Oman and Bahrain, which leveraged wealth toward educational equity through substantial infrastructure investments and targeted support for disadvantaged populations. Implementation requires establishing policy learning mechanisms that facilitate knowledge transfer between countries, conducting pilot programs to test adapted interventions before scaling up and developing context-specific strategies that maintain core equity principles while addressing local challenges. Countries should also invest in policy research capacity to generate evidence on what works in their specific contexts, moving beyond importing policies to developing indigenous solutions informed by global best practices.

5.7.4.4 Enhanced monitoring, accountability and data systems. Robust monitoring and accountability mechanisms are essential for tracking progress toward SDG4 targets and ensuring continued improvement in educational equity. The analysis revealed significant data gaps, particularly in countries with the highest educational inequality, which hampers effective policy development and progress assessment. Countries must strengthen their statistical capacity to collect, analyze and report disaggregated educational data that captures within-country disparities based on gender, geography, socioeconomic status and other relevant characteristics. This requires establishing comprehensive educational management information systems (EMIS) that can track progress in real time, investing in statistical capacity building at national and subnational levels and developing standardized indicators that enable cross-country comparisons while capturing context-specific equity dimensions. International accountability mechanisms should include regular equity audits that assess not only national progress but also internal disparities, with technical and financial support provided to countries with limited monitoring capacity. Civil society organizations and communities should be engaged in monitoring processes to ensure accountability and provide feedback on policy implementation effectiveness. Additionally, countries should establish regular review cycles that assess progress toward equity targets, identify emerging challenges and adjust strategies accordingly, with transparent reporting mechanisms that enable stakeholders to track performance and advocate for necessary improvements. The monitoring system should also incorporate predictive analytics to identify countries and regions at risk of falling behind SDG4 targets, enabling proactive interventions rather than reactive responses to emerging inequalities.

Conclusion

This research provides a comprehensive analysis of global educational inequality trends from 2010 to 2024, offering critical insights for achieving the equitable education targets outlined in SDG4. The findings reveal a complex landscape of progress and persistent challenges that demand urgent and targeted interventions. Educational inequality has shown

a gradual global improvement, with the average index decreasing from 20.7 in 2010 to 18.0 in 2021. However, this progress masks significant regional disparities, with Sub-Saharan Africa and South Asia maintaining alarmingly high levels of inequality (32.9 and 33.2, respectively, in 2021). These regional patterns mirror broader development disparities, highlighting the interconnected nature of the SDGs. The strong correlation ($r = 0.80$) between HDI ranking and educational inequality underscores that educational equity cannot be achieved in isolation from broader socioeconomic development.

Despite these challenges, our analysis has identified notable success stories that provide valuable policy insights. The "Central Asian model" demonstrated by Uzbekistan, Kyrgyzstan and Tajikistan offers compelling evidence that equitable education is achievable despite resource constraints. These countries have maintained remarkably low educational inequality indices through strong public education systems, cultural emphasis on literacy and prioritizing educational continuity during economic transitions. Similarly, resource-rich countries like Oman and Bahrain have effectively leveraged their wealth toward educational equity through substantial investments in universal education infrastructure and targeted support for disadvantaged populations. Based on these findings, several recommendations emerge for accelerating progress toward SDG4 targets. First, international efforts should prioritize regions with the highest educational inequality, particularly Sub-Saharan Africa and South Asia, where the risk of missing SDG4 targets is the greatest. Second, educational policies should be integrated within broader development strategies addressing poverty, health-care and gender equity, recognizing the interconnected nature of these challenges. Third, successful models from high-performing countries should be adapted to different contexts while ensuring local ownership and community engagement. Finally, data collection and monitoring systems must be strengthened to track progress and hold stakeholders accountable, particularly in countries with limited statistical capacity.

The research also reveals important areas for future investigation, including more granular analysis of subnational disparities, better integration of educational quality metrics alongside access indicators and exploration of emerging challenges such as digital divides and climate change impacts on educational systems. As Osborne *et al.* (2022) argue regarding health literacy, educational equity requires approaches that are cognizant of people's daily experiences and social practices, avoiding deficit-focused interventions in favor of community-based solutions.

As we approach the 2030 deadline for the SDGs, addressing educational inequality must become a global priority. The COVID-19 pandemic has further exacerbated educational disparities in many contexts, making accelerated action even more urgent. The evidence presented in this study demonstrates that significant reductions in educational inequality are achievable with political will, appropriate policies and adequate resources. However, it also highlights the substantial work that remains to ensure that quality education becomes truly accessible to all, regardless of geography, gender or socioeconomic status. Educational equity represents both a moral imperative and a strategic investment in sustainable development. By reducing educational inequality, countries not only advance SDG4 but also create the foundation for progress across the entire sustainable development agenda. The path toward 2030 demands renewed commitment, evidence-based policies and targeted interventions that leave no learner behind. Only through such concerted efforts can we transform the promise of equitable education from aspiration to reality for children and adults worldwide.

This analysis must be interpreted in light of the unprecedented global disruption caused by the COVID-19 pandemic, which began affecting educational systems worldwide in 2020. Our projections for 2021–2024 are based on pre-pandemic trends and cannot account for the

differential impacts of school closures, economic recession and shifting government priorities that have likely altered educational access patterns significantly. The pandemic has disproportionately affected marginalized populations' access to education while simultaneously reducing global investment in education as countries prioritize health and economic recovery. Therefore, while our analysis provides valuable insights into pre-pandemic trends and successful policy models, achieving SDG4 targets by 2030 may require even more urgent and targeted interventions than our projections suggest. Future research should prioritize gathering post-pandemic data to assess the true impact of COVID-19 on global educational access equity and recalibrate projections accordingly.

Author contributions

Conceptualization, Yavuz Selim Balcioglu and Erkut Altindag; methodology, Yavuz Selim Balcioglu; software and algorithm implementation, Yavuz Selim Balcioglu; formal analysis, Yavuz Selim Balcioglu and Erkut Altindag; data collection, Yavuz Selim Balcioglu; writing – original draft preparation, Yavuz Selim Balcioglu, Ahmet Alkan Çelik and Erkut Altindag; writing – review and editing, Yavuz Selim Balcioglu, Ahmet Alkan Çelik and Erkut Altindag; supervision, Erkut Altindag and Ahmet Alkan Çelik. All authors have read and agreed to the published version of the manuscript.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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