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PAPER

Educational Inclusion and Vulnerable Heterogeneity in Ecuador: Beyond Digital Access

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ABSTRACT

This study examines heterogeneity patterns in educational exclusion among vulnerable population groups in Ecuador. The analysis uses data from the 2024 National Survey on Employment, Unemployment, and Underemployment (ENEMDU) and includes 2,345 individuals aged between 5 and 24 years, representing an expanded population of approximately 1.6 million people nationwide. A cross-sectional analytical design was applied using logistic regression models with a complex sample structure. Educational exclusion was defined as non-attendance at an educational institution during the corresponding school-age period. Multidimensional poverty was measured through an index based on education, health, living conditions, and access to basic services. The results identify a "truncated success paradox", in which the vulnerable group shows low levels of exclusion in secondary education (3%) but the highest levels of exclusion in higher education (71%), compared to other poverty groups. Severe poverty is associated with persistent exclusion across educational stages. Internet access is not significantly associated with educational exclusion, with only minor differences observed between households with and without connectivity. The findings indicate that educational exclusion is driven primarily by structural and institutional factors rather than technological ones, particularly the limited availability of higher education admission slots. These findings call for differentiated, sustainable inclusion policies that prioritize structural reforms over technological solutions alone.

KEYWORDS

educational inclusion, educational equity, vulnerable populations, multidimensional poverty, differentiated policies, Ecuador

1 INTRODUCTION

Latin American educational systems currently face the dual challenge of steadily expanding coverage and ensuring quality, relevance, and sustainability without aggravating inequalities within historically excluded populations [1]. In Ecuador, this challenge arises from the fact that, despite digital coverage, only 47.3% of young

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people between 18 and 24 years old have access to higher education [2], exposing structural exclusion gaps that exceed conventional technological explanations.

Modern educational studies consistently highlight the countless digital gaps across educational levels [1], [3]. However, something that remains overlooked is the disparities, heterogeneities, and institutional mechanisms within the most vulnerable groups, which reinforce a subtle yet constant form of exclusion [4]. Likewise, some working-class students achieve relative educational success in the early stages but later face invisible institutional gaps at critical transition points, especially when attempting to access higher education [5]. A country's development must be viewed as a way of achieving genuine freedoms; in educational matters, this entails recognizing and addressing the diversities of capabilities, needs, and aspirations among so-called homogeneous groups [6].

In Ecuador, studies on educational exclusion indicate that university dropout rates have numerous interrelated causes; economic, academic, and institutional are the most significant [7]. However, many of these approaches tend to homogenize vulnerable sectors, ignoring internal differences that are essential for understanding the heterogeneous realities of exclusion. The specialized literature on Latin American environments suggests that, to analyze conditions of educability, it is necessary to establish vulnerability categories that help identify the various mechanisms and pathways through which exclusion occurs [4]. This perspective is essential for developing more effective and efficient interventions that surpass conventional solutions.

Higher education in Ecuador is facing a structural crisis in the allocation of university admission slots, which excludes approximately 100,000 high school graduates each year, equivalent to 54% of those entering from secondary school [8]. However, this exclusion is not evenly distributed among vulnerable groups, suggesting the presence of differentiated mechanisms of selection and exclusion that go beyond factors solely related to economic constraints or access to technology.

Evidence from some regional and Latin American studies has revealed these internal differences. [9] notes that massified higher education systems lead to processes of "subtle selection," disproportionately affecting various subgroups within historically marginalized sectors. In the Latin American context, [10] describes cases of enrollment systems that, although increasing overall access, continue to perpetuate forms of exclusion for specific profiles within disadvantaged populations.

This study contributes to closing these gaps by investigating differentiated educational trajectories according to multidimensional levels in the country, while also identifying key intervention points for more effective and sustainable public policies.

For this reason, the objective of this study is to examine the heterogeneity patterns of educational exclusion among vulnerable sectors in Ecuador and to develop solutions or sustainable inclusion models that transcend traditional homogeneous approaches. Additionally, the study will take into account the heterogeneities in educational exclusion according to different levels of multidimensional poverty and the academic pathways across groups. The study is also designed to analyze the relative influence of technological factors compared to structural and institutional factors on the educational exclusion of vulnerable students. The primary goal is to propose a sustainable educational inclusion model centered on recognizing heterogeneities and cost-effective mechanisms.

This becomes even more relevant in a context where digital technology has become an essential component of today's society and academic systems; however, access to technology and internet connection remains unevenly distributed [11].

The study proposes developing a sustainable model of educational inclusion based on awareness of internal differences and cost-effective strategies.

This will help restore meaning to young people's lives and equip them with the skills and ambition to remake our societies, economies, and organizations. To flourish over a lifetime, people will need to be adaptive problem solvers, ethically competent, and able to understand, appreciate, and act in the world [12].

This digital inequality is particularly concerning in the Latin American context, where digitalization processes intersect with persistent poverty patterns. Recent theoretical reviews demonstrate that, without comprehensive policies addressing both technological access and underlying socioeconomic conditions, digital initiatives risk reinforcing rather than reducing educational exclusion among vulnerable populations [13].

2 MATERIALS AND METHODS

This study employs a cross-sectional analytical design, using data from the 2024 National Employment, Unemployment, and Underemployment Survey (ENEMDU), executed by the National Institute of Statistics and Census of Ecuador. The ENEMDU is administered to households and has national representativeness since the survey employs a stratified, multi-stage sampling design [14].

AI language models were used for language editing and reference formatting. All scientific content, analysis, and interpretations are original works of the authors.

Using nationally representative data, the sample comprises 2,345 individuals aged between five and 24 years, representing an expanded population of approximately 1.6 million people nationwide. The sampling design incorporates expansion factors, clusters, and strata, allowing statistically reliable conclusions about the Ecuadorian population within the analyzed age range.

Dependent variable: Academic exclusion was defined as not attending an educational institution during the standard school-age years, which captures the gap between educational expectations and actual school attendance.

Main independent variable: Multidimensional poverty was defined through an adaptation of [15] approach, considering four dimensions:

Education: Deprivation is defined as not attending an educational institution between the ages of five and 17.

Health: Deprivation is defined as not being covered by any form of health insurance or social security.

Living conditions: Deprivation is defined as having at least one precarious dwelling condition in floors, walls, or roofs or experiencing overcrowding (≥3 persons per bedroom).

Basic services: Deprivation is defined as the absence of at least one essential service: safe drinking water from the public distribution system, an improved sanitation system, or electricity.

This information was used to generate an index with equal weights, setting the poverty threshold when individuals encounter two or more simultaneous deprivations. Additionally, four categories were established to capture the heterogeneity within vulnerable populations: severe poverty (3–4 deprivations), moderate poverty (2 deprivations), vulnerable (1 deprivation), and non-poor (0 deprivations).

Control Variables: The model included geographical zone (urban/rural), sex (male/female), school-age group (categorical variable), and academic level (elementary school, high school, and higher education). The descriptive statistics of the variables included in the model are presented in Table 1.

Table 1. Descriptive statistics

Variables	Categories	Frequency	Weighted %
Multidimensional poverty	Severe Poverty	1,544	75.23%
	Moderate Poverty	651	20.86%
	Vulnerable	150	3.91%
Educational stage	Basic Education	95	7.23%
	High School	230	11.83%
	Higher Education	2,011	80.93%
Geographic area	Urban	1,581	63.61%
	Rural	764	36.39%
Sex	Male	1,247	54.12%
	Female	1,098	45.88%
Internet access	With Internet	1,817	68.34%
	Without Internet	528	31.66%
Total		**2,345**	**1633350**

To perform the analysis, a logistic regression with a complex sample design was applied:

$$\text{logit}(P(Y = 1)) = \beta_0 + \beta_1 \text{Multidimensional\_poverty} + \beta_2 \text{Controls} + \varepsilon$$

"Y" represents the probability of educational exclusion.

The average marginal effects were obtained using the "margins" command, which allowed the results to be expressed as variations in probabilities rather than odds ratios. To capture specific heterogeneities, interaction terms between multidimensional poverty, educational stage, and internet access were estimated:

$$\text{logit}(P(Y = 1)) = \beta_0 + \beta_1 \text{Poverty} + \beta_2 \text{Stage} + \beta_3(\text{Poverty} \times \text{Stage} \times \text{Internet}) + \beta_4 \text{Controls} + \varepsilon$$

The level of significance adopted was $\alpha = 0.05$, and all confidence intervals were reported at 95%. Model fit was examined using pseudo R^2 and goodness-of-fit tests.

The study was based only on secondary, anonymous, and publicly available data provided by INEC. The ethical protocols for research on secondary information were followed, ensuring confidentiality and the exclusively academic purpose of the analysis.

3 RESULTS

The initial findings of the study revealed significant heterogeneities within vulnerable groups, giving rise to a phenomenon known as the "Truncated Success Paradox." Table 2 shows that, regardless of internet access, severe poverty is associated with consistently high levels of early and persistent exclusion (41.8% in secondary education and 50.4% in higher education); the vulnerable group follows an

opposite pattern: no exclusion in secondary education but a peak of exclusion in university (76.4%).

Analyzing poverty levels shows that severe and moderate poverty groups display the highest probabilities of school dropout. In contrast, the vulnerable population exhibits much lower probabilities, except for age group 3 (university), where the highest likelihood of leaving the educational system is concentrated.

Finally, a counterintuitive result emerges: internet access shows no significant association with educational exclusion ($p = 0.84$), challenging conventional assumptions about the digital divide as the primary barrier to educational inclusion.

Table 2. Probabilities of educational exclusion by poverty level and educational stage

Probability of School Dropout by Age Group and Internet Access						
Poverty Level	**Age Group**	**Internet Access**	**Margin**	**Std. Error**	**p-Value**	**95% CI**
Severe Poverty	5–14	Without Internet	0.157	0.087	0.071	[–0.013, 0.327]
	5–14	With Internet	0.188	0.092	0.042*	[0.007, 0.369]
	15–17	Without Internet	0.367	0.071	<0.001***	[0.227, 0.506]
	15–17	With Internet	0.418	0.064	<0.001***	[0.293, 0.543]
	18–24	Without Internet	0.450	0.033	<0.001***	[0.385, 0.571]
	18–24	With Internet	0.504	0.036	<0.001***	[0.433, 0.574]
Moderate Poverty	5–14	Without Internet	0.676	0.198	0.001***	[0.288, 1.065]
	5–14	With Internet	0.722	0.186	<0.001**	[0.356, 1.088]
	15–17	Without Internet	0.310	0.098	0.002**	[0.118, 0.502]
	15–17	With Internet	0.358	0.104	0.001***	[0.154, 0.562]
	18–24	Without Internet	0.469	0.053	<0.001***	[0.364, 0.573]
	18–24	With Internet	0.522	0.046	<0.001***	[0.432, 0.612]
Vulnerable	5–14	Without Internet	Not estimable	–	–	–
	5–14	With Internet	Not estimable	–	–	–
	15–17	Without Internet	0.003	0.003	0.346	[–0.003, 0.009]
	15–17	With Internet	0.004	0.004	0.342	[–0.004, 0.011]
	18–24	Without Internet	0.722	0.059	<0.001***	[0.606, 0.838]
	18–24	With Internet	0.764	0.051	<0.001***	[0.663, 864]

Notes: *Statistical significance: *p < 0.05, **p < 0.01, ***p < 0.001. Population: 2,345 individuals, representing 1.63 million people.
Source: ENEMDU 2024, logistic model with complex sample design.

Analysis of the odds ratios of the model variables reveals that school dropout among young people is a complex issue, with higher education being the most critical stage, challenging the traditional assumption that educational conflicts are primarily concentrated in basic education. According to Table 3, university students are 4.5 times more likely to drop out, particularly those belonging to the vulnerable groups. This paradox—that young people who manage to access higher education face the highest risk of dropping out—highlights the severe retention rate problems in higher education levels.

Contrary to traditional and conventional expectations based on the literature about the digital gap [11], [1] Internet access was not significantly associated with educational exclusion ($p = 0.84$).

Heterogeneities were also observed in the control variables. Living in rural areas increases the risk of exclusion by 37% ($p < 0.001$), while being female acts as a significant protective factor (–20.8%; $p < 0.001$). These differences intersect with poverty levels, emphasizing the need for multidimensional interventions that recognize such intersectionalities.

Table 3. Logistic regression model for factors associated with educational exclusion (Odds Ratios – OR)

Variable	OR	95% CI	p-Value
Moderate Poverty	1.16	[0.39–3.42]	0.781
Vulnerable	1.80	[1.15–2.84]	0.010**
High School	2.28	[1.06–4.90]	0.034*
Higher Education	4.48	[2.26–8.87]	0.000***
Urban Area	0.63	[0.49–0.73]	0.000***
Male	1.84	[1.56–2.19]	0.000***
With Internet	1.01	[0.84–1.22]	0.84
Poverty × Stage Interaction	0.046	[0.005–0.37]	0.004**

Notes: *Pseudo $R^2 = 0.56$; $n = 2{,}345$; ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

At a socioeconomic level, the odds ratio (OR) of 1.89 in the vulnerable sector indicates a significantly higher risk of school dropout compared to the reference category (the severe poverty group), indicating an 80% higher probability. This is a moderate and significant effect. Regarding household educational levels, the odds ratio (OR) for individuals in the high school category is 2.3, indicating 2.3 times higher odds relative to the reference category. For higher education, the OR increases to 4.5.

An analysis of the demographic variables shows that males are 84% more at risk than females. In contrast, urban areas become a protective factor, as they are 37% less likely to experience dropouts than rural areas. The relationship between school dropout and Internet access is not significant; however, the interaction of poverty by educational stages plays a critical role, with an OR of 0.046. An OR below 1 indicates that the effect of poverty depends on the stage of education and has a significant impact.

4 DISCUSSION

When analyzing access to innovative forms of educational programs, significant inequalities were observed. Only 5.8% of all students (418) have access to distance education, with distributions disproportionately favorable to non-poor groups. Vulnerable populations, by contrast, are 42.3% less likely to access a distance education program compared to the non-poor group ($p < 0.001$), highlighting how available educational innovations tend to reinforce existing inequalities.

This study uncovers patterns of educational exclusion that challenge traditional explanations, such as the truncated success paradox. These observations are reinforced by the high explanatory power of the logistic model, which shows a pseudo

R^2 of 0.56—an unusually high value for social science research—indicating that the structural and institutional variables included (multidimensional poverty level and educational stage) account for more than half of the variability in the probability of exclusion.

The truncated success phenomenon, in which vulnerable populations experience minimal exclusion during secondary education (3%) but peak exclusion in higher education (71%), suggests that exclusion mechanisms operate differently across the educational transitions. This corroborates the arguments of [9] and [5] about the "invisible barriers" and the processes of "subtle selection" in higher education, which excessively affect those who successfully progress through early stages of education but encounter a system that does not support their further studies.

Another counterintuitive and highly relevant factor in the policy education field is the lack of a significant association between Internet access and educational exclusion ($p = 0.84$). This challenges the prevailing narrative that frames the digital gap as the principal barrier to inclusion [11], [1] and shifts the focus towards structural and institutional factors. Evidence indicates that, in the Ecuadorian context, just having connectivity availability is insufficient to ensure student retention, particularly in higher education. Instead, the structural deficit in university slots—approximately 80,000 annually—emerges as a critical barrier. This shows that policies focused exclusively on digital infrastructure, even though they are necessary, are profoundly insufficient if the bottlenecks in institutional provision and allocation mechanisms that perpetuate exclusion are not addressed simultaneously [4], [8].

The heterogeneity observed within vulnerable populations calls for a reorientation of inclusion policies. Results demonstrate that a uniform approach is ineffective, since the needs of a student experiencing severe poverty (who requires early educational stage support) differ qualitatively from those of a student in the vulnerable sector (who requires retention mechanisms and flexible pathways in higher education). Combining a strong statistical model (Pseudo $R^2 = 0.56$), this heterogeneity analysis provides solid empirical grounding for targeted, cost-effective interventions. Strategies such as stackable micro-credentials, recognition of prior learning, and alignment of academic offerings with labor market demand are not merely desirable innovations but essential instruments for transforming initial access into sustainable and complete educational trajectories.

Another effective pathway is through micro-credentials. Because they are smaller, more targeted, and more flexible than traditional education and training programs, micro-credentials have become a prominent feature of education, training, and labor market policy discussions in recent years. Several OECD countries have already started the development of national micro-credential ecosystems, and many others are looking to follow suit [16], [17]. Similarly, evidence highlights the need to promote open education and increase bandwidth for connectivity when implementing blended learning approaches [18].

Inequality is stubbornly high in Latin America and the Caribbean. It manifests itself in many aspects of people's lives: from unequal opportunities and unequal access to justice, health services, or high-quality education to enormous differences in families' ability to cope with disasters, whether pandemics or climate change [19], [20].

5 CONCLUSIONS

The results of this study fundamentally challenge homogeneous models of educational inclusion and emphasize the urgent need for differentiated policies that

recognize and respond to the heterogeneities within vulnerable sectors, where cost-effective and scalable interventions are prioritized over indiscriminate growth that has proven to be of limited effectiveness.

This study documents evidence that directly questions homogeneous educational inclusion and highlights the necessity of shifting towards other alternatives that recognize and respond to the diverse realities of vulnerable groups. The so-called "paradox of truncated success" shows how standardized interventions fail to capture the differentiated needs and capacities of students, particularly at critical points in their educational trajectories.

The finding that Internet access has no influence indicates that the most critical barriers to educational inclusion are predominantly rooted in structural and institutional factors rather than technological ones. Consequently, strategies centered solely on digital infrastructure—even when they are necessary—are insufficient to address forms of exclusion that are deeply rooted in the architectural pillars of the education system.

The policy implications must be extensive and multidimensional. In the first place, they must focus on differentiated interventions, recognizing that students in vulnerable groups and those in severe poverty require qualitatively distinct forms of support. The former group needs retention-oriented strategies during critical transition stages, as well as mechanisms that recognize and validate their capabilities. The latter requires comprehensive early support and the development of basic skills.

In the second place, sustainability must be pursued through efficiency. This requires strategically reoriented resources from oversubscribed academic programs toward fields with growing labor-market demand, complemented by stackable micro-credential systems and mechanisms for recognizing prior learning. These pathways will provide educational inclusion while enhancing relevance and ensuring financial sustainability.

Educational innovation is necessary, but it must be evaluated not only for its technical potential but also for its ability to respond to specific heterogeneities and its sustainability in resource-limited contexts.

Finally, it should be emphasized that the strengthening of educational inclusion should be addressed alongside the global economic and political environment. In this context, targeted public policies, coordinated with international cooperation mechanisms and commitments arising from trade agreements, represent a strategic axis for reducing structural gaps in educational access and retention.

Through international cooperation, it is possible to obtain resources, technical assistance, and financial support to design sustainable educational models that respond to the heterogeneities detected in vulnerable populations. This also provides an opportunity to link economic openness with human capital development, promoting joint programs for technical training, scholarships, digital innovation, and institutional strengthening. These synergies between national education policy and international cooperation are essential for building an inclusive architecture that is sustainable and relevant to the country's challenges.

This study faces several limitations that must be taken into account. The cross-sectional design limits the analysis and prevents the establishment of causal relationships and the identification of directions in the observed associations. Future research should adopt longitudinal designs that facilitate the traceability of educational pathways of specific cohorts over time. In addition, operationalizing educational exclusion as school non-attendance may capture heterogeneous phenomena. New research studies should incorporate additional subjective dimensions of exclusion, as well as measurements more directly linked to educational quality.

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