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School Access and Educational Inclusion of Children with Functional Difficulties in Latin America: Empirical Evidence for Educational Policy based on MICS Data

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Abstract. This study applies data mining techniques and multivariate statistical analysis to the 2019 Multiple Indicator Cluster Surveys (MICS) conducted by UNICEF in six Latin American and Caribbean countries, focusing on children aged 5 to 17. The research examines the main determinants of school attendance among children with and without functional difficulties. The analysis was structured in three phases: (1) descriptive analysis through SQL queries in BigQuery, (2) confirmatory analysis using correlation coefficients between age, country, and functional condition with school attendance, and (3) predictive modelling with Boosted Trees in BigQuery ML. Results indicate that 40.1% of children present at least one functional difficulty, primarily associated with learning, concentration, and behavioural adaptation. Nevertheless, school attendance was high in both groups: 97.19% for children with functional difficulties and 98.04% for those without. Correlation coefficients were low, indicating weak linear relationships. However, predictive analysis showed that age and country are the most influential factors in predicting school attendance, while functional difficulties had a minor impact. These findings provide relevant empirical evidence for the design of data-driven educational policies, especially regarding the targeting of resources for inclusive education.

Keywords: School Attendance; Functional Difficulties; Educational Inclusion; Educational Analytics; BigQuery.

1. Introduction

Inclusive education constitutes one of the main challenges of contemporary educational systems, particularly regarding the guarantee of the right to education for children with functional difficulties. The Incheon Declaration (2015) and Sustainable Development Goal 4 (SDG 4) reaffirm the international commitment to ensuring equitable, inclusive, and quality education for all people, regardless of their individual or contextual conditions (UNESCO, 2016).

However, the realization of this right continues to face significant structural limitations. Among them is the scarcity of disaggregated information that allows for a precise understanding of the school access conditions for children with functional difficulties. This lack of data restricts the understanding of existing inequalities and favors generalized institutional responses with limited capacity to address specific needs.

In this context, big data analysis technologies—such as BigQuery—are becoming established as a methodological opportunity to process large volumes of educational information, identify relevant patterns and relationships, and detect inequalities that rarely emerge through traditional approaches. In this sense, the analysis of microdata from international surveys allows for an empirical visualization of the school access conditions for children with functional difficulties, as well as existing gaps based on sociodemographic and contextual variables.

From an educational policy perspective, the empirical characterization of this population is essential to support evidence-based decisions. In particular, it allows for measuring the magnitude of the phenomenon, identifying subgroups with higher levels of vulnerability, and guiding more focused strategies and a more efficient allocation of resources for educational inclusion.

In this framework, the research poses the following question: what are the factors that determine school access for children and adolescents aged 5 to 17 with functional difficulties in 2019 in Latin America and the Caribbean? Based on this question, the study aims to characterize this population in six Latin American countries, analysing their school access according to sociodemographic variables and types of functional difficulty, based on the 2019 Multiple Indicator Cluster Surveys (MICS) microdata. Additionally, the utility of BigQuery for analysing large volumes of educational data and its potential to generate comparable empirical evidence to support the design of equity and social inclusion policies is evaluated.

2. Conceptualization

This approach is promoted by the World Health Organization through the International Classification of Functioning, Disability and Health (ICF) (World Health Organization, 2001), which distinguishes three interrelated levels: impairments in body functions or structures; activity limitations such as

communication, mobility, or self-care; and participation restrictions in social life situations.

This classification helps understand that limitations arise not only from a medical condition but also from the way society is organized.

Consistent with this perspective, the Convention on the Rights of Persons with Disabilities (2006), ratified by the countries included in this study, establishes that disability arises from the interaction between impairments and environmental barriers that restrict full and effective participation on equal terms (CNDH, 2022).

From this perspective, disability does not reside exclusively in the body, but in a society that limits participation by failing to guarantee accessibility, reasonable accommodations, and inclusive policies. Within this framework, inclusive education constitutes not only a pedagogical principle but a fundamental human right that must be guaranteed from early childhood.

Disability resides not in the body, but in a society that limits participation by not guaranteeing accessibility, reasonable adjustments, and inclusive policies.

3. Regulatory Framework and International Commitments

The recognition of inclusive education as a human right is supported by various international instruments. Among them, the 2030 Agenda for Sustainable Development, through SDG 4, establishes the commitment to ensure inclusive, equitable, and quality education for all individuals (United Nations, 2025).

Similarly, the Convention on the Rights of Persons with Disabilities establishes in its Article 24 the right to education without discrimination and on equal opportunities, requiring States to implement accessibility measures, reasonable accommodations, teacher training, and attention to diversity (United Nations Human Rights, 2014).

Despite these advances, significant gaps persist in Latin America regarding access, retention, and school participation of children with functional difficulties. This is compounded by the lack of disaggregated data, which limits understanding of their educational conditions and the formulation of appropriate responses (UNESCO Education Sector, 2025).

Based on this normative framework, the present study adopts these references as ethical and legal support and proposes the use of BigQuery as a tool to generate evidence for designing more inclusive educational policies.

4. The Problem

Children and adolescents with one or more functional difficulties face multiple barriers in exercising their right to education. These include social stigma,

insufficient accessible services, limited adapted infrastructure, and the persistence of public policies that do not always adequately respond to their needs.

Before the COVID-19 pandemic, more than 260 million children and youth were out of school, a situation that worsened during and after the health emergency, especially among historically excluded groups such as persons with disabilities (UNESCO, 2016). In Latin America and the Caribbean, UNICEF estimated that in 2021 there were 19.1 million children and adolescents with functional difficulties, while globally the figure exceeded 240 million. However, in 2022 only 30.5% of countries had inclusive social protection systems, highlighting persistent structural gaps in addressing this population (UNICEF, 2021; UNICEF, 2022).

Exclusion is not only expressed through limited access but also through forms of structural segregation. As of 2022, 42% of countries continued to offer special education in separate settings, while only 16% promoted inclusive education models (UNESCO, 2016). This panorama reflects that inclusion continues to face structural barriers limiting the full participation of children with functional difficulties.

5. Justification

In this context, it is necessary to strengthen the production of evidence to better understand the conditions of access and school retention among children with functional difficulties. For a long time, difficulties in defining, measuring, and recording these conditions—combined with stigma and limited use of relevant data—have restricted understanding of the phenomenon and the development of appropriate educational responses.

In this sense, the generation and analysis of disaggregated information is a key condition for identifying personal and contextual dimensions that influence educational participation. This need becomes especially relevant considering that the inclusion of persons with disabilities cuts across multiple Sustainable Development Goals, requiring more precise diagnoses and evidence-based intervention strategies.

Likewise, initiatives such as UNICEF's Inclusion Strategy 2022–2030 have highlighted the importance of data use to guide programs aimed at reducing inequalities, promoting the publication of estimates on child functioning and educational variables in more than 50 countries (UNICEF, 2022).

Within this framework, the present research is justified by its empirical and methodological contribution. Through the use of BigQuery as a tool for analyzing large volumes of data, it seeks to characterize the child population with functional difficulties in Latin America and identify factors associated with school access. In doing so, it aims to contribute to the development of useful evidence for designing

more targeted, informed, and sustainable public policies in inclusive education.

6. Literature Review

Before presenting the methodology and collected data, it is essential to review previous studies on related topics. This review helps identify gaps in existing knowledge and supports the relevance of this research.

6.1. Inclusive Education and Disability

Various studies have addressed the educational inclusion of children and adolescents with disabilities in different regions of the world (Arroyo-Rojas et al., 2024; Nnamani & Lomer, 2024; Rosado-Castellanos et al., 2022; Isschot de la Peña, 2017).

In the case of Latin America, Granda Encalada (2024) notes that the region is characterized by high inequality in inclusive education, resulting from the recent and slow implementation of public policies in this area. The main limitations identified include insufficient specialized teacher training, lack of resources, barriers to equitable access, and lack of cultural adaptations.

This situation highlights the need to better characterize populations with functional difficulties using tools that can overcome the current lack of information and support educational policy decisions.

6.2. Factors Affecting School Access and Retention

Several studies agree that multiple structural and contextual factors negatively affect access, retention, and potential school dropout among children with functional difficulties.

These factors include persistent inequality in achieving truly inclusive education, lack of teacher training in adaptive pedagogical approaches, scarcity of material and human resources, and limited implementation of sustained public policies.

Additional challenges include the effects of emergencies such as the COVID-19 pandemic and low participation in community projects aimed at inclusion, which restrict opportunities for socialization and future labour development (Narváez Zambrano et al., 2022; Rodríguez Molina & Valenzuela Zambrano, 2019; Romero Reyna, 2023; Mesías Crespin et al., 2022).

This research builds on these factors by analysing them using large-scale and disaggregated data to identify patterns that may inform strategies for school retention in inclusive contexts.

6.3. Use of Technologies and Algorithms in Education

The literature shows growing interest in characterizing students with functional difficulties and in using data mining algorithms to identify patterns associated with educational lag and dropout.

Studies highlight the application of advanced techniques such as neural networks and decision trees to analyse large datasets and uncover hidden relationships. These predictive models help design effective interventions that address the specific needs of students with functional difficulties, promoting more inclusive and equitable education (Madrid Orrego et al., 2023; López Pedraza et al., 2019; Guzmán Islas et al., 2018).

This research applies advanced data mining techniques to identify patterns and specific needs of students with functional difficulties, developing predictive models to prevent educational lag and dropout. Unlike studies focused on closed or local datasets, this work uses BigQuery to analyse international survey microdata, enabling the identification of structural barriers across different national contexts.

7. Methodology and Data Source

According to the methodology proposed by Hernández, Fernández, and Baptista (Hernández Sampieri et al., 2014), there are exploratory, descriptive, correlational, and explanatory studies. The present study adopts a quantitative approach, with a methodological design of descriptive, confirmatory, and predictive scope, aimed at characterizing children and adolescents with functional difficulties in Latin America through the analysis of open microdata.

The methodological process included a bibliographic and hemerographic review of the phenomenon under study, as well as the exploration of datasets from Latin American and Caribbean countries available in UNICEF's open data catalogs, specifically within the repository of the Multiple Indicator Cluster Surveys (MICS).

For this study, microdata corresponding to surveys conducted in 2019 were selected. Among the countries in Latin America and the Caribbean that participated in MICS 2019, only six had the complete Child Functioning Module (CFM), so no additional exclusion criteria were applied. The countries included were: Argentina, Turks and Caicos Islands, Cuba, Dominican Republic, Honduras, and Guyana.

The target population was limited to children and adolescents aged 5 to 17 years, resulting in a combined sample of 39,649 individual records, allowing for a robust and regionally comparative characterization of functional and educational profiles.

7.1 Use of the BigQuery Data Analysis Platform

For data analysis, BigQuery was used, a cloud-based analytics tool provided by Google Cloud Platform that enables SQL queries on large structured datasets. This technology was particularly useful for handling public microdata, facilitating fast and scalable exploration of information relevant to this study.

The use of BigQuery was key for processing and cross-referencing data at the individual level, analysing functional variables (such as vision, hearing, mobility, communication, learning, and emotions) and relating them to educational indicators such as school attendance, educational level attained, and reasons for non-attendance.

The architecture adopted for data flow management included tools such as:

- Cloud Storage, for temporary storage of downloaded CSV files
- BigQuery load/export, for loading data into the central database
- Dataflow, for quality control, cleaning, and synchronization

The complete flow is illustrated in Figure 1, which represents the analysis and validation architecture based on Google Cloud services.

7.2 Ethical Considerations

The data used are publicly accessible, anonymized, and available under UNICEF's open data policy. They do not contain information that allows individual identification of participants; therefore, approval from an institutional ethics committee was not required.

8. Data Analysis, Decision Trees, and Prediction Results

The first step was compiling data from the results of the 2019 Multiple Indicator Cluster Surveys[1] (MICS) applied to households in the six countries under study (UNICEF, 2025).

For this process, a combined database was created, integrating attributes from each country related to:

- Personal characteristics of children
- Type and degree of functional difficulty (according to ICF modules)
- Variables associated with school access, retention, or educational lag

Table 1 details the main attributes used, along with their descriptions and possible categorical values. This structuring enabled preparation of the dataset for predictive modelling.

[1] The 2019 Survey on Child Functioning and Disability (ENFin) is part of the Child Functioning Module included in the Multiple Indicator Cluster Surveys (MICS), promoted by UNICEF. These surveys represent an international effort to collect comparable data on the situation of children, particularly regarding development, functioning, and disability. The specific module used in this study was developed in collaboration with the Washington Group and is based on the principles of the WHO International Classification of Functioning, Disability and Health (ICF), allowing for internationally comparable estimates of child functioning.

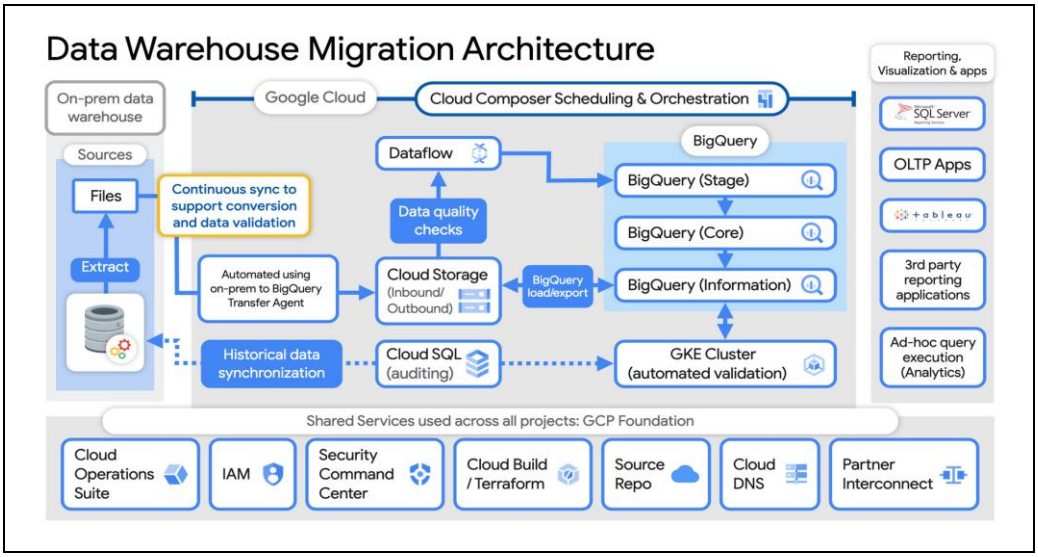

Figure 1: Data migration and analysis architecture implemented on Google Cloud Platform, highlighting the integration of services for data management and processing in BigQuery. (Google, 2021).

Table 1. Scheme of variables of the consolidated data set.

Attribute	**Description**	**Type**
Country	Geographic location where the survey was conducted. Possible outputs: Argentina; Cuba; Turks and Caicos Islands; Dominican Republic; Honduras; Guyana	String
FS1	Cluster number	Integer
FS2	Household number	Integer
FS3	Child's name and line number	Integer
FS17	Identifies whether the survey was completed. Possible outputs: 01 Completed; 02 Absent; 03 Refused; 04 Partially completed; 05 Incapacitated; 06 No adult consent	Integer
CB3	Age. Possible values: 5 to 17 years	
CB4	Does (name) currently attend or has attended any educational or preschool institution? Possible outputs: 1 Attends; 2 Does not attend, but attended; 3 Never attended	Integer
CB5A	Education level. Possible outputs: 1 Primary; 2 Basic General Education (EGB); 3 Polimodal; 4 Secondary; 5 Secondary (Fines program); 9 Special education	Integer
CB5B	Grade	Integer
CB7	What school schedule does he/she attend? Possible outputs: 1 Half-day; 2 Full-day; 3 Flexible	Integer
FCF1	Uses glasses or contact lenses. Possible outputs: 1 Yes; 2 No	Integer
FCF2	Uses a hearing aid. Possible outputs: 1 Yes; 2 No	Integer
FCF3	Uses a device or receives assistance to walk. Possible outputs: 1 Yes; 2 No	
FCF6	Difficulty seeing. Possible outputs: 1 None; 2 Some; 3 A lot; 4 Cannot see at all	Integer

FCF8	Difficulty hearing sounds such as voices or music. Possible outputs: 1 None; 2 Some; 3 A lot; 4 Cannot hear at all	Integer
FCF10	Difficulty walking 100 meters. Possible outputs: 1 None; 2 Some; 3 A lot; 4 Cannot walk 100 meters	Integer
FCF11	Difficulty walking 500 meters. Possible outputs: 1 None; 2 Some; 3 A lot; 4 Cannot walk 500 meters	Integer
FCF12	When using a device or assistance, difficulty walking 100 meters. Possible outputs: 1 None; 2 Some; 3 A lot; 4 Cannot walk 100 meters	Integer
FCF13	When using a device or assistance, difficulty walking 500 meters. Possible outputs: 1 None; 2 Some; 3 A lot; 4 Cannot walk 500 meters	Integer
FCF14	Compared to children of the same age, does (name) have difficulty walking 100 meters on flat ground? Possible outputs: 1 None; 2 Some; 3 A lot; 4 Cannot walk 100 meters	Integer
FCF15	Compared to children of the same age, does (name) have difficulty walking 500 meters on flat ground? Possible outputs: 1 None; 2 Some; 3 A lot; 4 Cannot walk 500 meters	Integer
FCF16	Difficulty with self-care. Possible outputs: 1 None; 2 Some; 3 A lot; 4 Cannot take care of self	Integer
FCF17	Difficulty being understood when speaking by people in the household. Possible outputs: 1 None; 2 Some; 3 A lot; 4 Cannot be understood	Integer
FCF18	Difficulty being understood when speaking by people outside the household. Possible outputs: 1 None; 2 Some; 3 A lot; 4 Cannot be understood	Integer
FCF19	Compared to children of the same age, difficulty learning things. Possible outputs: 1 None; 2 Some; 3 A lot; 4 Cannot learn	Integer
FCF20	Compared to children of the same age, difficulty remembering things. Possible outputs: 1 None; 2 Some; 3 A lot; 4 Cannot remember	Integer
FCF21	Difficulty concentrating on things they enjoy. Possible outputs: 1 None; 2 Some; 3 A lot; 4 Cannot concentrate	Integer
FCF22	Difficulty accepting changes in routine. Possible outputs: 1 None; 2 Some; 3 A lot; 4 Cannot accept changes	Integer
FCF23	Difficulty controlling behaviour. Possible outputs: 1 None; 2 Some; 3 A lot; 4 Cannot control behaviour	Integer
FCF24	Difficulty making friends. Possible outputs: 1 None; 2 Some; 3 A lot; 4 Cannot make friends	Integer
FCF25	Frequency of being very anxious, nervous, or worried. Possible outputs: 1 Daily; 2 Weekly; 3 Monthly; 4 Several times a year; 5 Never	Integer
FCF26	Frequency of feeling sad or depressed. Possible outputs: 1 Daily; 2 Weekly; 3 Monthly; 4 Several times a year; 5 Never	Integer
ED5A	Highest level of education attended. Possible outputs: 0 Initial (preschool, kindergarten); 1 Primary; 2 EGB; 3 Polimodal; 4 Secondary; 5 Adult secondary/Fines program; 6 Tertiary; 7 University; 8 Postgraduate; 9 Special education; 98 No response	Integer
ED5B	Grade or year. Possible outputs: 1 to 9	Integer

Before loading the dataset into BigQuery, a process of data cleaning, transformation, and validation was carried out. This included:

- Detection of outliers or invalid values
- Removal of records with missing data
- Normalization of attributes

Once the final dataset was prepared, an analytical strategy aligned with the study objective was designed. The analysis was divided into three complementary phases:

- Descriptive analysis
- Confirmatory analysis
- Predictive analysis

8.1 Descriptive Analysis

To obtain a general understanding of the dataset, seven SQL queries were executed in BigQuery. These queries allowed characterization of the sample of 39,649 children and adolescents aged 5 to 17 years who participated in MICS 2019.

8.1.1. Country distribution

- Dominican Republic: 33% (n=13,169)
- Honduras: 30% (n=11,966)
- Argentina: 16% (n=6,536)
- Cuba: 11% (n=4,297)
- Guyana: 8% (n=3,242)
- Turks and Caicos Islands: 1% (n=439)

8.1.2. Regarding functional difficulties

- 15,899 children (40.1%) reported at least one difficulty
- 23,750 (59.9%) reported none

Thus, 4 out of every 10 children faced barriers related to body functioning or social participation.

Most frequent difficulties:

- Learning: 21.7%
- Vision: 18.7%
- Behavioral control: 17.9%

Other reported difficulties included memory, adaptation to change, self-care, making friends, concentration, hearing, and mobility.

8.1.3. Respect the School Access

Children without difficulties:

- 98.04% attending school
- 1.86% dropped out
- 0.09% never attended

Children with difficulties:

- 97.19% attending
- 2.71% not currently attending
- 0.08% never attended

These results suggest that although access is generally high, children with functional difficulties face slightly greater disadvantages.

8.2 Confirmatory Analysis

An inferential statistical analysis was conducted using three independent variables:

- Age (continuous)
- Country (categorical)
- Functional difficulty (binary)

School attendance was transformed into a binary variable:

- Attendance = 1
- Non-attendance = 0

Spearman correlation coefficients showed:

- Age: weak positive correlation ($\rho = 0.039$, $p < .001$)
- Functional difficulty: not significant
- Country: not significant

Additional analysis by type of difficulty showed: Walking 100 meters and hearing had slightly positive correlations (~0.04).

Overall, correlations were weak, but patterns could still be identified.

8.3 Predictive Analysis

We applied machine learning techniques using BigQuery ML to estimate school attendance probability.

Due to class imbalance (most children attend school), we used the Boosted Trees algorithm.

Model evaluation:

- Accuracy: 95.9%
- Strong performance in predicting attendance

- Lower performance in predicting non-attendance (expected in imbalanced datasets)

Feature importance analysis showed:

- Most influential variables:
- Age
- Country
- Emotional variables (FCF25, FCF26)

This suggests that, although correlations were weak, these variables are important in predictive modelling.

9. Analysis, Discussion, and Final Remarks

The descriptive analysis reveals significant diversity in the distribution of data collected from the six participating countries. The majority of surveyed children come from the Dominican Republic (33%) and Honduras (30%), while a smaller proportion comes from the Turks and Caicos Islands (1%).

This imbalance in country representation may influence the overall findings, as educational and social contexts vary significantly across countries, even within the same region.

Regarding age distribution, the sample shows a relatively uniform concentration across age groups, allowing for a balanced evaluation of functional difficulties and their impact on school attendance. However, it is important to note that 40.1% of respondents present at least one functional difficulty, which, although not exceeding 50%, highlights the prevalence of these conditions among the child population in the region.

Among the most common functional difficulties are problems with learning, concentration, and adapting to change. This suggests specific areas where educational interventions could be most effective and represents an opportunity for implementing inclusive educational policies.

School attendance remains high for both groups:

- With difficulties: 97.19%
- Without difficulties: 98.04%

This finding aligns with Granda Encalada (2024) regarding progress in inclusive policy implementation in the region, although gaps persist in educational quality and school retention.

Thus, while access appears to be largely ensured, it remains necessary to analyse quality and sustainability of learning, beyond mere physical presence in classrooms.

About the confirmatory analysis discussion, the correlations between independent variables (age, country, functional difficulties) and school attendance were weak. Examples:

- Age: 0.039
- Functional difficulties: 0.001

These results suggest that other factors—possibly institutional, family-related, or cultural—may play a more significant role in school attendance but were not included in this first stage of the study.

About the predictive analysis discussion, the Boosted Trees model proved effective in handling class imbalance and delivering reliable results.

The confusion matrix shows:

- Strong performance in predicting attendance
- Some discrepancies between predicted and actual classes (common in predictive models)

Feature importance analysis indicates:

- Age and country are the most influential predictors
- Functional difficulties have a lesser impact

This suggests that sociodemographic factors play a more decisive role than functional difficulties themselves. Then, the results indicate that although functional difficulties are common, they are not the primary determinant of school attendance among the surveyed children.

This could be explained by the implementation of inclusive educational policies that mitigate their impact. However, the weak correlations suggest that further research is needed to identify additional influencing factors.

As a future line of research, the authors propose analysing whether assistive devices (hearing aids, wheelchairs, canes, orthopedic devices, etc.) facilitate school access for children with functional difficulties.

Finally, this study demonstrates the potential of applying advanced machine learning techniques—such as Boosted Trees in BigQuery ML—to analyse large volumes of data and generate insights relevant for public policy design.

However, it also recognizes the need to:

- Improve models
- Expand variables
- Increase predictive accuracy

10. Conclusions

This study provides robust empirical evidence on school attendance patterns among children with disabilities in six Latin American and Caribbean countries. The analysis reveals three key findings with significant implications for educational policies and practices:

- The research shows a significant prevalence of disabilities, affecting 40.1% of the study population. The most common challenges were learning difficulties, visual impairment, behavioral control difficulties, and memory difficulties. This heterogeneous distribution underscores the need for differentiated educational interventions tailored to specific types of disabilities, particularly in the cognitive and behavioral domains.
- Multivariate analysis demonstrates that sociodemographic factors—especially age and country of residence—were more predictive of school attendance than the mere presence of disabilities. The weak correlations observed suggest that current inclusive education policies may be effectively mitigating traditional barriers to access, although further research is needed to identify the specific mechanisms behind this phenomenon.
- The application of the Boosted Trees model using BigQuery ML showed an overall accuracy of 95.9% on the test set, proving particularly useful for identifying at-risk subgroups. The feature significance analysis (see Figure 8) confirmed that age and country of residence are the factors with the strongest predictive power for school attendance, above specific functional difficulties, providing actionable information for targeted interventions.

The study has some limitations to consider. The uneven geographical distribution of the sample, with the Dominican Republic and Honduras overrepresented compared to the Turks and Caicos Islands, limits the external validity of the results. Furthermore, the cross-sectional design does not allow for the analysis of post-pandemic trends, while unmeasured variables such as teaching quality, family environment, and physical accessibility could influence the results.

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This article was developed in accordance with principles of academic integrity. Generative artificial intelligence tools (such as ChatGPT) were used solely to support writing and style.

The conceptual development, analysis, and interpretation of results correspond entirely to the authors, who verified the information using reliable academic sources.