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# Access to rehabilitation services for children and adolescents with cerebral palsy in Argentina: A multicenter cross-sectional study

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## ABSTRACT

***Introduction.*** Therapeutic intervention for cerebral palsy (CP) involves a set of strategies implemented from the first months of life onward to promote motor, cognitive, and social development. There is limited regional information on how socioeconomic characteristics affect this population's access to health care.

***Objective.*** To analyze access to therapeutic rehabilitation interventions and the age at which they begin, in relation to health coverage and the educational level of caregivers in the pediatric population with CP in Argentina.

***Population and methods.*** A multicenter, observational, cross-sectional study using data from the Argentine Cerebral Palsy Registry (RAR-PC) was conducted between October 2021 and May 2023. The study included individuals with cerebral palsy aged 1 to 19 years. The age of onset and access to rehabilitation were assessed based on health coverage and the caregivers' educational level.

***Results.*** A total of 399 patients were analyzed; 73.4% (n = 293) were between 1 and 10 years old, and 65.9% (n = 244) had severe motor impairment. The median age at diagnosis was 1 year (IQR 1-1.75); 18.7% (n = 72) had insufficient access to rehabilitation. The type of health coverage and the caregiver's low educational level were associated with reduced access ($p$ = 0.001; $p$ = 0.009).

***Conclusion.*** Caregivers' health insurance coverage and educational level influence access to rehabilitation. This highlights the need for strategies to promote greater equity.

***Keywords:*** *cerebral palsy; early medical intervention; rehabilitation; registries; Argentina.*

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## INTRODUCTION

Cerebral palsy (CP) is a widely used descriptive term for a spectrum of motor impairments caused by a non-progressive brain injury or malformation that occurs during early development.[1] In low- and middle-income countries (LMICs), CP presents distinct challenges: a higher prevalence than in high-income countries (3.4 vs. 1.6 per 1000 live births) and a higher proportion of severe cases.[2] Furthermore, diagnosis (the time of clinical identification) and the start of rehabilitation at later ages limit the potential to maximize neuroplasticity, resulting in greater functional impairment.[3-5] In developed countries, early diagnosis and intervention (within the first 6 months of life) have been associated with reduced severity of motor impairment.[6,7]

Currently, there is little regional data on the impact of socioeconomic factors on access to health care for people with cerebral palsy. Studies in Latin America have indicated that health coverage and caregivers' literacy levels affect access to services.[8,9] In Argentina, although the Argentine National Disability Certificate (CUD, by its Spanish acronym) legally guarantees benefits that exceed those of the Mandatory Health Plan, official data reveal that 32.9% of people with disabilities rely exclusively on the public system.[10] This reality underscores the importance of analyzing disparities in effective access to rehabilitation.

In Argentina, the fragmentation of the healthcare system could create barriers to access that cannot be explained solely by international models. To address this knowledge gap relative to developed countries, Argentina joined the Global Low- and Middle-Income Cerebral Palsy Register (GLM-CPR). It created the Argentine Cerebral Palsy Registry (RAR-PC, by its Spanish acronym).[11] In its first report, the data indicate that 44.1% receive a diagnosis after their first birthday, and 24.3% do not begin rehabilitation until after age 2.[12] Despite these indicators, there has been no local analysis of how social determinants and the type of health coverage influence these timeframes.

The objective of this study is to analyze access to therapeutic rehabilitation interventions and the age at which they begin, in relation to health coverage and caregivers' educational level among children with CP in Argentina. The hypothesis is that a lower level of education among caregivers and the lack of private health insurance are associated with reduced access to rehabilitation and later ages at the start of treatment.

## POPULATION AND METHODS

### Design and population

A multicenter observational, cross-sectional, and analytical study was conducted. The data were obtained from the RAR-PC, which collects information through voluntary population- and institution-based surveillance, using a protocol adapted from the GLM-CPR. The study was approved by the Ethics Committee of the National Clinical Hospital of the Universidad Nacional de Córdoba (Protocol No. 12082021) in 2021 and complies with the Personal Data Protection Act. The purpose of the CP registry was explained in detail to each participant, including children under 13 years of age, to obtain their assent in accordance with their level of understanding. Families and individuals 13 years of age and older provided written informed consent.

### Data collection procedure

Data were collected (October 2021-May 2023) at healthcare facilities in Córdoba, the Autonomous City of Buenos Aires (CABA), the Province of Buenos Aires, Jujuy, and Santa Fe. Sampling was sequential and included all cases that visited the participating facilities. Data entry was performed by professionals from the treating team through a review of medical records and structured interviews with caregivers, thereby validating the reported clinical information.[11]

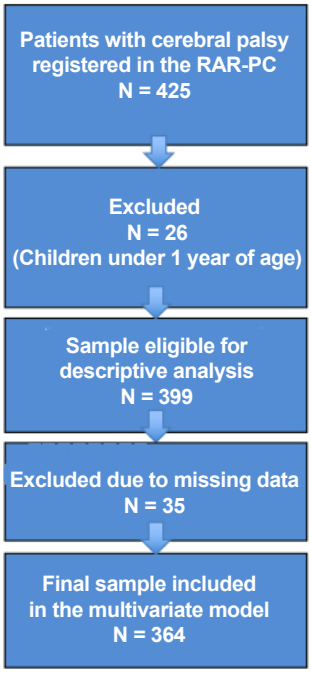
### Inclusion and exclusion criteria

The study included individuals diagnosed with CP, defined according to the five key elements of the RAR-CP (movement/postural disorder; permanent but not immutable; origin in an immature brain; non-progressive lesion; and functional impairment). Individuals younger than 1 year and older than 19 years were excluded (*Figure 1*).

### Outcome measures

The primary measure was access to rehabilitation: We assessed access to therapeutic rehabilitation interventions, including therapies focused on neurodevelopment and function (for example, physical therapy, occupational therapy, and speech-language pathology). Access was categorized as "regular access" versus "lack of access," which included both a complete absence of rehabilitation and sporadic access. The latter was defined as the inability to adhere to the recommended frequency or fragmented care (receiving only some of the required disciplines).

**Figure 1. Flowchart of the sample for multivariate analysis**




*RAR-PC: Argentine Registry of Cerebral Palsy (by its Spanish acronym); N: number of subjects.*

The secondary outcome was the age at which rehabilitation began: it was categorized as either before or after the first year of life for the subgroup diagnosed before 12 months of age (time of clinical identification). The cutoff point was set at 12 months to optimize the reliability of the retrospective report (minimize recall bias) and to align the analysis with local clinical practice.

### Variables analyzed

Health coverage (public or private health insurance) and the caregiver's educational level (mother and head of household) were assessed and categorized as low (incomplete secondary education or lower) or medium/high (complete secondary education or higher). Clinical variables included gross motor function, as defined by the Gross Motor Function Classification System (GMFCS),[13,14] grouped into levels I-III (mild-moderate) and IV-V (severe). CUD status was excluded from the multivariate analysis due to its low variability (95.3%), as it was considered an intrinsic characteristic of the sample.

### Statistical analysis

Continuous variables were described using means (standard deviation [SD]) or medians (interquartile range [IQR]) depending on their distribution, and categorical variables were described using absolute frequencies and percentages. Binary logistic regression models were used to assess the factors associated with the initiation of rehabilitation after the first year of life and lack of access to rehabilitation. Variables were included in the multivariate model based on statistical significance in the bivariate analysis ($p$ <0.05). Effect sizes were expressed as odds ratios (OR) with 95% confidence intervals (95%CI), and significance was assessed using the Wald statistic.

Missing data were handled using list-based exclusion. To assess potential selection bias, a sensitivity analysis was conducted comparing baseline and clinical characteristics between cases included in the study and those excluded due to incomplete data.

The analysis was performed using SPSS™ software.

## RESULTS

### Participant selection and missing data

The final sample for the descriptive analysis included 399 individuals, and for the multivariate analysis, it was 364 patients (*Figure 1*). The sensitivity analysis showed no significant differences in characteristics between the

included cases and those with incomplete data ($p$ >0.05), suggesting no bias due to missing data. The descriptive variables are presented in *Tables 1* and *2*.

### Time to diagnosis and start of rehabilitation

The median age at diagnosis was 1 year (IQR 1-1.75). In the subgroup of patients diagnosed before age 1, 22.1% (n = 31) began rehabilitation before age 1 (*Table 2*). Univariate analysis did not identify any significant associations among the variables studied regarding the start of rehabilitation after one year (*Table 3*).

### Access to rehabilitation

Seventy-two patients (18.7%) lacked access to rehabilitation. The main barriers identified were a lack of coverage by health insurance or private health plans and a lack of operational capacity at the centers (*Table 2*).

In the univariate model, an association was found between lack of access and type of coverage ($p$ <0.001), the mother's educational level ($p$ = 0.03), and the primary breadwinner's educational level ($p$ <0.001) (*Table 4*). When adjusting the multivariate model for lack of access to rehabilitation (*Table 5*), it was found that lack of coverage by health insurance or private health plans was associated with a higher probability of lack of access to rehabilitation (aOR 4.45; 95%CI 2.4-8.24; $p$ <0.001), along with a low educational level of the primary breadwinner (ORa 2.56; 95%CI 1.27-5.29; $p$ = 0.009). The mother's educational level lost statistical significance after adjustment in the multivariate model.

## DISCUSSION

Access to rehabilitation for children and adolescents with cerebral palsy (CP) in Argentina is significantly associated with health coverage and the educational level of the primary breadwinner. A key finding is the dissociation between these processes: while access to rehabilitation shows a strong association with the aforementioned variables, the age at which rehabilitation begins showed no significant

**Table 1. Sample characteristics (n = 399)**

| Variable | n | % |
|---|---|---|
| Gender | 399 | |
| Female | 296 | 43.9 |
| Male | 224 | 56.1 |
| Age group | 399 | |
| Children (1-10 years old) | 296 | 73.4 |
| Adolescents (11-18 years old) | 106 | 26.6 |
| Province of origin | 399 | |
| Buenos Aires | 194 | 48.5 |
| Jujuy | 100 | 25.0 |
| Santa Fe | 38 | 9.5 |
| CABA | 32 | 8.0 |
| Córdoba | 30 | 7.5 |
| Others | 5 | 1.5 |
| Mother's educational level | 382 | |
| Low | 136 | 35.6 |
| Medium/high | 246 | 64.4 |
| Primary breadwinner's educational level | 386 | |
| Low[a] | 161 | 41.7 |
| Medium/high[b] | 225 | 58.3 |
| Health insurance coverage | 395 | |
| Yes (prepaid/health insurance) | 233 | 59.0 |
| No | 162 | 41.0 |
| Submits CUD | 385 | |
| Yes | 367 | 95.3 |
| No | 18 | 4.7 |

*CABA: Autonomous City of Buenos Aires, CUD: Argentine National Disability Certificate (by its Spanish acronym).*

[a] *Incomplete secondary education or less.*

[b] *High school diploma or higher.*

**Table 2. Clinical and access characteristics**

| Variable | n | % |
|---|---|---|
| Motor function (GMFCS) | 370 | |
| Levels I-III (mild-moderate) | 126 | 34.1 |
| Levels IV and V (severe) | 244 | 65.9 |
| Diagnosis after the first year of life | 341 | |
| Yes | 189 | 55.4 |
| No | 125 | 44.6 |
| Start of rehabilitation at one year of age[#] | 140 | |
| Yes | 109 | 77.9 |
| No | 31 | 22.1 |
| Currently attending rehabilitation | 386 | |
| Yes[a] | 314 | 81.3 |
| Occasionally[b] | 34 | 8.8 |
| No[c] | 38 | 9.9 |
| Barriers for the access | 72 | |
| No health insurance/prepaid plan | 19 | 26.4 |
| Lack of capacity at the facility | 18 | 25.0 |
| There is no facility nearby | 11 | 15.3 |
| Other | 11 | 15.3 |
| Unknown | 13 | 18.0 |
| Access to the requested equipment | 381 | |
| Yes[d] | 186 | 48.8 |
| Partial[e] | 133 | 34.9 |
| No[f] | 62 | 16.3 |

*GMFCS: Gross Motor Classification System.*
*[a] Accesses regularly.*
*[b] Inability to meet the specified frequency or fragmented care.*
*[c] Complete lack of access.*
*[d] Has access to all the equipment required.*
*[e] Has partial access to the equipment required.*
*f Has no access at all.*
*[#]The percentage was calculated based on cases with valid data in the subgroup of patients diagnosed before their first birthday; 12 cases with missing data were excluded.*

**Table 3. Univariate analysis of factors associated with the start of rehabilitation after the first year of life***

| | OR (95%CI) | *p*-value |
|---|---|---|
| Low educational level (breadwinner) | 0.77 (0.34-1.73) | 0.53 |
| Low educational level (mother) | 0.87 (0.38-2) | 0.75 |
| Without coverage | 1 (0.45-2.9) | 0.97 |
| GMFCS IV-V (severe) | 1.3 (0.46-2.76) | 0.79 |

**Only patients diagnosed before their first birthday are included; 12 patients were excluded due to missing data (n = 140).*
*GMFCS: Gross Motor Function Classification System; OR (95%CI): odds ratio and 95% confidence interval.*
*Low educational level: incomplete high school or less.*
*Lack of coverage: exclusively public health system coverage.*

associations with the socioeducational variables. This finding could be explained by a selection bias in the RAR-PC, which, being an institutional program, includes families with a similar ability to navigate the system. Likewise, the lack of statistical significance could be due to insufficient power in this subanalysis or to the variable's low sensitivity when categorized as binary.

Furthermore, the median age at diagnosis was lower than the 3 years reported in the preliminary results of the GLM-CPR.[15] In this study, nearly half of the children and adolescents are diagnosed before their first birthday, a proportion similar to that in developed countries such as Australia. However, this apparent parity in diagnosis should be interpreted with caution. While the Australian Cerebral Palsy Register (ACPR) reports 26% of cases as severe,[16] our sample showed 65.9%

**Table 4. Univariate analysis of factors associated with lack of access to rehabilitation (no access or sporadic access)**

| | OR (95%CI) | *p*-value |
|---|---|---|
| Diagnosis after the first year | 0.6 (0.34-1.07) | 0.08 |
| No health insurance coverage* | 5.77 (3.25-10.26) | **<0.001** |
| Low educational level (mother) | 2.22 (1.31-3.78) | **0.003** |
| Low educational level (breadwinner) | 3.33 (1.93-5.75) | **<0.001** |
| GMFCS IV-V (severe) | 1.73 (0.95-3.14) | 0.071 |

*GMFCS: Gross Motor Function Classification System, OR (95%CI): odds ratio and 95% confidence interval.*
*Low educational level: incomplete high school or less.*
** Public system health coverage only.*

**Table 5. Multivariate analysis: lack of access to rehabilitation (n = 364)**

| | OR (95%CI) | *p*-value |
|---|---|---|
| No health insurance coverage* | 4.45 (2.4-8.24) | **<0.001** |
| Low educational level (mother) | 0.85 (0.42-1.74) | 0.65 |
| Low educational level (breadwinner) | 2.56 (1.27-5.29) | **0.009** |

*GMFCS: Gross Motor Function Classification System, OR (95%CI): odds ratio and 95% confidence interval.*
*Low educational level: incomplete high school or less.*
** Public system health coverage only.*

(n = 244) as severe. This disparity suggests that motor severity may be a confounding factor: the literature indicates that a high degree of motor disability is a significant predictor of earlier diagnosis.[17]

Most of the information on early diagnosis comes from developed countries, and there is little evidence regarding the implementation of specific tools in low- and middle-income countries.[18] It is possible that the age at diagnosis observed in our setting reflects a registration bias, whereby the system more effectively detects cases with obvious motor impairment, while milder forms may be underdiagnosed or referred late.[19]

Despite the findings regarding the age at diagnosis, only 22.1% (n = 31) of children and adolescents can begin rehabilitation before their first birthday. This raises the possibility of a gap between detection and therapeutic intervention.

The literature describes other variables that influence the age at referral beyond motor impairment, such as risk factors and the source of referral.[20]

These findings raise new questions for future research aimed at determining the extent to which these variables act as barriers to access across all health subsystems in our context.

Unlike the age at which rehabilitation began, the educational level of the primary breadwinner and the type of coverage were significantly associated with a lack of access to rehabilitation. Although in LMICs a severe GMFCS level might represent a protective factor for access,[21] no such associations were found in the present study. However, the literature highlights that socioeconomic status, mental health, and the educational level of families have a decisive influence on the development of children and adolescents with cerebral palsy.[22] Maternal and paternal education (particularly illiteracy and incomplete primary education) is significantly associated with access to rehabilitation services in LMICs.[23] A recent Argentine study shows that the amount of rehabilitation provided depends significantly on socioeconomic factors: children from lower-middle socioeconomic backgrounds, without social security coverage, and attending public institutions receive significantly fewer hours of therapy, regardless of their level of motor engagement.[24] In the Argentine context, given that social security or private health coverage is closely linked to participation in the formal labor market,[25] it is important to continue exploring how a household's socioeconomic structure influences its ability to cope with indirect costs, administrative procedures, and the availability of guaranteed care time—factors that, together, determine treatment continuity.

The high prevalence of CUD in the study population is notable: 95.3% (n = 367) of patients had one. This document legally guarantees comprehensive health coverage, transportation, and financial assistance. However, the data suggest that possession of the CUD does not

guarantee full access. This gap between legal coverage and actual access highlights the need for policies that go beyond certification and ensure the actual availability of resources across all socioeconomic strata.[26]

This study has limitations in external validity due to potential selection bias inherent in the use of the RAR-PC as a data source. Referral centers may underrepresent patients from rural areas or those in extremely vulnerable situations. To mitigate this effect, institutions from various geographic regions and levels of complexity were included to ensure greater representativeness of the sample.

The high proportion of cases with severe motor impairment suggests a selection bias toward more complex clinical presentations. Although the literature indicates that the severity of motor impairment may affect access to rehabilitation,[21,27] no such associations were found in our study.

The operational definition of "lack of access to rehabilitation," while intended to encompass all types of access deficiencies, is broad and could obscure relevant differences among barriers that require specific approaches.

Furthermore, the ages at diagnosis and at the start of rehabilitation were based on caregivers' reports, which introduces recall bias. To mitigate this limitation, a uniform operational definition based on chronological milestones (before and after the first year of life) was established, thereby facilitating reporting accuracy compared with continuous variables, which are more difficult to specify. Additionally, the information was cross-checked against institutional clinical records whenever possible to strengthen the reliability of the data.

Socioeconomic variables were approximated using educational level and health coverage. Although this does not fully reflect socioeconomic complexity, these variables were chosen for their stability and frequent use in epidemiological studies on LMICs, which may introduce residual confounding. Finally, the results should be interpreted with caution regarding their generalizability to the entire Argentine population, especially for those without access to formal health services.

One of its strengths is the use of the RAR-PC, a multicenter data source that, for the first time, allows for a nationwide analysis of access to rehabilitation among a broad population of children and adolescents with cerebral palsy.

The focus on structural determinants, such as health coverage and education, addresses a significant knowledge gap in Argentina, generating evidence to guide health planning and strengthen early intervention networks.

## CONCLUSION

This study shows that access to rehabilitation for children and adolescents with cerebral palsy in Argentina is associated with health coverage and the educational level of their caregivers. While early diagnosis is feasible, it does not in itself guarantee the initiation of rehabilitation during critical stages of development. These findings highlight the need for public policies that ensure equity and eliminate structural barriers in the national health system. ■

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