Clinical, functional profile and neuroimaging in cerebral palsy: a population-based study

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INTRODUCTION

Cerebral palsy (CP) is the most common cause of lifelong motor disability in childhood, resulting from a non-progressive injury to the developing brain that affects movement, posture, and often cognition. CP remains a complex and heterogeneous condition with multifactorial origins. Population-based registries are key to understanding its clinical spectrum and associated comorbidities, yet epidemiological data from Spain remain scarce. Regional studies integrating standardized functional and neuroimaging classifications are needed to refine etiological understanding and guide healthcare planning.

OBJECTIVE

Primary objective: To estimate the prevalence of cerebral palsy (CP) and describe the functional profile and associated comorbidities of affected children in a population-based registry.

Secondary objective: To analyse their relationship with brain MRI patterns, classified according to the Magnetic Resonance Imaging Classification System (MRICS).

Exploratory objective: To examine how MRICS categories correspond to differences in motor function, communication, feeding, and associated neurodevelopmental disorders, supporting aetiological interpretation and clinical counselling.

METHOD

Population and data collection:
A population-based registry was established including all children with cerebral palsy (CP) aged 3–17 years born in Navarre, Spain (2006–2021). Demographic, clinical, and functional data were obtained from medical records and direct interviews, following the Surveillance of Cerebral Palsy in Europe (SCPE) criteria.

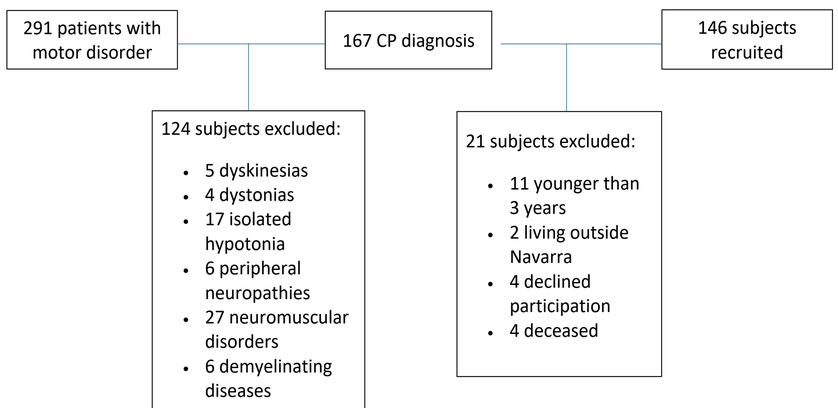
Functional assessment:
Seven validated scales were used to evaluate gross and fine motor skills (GMFCS, MACS, BFMF), communication (CFCS), feeding (EDACS), and visual function (VFCS) and speech ability (VSS).

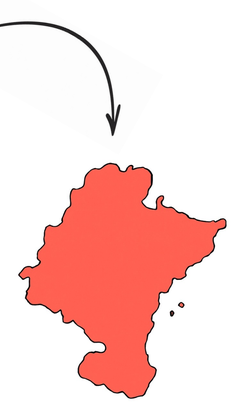
MRI classification:
Brain MRI findings were reviewed and categorised according to the Magnetic Resonance Imaging Classification System (MRICS):
A – malformations, B – white matter injury, C – grey matter injury, D – miscellaneous, and E – normal imaging.

Statistical analysis:
All analyses were performed in R. Associations between variables were evaluated using the Monte Carlo version of the Chi-square test.

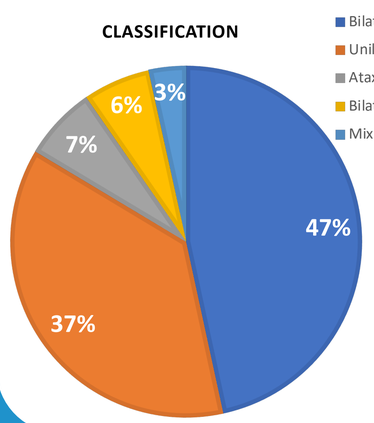
RESULTS

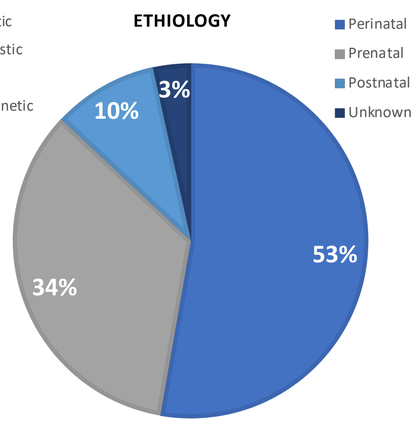
A total of 291 patients with motor disorders were identified through multiple sources, including the Neuropediatric Clinic of the University Hospital of Navarra (HUN), the Complex Chronic Unit, the Rehabilitation Service, District Hospitals, Education, and ASPACE Foundation for Cerebral Palsy.

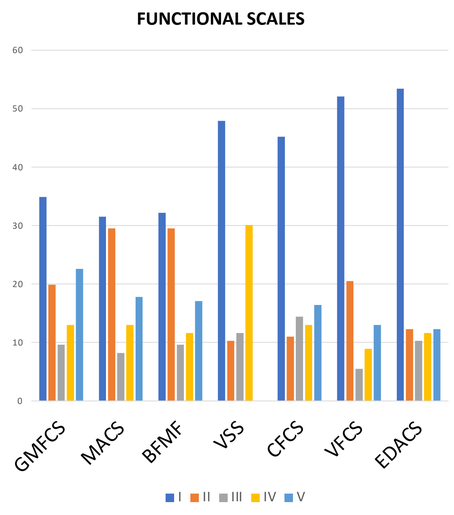


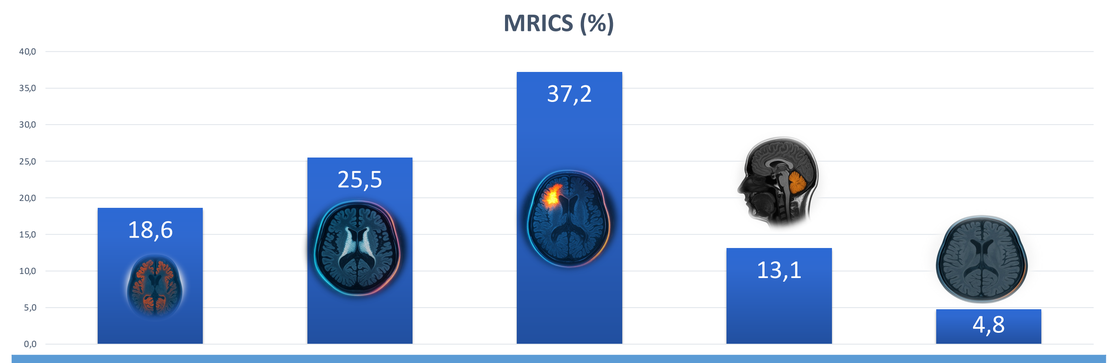


Prevalence of cerebral palsy in Navarra:
1.57 per 1,000 live births (95% CI: 0.16–2.98)
Median age**:** 9.97 y.o.(SD 4.25) I M:F 1.43:1









MRICS A	MRICS B	MRICS C	MRICS D	MRICS E
Etiology • Prenatal • Genetic etiology pressumed but not present **Classification** • Bilateral spastic **Functional profile** • GMFCS V • MACS V • BFMF V • CFCS V • EDACS III • VSS IV **Comorbidities** • Severe intellectual disability • Severe epilepsy with epileptic encephalopathy • Severe visual impariment • Moderate hearing loss • Language impairment **Impairment index** • High	**Etiology** • Perinatal **Classification** • Unilateral spastic / Hemiplegic **Functional profile** • GMFCS I • MACS I • BFMF I • CFCS I • EDACS I • VSS I **Comorbidities** • Absence of epilepsy • Normal or near-normal cognition • No language impairment • Normal vision and hearing **Impairment index** • Low	**Etiology** • Perinatal **Classification** • Bilateral dyskinetic **Functional profile** • GMFCS II • MACS II • BFMF IVb • CFCS V • EDACS V • VSS III **Comorbidities** • Moderate intellectual disability • Moderate epilepsy (focal or structural–non-genetic) • Severe visual impairment • Severe hearing loss **Impairment index** • Moderate **Additional features** • Term or late-preterm birth	**Etiology** • Prenatal • Genetic evidence present **Classification** • Ataxic (non-spastic) • Bilateral **Functional** profile • GMFCS III • MACS III • BFMF IIb • CFCS III • EDACS II • VSS II **Comorbidities** • Severe intellectual disability • Language impairment • Learning difficulties • Epilepsy often absent (SZTYPE = None) **Impairment index** • Moderate	**Etiology** • Prenatal • Genetic evidence present **Classification** • Non-spastic: ataxic / dystonic–ataxic • Diplegia enriched **Functional profile** • GMFCS III • MACS III • BFMF IIa • CFCS I • EDACS II • VSS II **Comorbidities** • Epilepsy absent • No intellectual disability • No language impairment • Vision and hearing largely normal **Impairment index** • Low

CONCLUSIONS

•The **prevalence** of cerebral palsy in Navarra is **1.57 per 1,000 live births** and is comparable to that reported in other high-income regions, supporting the reliability of the regional surveillance system.

•**MRI patterns** according to the **MRICS** classification are **strongly associated** with the **functional profile** (funcional scales) and comorbidity spectrum in children with cerebral palsy.

•**Prenatal malformations (MRICS A)** and **white matter injury (MRICS B)** represent **opposite** ends of the clinical spectrum, from severe to mild functional impairment.

•**Grey matter and mixed injuries (MRICS C–D)** show intermediate profiles, while **normal MRI (MRICS E)** is linked to preserved motor and cognitive function and a higher rate of genetic findings.

•Integrating MRI and standardized functional scales supports a multidimensional interpretation of CP, enhancing etiological understanding and clinical counselling.

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