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ARTICLE/ARTÍCULO

Prevalence and Academic Decisions of Students with Reading Learning Disorders (Developmental Dyslexia) in Andalusia, Spain

Prevalencia y decisiones académicas del alumnado con trastorno del aprendizaje de la lectura (dislexia del desarrollo) en Andalucía (España)

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ABSTRACT

Limited information exists regarding the prevalence of developmental dyslexia in Spain and the academic decisions made by students with developmental dyslexia (DD) following compulsory education. These aspects are investigated in Andalusia, using a reference population of 944,118 students aged 6–16 years. Among them, 11,705 are classified as having DD, with an observed prevalence of 1.24% (criterion of -2 standard deviations [SDs] below the mean) and an estimated prevalence of 3.6% (criterion of -1.5 SDs below the mean). Approximately 31,700 students may experience difficulties associated with DD without being identified. The prevalence ratio of DD in Andalusia by gender is 1.3 boys/girl. Higher-than-expected values are noted in Granada (2.04%), while lower values are observed in Cádiz (0.83%). The municipalities with the lowest prevalence are Seville, Alcalá de Guadaira, Algeciras, Chiclana, Jerez, La Línea de la Concepción, El Puerto de Santa María, Sanlúcar, Jaén, Benalmádena, Marbella and Torremolinos. The typical age of diagnosis is approximately 10 years, and efforts should be made to lower this age to 6–7. In total, Andalusia has 16,600 students with DD in non-university education, with 4,415 pursuing post-compulsory studies. Vocational training emerges as the predominant choice for students with DD, and this decision is not contingent on gender.

KEYWORDS: developmental dyslexia, prevalence, academic decisions, geostatistics.

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RESUMEN

Apenas hay información sobre la prevalencia de la dislexia del desarrollo en España y sobre las decisiones académicas del alumnado con dislexia del desarrollo (DD) tras la enseñanza obligatoria. Se estudian estos dos aspectos en Andalucía, con una población de referencia de 944.118 estudiantes de 6-16 años, 11.705 están calificados con DD, con prevalencia observada del 1,24% (criterio -2 desviaciones típicas (DT) debajo de la media) y prevalencia estimada del 3,6% (criterio -1,5DT debajo de la media). Unos 31.700 alumnos podrían presentar dificultades asociadas a DD y no estar identificados. La proporción de prevalencia de DD en Andalucía por sexo es de 1,3 niños/niña. Se encuentran valores más altos de lo esperado en Granada (2,04%) y más bajos en Cádiz (0,83%). Los resultados más bajos se encuentran en los municipios de Sevilla, Alcalá de Guadaira, Algeciras, Chiclana, Jerez, La Línea de la Concepción, El Puerto de Santa María, Sanlúcar, Jaén, Benalmádena, Marbella y Torremolinos. La edad de diagnóstico está sobre los 10 años, siendo necesario bajar esta edad hasta los 6-7. En total, en Andalucía se cuentan 16.600 alumnos con DD en enseñanzas no universitarias, 4.415 realizan estudios posobligatorios, encontrando que la Formación Profesional es la opción más frecuente en el alumnado con DD sin que esta decisión dependa del sexo.

PALABRAS CLAVE: dislexia del desarrollo; prevalencia; decisiones académicas; geoestadística.

1. Introduction

1.1. Concept of Developmental Dyslexia

Developmental dyslexia (DD) refers to persistent challenges in acquiring skills related to written language and reading in individuals with normal or higher intelligence, conventional schooling and a socio-cultural situation that is not disadvantageous (Angerri, 2005).

Developmental dyslexia (DD), or difficulty in acquiring written language, is distinct from dyslexia or alexia, which is the loss of the ability to read as a consequence of a cerebrovascular accident (World Health Organization [WHO], 2019).

It differs from reading and writing delay due to the persistence of reading difficulties, despite appropriate individual psychopedagogical intervention (Moojen et al., 2020) lasting more than six months for DD (American Psychiatric Association [APA], 2013).

Reading and writing delay and DD share risk indicators. Between the ages of 4–5, speech difficulties are common (Dale et al., 2014), including challenges in learning nursery rhymes, automatic naming of objects, numbers, colours or shapes, and in narrating stories.

In the first year of Primary Education, when classmates read short texts, it is often challenging for them to recognise words. Lexical confusions, substitutions of words for others that are similar or more familiar and morphosyntactic errors (lexical representation) are common, making it challenging for them to comprehend what is written (semantic representation). Reading can be slow and imprecise, especially with long words and those with a low frequency of use (Suárez-Coalla et al., 2022). Their initial lack of interest in reading evolves into a fear of reading, especially in

public. They employ strategies such as counting paragraphs to anticipate what they will have to read in order to practice (Cheyne-Collante et al., 2021), because "the pain of getting it wrong is like torture" (Deacon et al., 2020, p. 9).

As their peers improve their reading, the challenges of students with DD extend to other areas of school learning (Lithari, 2019), and the fear of reading expands to all academic subjects. They adopt beliefs of incompetence that align with comments from parents and teachers about laziness or lack of ability (Undheim, 2003), which diminish self-esteem, increase anxiety and lead to behavioural issues (Zuppardo et al., 2020). They often describe their relationship with school as a struggle (Wilmot et al., 2023), which has implications for their vocational preferences and academic decisions (Berkeley et al., 2011).

DD has a neurogenetic basis (Shaywitz and Shaywitz, 2005). It typically affects the temporoparietal brain regions (phonological processing) (Parrilla et al., 2020) and the temporal-occipital region (orthographic processing) of the left hemisphere (Bosch-Bayard et al., 2020). It is hereditary (Soriano-Ferrer and Piedra-Martínez, 2017), with up to a fivefold higher likelihood of presenting DD when there are direct family history precedents (Andreola et al., 2021).

1.2. Diagnostic Criteria for Developmental Dyslexia

The diagnosis is based on three criteria (González-Valenzuela and Martín-Ruiz, 2020; Soriano-Ferrer and Miranda-Casas, 2003):

a) Specificity criterion: it affects the learning of reading and "is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities" (Lyon et al., 2003, p. 5). Differences in criteria justify diagnostic variations, such as a reading delay below -2 standard deviations (SDs) (Regional Government of Andalusia, 2017), a percentile below 50 in standardised reading comprehension tests (Government of the Canary Islands, 2010) or generally, -1.5 SDs below reading age (Hulme and Snowling, 2016).

Ramos and Cuetos (2009) propose that 2 SDs below the mean implies difficulties requiring specific intervention, and between 1 and 2 SDs below the mean, a detailed assessment is recommended to confirm or reject the existence of DD.

Deficits in phonological awareness and rapid automatic naming are the variables that best predict reading difficulties (Outón and Ferraces, 2021). However, this does not imply that all individuals with DD exhibit deficits in phonological awareness and rapid naming (Moll and Landerl, 2009), nor that all individuals with phonological and rapid-naming difficulties experience reading and writing difficulties (Moll et al., 2016). Students with high intellectual abilities, in particular, often compensate for low levels of phonological awareness and rapid naming with a good working memory, vocabulary and grammatical level, which mask the learning difficulties in reading until increased demands result in unexpected challenges in their academic performance (Reynolds and Shaywitz, 2009; Van-Viersen et al., 2016).

The degree is specified as mild, moderate or severe (APA, 2013): mild, when it affects one or two academic areas, requiring minor adaptations or support services; moderate, with notable difficulties affecting one or more academic areas, necessitating intensive and specialised educational attention during the school years; and severe, with widespread academic difficulties requiring constant, intensive and individualised educational attention throughout their schooling.

The most commonly used language assessment tests in Spanish for the detection and diagnosis of DD (PROLEC R, PROLEC SE, DSTJ, PROLEXIA, LEE and BECOLE) provide references on the degree of impairment (Table 1).

Table 1

Tests for the Assessment of Written Language. Degree of Impairment and Cut-Off Points

	PROLEC R (Cuetos et al., 2007, p. 46)	PROLEC SE (Ramos and Cuetos, 2009, p. 31)	DST-J (Fawcett and Nicolson, p. 139)	PROLEXIA (Cuetos et al., 2020, p. 98)	LEE (Defior et al., 2006)	BECOLE-R (Galve-Manzano, 2020, p. 22)
No difficulty - Normal	Up to -1 SD (Normal)		RI values 0.00–0.59. 23rd–77th percentile (No risk)	Performance <0.5 SD (No difficulty) Between 0.5–0.99 SD: Mild difficulty	>30th percentile	>40th percentile
Mild difficulty	Between 1 and 2 SDs (Mild)	Between 1 and 2 SDs below the mean: it is advisable to evaluate in more detail to confirm or reject the existence of difficulty	Mild risk: -1.25 SDs RI values 0.60–0.89 12th–22nd percentile	Between 1.00–1.99 SDs: Severe difficulty	<30th percentile In all tests, <1 SD competency level with difficulty	Between the 21st–40th percentile, significant difficulties
Moderate - severe - very severe difficulty	More than 2 SDs (Severe)	≥2 SDs below average: intervention is required to recover an adequate level and improve performance	Moderate risk: -1.75 SDs RI values 0.9–1.19 5th–11th percentile	≥2 SDs: Very severe difficulty		<20th percentile, very significant difficulties
			High risk: -2.25 SDs RI values 1.20–3.00 1st–4th percentile			

b) Exclusion criterion: it cannot be attributed to mental retardation, sensory or emotional disorders or socio-educational disadvantage.

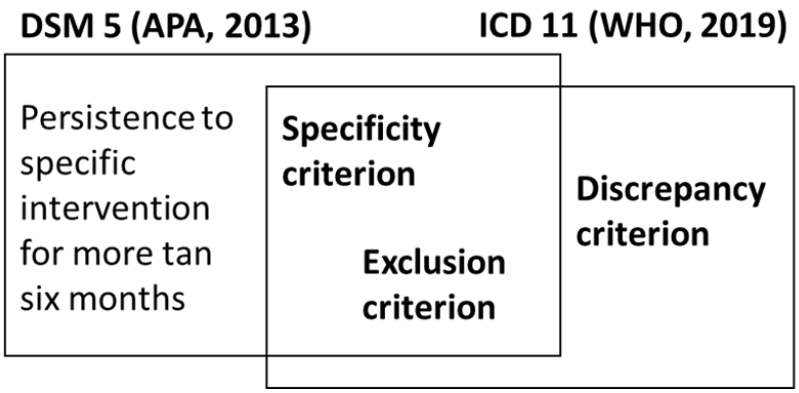
c) Discrepancy criterion between their cognitive potential and reading performance (WHO, 2019).

If a criterion for determining DD is used based on an SD of <1.5 in a bivariate distribution between intelligence quotient (IQ) and reading performance, subjects with an IQ close to 70 and similar reading difficulties to other children with a higher IQ may

not be classified with DD (Stuebing et al., 2002). This criterion is challenging to apply in practice, and therefore the specificity and exclusion criteria serve as the reference points for the diagnosis of DD (Jiménez et al., 2003), with the discrepancy criterion not included in DSM-5 (APA, 2013) as a diagnostic criterion (Figure 1).

Figure 1

Diagnostic Criteria for Developmental Dyslexia (DSM-5 and ICD-11)



1.3. Educational Implications

Students with DD require significant effort from both themselves and their families to achieve mediocre academic results (Soriano-Ferrer, 2017). The consequence is often task avoidance behaviours, making it necessary for them to have the opportunity for success in their reading experiences (Syal and Torppa, 2019).

Specific intervention should be initiated as soon as possible (Ehri et al., 2001), and it is relevant that the teaching of reading and writing in children at risk for DD be conducted by experienced teachers in the instruction of written language (Galuschka et al., 2014; McArthur et al., 2018).

In general, supportive technologies such as audiobooks, text trackers, specific typefaces (Krivec et al., 2020), having exams read to them or presented orally, not penalising spelling mistakes or providing extra time (Lewandowski et al., 2008) are useful. Objective tests with error penalties, time adjustments with timed tasks or the impossibility of reviewing answered questions are variables that ensure the failure of students with DD (Linstrom, 2007).

1.4. Academic Decisions of Students with Developmental Dyslexia

Regarding their academic decisions, in Messina (Italy), 44.7% of students with DD attend vocational schools instead of traditional secondary schools (8.6%), and 68.1%

express disinterest in pursuing university studies (Donato et al., 2022). In Sweden, Ingesson (2007) notes that the majority of students with DD choose vocational-style studies within secondary school, with fewer opting for university studies. In Trapas (Greece), Diakogiorgi and Tsiligirian (2016) find that school counsellors recommend vocational training over university studies for students with dyslexia. In Jyväskylä (Finland), after completing compulsory studies, 62.5% of students with DD prefer to study vocational training, while 66.7% of students without DD aim for the baccalaureate (Rimkute et al., 2014).

1.5. Gender Differences in Developmental Dyslexia

Concerning gender, Reilly et al. (2019, p. 454), based on reading assessments from the National Assessment of Educational Progress (NAEP) in the United States from 1988 to 2015, observe that "the likelihood of being average or higher in reading ability for a student at the end of high school increases from 42.1% for boys to 57.8% for girls". This is associated with lower processing speed and reading fluency in boys (Cammarata and Woodcock, 2006). Differences in rapid-naming tasks (Outón and Ferraces, 2021) partially account for the higher prevalence of DD in boys compared to girls.

Brimo et al. (2021) and Reilly et al. (2019) suggest that it affects 1.5 boys per every girl in the English language. Quinn (2018) finds that males are 1.83 times more likely to have DD than females, a pattern similar to the ratio of 1.8 identified by Cheruiyot and Muthoni-Mathai (2011) for English-speaking boys in Nairobi, Kenya.

In China, Zhao et al. (2016) report a ratio of 2 boys to 1 girl, Liu et al. (2016) of 3 and Lin et al. (2020) of 3.7 boys to 1 girl.

In Uruguay, Costa-Ball (2021) finds no significant differences between girls and boys, while Jiménez et al. (2011) indicate a ratio of 1.5 for Spain and 1.3 for Guatemala.

1.6. Prevalence of Developmental Dyslexia

The acquisition of written language is influenced by the alphabetic and logographic character, syllabic complexity and orthographic depth of each language (Morfidi et al., 2007), with implications for the prevalence of DD across different languages (Ziegler et al., 2003).

The American Psychiatric Association (2013) suggests a DD prevalence between 5–15%, a range specified by Wagner et al. (2020) as 3–7% in English, with a criterion of -1.5 SDs below the reading mean.

In Greece, in 2007, Anastasiou and Polychronopoulou (2009) recorded a prevalence of 1.7%. In France, in 2006, Fluss et al. (2018), for a sample of 1,020 7-year-old students, reported a prevalence of 3.30%. In Italy, Barbiero et al. (2019), for a sample of 9,964 students, found a prevalence of 3.5%. In Portugal (Braga and Vila Real), Vale et al. (2011), for a sample of 1,460 students in years two to four, found a prevalence of 5.4%.

In Uruguay (Montevideo), in 2011, Cuadro et al. (2017), for 1,408 students from years two to six of primary education, indicated a prevalence of 2.2–5.3%. In 2018, also in Montevideo, Costa-Ball (2021), for a sample of 1,820 students from years two to six, found a prevalence of 4.88%.

In Colombia (Barranquilla), in 2007, De los Reyes-Aragón et al. (2008), for 112 7-year-old students, indicated a prevalence of 3.32%; in Bogotá, Pardo-Cardozo (2015), in 2013, for a sample of 220 students, reported a prevalence of 3.63%.

In Spain, three notable studies include two in the Canary Islands with prevalences of 3.2% (González-Martín et al., 2013; Jiménez, Guzmán et al., 2009), and one in the Region of Murcia, with a prevalence of 11.8% (Carrillo et al., 2011) (Table 2).

Table 2

Prevalence Studies of Reading Learning Disorders (Developmental Dyslexia) in Spain

Author	Year	Location	Sample	Prevalence (-1.5 SDs)
González Martín et al., 2013	(n.d.)	Tenerife (Spain)	78 participants enrolled in Secondary Education	3.2%
Carrillo et al., 2011	2009–2010	Molina de Segura (Murcia) (Spain)	1,894 participants. Primary Education. Years 2, 4 and 6. Specificity criterion: below 1.5 standard deviations from reader level	11.8%
Jiménez, Guzmán et al., 2009	Academic year 2005/2006	Canary Islands	1,050 participants, 293 with specific written language difficulties, and 34 meeting dyslexia criteria	3.2%

1.7. Justification of the Need and Research Objectives

The scarcity of information regarding the prevalence of DD in Spain is exemplified in the Report of the Legal Representative of Castile and León (Government of Castile and León, 2019, p. 487), which states, with regards to statistical aspects, that the Regional Ministry of Education indicates in the report accompanying the document dated 19 April 2018 that there are no specific statistical data on students with a specific diagnosis of dyslexia.

On the other hand, in Spain, there are no known studies regarding the academic decisions of students with dyslexia after the compulsory education period (ESO, according to its initials in Spanish). It is essential to understand how many students with DD there are and what they pursue in their studies after completing ESO.

Two study objectives are proposed: (1) to calculate the prevalence of students with DD in Andalusia, including their distribution, gender differences and age of diagnosis; and (2) to determine whether DD influences the academic choices of students when they finish compulsory education, considering variables such as educational stage, gender and province.

2. Method

2.1. Population

As a reference population for comparison, students aged between 6–11 years (Primary Education [Pr. Ed.]) and 12–16 years (Compulsory Secondary Education [ESO]) are used (Regional Government of Andalusia, 2021a, 2021b), amounting to 944,118 students in 2020–2021 in Andalusia (Spain) (Table 3).

Table 3
Enrolled Students

Province	6-11 years old (Pr. Ed.)			12-16 years old (ESO)			Total		
Gender	M	F	M+F	M	F	M+F	M	F	M+F
Almería	25,882	24,376	50,258	17,867	17,200	35,067	43,749	41,576	85,325
Cádiz	40,855	38,420	79,275	32,485	30,632	63,117	73,340	69,052	142,392
Córdoba	23,829	22,381	46,210	17,846	16,798	34,644	41,675	39,179	80,854
Granada	29,068	26,963	56,031	21,879	20,973	42,852	50,947	47,936	98,883
Huelva	17,755	16,535	34,290	13,052	12,328	25,380	30,807	28,863	59,670
Jaén	18,520	17,433	35,953	14,186	13,613	27,799	32,706	31,046	63,752
Málaga	53,681	50,780	104,461	39,913	37,764	99,768	93,594	88,544	182,138
Seville	67,506	63,830	131,336	51,290	48,478	99,768	118,796	112,308	231,104
Andalusia	277,096	260,718	537,879	208,518	197,786	406,304	485,614	458,504	944,118

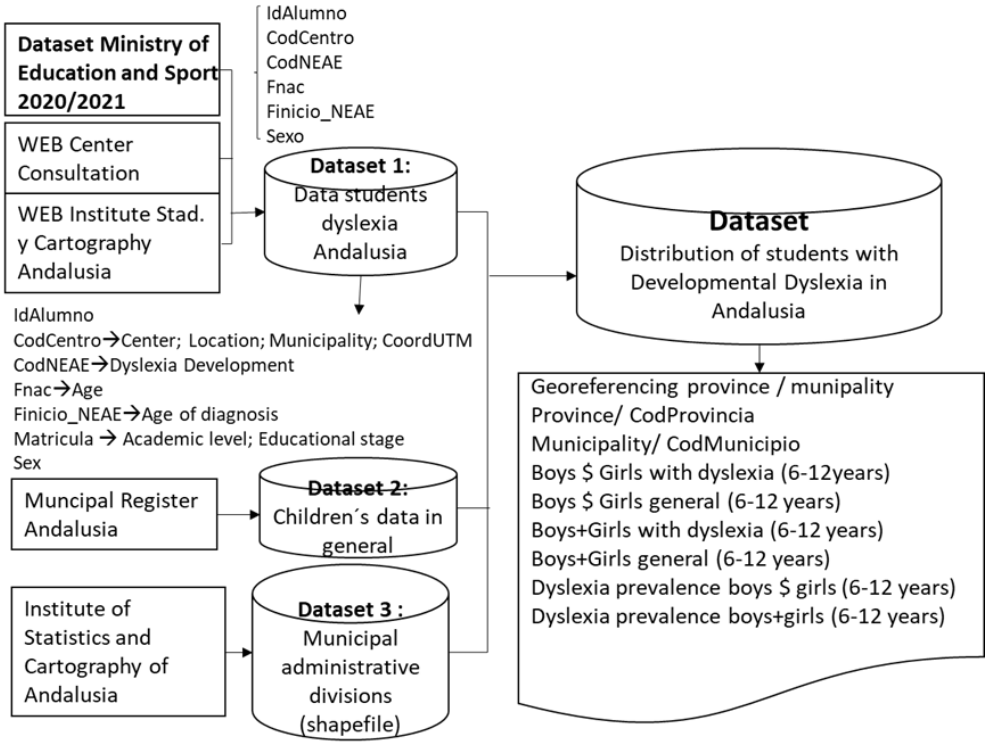
Source: compiled from data provided by the Regional Government of Andalusia (2021a, 2021b).

2.2. Data Sources

The information used has been provided by the Regional Ministry of Education of the Regional Government of Andalusia and pertains to the census of students with DD across the eight provinces of Andalusia (Figure 2).

Figure 2

Construction of the Dataset for Students with Developmental Dyslexia in Andalusia



To estimate the percentage of type I errors (false positives), the minimum representative sample is calculated in 118 cases, for an estimated population of 11,700 subjects [prevalence, 1.24%; accuracy, 98%] (Escalante-Angulo, 2004). The review of psycho-pedagogical evaluation reports, suitably anonymised, was conducted for 250 cases identified with developmental dyslexia (159 boys and 91 girls), randomly selected in the province of Almería. It was observed that, on average, 1.5 specific tests per student were used in the assessment: PROLEC-R or PROLEC-SE (94.4%; 236 cases), DST-J (81 cases), PROLEXIA (35 cases) and BECOLE (29 cases).

Notably, it was explicitly mentioned that the subjects' scores deviated two or more standard deviations below the expected levels for their age group (95.6% of cases).

The cartographic data for the municipalities of Andalusia and the municipal register data were sourced from the Institute of Statistics and Cartography of Andalusia (https://www.juntadeandalucia.es/institutodeestadisticaycartografia/).

2.3. Variables and Units of Measurement

Five variables are considered: educational stage, province, gender, age group and age of diagnosis (Table 4).

The units of measurement employed include the frequency or number of students identified with DD and the prevalence or number of subjects per population unit, expressed as a percentage (%).

Table 4
Variables

Educational Stage	Primary Education (Pr. Ed.) Compulsory Secondary Education (ESO) Baccalaureate (Bacc.) Intermediate Vocational Training Diploma (IVTD) Advanced Vocational Training Diploma (AVTD) Basic Vocational Training (BVT) Adult Secondary Education (ASE) Adult Baccalaureate (Adult Bacc.)
Province	Almería (AL) Cádiz (CA) Córdoba (CO) Granada (GR) Huelva (HU) Jaén (JA) Málaga (MA) Seville (SE)
Gender	Male (M) Female (F)
Age Group	6–8 years (5 years 6 months to 8 years 5 months) 8–12 years (8 years 6 months to 12 years 5 months) 12–16 years (12 years 6 months to 16 years 5 months) >16 years
Age of Diagnosis	6–8 years (5 years 6 months to 8 years 5 months) 8–12 years (8 years 6 months to 12 years 5 months) 12–16 years (12 years 6 months to 16 years 5 months) >16 years

2.4. Statistical Analysis

2.4.1. Prevalence and Gender

The prevalence calculation was based on students aged 6–16 years, distinguished by provinces, municipalities, gender and educational stages (Pr.Ed.–ESO). In the numerator, the number of students with DD in Andalusia aged 6–16 years was specified while in the denominator, the total number of students enrolled in Andalusia aged 6–16 years was multiplied by 100 (Merletti et al., 2011) [1*], calculating their estimated variance [2*] and the 95% confidence interval [3*] (Botella-Ausina and Sánchez-Meca, 2015). As the effect size of prevalence variations between provinces, the prevalence difference for each province and that observed for Andalusia was calculated [4*], along with the 95% confidence interval [6*, 7*] based on its estimated variance [5*]. To comprehend the relationship between the observed prevalence for

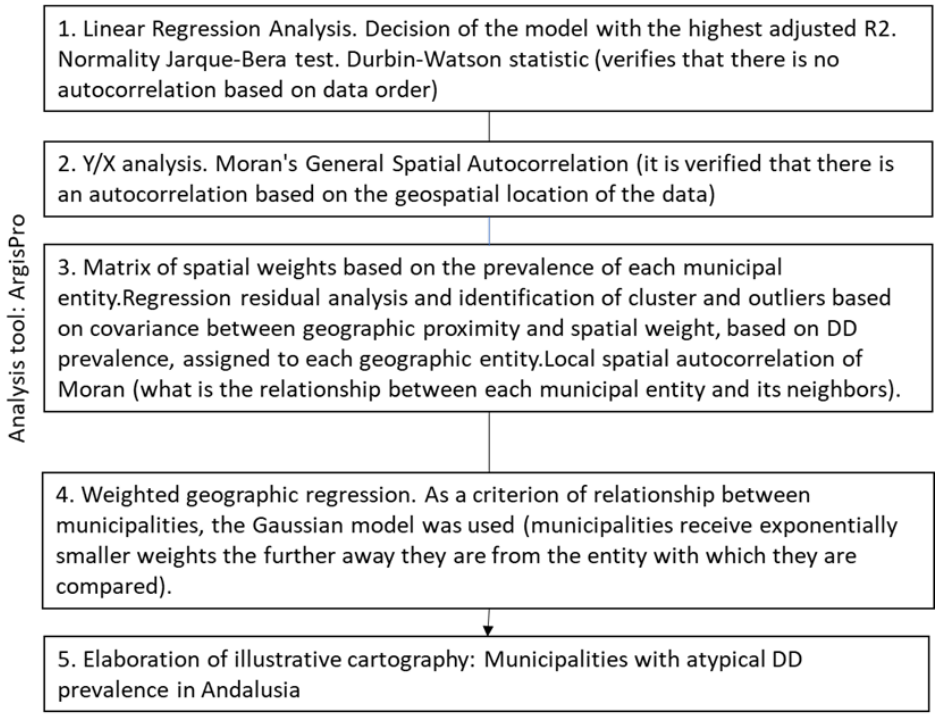
each gender, the prevalence ratio [8*, 9*] and confidence interval [11*, 12*] were determined. For the 95% CI, the value was set at $\left|z_{1-\frac{\alpha}{2}}\right|$=1.96.

Prevalence of DD in Andalusia	$p = \frac{\text{Estudiantes DD } 6-16\text{y.}}{\text{Estudiantes } 6-16 \text{ a.}} \text{ x } 100$	[1*]
Estimated prevalence variance	$v_p = \frac{p \cdot (1-p)}{N_{estudiantes\ 6-16\ años}}$	[2*]
Upper confidence interval	$p + \left\|z_{1-\frac{\alpha}{2}}\right\| \cdot \sqrt{v_p}$	[3*]
Lower confidence interval	$p - \left\|z_{1-\frac{\alpha}{2}}\right\| \cdot \sqrt{v_p}$	
Prevalence difference	$d_{p1\text{-}p0} = p_1 - p_0$	[4*]
Estimated variance of prevalence difference	$v\ pd1\text{-}p0 = \frac{p_1 \cdot (1-p_1)}{n_1} \cdot \frac{p_0 \cdot (1-p_0)}{n_0}$	[5*]
Upp. Conf. Int. Preval. difference	$d_{p1-p0} + \left\|z_{1-\frac{\alpha}{2}}\right\| \cdot \sqrt{v_{dp1-p0}}$	[6*]
Low. Conf. Int. Preval. difference	$d_{p1-p0} - \left\|z_{1-\frac{\alpha}{2}}\right\| \cdot \sqrt{v_{dp1-p0}}$	[7*]
Prevalence ratio by gender (PR)	$PR = p_m / p_f$	[8*]
	$LogPR = \text{Log}_e(p_m / p_f)$	[9*]
Estimated variance of prevalence ratio	$v_{LogPR} = \frac{(1-p_h)}{p_h \cdot n_h} \cdot \frac{(1-p_m)}{p_m \cdot n_m}$	[10*]
Confidence interval for PR	$LogRP + \left\|z_{1-\frac{\alpha}{2}}\right\| \cdot \sqrt{v_{LogRP}};\ LogRP + \left\|z_{1-\frac{\alpha}{2}}\right\| \cdot \sqrt{v_{LogRP}};$	[11*]
	$+95\%CI\ PR = e^{+CI95LogPR};\ -95\%CI\ PR = e^{-CI95LogPR}$	[12*]

To determine the relationship between the overall student distribution and students with DD, a regression analysis (Díaz-Quijano, 2016) and geographically weighted regression (GWR) were performed. Atypical cases corresponding to provinces or municipalities were identified through standardised residuals analysis with SDs >|2|, indicating the difference between each observed value and that predicted by the regression model, divided by the SD of all residuals except itself (Moore et al., 2014) (Figure 3).

Figure 3

Analysis Procedure for the Distribution of Students with DD in Andalusia



To determine the homogeneity in the gender-based distribution of prevalence across provinces, a hierarchical cluster analysis was performed (Vilà-Baños et al., 2014), employing the squared Euclidean distance as the mean and utilising the linkage between groups as the clustering method.

Three types of cartographic representations were provided: a frequency map (indicating the number of students with DD and their locations), a prevalence map of DD (Figure 4) and a regression residuals map (Figure 7). These maps aimed to identify municipalities with significant differences between observed prevalence and that predicted by the regression model.

2.4.2. Age Groups and Age of Diagnosis

Percentages were calculated for each age group and classified using k-means cluster analysis. Each category was treated as an independent variable (6–8 years, 8–12 years, 12–16 years, >16 years) (Table 4), labelled by provinces. ANOVA (Rubio-Hurtado and Berlanga-Silvestre, 2012) was conducted to determine significant differences among various age groups by provinces.

2.4.3. Academic Choices in Students with DD upon Completing ESO

Frequencies and percentages are indicated concerning the total number of students with DD at each educational stage, broken down by gender, age group and provinces. A hierarchical cluster analysis of percentages was conducted (Vilà-Baños et al., 2014) for the variables stage, gender and province.

2.5. Software Used

SPSS v.27 and ArcGIS Pro.

3. Results

3.1. Prevalence

Prevalence is balanced across provinces, stages and gender. Percentages by province and educational stage refer to students with DD by gender enrolled in that province (Table 5).

Table 5

Prevalence of Developmental Dyslexia in Andalusia. Specificity criterion <2 SDs

	Pr. Ed. (%)			ESO (%)			Pr. Ed. + ESO (%)		
	M	F	T	M	F	T	M	F	T
Almería	1.57	1.16	1.37	1.81	1.28	1.55	1.67	1.21	1.45
±95% CI	1.4–1.7	1.0–1.3	1.3–1.5	1.6–2.0	1.1–1.4	1.4–1.6	1.5–1.8	1.1–1.3	1.4–1.5
Cádiz	0.75	0.61	0.68	1.17	0.83	1.01	0.94	0.71	0.83
±95% CI	0.7–0.8	0.5–0.7	0.6–0.7	1.1–1.3	0.7–0.9	0.9–1.1	0.9–1.0	0.6–0.8	0.8–0.9
Córdoba	1.38	1.02	1.21	1.94	1.08	1.52	1.62	1.05	1.34
±95% CI	1.2–1.5	0.9–1.2	1.1–1.3	1.7–2.1	0.9–1.2	1.4–1.6	1.5–1.7	0.9–1.1	1.3–1.4
Granada	1.67	1.46	1.57	3.08	2.21	2.66	2.27	1.79	2.04
±95% CI	1.5–1.8	1.3–1.6	1.5–1.7	2.8–3.3	2.0–2.4	2.5–2.8	2.1–2.4	1.7–1.9	1.9–2.1
Huelva	1.05	0.66	0.86	1.61	1.05	1.34	1.29	0.82	1.06
±95% CI	0.9–1.2	0.5–0.8	0.8–1.0	1.4–1.8	0.9–1.2	1.2–1.5	1.2–1.4	0.7–0.9	1.0–1.1
Jaén	1.00	0.70	0.85	1.48	1.18	1.33	1.21	0.91	1.06
±95% CI	0.9–1.1	0.6–0.8	0.8–0.9	1.3–1.7	1.0–1.4	1.2–1.5	1.1–1.3	0.8–1.0	1.0–1.1
Málaga	1.06	0.86	0.96	1.81	1.36	1.59	1.38	1.08	1.23
±95% CI	1.0–1.1	0.8–0.9	0.9–1.0	1.7–1.9	1.2–1.5	1.5–1.7	1.3–1.4	1.0–1.1	1.2–1.3
Seville	1.08	0.85	0.97	1.61	1.11	1.37	1.31	0.96	1.14
±95% CI	1.0–1.2	0.8–0.9	0.9–1.0	1.5–1.7	1.0–1.2	1.3–1.4	1.2–1.4	0.9–1.0	1.1–1.2
Andalusia	1.15	0.90	1.03	1.77	1.24	1.51	1.42	1.05	1.24
±95% CI	1.1–1.2	0.9–1.0	1.0–1.1	1.7–1.8	1.2–1.3	1.5–1.6	1.4–1.5	1.0–1.1	1.2–1.3

M: boys; F: girls; T: boys+girls; 95 CI: 95% Confidence Interval.

3.2. By Gender

The population of students with DD is divided into 60% males and 40% females (1.5 males: 1 female). Comparing the prevalence of DD in males to females aged 6–16 years (1.42% in males/1.05% in females) reduces the ratio to 1.35 male/female (95% CI: 1.3523–1.3524) [11*–12*].

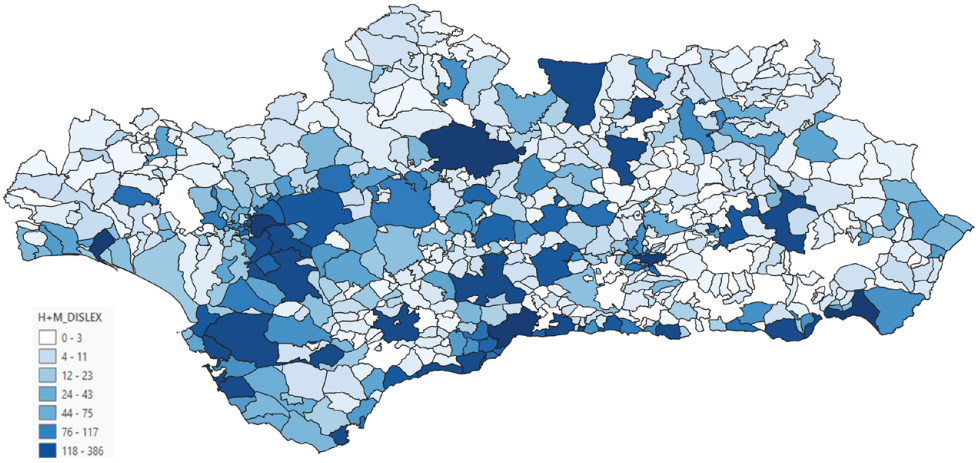
3.3. By Provinces

The overall estimated prevalence is 1.24% (95% CI: 1.22–1.26), indicating that 2 students out of every 161 enrolled in Primary Education and ESO in Andalusia exhibit a reading delay of 2 SDs or more compared to their age group (Figure 4).

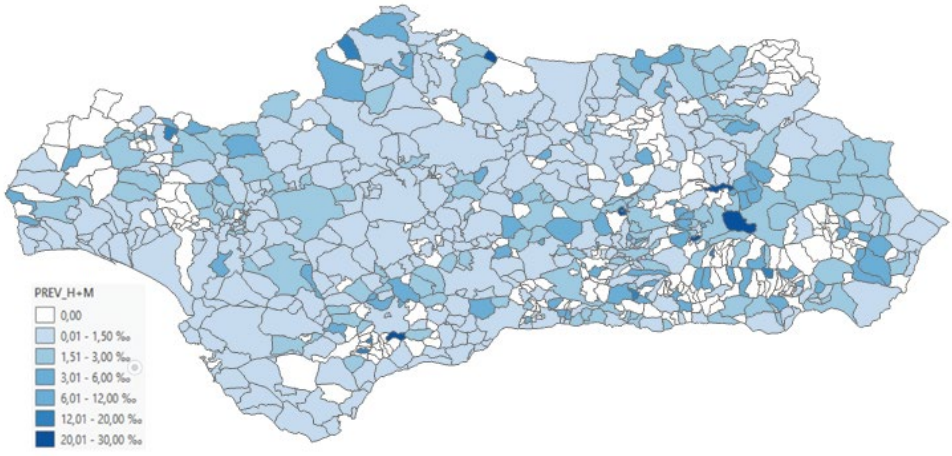
Figure 4

Distribution of Frequencies and Prevalence of Students with Dyslexia in Andalusia

Frequencies



Prevalence

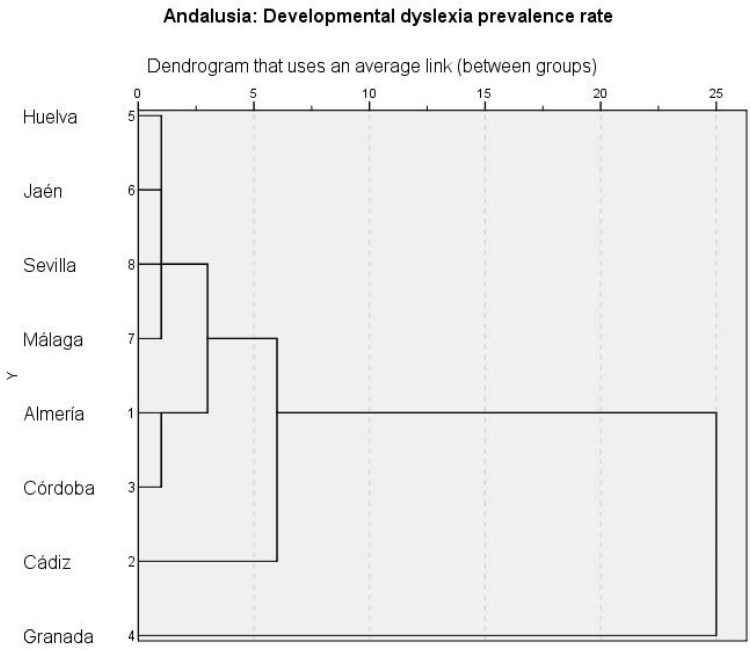


The hierarchical cluster analysis reveals three groups: Granada, with a prevalence of 2.04%; Cádiz, with a prevalence of 0.83%; and the rest of the provinces.

In the third group, two subgroups are distinguished: (1) Huelva (1.06%), Jaén (1.06%), Seville (1.14%) and Málaga (1.23%); and (2) Almería (1.45%) and Córdoba (1.34%) (Figure 5).

Figure 5

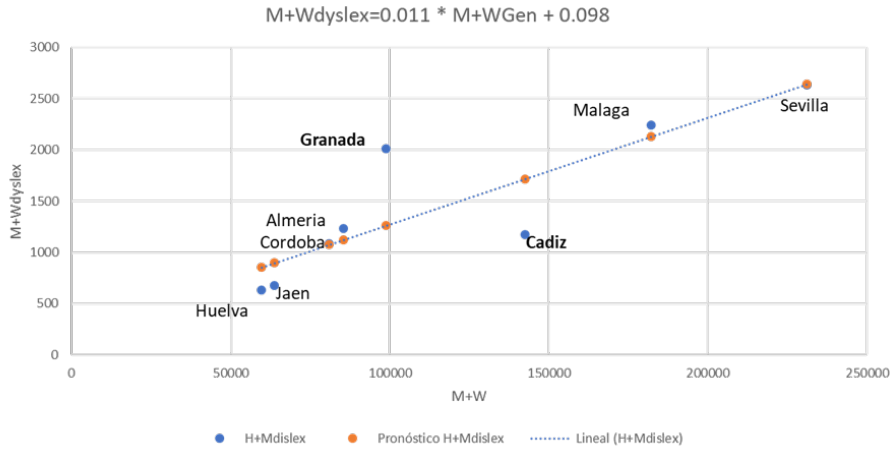
Dendrogram. Andalusia: Prevalence of Developmental Dyslexia



The prevalence of DD among students in ESO in Granada (3.08% in males and 2.66% in females) is at the upper end, making it the province with the highest DD prevalence in Andalusia. Conversely, Cádiz records the lowest prevalence (0.83%). Both values for Granada and Cádiz deviate from the overall prevalence observed in Andalusia (Figure 6).

Figure 6

Regression Analysis of Students with DD in Andalusia



The prevalence difference for each province compared to Andalusia positions Huelva, Jaén and Cádiz with negative values (below expectations), while Almería and, notably, Granada exhibit values higher than anticipated (Table 6).

Table 6

Difference in DD Prevalences Between Each Province and Andalusia

Province	Prev <2 SDs	NDD	Prev Dif [4*]	Prev Dif Var [5*]	+95 CI [6*]	-95 CI [7*]
Almería	1.45	1,584	0.21	7.385·10−9	0.210	0.000
Cádiz	0.83	1,707	-0.41	-1.482·10−9	-0.409	-0.413
Córdoba	1.34	1,510	0.1	5.409·10−9	0.100	0.000
Granada	2.04	2,832	0.8	1.343·10−8	0.800	0.000
Huelva	1.06	920	-0.18	1.239·10−9	-0.180	0.000
Jaén	1.06	990	-0.18	1.152·10−9	-0.180	0.000
Málaga	1.23	3,218	-0.01	1.576·10−9	-0.010	0.000
Seville	1.14	3,839	-0.1	7.453·10−10	-0.100	0.000

3.4. By Municipalities

The normality of data distribution is confirmed with a p-value from the Jarque-Bera test <0.05 (p=0.00). Students with DD are distributed proportionally to the population across the municipalities in Andalusia. The regression model (Figure 3) explains 86.72% of the variability in the distribution of students aged 6–16 years with DD in Andalusia (p-value: 0.00, adjusted R^2: 0.867), showing a robust correlation between the distribution of students aged 6–16 years and those with DD (correlation coefficient: 0.931). The p-value of the Durbin-Watson (DW) statistic is greater than 0.05

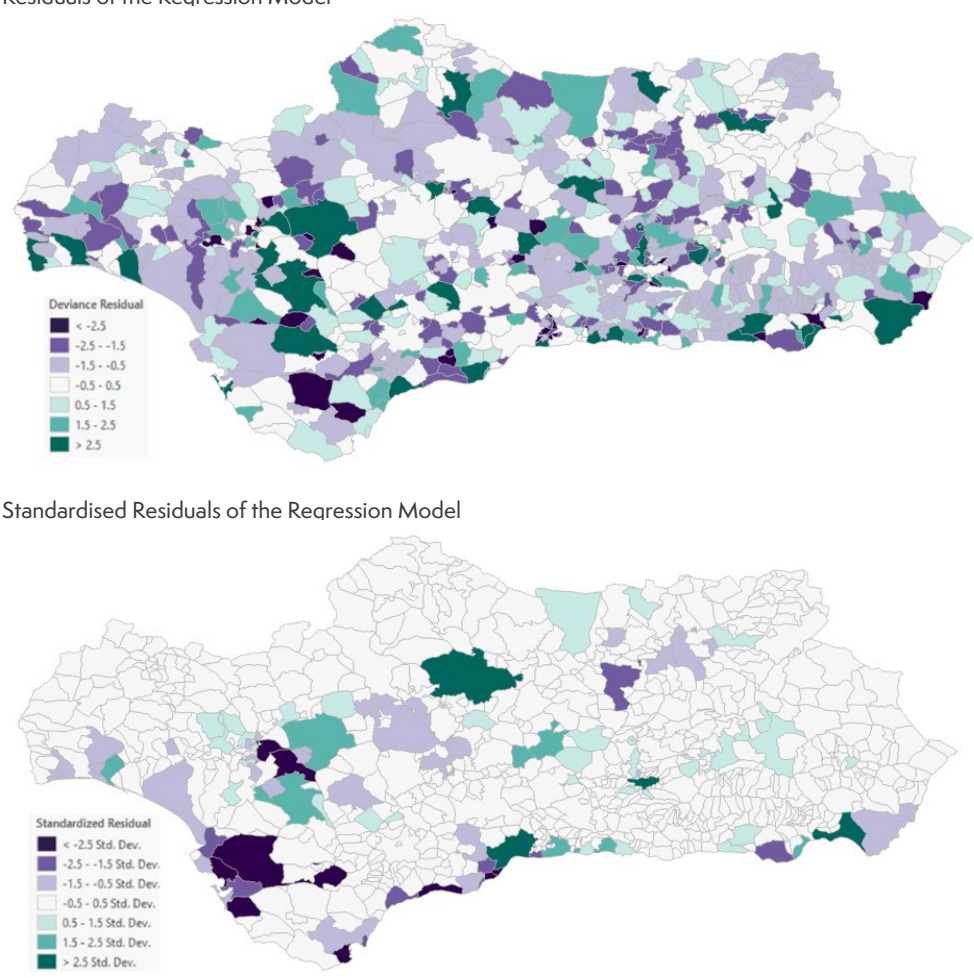
https://doi.org/10.54790/rccs.53

(DW: 1.97, p-value: 0.34), indicating no serial correlation in residuals, suggesting a random distribution of residuals. The global Moran's index (0.27; z=5.15; p-value: 0.00) suggests a probability of less than 1% that the clustered geostatistical pattern is due to random chance. In other words, there is a significant relationship between the prevalences found for each municipality and those of neighbouring municipalities.

The municipal regression analysis (geographically weighted regression[GWR], ArcGIS Pro.v2.7.0) identifies 16 municipalities with atypical prevalence (standardised residuals SD >|2|) (Figure 7).

Figure 7

Municipalities with Atypical DD Prevalence in Andalusia



Municipalities such as Almería, Granada, Nerja and Carmona demonstrate higher prevalence than anticipated. In the province of Cádiz, the municipalities of Algeciras, Chiclana, Jerez, La Línea, El Puerto de Santa María and Sanlúcar exhibit lower prevalence than expected, ranging from 0.46% to 0.54%. Torremolinos (Málaga) records the lowest prevalence of all (0.28%) (Table 7).

Table 7

Municipalities in Andalusia with Atypical DD Prevalence Values >|2 SD|

Province	Municipality	Gen. M+F	M+F with DD	Predict. of M+F with DD	Residuals	Stand. Resid.	Prev. (%)
Almería	1. Almería	13,124	251	132.99	118.00	13.6	1.91
Cádiz	2. Algeciras	8,646	43	87.65	-44.65	-4.64	0.49
	3. Chiclana de la Frontera	6,103	28	61.90	-33.90	-3.49	0.46
	4. Jerez de la Frontera	14,304	75	144.94	-69.94	-7.53	0.52
	5. La Línea de la Concepción	3,974	17	40.34	-23.34	-2.39	0.43
	6. El Puerto de Santa María	6,016	32	61.02	-29.02	-2.98	0.53
	7. Sanlúcar de Barrameda	4,631	25	46.99	-21.99	-2.25	0.54
Granada	8. Granada	12,832	301	130.04	170.96	22.9	2.35
Jaén	9. Jaén	6,852	49	69.48	-20.48	-2.1	0.72
Málaga	10. Benalmádena	4,521	20	45.88	-25.88	-2.65	0.44
	11. Marbella	9,834	67	99.68	-32.68	-3.38	0.68
	12. Nerja	1,204	36	12.29	23.71	2.42	2.99
	13. Torremolinos	4,334	12	43.98	-31.98	-3.28	0.28
Seville	14. Alcalá de Guadaira	6,092	31	61.79	-30.79	-3.17	0.51
	15. Carmona	1,821	39	18.54	20.46	2.09	2.14
	16. Seville	41,096	358	416.24	-58.24	-7.58	0.87

3.5. Age Groups

Regarding age groups, there are 504 students with DD in the 6–8 years category (3%), 5,164 in the 8–12 years category (31%), 4,908 in the 12–16 years category (29.6%) and 6,024 in the >16 years category (36.3%).

K-means cluster analysis reveals two groups: Almería and Córdoba on the one hand, and on the other, the remaining provinces, further divided into two subgroups: (1) Cádiz-Huelva-Seville, and (2) Málaga-Jaén-Granada (Table 8).

ANOVA analysis only indicates significant differences in the 6–8 years group, with higher percentages in Málaga-Jaén-Granada and lower percentages in Cádiz-Huelva-Seville.

Table 8

Mean Percentage Distribution of Students with DD by Provinces

%	Almería-Córdoba	Cádiz-Huelva-Seville	Málaga-Jaén-Granada
6–8 years	2.83	2.70	3.75
8–12 years	30.23	31.40	33.40
12–16 years	30.97	28.47	29.20
>16 years	35.97	37.47	33.65

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3.6. Age of Diagnosis

The analysis of ages of detection, using the *t*-test, yields an average value of 9 years and 4 months, with an SD of 2 years and 5 months. The confidence interval is 99%, with a standard error of 0.02 (bilateral significance: 0.00), spanning from 9 years and 4 months to 9 years and 5 months, with a median of 8 years and 9 months (Table 9).

Table 9

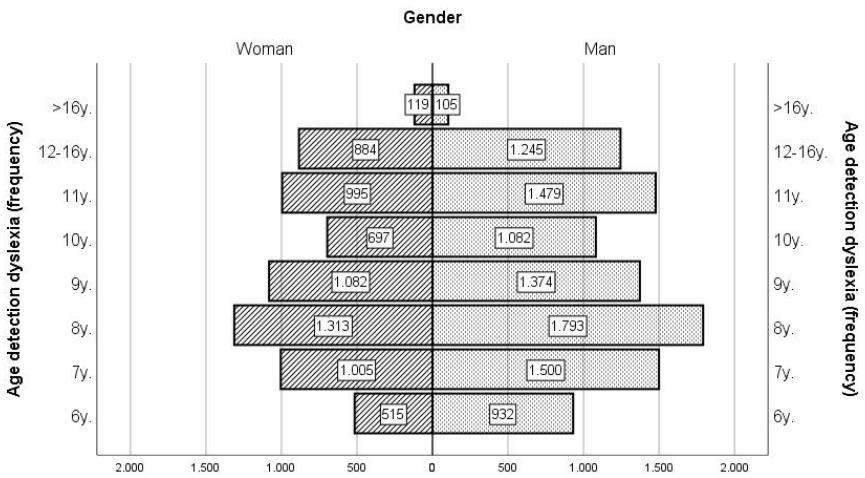
Age of Diagnosis of Reading Disorders (Developmental Dyslexia) in Andalusia

	Male		Female		Total		
Age	Male	%	Female	%	Total	%	Accum. %
6 years	932	9.86	515	7.79	1,447	8.98	9
7 years	1,500	15.86	1,005	15.20	2,505	15.54	24.38
8 years	1,739	18.39	1,313	19.86	3,106	19.27	43.65
9 years	1,374	14.53	1,082	16.37	2,456	15.24	58.89
10 years	1,082	11.44	697	10.54	1,779	11.04	69.93
11 years	1,479	15.64	995	15.05	2,474	15.35	85.28
12–16 years	1,245	13.17	884	13.37	2,129	13.21	98.49
>16 years	105	1.11	119	1.80	224	1.39	100
	9,456	100.00	6,610	100.00	16,120	100.00	

From the analysis of frequency percentages of detection ages (Table 7), 24.38% of students are identified at 7 years old. By the age of 10, this percentage increases to 70%, reaching 98.49% at 16 years old. The highest identification percentage (50%) occurs between 7–9 years (Figure 8).

Figure 8

Andalusia: Age of Diagnosis of Developmental Dyslexia



3.7. Academic Choices of Students with DD upon Completing ESO

In Andalusia, 16,600 students with DD are enrolled in non-university education, comprising 9,793 males (59%) and 6,807 females (41%) (Table 10).

Table 10

Distribution of Students with Developmental Dyslexia by Educational Stages

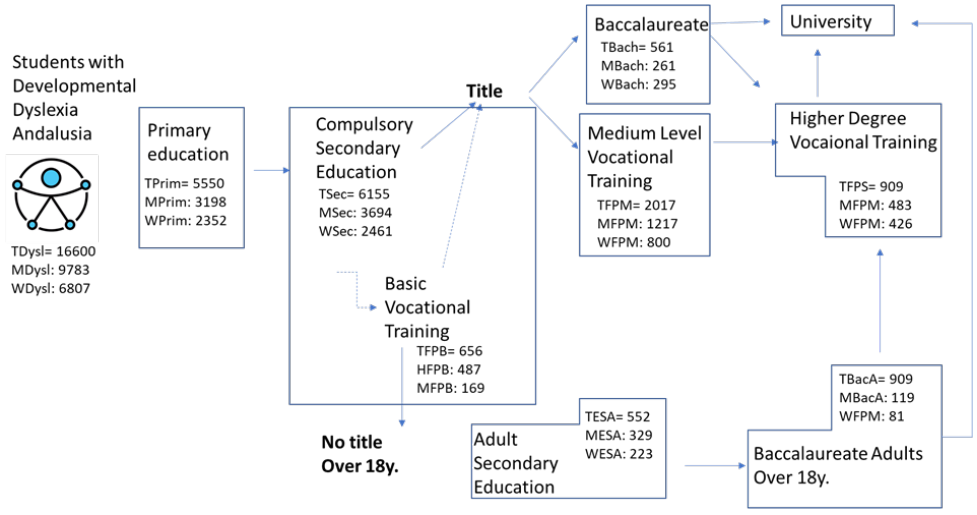
Educational Stage	Almería	Cádiz	Córdoba	Granada	Huelva	Jaén	Málaga	Seville	Andalusia
Pr. Ed.	689	543	557	878	295	307	1,006	1,275	5,550
ESO	544	635	528	1,138	339	371	1,237	1,363	6,155
BVT	38	67	87	133	44	47	129	111	656
IVTD	117	221	162	316	118	143	423	517	2,017
AVTD	74	64	89	136	52	51	169	274	909
Baccalaureate	42	70	33	112	23	27	132	122	561
ASE	47	90	41	85	39	37	91	122	552
Adult Bacc.	33	17	13	34	10	7	31	55	200
	1,584	1,707	1,510	2,832	920	990	3,218	3,839	16,600

Pr. Ed.: Primary Education; ESO: Compulsory Secondary Education; BVT: Basic Vocational Training; IVTD: Intermediate Vocational Training Diploma; AVTD: Advanced Vocational Training Diploma; ASE: Adult Secondary Education; Baccalaureate; Adult Baccalaureate.

656 students with DD—3.95%—(487 boys and 169 girls) opt for Basic Vocational Training as an alternative to ESO, and 552—3.33%—(329 boys and 223 girls) attend Adult Secondary Education after not obtaining the ESO diploma (Figure 9).

Figure 9

Distribution of Students with DD in Andalusia by Educational Stages



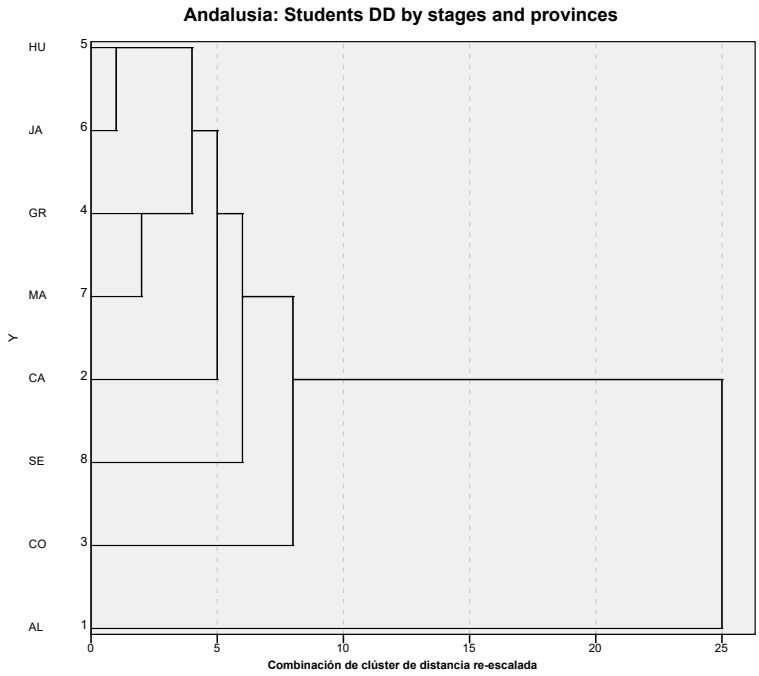
After completing ESO, 561 (3.38%) pursue Baccalaureate (266 boys and 295 girls), and 2,017 (12.5%) pursue an Intermediate Vocational Training Diploma (IVTD) (1,217 boys and 800 girls). The highest percentage of students with DD studying Baccalaureate is in Cádiz-Málaga (4.10%) and Granada (3.95%), while the lowest is in Almería (2.65%), Jaén (2.73%) and Huelva (2.50%).

Vocational Training is the preferred option for students with DD, with the highest percentage in Jaén (14.44%), followed by Seville (13.47%), Málaga (13.14%), Huelva (12.83%) and Cádiz (12.9%). Next are Córdoba (10.73%) and Granada (11.6%), and finally, Almería (7.39%).

Upon completing Baccalaureate or IVTD studies, 909—5.48% (483 boys and 426 girls)—continue studies in Higher Vocational Training. The exact number continuing university studies is unknown. The highest percentage is in Seville (7.14%), and the lowest is in Cádiz (3.75%). In between are Huelva-Córdoba (5.65–5.89%), Jaén-Málaga (5.15–5.25%) and Granada-Almería (4.80–4.67%) (Figure 10).

Figure 10

Dendrogram. Andalusia: Students with DD by Stages and Provinces



4. Discussion and Conclusions

4.1. Prevalence

In line with Brimo et al. (2021) and Jiménez et al. (2011), the gender-based prevalence differences for DD are 1.3 male/female.

The prevalence of DD in Andalusia, with a specificity criterion of <2 SDs, is 1.24%, meaning 1 in every 80 students requires specific intervention related to severe developmental dyslexia (Cuetos et al., 2007) or very severe dyslexia (Cuetos et al., 2020).

Assuming that reading ability conforms to the normal distribution, an approximate adjustment is performed of the observed prevalence for <2 SDs to an estimated prevalence for <1.5 SDs based on the empirical rule that relates data distribution percentages to the standard deviation (Dagnino, 2014; Johnson and Kuby, 2012) (Table 11).

This results in an estimated prevalence of DD in Andalusia, for the <1.5 SD criterion, of 3.61% (Figure 11), similar to those reported by Jiménez et al. (2009) and González-Martín et al. (2013) in the Canary Islands, at 3.2%, using the same <1.5 SD specificity criterion.

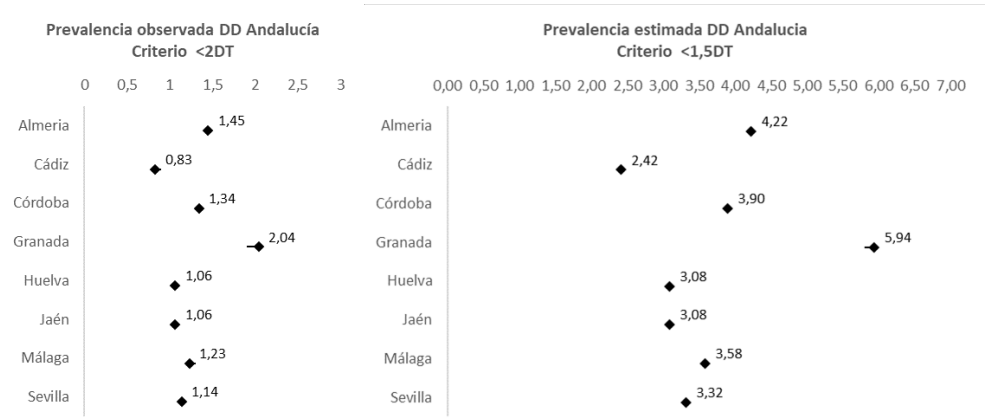
Table 11

Observed Prevalence (crit. of <2 SDs) and Estimated Prevalence (crit. of <1.5 SDs) of Students with DD in Andalusia

Province	Prev1 <2 SDs	Prev1 95% CI	Ndislex1 <2 SDs	Prev2 <1.5 SDs	Prev2 95% CI	Ndislex2 <1.5 SDs	Ndislex2 95% CI
Almería	1.45	1.4–1.5	1,584	4.22	4.11–4.33	4,609	4,493–4,726
Cádiz	0.83	0.8–0.9	1,707	2.42	2.36–2.47	4,967	4,962–5,073
Córdoba	1.34	1.3–1.4	1,510	3.90	3.80–4.00	4,394	4,282–4,506
Granada	2.04	1.9–2.1	2,832	5.94	5.82–6.05	8,241	8,079–8,403
Huelva	1.06	1.0–1.1	920	3.08	2.99–3.18	2,677	2,594–2,761
Jaén	1.06	1.0–1.1	990	3.08	2.99–3.18	2,881	2,794–2,967
Málaga	1.23	1.2–1.3	3,218	3.58	3.52–3.64	9,364	9,203–9,525
Seville	1.14	1.1–1.2	3,839	3.32	3.27–3.37	11,171	10,998–11,345
Andalusia	1.24	1.2–1.3	16,600	3.61	3.58–3.64	48,306	47,940–48,672

Figure 11

Observed Prevalence (<2 SDs) and Estimated Prevalence (<1.5 SDs) of DD in Andalusia



Significant differences are evident for Granada (2.04%) and Cádiz (0.83%). It is important to review the identification and diagnosis processes of students with DD in the municipalities of Seville, Alcalá de Guadaira, Algeciras, Chiclana, Jerez, La Línea de la Concepción, El Puerto de Santa María, Sanlúcar, Jaén, Benalmádena, Marbella and Torremolinos, where the prevalence is lower than expected (Table 5).

Assuming that 16,600 students with DD need specific educational intervention (specificity criterion of <2 SDs), there would be an estimated 47,306 (95 CI: 47,940–48,672) students with DD for a specificity criterion of <1.5 SDs. This suggests that 31,706 students with reading difficulties might need compensatory educational measures to facilitate their learning, despite not being identified as students with DD. It is necessary to review the inclusion criteria for students with DD in the census of students with specific educational support needs in Andalusia.

4.2. Age of Diagnosis

The results of DD intervention are particularly effective in the first school year, when there is a more intensive approach to written language acquisition (Ehri et al., 2001). However, detection is relatively low at 7 years old (24.38%), having to wait until 10 years to reach 70% (fourth year of Primary Education). Early detection at younger ages is necessary.

4.3. Academic Choices of Students with DD upon Completing ESO

Upon completing ESO, 34.42% of the general student population pursue Vocational Training and 65.58% pursue Baccalaureate (Regional Government of Andalusia, 2019). Students with DD prefer the Vocational Training option (Donato et al., 2022;

Rinkute et al., 2014), and this decision is not contingent on gender. Upon completing ESO, 54.71% of students with DD in Andalusia pursue Vocational Training and 45.29% pursue Baccalaureate.

Of the total number of DD students enrolled in post-compulsory education (3,687), 79.36% (54.71% IVTD and 24.65% AVTD) pursue Vocational Training studies.

The decision to study Baccalaureate or Vocational Training could be influenced by academic difficulties associated with DD, potentially overshadowing their preferences or personal interests (Peer Review 1, 2023).

Almería is the province with the lowest percentage of DD students who, after completing ESO, enrol in IVTD or Baccalaureate. It is essential to know the number of DD students who do not complete ESO.

4.4. Limitations

The prevalence results obtained relate to a reading level below 2 SDs than that expected for their age, whereas reference studies use a criterion of 1.5 SDs. Therefore, an estimation based on the normal distribution for 1.5 SDs has been made.

Concerning the study of academic decisions made by students with DD, there is a lack of information on DD students pursuing university studies, as well as the number who leave the educational system without obtaining a basic qualification. Although the reintegration of DD students into the educational system with Adult Secondary Education has been explored, there is no data on students attempting to obtain qualifications through free tests.

4.5. Prospective

Regarding the prevalence of DD in Andalusia, it is advisable to conduct sample assessments in the different provinces of Andalusia to assess the reliability of the data used, with particular attention to the differences in the number of students who might experience reading difficulties due to a reading level below 1.5 SDs expected for their age and are not identified as students with DD.

Concerning the academic decisions made by students with DD, it is essential to understand which students do not complete ESO and discontinue studies in the various provinces of Andalusia.

5. Ethical Declaration

The study was approved by the Bioethics Committee of the University of Almería (UALBIO 2022/058).

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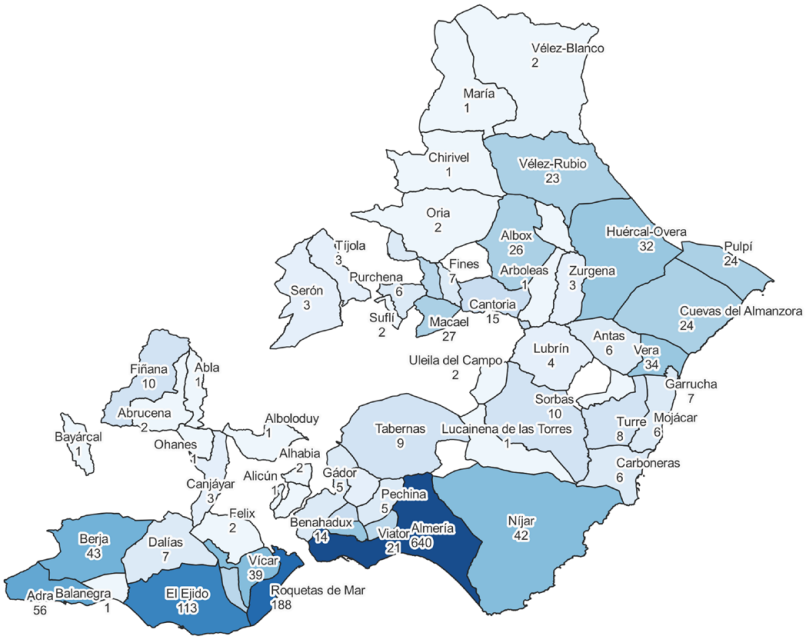
Appendix. Distribution of Students with Developmental Dyslexia in Andalusia by Provinces

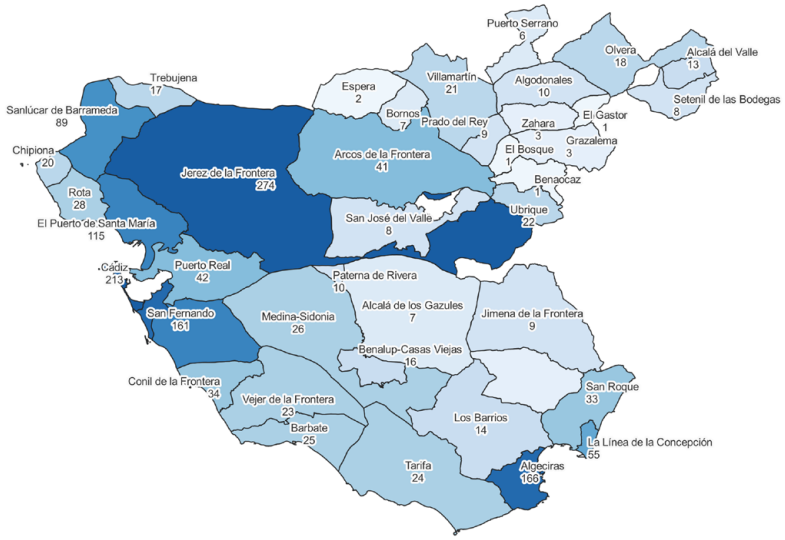
Almería

1,584 students with Dyslexia
Prevalence 1.45 % [Specificity Criterion <2 SDs]



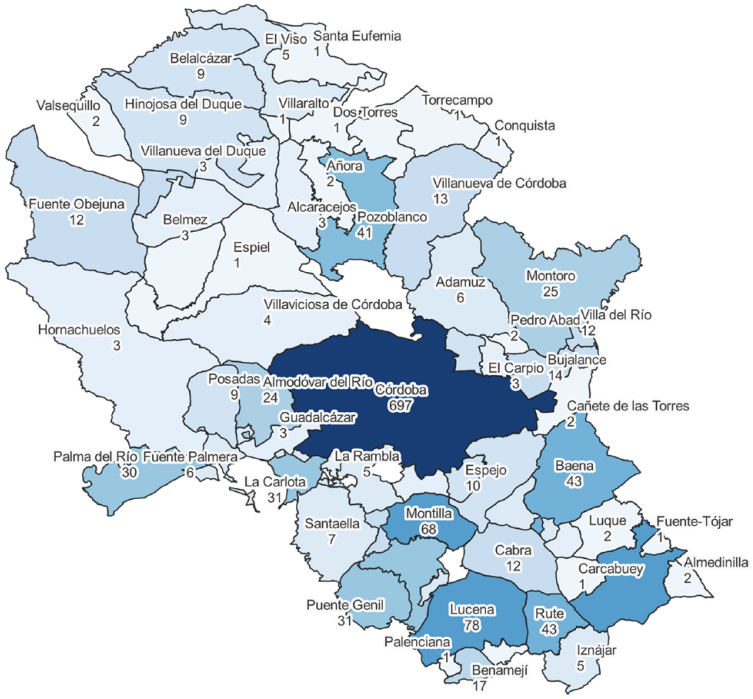
Cádiz

1,707 students with Dyslexia
Prevalence 0.83 % [Specificity Criterion <2 SDs]



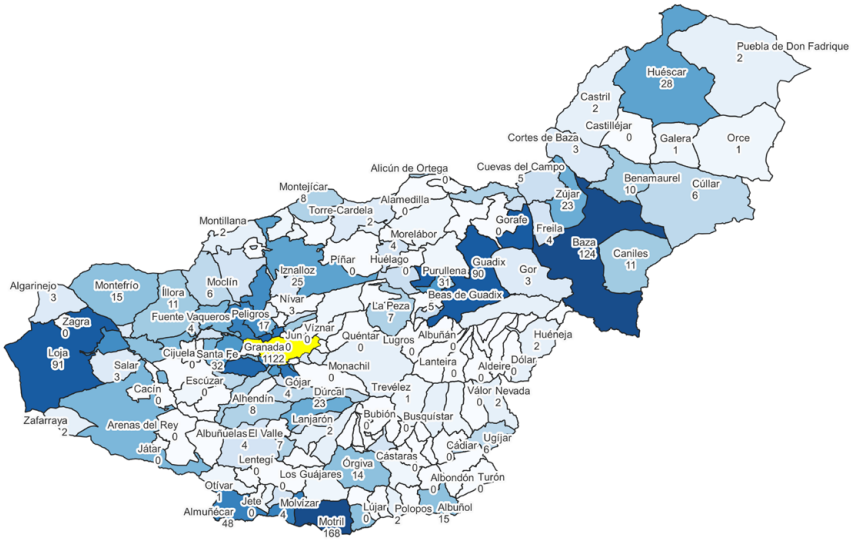
Córdoba

1,510 students with Dyslexia
Prevalence 1.34% [Specificity Criterion <2 SDs]



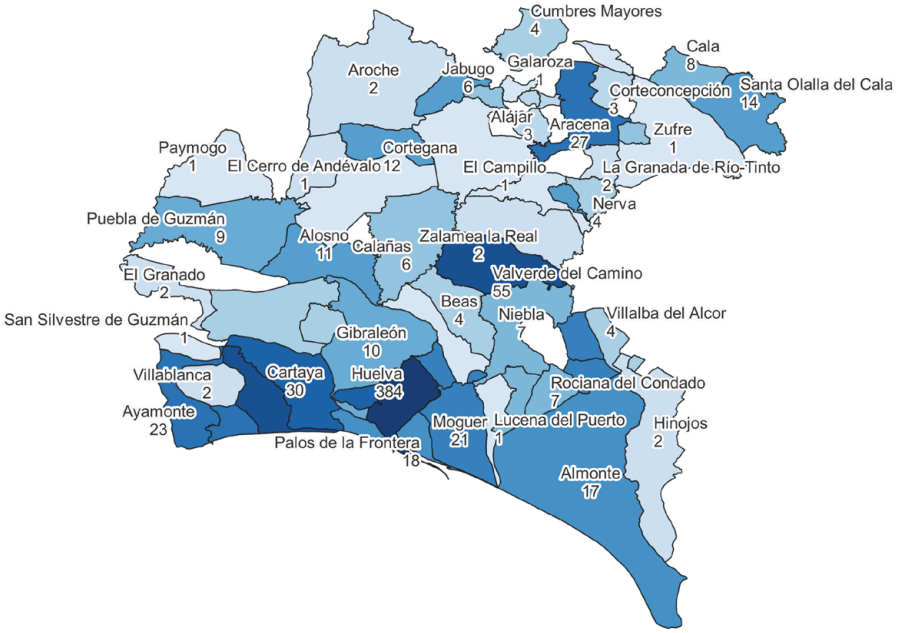
Granada

2,832 students with Dyslexia
Prevalence 2.04 % [Specificity Criterion <2 SDs]



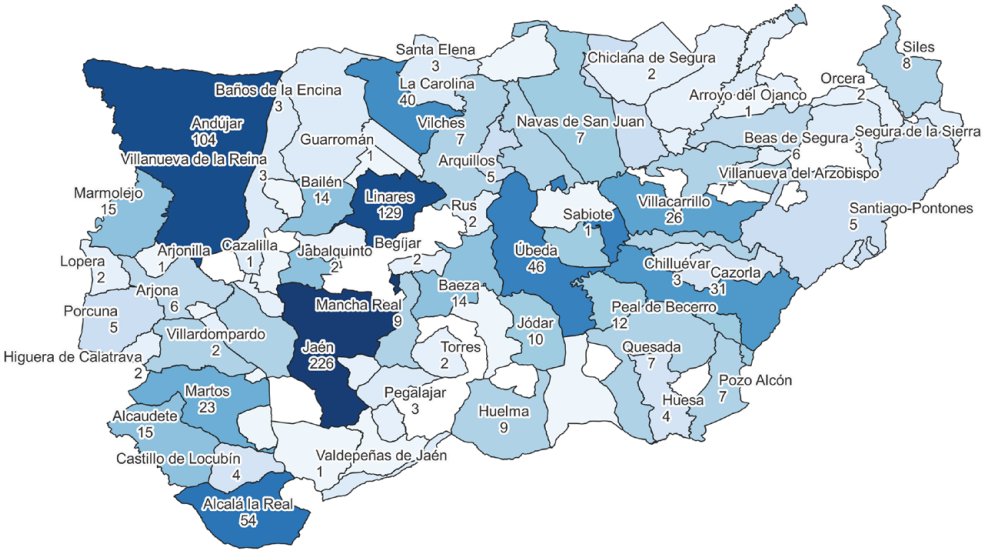
Huelva

920 students with Dyslexia
Prevalence 1.06% [Specificity Criterion <2 SDs]



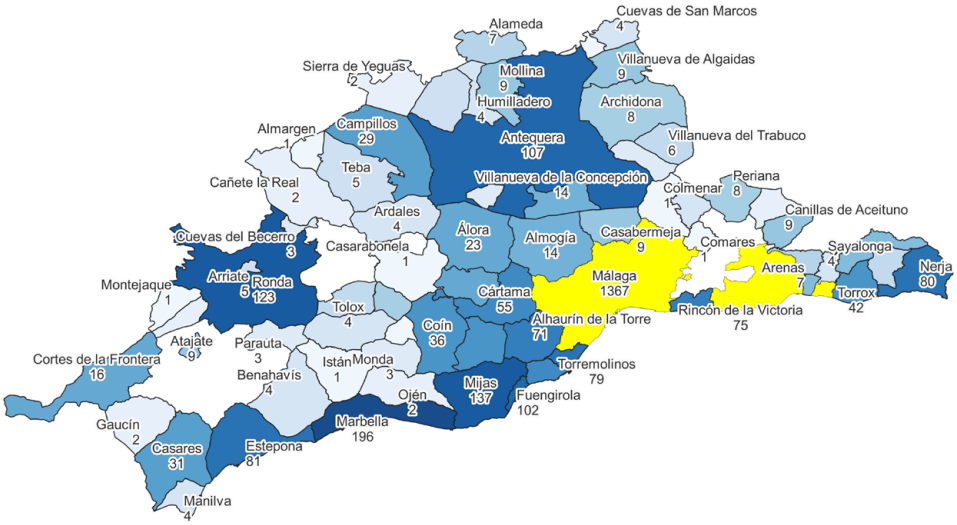
Jaén

990 students with Dyslexia
Prevalence 1.06% [Specificity Criterion <2 SDs]



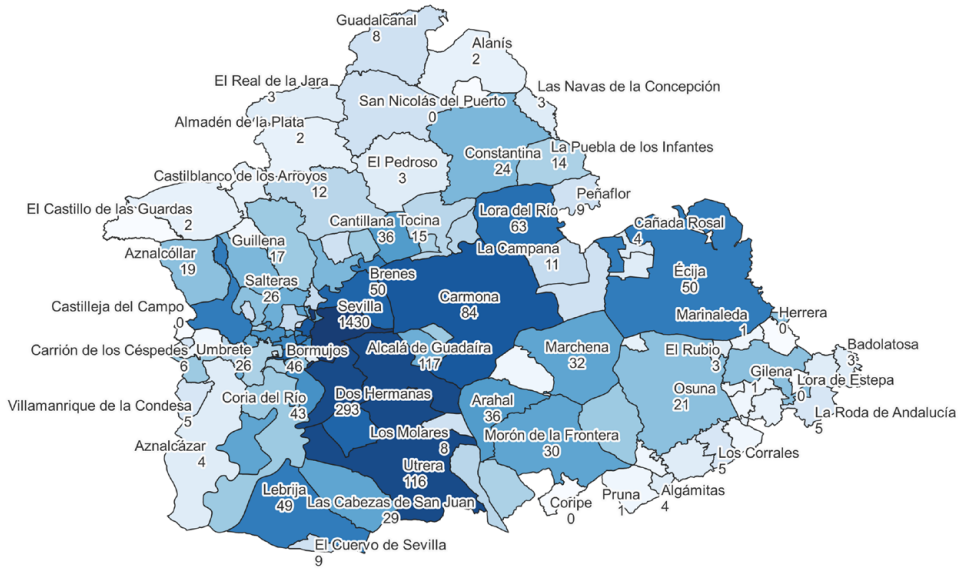
Málaga

3,218 students with Dyslexia
Prevalence 1.23% [Specificity Criterion <2 SDs]



Sevilla

3,839 students with Dyslexia
Prevalence 1.14% [Specificity Criterion <2 SDs]



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