

A First Estimate of the Prevalence of Developmental Language Disorder in Mexico: A Retrospective Study

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ABSTRACT

This was a retrospective study that aimed to provide a first estimate of the prevalence of developmental language disorder (DLD) in Mexico, where there is currently a lack of epidemiological data on this disorder. Children aged 4;0 to 6;11 years in the cities of Mexico, Queretaro, and Monterrey were classified into two groups: those with DLD ($N = 46$) and those with typical language development ($N = 497$). The diagnosis of DLD was based on standardized norm-referenced assessment and language sample analyses. Children with other disabilities were excluded from the final sample. The final sample consisted of 543 children (55% male; 45% female) aged 4;0 to 6;11 years. The estimated prevalence of DLD was 8.5%. The study has clinical implications given that the prevalence of DLD in Mexico may raise awareness of this long-lasting disorder and may help health and educational authorities establish a system to early identify and diagnose children with DLD.

KEYWORDS: developmental language disorder, Spanish-speaking children, monolingual Spanish speakers, prevalence

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Learning Outcomes: As a result of this activity, the reader will be able to:

- Understand the scope and magnitude of DLD in children aged 4;0 to 6;11 years in Mexico.
- Emphasize the significance of employing rigorous and validated diagnostic tools to accurately identify children with DLD.
- Raise awareness of DLD to inform the health and educational authorities to establish systems for early identification and diagnosis of children with DLD.

Developmental language disorder (DLD), formerly known as specific language impairment (SLI), is a language condition characterized by deficits with grammar, phonology, semantics, syntax, and/or pragmatics, in the absence of cognitive, motor, neurological, or hearing problems (Leonard 2014; Bishop & Leonard 2000; Kapantzoglou et al. 2015). Difficulties may change over time with age (Conti-Ramsden & Botting 1999; Heilmann et al. 2010), as well as the severity and impact on daily life. The rate of prevalence refers to the proportion of individuals within a specific sample who have a particular condition such as DLD. The prevalence of DLD can vary across different countries and populations due to various factors, including diagnostic criteria, cultural differences, and access to healthcare services. In Mexico, it is estimated that 15% of people, including children and adults, have a communication and/or language disability, according to the Instituto Nacional de Estadística, Geografía e Informática (INEGI 2020). The estimation of people with communication disorders has dramatically increased from 2010 (8.3%) to 2020 (15%). The majority of children in Mexico (93%) are reported to be monolingual Spanish speakers. Among individuals who have a communication and/or language disability, 3.2% are children between 3 and 4 years of age, and 14.8% are children between 5 and 9 years of age.

The prevalence of communication disorders can vary depending on the questions asked about language concerns. For instance, the INEGI (2020) included a single question about language use in their surveys and census: “Do you have difficulties speaking, communicating, or having a conversation in your everyday life?” This question encompasses all types of speech and language deficits, regardless of their etiology or age of onset. However, the prevalence of specific language disorders, such as DLD in monolingual Spanish-speaking children in

Mexico, has yet to be estimated. The present study, although not an epidemiological study, conducted secondary analyses to obtain a first estimate of the prevalence of diagnosed DLD in Mexico based on data from three different cities of Mexico: Queretaro, Mexico, and Monterrey.

PREVALENCE OF DEVELOPMENTAL LANGUAGE DISORDER

The estimated prevalence of diagnosed DLD varies across different countries and populations. For instance, studies on monolingual English-speaking children from the United States and England indicate that approximately 7.5% of children 4 to 6 years of age present with the disorder (Norbury et al. 2016; Tomblin et al. 1997). In Australia, McLeod and Harrison (2009) estimated a prevalence of 13 to 14.7% in 4- to 5-year-old children, and Calder et al. (2022) found a prevalence of 6.4% in 10-year-old children. In Finland, Hannus et al. (2009) reported that 2.5% of 0- to 6-year-old children presented with DLD. In China, Wu et al. (2023) found a prevalence of 8.5% in children aged 5 to 6 years. Large variability in outcomes is also noted across studies that have been conducted in developing countries. For example, Tchoungui Oyono et al. (2018) found that 4.3% of 3- to 5-year-old French-speaking children in Cameroon had DLD; Melchioris Angst and colleagues (2015) reported a similar prevalence of 4.58% in 4- to 6-year-old children in Brazil; Oryadi-Zanjani et al. (2015) found a prevalence of 3.3% in 5-year-old Persian-speaking children of Iran; and Gad-Allah et al. (2012) reported a prevalence of 19.7% in Egypt in 3- to 5-year-old children.

There is a dearth of studies on the prevalence of DLD in Spanish-speaking countries in Central or Latin America (De Barbieri et al. 1999; Villanueva et al. 2008). Chile has been at the forefront of identifying children with DLD

for many years. In the study of Barbieri et al. (1999), 316 children aged between 1 and 7 years were evaluated using an expressive communication developmental scale and specific diagnostic tools for different language development levels. The authors found that 6.8% of children presented with some type of language impairment, with a higher incidence in males (66.4% of cases).

There is a variety of factors that affect the prevalence estimates including changes in the definition of language disorders, variability in the characteristics of the populations under study, differences in measurement of language abilities, and other methodological characteristics of the studies conducted. Regarding the definition, in recent years, the term “DLD” has been adopted based on a consensus study involving a panel of experts (Bishop et al. 2017). These researchers emphasized the importance of using the same label—DLD—for a complex and multifactorial disorder. Several years ago, Bishop (2014) suggested maintaining the term “specific language impairment” with the understanding that “specific” implies an unknown etiology rather than a pure impairment that does not imply any other cognitive deficit (e.g., working memory). Moreover, the DSM-V term “language disorder” remains confusing because it is wide in its definition, and boundaries among disorders are diffuse. It is possible that a substantial misclassification of children with expressive language disorders, including DLD, is taking place in different countries, including Mexico, and variability in prevalence outcomes is partially affected by the lack of consistency in the definition. Researchers working with Spanish-speaking children have now adopted the term DLD to promote consistency and clarity in discussing the condition (e.g., Andreu et al. 2021; Castilla-Earls et al. 2021), and for the present study we also adopted the same term.

In addition, the studies conducted across different countries vary with respect to the age, sex, and sociocultural characteristics of the participants, which contribute to the variability in the findings. For example, Tchoungui Oyono et al. (2018) found that the prevalence of DLD ranged from 2.6 to 7.1% for the three age groups included in the study (3–5 years of age) with

the highest prevalence observed in 5-year-old children, whereas Barbieri et al. (1999) found higher frequency of language impairments between 3 and 4 years of age (66.4% of the cases) than at 5 years of age (24.2% of cases) and at younger than 3 (9.4% of cases). Furthermore, there is relative consistency in findings across studies that the prevalence of the disorder is higher in male than in female participants (e.g., Calder et al. 2022; De Barbieri et al. 1999; Norbury et al. 2016; Tomblin et al. 1997). Regarding the sociocultural characteristics of the groups examined, some studies used a nationally representative sample or stratified sampling from urban, suburban, and rural areas to account for the socio-demographic conditions in different residential areas (e.g., McLeod & Harrison 2009; Norbury et al. 2016; Tomblin et al. 1997), whereas other studies used sample from a single city (e.g., De Barbieri et al. 1999; Hannus et al. 2009; Tchoungui Oyono et al. 2018). In addition, it is important to consider that the particular sociocultural characteristics of the populations examined are likely to affect children’s scores on the measures used (e.g., Barragan et al. 2018); therefore, sociocultural differences across studies are likely to affect differentially the scores and outcomes on the prevalence of the disorder across the different populations (Kapantzoglou et al. 2016). In the present study, the sample was not stratified but collected from three different urban areas in Mexico, including children who attended public and private schools. Therefore, besides estimating the prevalence of DLD for each age and sex group separately, the study also examined the effects of the sociocultural characteristics of the sample—maternal education and the type of school children attended—on the prevalence estimates. Finally, identification of DLD in the present study was based on measures with validity evidence for their use with the target population.

There is also a discussion in the literature regarding possible differences in the prevalence of the disorder between developing and high-income countries. The rationale behind this is that children living in socioeconomically disadvantaged situations might be more prone to develop difficulties acquiring language (Black et al. 2008; Hoff 2003; Jensen et al. 2017), which may be more pronounced in children with DLD

(Auza & Peñaloza 2019; Lara-Díaz et al. 2021; Norbury et al. 2021). For instance, Norbury et al. (2021) found that the predicted probability of language disorder was 2.5 greater at the 10th percentile of Income Deprivation Affecting Children Index (McLennan et al. 2010). The findings are mixed with studies suggesting that prevalence rates vary across developing countries (e.g., Tchoungui Oyono et al. 2018; Gad-Allah et al. 2012), and the present study will be the first to provide evidence from Mexico.

Prevalence studies also vary widely in their diagnostic approach for DLD and other methodological characteristics. Specifically, some studies used direct assessment that included a diagnostic battery with a variety of measures such as hearing screening, parent interviews, standardized tests, and language sample analyses (e.g., Tomblin et al. 1997), whereas in other studies, language assessment was based on a single language test (e.g., Calder et al. 2022) or on indirect measures, such as parent and teacher questionnaires (Gad-Allah et al. 2012). In some cases, the prevalence estimates were based on retrospective data (Hannus et al. 2009). There is also variability in the cut scores applied across studies for identifying DLD. Given lack of standard cut scores, depending on the types of tests conducted and researchers' related decisions, cut scores can range from 1 to 2 standard deviations below the mean (e.g., Calder et al. 2022; Norbury et al. 2016; Tomblin et al. 1997). In some cases, a re-norming process was followed, in which the study sample served as its own reference given that the characteristics of the standardization sample in the test did not match the characteristics of the target population (e.g., Tchoungui Oyono et al. 2018). Finally, as expected, the sample size also varies widely across different studies and in some studies the sample is population based, whereas in other cases it is clinically based (e.g., De Barbieri et al. 1999; Hannus et al. 2009).

SCREENING AND DIAGNOSING DEVELOPMENTAL LANGUAGE DISORDER IN MEXICO

A main issue concerning the identification of DLD in Mexico is the diagnostic terminology that has been used over time. For over three

decades, expressive language disorders in Mexico have been identified in several public institutions with a nomenclature based on adult neurological deficits, such as “retardo anártrico” (anarthric delay) and “retardo anártrico-afásico” (anarthric-aphasic delay) (Azcoaga et al. 1987). These terms, as well as “developmental dysphasia” (Parise & Maillart 2009), are still used, especially in clinical settings, although the international nomenclatures in the medical classification system, such as the ICD-11 (F80.9) and the DSM-V, “language disorder,” have become more common among clinicians and researchers globally. When obsolete terminology is still used, it can potentially contribute to misdiagnosis because without clear definitions, varied interpretations among healthcare professionals are possible. Many clinicians still use older terms as synonyms and are less aware of the most recent term “DLD” (Bishop et al. 2017). The accuracy in describing the condition of interest (in this case DLD), as well as in the collection and analysis of data, are key components in the outcomes of the prevalence of DLD (Hannus et al. 2009). For instance, the disorder has been defined in various ways, such as language disorder with unspecified or of unknown origin (Barbieri et al. 1999; McLeod & Harrison 2009; Norbury et al. 2016), specific language disorder (Hannus et al. 2009; Tomblin et al. 1997), or DLD (Calder et al. 2022). Changes in terminology within the field may lead to under-identification of DLD if there is inconsistency in how terms are used or understood. If the term has changed over the years and new terminology is introduced without a clear definition and/or criteria, it may result in overlooked or incorrect diagnosis.

Low awareness of DLD in Mexico is another main issue for the accurate and early identification of the disorder, even among the professional community of speech-language pathologists. There are no established procedures in place in the country, in schools or medical settings, to screen children for DLD. Parents typically seek help when they are concerned about their children's development, particularly when they observe speech delays rather than difficulties with grammar use. The Encuesta Nacional de Salud y Nutrición (National Survey of Health and Nutrition—ENSANUT—)

indicated that 30.8% of boys and 27.8% of girls aged between 2;0 and 9;0 years were identified as being at risk of experiencing a developmental disorder. This risk is defined as the presence of a disorder in any of the neurodevelopmental domains, including motor skills, cognition, language, and personal-social development (Romero-Martínez et al. 2012). The parents who participated in the survey observed problems in the cognitive and communicative domains. Specifically, parents reported difficulties with talking, understanding (classified in this survey as cognitive deficits), or maintaining a conversation to be the main issues in 13.3% of children between 2;0 and 5;0 years of age, and in 11.5% of children between 6;0 and 9;0 years of age (Romero-Martínez et al. 2012).

Finally, another main challenge in identifying DLD is that the instruments for screening and diagnosing monolingual Spanish-speaking children in Mexico, as in other developing countries, are scarce. Nevertheless, recently there has been some improvement in identification methods due to the emergence of certain tests. Specifically, for children less than 5 years of age, the Evaluación del Desarrollo Infantil/Child Development Assessment (EDI; Rizzoli-Córdoba et al. 2014) can be used for the identification of neurodevelopmental delays, including language delays. For children older than 4 years, there are also some options. Recently, in 2018, the first screening tool for identifying monolingual Spanish-speaking children with a risk of presenting grammatical disorders was published in Mexico (Auza Benavides et al. 2018b, 2018c). Also, other tests such as the Bilingual English-Spanish Language Test (BESA; Peña et al. 2014), and the Spanish Clinical Evaluation of Language Fundamentals – Fourth Edition, Spanish (CELF-4; Semel et al. 2006) that have been standardized on Spanish-English speaking populations in the United States, are also used to diagnose DLD. However, the efficacy of the detection system could be enhanced through the implementation of a systematic methodology for language screening and assessment. Moreover, further investigation is needed regarding the diagnostic standards that are appropriate for the characteristics of local populations in Latin America, to identify children with DLD accurately and

efficiently. Currently, the gold standard for language assessments is the use of converging evidence from various methods of assessment (Auza Benavides et al. 2018b; Barragan et al. 2018; Castilla-Earls et al. 2020) and this is the approach followed in the present study as well.

Studying the prevalence of children with DLD in Mexico is crucial not only for understanding the rate of affected individuals but also for evaluating the consequences of our assessment protocols and establishing a system to early identify and diagnose DLD, as well as for gathering further evidence regarding possible differences in the prevalence of DLD between developing and high-income countries. Given so, the purpose of this study was to obtain a first estimate of the prevalence of DLD in Mexico based on secondary analyses. Specifically, the study aimed to answer the following research questions:

1. What is the overall estimate of prevalence of children presenting with DLD?
2. What is the estimate of prevalence of children presenting with DLD at different ages?
3. What is the estimate of prevalence of boys and girls presenting with DLD?

METHOD

A cross-sectional retrospective study was conducted to investigate the prevalence of children with DLD in a sample of monolingual Spanish-speaking children aged between 4;0 and 6;11 years. The study recruited children from 137 public and private schools across three cities in Mexico: Queretaro, Mexico, and Monterrey. Parents of the children were invited to participate in the study through open and free talks delivered in schools and public health centers in the three cities. During these talks, information was provided about language development and disorders, and it was emphasized that anyone could participate, whether they were concerned about their child's language development or not.

Participants

The initial sample for this study consisted of 872 children who were eligible for inclusion in a larger study that validated a screener instrument

(Auza Benavides et al. 2018b). Four children were excluded from the sample because they were native speakers of languages other than Spanish. Of the remaining 868 children, parental consent was not provided for 118 children, who either withdrew from the study or did not complete testing. In some cases, children did not attend school on the days of testing or were taken out of school. Additionally, some parents did not provide the necessary biological and sociocultural information on the initial questionnaire (Auza et al. 2023), which was crucial for sample selection (Auza et al. 2019). A total of 38 children were excluded during testing due to other conditions such as neurological impairment, hearing loss, intellectual disability, autism spectrum disorder, or a psychiatric condition. This left us with a sample of 712 children. However, since this sample came from a larger one, we did not include the 115 children who were tested in hospitals or clinics, as this may have led to potential referral bias and inflated prevalence rates in the community. Therefore, only children attending public or private schools were included in this sample. Another 54 children were ruled out of the sample because they did not complete the whole language assessment. In total, 543 monolingual Spanish-speaking children aged 4 to 6 years participated in this study (typical language development [TLD]: $N = 497$, $M_{\text{age}} = 63$, $SD = 9.22$; DLD: $N = 46$, $M_{\text{age}} = 62$, $SD = 9.81$). At the time of testing, all the 46 children diagnosed with DLD had undergone language services for duration of less than 2 months, even children aged 6 who were late diagnosed. None of the children had any contact with indigenous languages. Additionally, none of the participants had a history of hearing loss, sensorimotor or neurological problems, severe psychological disorders, or health problems, as reported by their parents. In cases where there was a concern about any of these issues, children were referred for evaluation, and if the problem was clinically confirmed, they were excluded from the study.

The study included children with TLD and children with DLD. For all children, their non-verbal IQ score was 80 or above on the Kaufman Assessment Battery for Children—2nd edition (KABC-2; Kaufman & Kaufman 2004). Chil-

dren with TLD met two of the following three criteria: (1) the number of grammatical errors per T-unit in their language sample was less than 20% (Restrepo 1998); (2) the mean length of utterance in words (MLUw) was age appropriate (Simón-Cerejido & Gutierrez-Clellen 2007); and (3) children scored at or above the cut score on the Tamiz de Problemas del Lenguaje (TPL), which included a morphology subtest and a sentence repetition subtest (Auza et al. 2018c).

Children with DLD met two of the following three criteria: (1) the percentage of grammatical errors per T-unit in their language sample was 20% or more; (2) the MLUw was low for their age (Simón-Cerejido & Gutierrez-Clellen 2007); and (3) children scored below the cut score on the TPL which included a morphology subtest and a sentence repetition subtest (Auza et al. 2018c).

General Procedures

Initially, an information session was organized for parents and teachers to apprise them of the significance of our study. During this session, we provided information on TLD and discussed potential red flags that indicate the likelihood of a language disorder in children. Parents willing to participate in the study completed the parent consent form. The KABC-2 non-verbal subtests were administered to rule out cognitive impairment. As a third step, the TPL (Auza et al. 2018c) and a language-sample were administered as a comprehensive assessment. The language-sample was used to obtain the MLUw and the percentage of grammaticality. All measures were administered by trained graduate students in linguistics or experienced SLPs in two or three distinct sessions during the same week at school. In each session, all tasks were administered in a randomized order. The test administrators were blind to the children's language status. The trained examiners conducted all the sessions in a quiet area at the children's school. Approximately 60% of all tests were independently scored by a second rater with a target agreement of 90%. In the case of any disagreements, the first author and the graduate students resolved them by consensus.

Measures

THE KABC-2

The nonverbal subtests of the KABC-2 were administered to rule out cognitive impairment. The subtests used in the study varied according to the age of the participants and encompassed a combination of several tasks, such as the following: conceptual thinking, face recognition, non-verbal story completion with images, triangles, block counting, pattern reasoning, and hand movements.

GRAMMATICALITY IN LANGUAGE SAMPLES

The children completed a story-retell task in Spanish using picture and a script support, utilizing the books “Si le das una galletita a un ratón/If You Give a Mouse a Cookie” (Numeroff 1985) and “Con una rana es suficiente/One Frog Too Many” (Mayer & Mayer 1975). The books are similar in length, they are wordless, have multiple episodes, and they are appropriate for the target age group. The children retold one of the stories after listening to the script, supported by accompanying pictures. In terms of story equivalence, previous reports have indicated no significant difference in the measures obtained from these two narratives, specifically in terms of MLUw and the percentage of ungrammaticality (Auza et al. 2018a). Consequently, 33.2% of the entire sample of children retold “If You Give a Mouse a Cookie,” while 66.8% retold “One Frog Too Many.” Within this total, 39.2% of children with DLD retold “If You Give a Mouse a Cookie,” and 60.8% retold “One Frog Too Many.” The narratives were transcribed, and the MLUw and grammatical errors were coded using the Systematic Analysis of Language Transcripts (SALT; Miller & Iglesias 2010). Grammatical errors included omissions, substitutions, additions, and word order errors. For instance, an example of an omission (*) of an obligatory preposition is: “*Corrieron *con-prep zapatos/(They ran *with-prep shoes)*”. An example of an article substitution [Subs] is “*El niño se enojó con la[Subs] (Feminine article) sapo/The boy got angry with the (Feminine article) toad*.” An example of an addition [Adic] is: “*la (Feminine clitic) estaba buscándola- (Feminine clitic) [Adic]/ (he) was looking for her- (Feminine clitic) [Adic]*.”

Semantic, phonological, or cohesive errors were excluded from the coding process. The percentage of ungrammatical sentences (number of sentences with grammatical errors divided by the total number of complete and intelligible sentences/terminal units [TU]) was computed. The MLUw was automatically obtained using SALT and was based on the complete sentences, children produced in the sample. All transcribers were graduate students in linguistics and received training in linguistic analysis to code grammatical errors. The inter-rater agreement for TU was 91%, and for percentage of ungrammatical sentences it was 90%.

TPL

This test comprises two grammatical tasks: a morphology cloze task and a sentence repetition task (Auza Benavides et al. 2018b; Auza et al. 2018c). These tasks are designed to target vulnerable grammatical elements that have been identified as strong indicators of DLD in monolingual Spanish-speaking children (e.g., Bedore & Leonard 2001, 2005; Morgan et al. 2009, 2013; Simón-Cerejido & Gutiérrez-Clellen 2007). The technical manual provides cut scores for children between 3;0 and 6;11 years of age. Sensitivity ranges between 74.6 and 88.9%, and specificity ranges between 92.1 and 95.0% across age groups. The TPL test also provides information for classifying children with a high probability (“red light”) or a low probability (“yellow light”) of having DLD. Children who score below the 16th percentile are considered to have a DLD.

Statistical Analysis

In this study, we initially characterized the socio-demographic and language development profiles of children with DLD and TLD across three age groups—3, 4, and 5 years old. We then compared these variables between the DLD and TLD groups. For continuous variables, we utilized Welch’s *t*-test for comparison (Delacre et al. 2017; Skovlund & Fenstad 2001; Ruxton 2006), and Cohen’s *d* was employed to determine effect sizes. Categorical variables were examined using the Chi-square test (Kroonenberg & Verbeek 2018), with the Phi coefficient for effect size assessment.

Given the sampling design, the proportion of DLD observed in our sample should not be construed as representative of the Mexican infant population; however, it offers a preliminary estimate. We present this proportion with 95% confidence intervals. Statistical significance was established at a p -value below 0.05. Effect sizes were interpreted using Cohen's benchmarks: a Cohen's d of 0.8, 0.5, and 0.2 (absolute values) signified large, medium, and small effects, respectively. The Phi index followed a similar scale, with 0.5, 0.3, and 0.1 (only positive values) representing large, medium, and small effects, respectively (Cohen 1988).

To answer the first and second research questions, we calculated the overall estimate of prevalence of having DLD and the estimate of prevalence for each of the three age groups (4, 5, and 6 years), using a logistic regression model. Also, logistic regressions were used to calculate the estimate of prevalence of boys and girls presenting with DLD. Odd ratios with 95% confidence intervals and a significance level of 0.05 were used. All statistical analyses were performed using R Project for Statistical Computing.

RESULTS

Table 1 presents the characterization of children with DLD and TLD by their socio-demographic and language development profiles, along with a comparison of these group profiles. The table also provides the same analysis for each of the three age groups.

The socio-demographic variables reveal modest differences: the DLD group was slightly younger than the TLD group (60.5 vs. 62.5 months, Cohen's $d = -0.22$, $p = 0.15$), had a higher proportion of girls (72 vs. 51%, Phi = 0.12, $p = 0.007$), and had mothers with fewer years of education (10.7 vs. 12.1 years, Cohen's $d = -0.32$, $p = 0.06$). Furthermore, a larger percentage of children with DLD attended public schools (52 vs. 39%, Phi = 0.12, $p = 0.08$). In terms of non-verbal cognitive abilities, differences in K-ABC scores, albeit small, were statistically significant (100.5 vs. 104.0, Cohen's $d = -0.31$, $p = 0.01$). In the analysis of the language development profile, the DLD group demonstrated lower performance across

all measured variables compared to the TLD group. Specifically, the quantification of ungrammatical sentences as a percentage and the total percentage of language proficiency (TPL) exhibited markedly vast disparities, at 52.0 versus 12.9% and 47.1 versus 87.9%, respectively. The trends in the distribution of these variables were consistent when analyzed by age group. A detailed inspection indicates that, for 5-year-olds, the discrepancy in the proportion of girls between the DLD and TLD groups was less pronounced (62 vs. 56%), while the difference in maternal education levels was more pronounced (9.4 vs. 12.6 years). In contrast, the K-ABC scores showed negligible differences (103.0 vs. 103.5). There was a modest divergence in MLUw (7.53 vs. 8.51), and for 6-year-olds, there was a slight difference in maternal education levels (10.2 vs. 10.4 years), and the percentage of children attending public schools (67 vs. 69%).

Regarding our first research question about the overall estimate of prevalence of children presenting with DLD, results suggested an 8.5%. Regarding our second research question about the estimate of prevalence of children presenting with DLD at different ages, we found 10.7% for 4-year-old children, 6.2% for 5-year-old children, and 8.2% for 6-year-old children. This showed no trend, such as a monotonic increase or decrease, across the ages. These results are summarized in Table 2.

For the third question, concerning the estimates of DLD prevalence by sex, a higher prevalence was observed among boys overall, and specifically among 4- and 6-year-olds, with differences from girls reflecting small effect sizes that were statistically significant. In the sample of 5-year-olds, sex differences were seldom found.

DISCUSSION

This study is the first in Mexico to investigate the prevalence of DLD in monolingual Spanish-speaking children between 4;0 and 6;11 years old. The study's findings indicated an overall estimated prevalence of 8.5%, with specific estimates of 10.7% for 4-year-old children, 6.2% for 5-year-old children, and 8.2% for 6-year-old children. This overall prevalence in

Table 1 Demographic and sociocultural characteristics of children with and without DLD

Total, <i>n</i> = 543	DLD <i>n</i> = 46	TLD <i>n</i> = 497	ES (95% CI)	<i>p</i>
Socio-demographic characteristics				
Age [month], mean (SD)	60.5 (9.1)	62.5 (9.3)	−0.22 (−0.52, 0.08)	0.15
Sex [male], <i>n</i> (%)	33 (72%)	253 (51%)	0.12 (0.05, 0.20)	0.007
Maternal education [year], mean (SD)	10.7 (4.6)	12.1 (4.2)	−0.32 (−0.65, 0.01)	0.06
Types of school [public], <i>n</i> (%)	24 (52%)	192 (39%)	0.08 (0.00, 0.17)	0.08
Diagnostic tools				
K-ABC [score], mean (SD)	100.5 (10.2)	104.0 (11.3)	−0.31 (−0.58, −0.03)	0.01
Language samples				
MLU [by no. of words], mean (SD)	6.67 (3.81)	8.14 (2.99)	−0.49 (−0.87, −0.11)	0.03
PU [percentage], mean (SD)	52.0 (26.0)	12.9 (11.5)	3.39 (2.70, 4.08)	<0.001
Screening task				
TPL [percentage], mean (SD)	47.1 (19.7)	87.9 (10.4)	−3.92 (−4.52, −3.31)	<0.001
TPL [red], <i>n</i> (%)	42 (91%)	9 (2%)	0.85 (0.77, 0.94)	<0.001
4-year-olds, <i>n</i> = 224				
	<i>n</i> = 24	<i>n</i> = 200		
Socio-demographic characteristics				
Age [month], mean (SD)	53.3 (3.5)	53.5 (3.4)	−0.09 (−0.52, 0.35)	0.39
Sex [male], <i>n</i> (%)	17 (71%)	92 (46%)	0.15 (0.07, 0.29)	0.022
Maternal education [year], mean (SD)	11.6 (4.1)	12.4 (4.1)	−0.19 (−0.61, 0.24)	0.39
Types of school [public], <i>n</i> (%)	11 (46%)	59 (30%)	0.11 (0.00, 0.25)	0.10
Diagnostic tools				
K-ABC [score], mean (SD)	99.6 (10.4)	104.0 (11.0)	−0.40 (−0.81, 0.01)	0.061
Language samples				
MLU [by no. words], mean (SD)	6.06 (4.17)	7.29 (2.56)	−0.48 (−1.15, 0.19)	0.17
PU [percentage], mean (SD)	53.9 (25.5)	12.8 (12.0)	3.44 (2.51, 4.36)	<0.001
Screening task				
TPL [percentage], mean (SD)	41.2 (19.9)	83.7 (12.3)	−3.44 (−4.18, −2.70)	<0.001
TPL [red], <i>n</i> (%)	22 (92%)	5 (3%)	0.85 (0.72, 0.98)	<0.001
5-year-olds, <i>n</i> = 209				
	<i>n</i> = 13	<i>n</i> = 196		
Socio-demographic characteristics				
Age [month], mean (SD)	63.7 (3.1)	64.3 (3.3)	−0.19 (−0.72, 0.35)	0.51
Sex [male], <i>n</i> (%)	8 (62%)	109 (56%)	0.03 (0.00, 0.18)	0.68
Maternal education [year], mean (SD)	9.4 (5.8)	12.6 (4.1)	−0.79 (−1.57, 0.00)	0.035
Types of school [public], <i>n</i> (%)	7 (54%)	63 (32%)	0.11 (0.00, 0.26)	0.11
Diagnostic tools				
K-ABC [score], mean (SD)	103.0 (10.7)	103.5 (12.0)	−0.04 (−0.55, 0.47)	0.87
Language samples				
MLU [by no. words], mean (SD)	7.53 (3.83)	8.51 (3.06)	−0.32 (−1.01, 0.38)	0.38
PU [percentage], mean (SD)	42.1 (28.3)	11.8 (10.6)	2.87 (1.38, 4.36)	0.002
Screening task				
TPL [percentage], mean (SD)	56.2 (14.1)	90.1 (8.2)	−4.13 (−5.16, −3.10)	<0.001
TPR [red], <i>n</i> (%)	12 (92%)	2 (1%)	0.88 (0.75, 1.00)	<0.001
6-year-olds, <i>n</i> = 110				
	<i>n</i> = 9	<i>n</i> = 101		
Socio-demographic characteristics				
Age [month], mean (SD)	75.0 (3.0)	76.8 (3.7)	−0.49 (−1.06, 0.07)	0.11
Sex [male], <i>n</i> (%)	8 (89%)	52 (51%)	0.21 (0.00, 0.40)	0.031
Maternal education [year], mean (SD)	10.2 (3.9)	10.4 (4.4)	−0.04 (−0.66, 0.58)	0.90

Table 1 (Continued)

Total, <i>n</i> = 543	DLD <i>n</i> = 46	TLD <i>n</i> = 497	ES (95% CI)	<i>p</i>
Types of school [public], <i>n</i> (%)	6 (67%)	70 (69%)	0.02 (0.00, 0.20)	0.87
Diagnostic tools				
K-ABC [score], mean (SD)	99.0 (9.1)	104.5 (10.8)	−0.53 (−1.11, −0.06)	0.11
Language samples				
MLU [by no. words], mean (SD)	7.07 (2.68)	9.12 (3.21)	−0.64 (−1.22, −0.06)	0.056
PU [percentage], mean (SD)	61.3 (21.3)	15.3 (12.2)	3.77 (2.49, 5.04)	<0.001
Screening task				
TPL [percentage], mean (SD)	49.6 (22.4)	91.9 (6.5)	−6.53 (−8.96, −4.07)	< 0.001
TPL [red], <i>n</i> (%)	8 (89%)	2 (2%)	0.83 (0.65, 1.00)	< 0.001

Abbreviations: K-ABC, Kauffman cognitive subtests; MLU, mean length of utterances; PU, percentage of ungrammatical utterances; TPL, Tamiz de Problemas del lenguaje; ES, effect of size; for quantitative variables: Glass's Δ (interpretation <0.2: null; 0.2–0.5, small; 0.5–0.8: medium; >0.8 large). For qualitative variables: ϕ index (interpretation <0.1: null; 0.1–0.3, small; 0.3–0.5: medium; >0.5 large).

Table 2 Global and age-stratified relative frequency of children presenting with DLD

Age group	DLD frequency [95% CI] (%)			ES (95% CI)	<i>p</i>
	All	Male	Female		
Global	8.5 [6.4, 11.1]	11.5 [8.3, 15.8]	5.1 [3.0, 8.5]	0.12 (0.05, 0.20)	0.007
4-y-olds	10.7 [7.3, 15.4]	15.6 [10.0, 23.6]	6.1 [3.0, 12.0]	0.15 (0.07, 0.29)	0.022
5-y-olds	6.2 [3.7, 10.3]	6.8 [3.5, 12.9]	5.4 [2.3, 12.1]	0.03 (0.00, 0.18)	0.68
6-y-olds	8.2 [4.4, 14.8]	13.3 [6.9, 24.2]	2.0 [0.1, 10.5]	0.21 (0.00, 0.40)	0.031

our study, while somewhat higher, closely aligns with the prevalence of the disorder in monolingual English-speaking children from the United States and England, which is approximately 7.5%, as established in prior research conducted by Norbury et al. (2016) and Tomblin et al. (1997). Importantly, all three studies encompassed samples of children aged 4 to 6 years, included methodologies to account for socio-demographic variables in various residential areas, and employed a range of assessment tools for identifying DLD. Furthermore, all three studies consistently observed a higher prevalence of the disorder among male participants, a trend consistent with the broader literature. However, it must be clarified that this study is a retrospective study based on data collected in three different Mexican cities—Queretaro, Mexico, and Monterrey—whereas studies of Norbury et al. (2016) and Tomblin et al. (1997) were based on probabilistic sampling from a population. The overall prevalence estimate of children with DLD in our current

study stands significantly higher than figures reported in various other regions. For instance, in Finland, a sample of children aged 0 to 6 years yielded a prevalence of 2.5% (Hannus et al., 2009), and in Cameroon, a sample of French-speaking children aged 3 to 5 years yielded a prevalence of 4.3% (Tchoungui Oyono et al. 2018). In Chile, research involving children aged 1 to 7 years indicated a prevalence rate of 6.8% (De Barbieri et al. 1999), and in Iran, a study involving 5-year-old Persian-speaking children reported a prevalence of 3.3% (Oryadi-Zanjani et al., 2018). Notably, these studies involved on average younger age groups than the current study. There is limited research that supported lower prevalence figures in older children (e.g., Calder et al. 2022; 6.4%). While the numeric estimates vary considerably in these studies with younger groups than our participants, they might be collectively suggesting potential challenges in identifying DLD in younger ages, likely due to the less advanced stage of language development at such ages.

Regarding within study comparisons across ages, in the present study, the highest prevalence estimate was found among the 4-year-old children (10.7%) and the lowest in the 5-year-old group (6.2%). These results are consistent with Barbieri et al. (1999) who also found higher frequency of language impairments, in Chile, between 3 and 4 years of age than at 5 years of age and the lowest frequency was identified at ages younger than 3, which our study did not include. Results are also consistent with Tchoungui Oyono et al. (2018) who found that the prevalence of DLD in French-speaking children in Cameroon was similar to that in our study (7.1%) for 5-year-old children; however, prevalence in their 3- and 4-year-old groups was significantly lower (3.3 and 4.2%). Our results were also similar to a study with 5- and 6-year-old Mandarin-speaking children, although their methodology was different from ours (Wu et al. 2023). Higher prevalence of 4-year-olds with DLD in our study could be due to differences in the identification measures across studies.

Drawing comparisons between estimates to gauge the proportion of DLD across different studies presents several inherent challenges. These challenges arise from a lack of consensus in clinical criteria, variations in assessment methods, differences in the age of children studied, limited knowledge about the disorder itself, diverse nomenclature, and the scarcity of standardized tests, among other complexities. In the present study, we addressed these challenges by employing a combination of assessment tools specifically tailored to our context. We utilized a grammatically standardized norm-referenced test developed in Mexico, along with two commonly accepted measures based on language sample analyses, namely, MLUw and the percentage of ungrammatical sentences. It is recognized that combining standardized measures of morphosyntax with MLUw and the assessment of ungrammatical utterances can provide valuable diagnostic information (Bedore et al. 2010; Eisenberg & Guo 2016; Gutiérrez-Clellen & Simon-Cerejido 2009).

The results of the present study differ substantially from those reported by the National Survey of Health and Nutrition in Mexico. Specifically, the National Survey of

Health and Nutrition in Mexico has reported a range of 27.8 to 30.8% for communication disorders among children aged 2 to 9 years (Romero-Martínez et al. 2012). However, this data did not include specific information on the proportion of children diagnosed with DLD. This disparity can be attributed to the broad classification criteria for language disorders and the wide age range considered in their analysis. In the present study, we focused on children between the ages of 4 and 6 years, a developmental stage where DLD is typically diagnosed. This narrower age range allowed us to provide more specific insights into the prevalence of DLD, which might account for the variation in our findings compared to the broader language disorder estimates in the National Survey.

In the present study, it was observed that maternal education was significantly lower in the DLD group than in the TLD group among 5-year-olds. It is worth noting that low maternal education, often indicative of a lower socioeconomic status, is potential risk factor for children with DLD, as mentioned in previous studies (Rudolph 2017; Tomblin et al. 1997; Valade et al. 2023; Wu et al. 2023). Maternal education's influence may arise from inadequate parent-child interaction practices and an increased likelihood of receiving a DLD diagnosis (Lara-Díaz et al. 2021). However, it is essential to clarify that these findings do not seek to establish a causal link between maternal education, socioeconomic status, and the occurrence of DLD. This distinction is vital because DLD is a complex condition characterized by diverse and dynamic manifestations. For instance, some children may indeed manifest DLD, but their grammatical challenges could be relatively mild and may not be readily apparent through standard clinical assessments.

Another finding of this study was that the prevalence of DLD differed according to sex. In our sample, the overall estimated prevalence of DLD was 11.5% in boys and 5.1% in girls. According to the provided prevalence rates, approximately 11 boys and 5 girls per 100 individuals were identified with DLD. The data were further stratified into three age groups; however, age-stratification resulted in a substantial reduction in sample size within each group. This necessitates caution in interpreting sex-

difference findings. Consequently, prioritizing the overall data for analysis is advisable due to its more robust statistical interpretation. These sex-based trends align with global research, which consistently indicates a higher incidence of DLD in males compared to females (e.g., Calder et al. 2022; De Barbieri et al. 1999; Norbury et al. 2016; Tomblin et al. 1997). Historical research has also contributed to our understanding, as a classical study conducted on 3-year-old children found a male-to-female ratio of 2:1 (Stevenson & Richman 1976). In a recent study in Iran, the estimated prevalence of DLD in males and females was reported as 4.2 and 2.4%, respectively (Oryadi-Zanjani et al. 2015). It is worth noting that the variable of sex may exhibit some variability in certain studies, with some indicating male sex as a risk factor for language disorders (Chilosi et al. 2023; Hannus et al. 2009; Harrison & McLeod 2010), while others do not find a significant sex difference (Beitchman et al. 1986; Calder et al. 2022; Tomblin et al. 1997). In general, language disorders have been regarded as having a genetic component, supported by epidemiological studies, twin studies, family aggregation research, and investigations into sex chromosome trisomy, although genetics alone do not determine outcomes (Chilosi et al. 2023). Therefore, the predisposition of males to DLD may be related to neurobiological factors on one hand, while environmental factors might also influence the manifestation of DLD.

CLINICAL IMPLICATIONS

The National Survey of Health and Nutrition in Mexico did not include specific data on the prevalence of DLD. This underscores the importance of recognizing and addressing DLD in Mexico and thus, the findings of the present study. Increasing awareness of this disorder is crucial, as it can lead to the development of strategies within the healthcare and educational systems aimed at early identification and diagnosis of DLD in children. Early recognition and diagnosis can significantly benefit children by positively impacting their language development and enhancing their educational and social skills. Identifying children with DLD allows for the provision of tailored interventions and support to address their unique needs.

Furthermore, the results of our current study hold critical significance as the initial reference for evaluating the consequences of our assessment protocols. If these protocols lead to under- or over-identification of DLD, it is essential to review and refine them to gradually establish an improved system for the early identification and diagnosis of DLD.

LIMITATIONS OF THE STUDY

One significant limitation of our current study is its retrospective nature, as it is based on a non-probabilistic sample derived from data collected in three distinct Mexican cities: Queretaro, Mexico, and Monterrey. The prevalence estimate of 8.5% in our study closely aligns with the reported rates for English-speaking children of similar ages in England and the United States, approximately 7.5%, as established in prior research by Norbury et al. (2016) and Tomblin et al. (1997), which employed population samples. Our result is also similar to another non-English study, which reported 8.5% in a large-scale population-based survey (Wu et al. 2023). However, it is important to note that our estimate may be subject to bias due to the non-probabilistic sampling method employed.

Another potential source of bias affecting the estimated percentages of children with DLD and those with TLD is the influence of parental concern. When parents do not believe their children are at risk of developing a language disorder, they may be less inclined to participate in a study focused on developmental language concerns. Consequently, a greater number of typically developing children attending school, whose parents do not have language-related concerns, may have chosen not to take part in the study. This, in turn, could result in an underestimation of the percentage of typically developing children in our sample.

Furthermore, it is important to consider the evolving nature of parental concerns as children grow, as such changes in parental concerns across different age groups may impact the estimated prevalence of DLD differently. Specifically, younger children might be less likely to have their language deficits recognized, as parents may not readily identify the warning signs of a language disorder. In fact, in the present study,

the percentage of parental concern in children with DLD was nearly three times higher than in children with TLD at 4 years of age. However, this difference increased to five times at ages 5 and 6 years. This finding suggests that language disorders are not generally perceived as a significant issue in younger Spanish-speaking children in Mexico, even though a diagnosis can be obtained by the age of 4 years.

Additionally, the study's limited sample size led to a wider confidence interval. As a result, there were no statistically significant differences in prevalence across age groups or between genders. It is also important to note that the statistical associations between maternal education and DLD in the 5-year-old cohort do not imply causation due to the study's inherent design limitations. To gain a more comprehensive understanding of this association, future research could entail more extensive investigations employing methodologies that enable the assessment of causality.

CONCLUSION

The prevalence of DLD in a Mexican sample of children was 8.5% between 4 and 6 years and 11 months of age. This study is the first in Mexico to estimate the prevalence of DLD and the risk of DLD. Identifying a prevalence of children with a clinically confirmed DLD in preschool and the first years of elementary school is crucial. We also found significant risk factors that may predict the diagnosis of DLD, such as being male. Early identification of these children is critical to reducing the impact throughout life. Using sensitive clinical assessment tools is essential for this process. The prevalence of DLD in Mexico should inform education and public health authorities to raise awareness of this long-lasting disorder and establish a system to identify and diagnose it effectively and deliver effective interventions.

DISCLOSURE

A.A.B. is the first author of the Manual de Tamiz de Problemas de Lenguaje (TPL), which was published by Manual Moderno Publishing Company. Therefore, she receives royalties from the sales.

CONFLICT OF INTEREST

None declared.

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