

Autism Spectrum Disorder (ASD) prevalence and associated sociodemographic factors in the school population: EPINED Study

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Funding details: This work was supported by the Ministry of Economy and Competitiveness of Spain and the European Regional Development Fund (ERDF) under Grant PSI2015-64837-P and RTI2018-097124-B-I00; Ministry of Education of Spain (FPU) under Grant FPU2013-01245.

Abstract

The autism spectrum disorder (ASD) prevalence data for southern Europe seem to be lower than international reports. The objective of the Neurodevelopmental Disorders Epidemiological Research Project was to estimate the prevalence of ASD in a representative school sample of Tarragona, Spain. Screening was performed through parents (N= 3,727) and teachers (N= 6894), and 781 children were individually assessed. The overall estimated prevalence was 1.53% (1.78% in pre-schoolers; 1.30% in primary school children), being significantly higher than the 0.83% previously registered (0.92% and 0.74%, respectively). Respectively, 4.23% and 2.85% of the children showed subclinical ASD. Girls showed a significantly lower prevalence in all the conditions. Severity profiles were distributed as 46% mild, 47% moderate and 7% severe. A high ratio of males (90%) and children from Eastern Europe (16%) was found among severe ASD. Language therapy (51%) and psychological (65%) and educational supports (65%) were given to children with ASD. Pharmacological treatment was only found among school-aged children (37.5%). Public schools provided more educational support (72%) than private schools (36%). The heterogeneity of ASD makes it difficult to determine specific associated sociodemographic factors. The results confirmed a high prevalence of ASD in this province, suggesting a current under-diagnosis by public health services.

Keywords: Prevalence; ASD; School-age children; Pre-school age children; Sex ratio; Sociodemographic factors

Introduction

An increase in the prevalence of Autism Spectrum Disorder (ASD) has been reported around the world over the last decade (Elsabbagh et al., 2012; Fombonne, 2018; Idring et al. 2015, Myers et al., 2019), despite the fact that the implementation of the latest version of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) has led to a 21% decrease in the number of diagnoses (Kulage, Goldberg, Usseglio, Romero, Bain & Smaldone, 2019). The current prevalence in developed countries has been estimated to be at least 1.5% (Lyall et al. 2017). Nevertheless, there is wide variability between studies and territories, with prevalence reports ranging from lower than 0.2% in some parts of Europe (Bachman, Gerste & Hoffmann, 2018; Skonieczna-Żydecka, Gorzkowska, Pierzak-Sominka, & Adler, 2017) and Asia (Rudra, Belmonte, Soni, Banerjee, Mukerji & Chakrabarti, 2017; Qiu et al., 2020) up to much more higher values in other countries, such as the 1.85% (Maenner et al., 2020) and 2.50% (Kogan et al., 2018) found in the United States, 2.50% in Australia (Randall et al., 2016), and 3.13% in Iceland (Delobel-Ayoub et al., 2020). In Europe, while there are extensive epidemiological studies in the northern countries, few studies have been published in Spain and southern

Europe. The prevalence rates found in these areas are still far from those obtained in northern Europe and other developed countries. In this regard, the estimated prevalence of ASD is between 0.56% and 2.65% for the Nordic countries (Idring et al., 2015; Delobel-Ayoub et al., 2020) and the United Kingdom (Russel et al., 2014), and between 0.05 and 0.61% in central and southern countries (Bachmann et al., 2018; Ferrante et al., 2015; Hansen et al., 2015; Nygren et al., 2012; Skonieczna-Żydecka et al., 2017 and Van Bakel et al., 2015).

In Spain, most of the epidemiological studies prior to 2012 are based on administrative records and reported rates of between 0.03% and 0.64% (Alcantud, Alonso & Mata, 2017). Recently, Pérez-Crespo et al. (2019) reported on children aged 2 to 17 years old in the public Catalan Health System an estimated a prevalence of 1.23% with significant variations between health areas (0.55% to 1.85%), and Carballal Mariño et al. (2017) reported 0.85% in children ≥ 14 years old from primary attention care services in Galicia. In community samples, a prevalence of 0.61% was estimated in 18 to 36 month-old infants in the Canary Islands and 0.59% in 7- to 9-year-old children in the Basque Country (Fuentes et al., 2020), these rates being lower than the 1.55% in 4-5-year-old children and the 1.00% in 10-11-year-olds found in Tarragona, Catalonia (Morales-Hidalgo, Roigé-Castellví, Hernández-Martínez, Voltas & Canals, 2018).

Additionally, few epidemiological studies have reported the distribution of severity of the autism spectrum phenotype. O Mazurek, Lu, Macklin and Handen (2019) reported that 25% of children in a clinical sample required support in both the social communication and behaviour domains, 27% required substantial support, 15% required very substantial support, and 33% had a heterogeneous profile. In population-based studies, Randall et al. (2016) reported 50-64% of ASD cases to be mild, unlike Narzisi et al. (2020), who reported that 21% were low severity cases, 16% were moderate and 63% were high. Differences could be due to sample characteristics and to the capability of diagnostic protocols to identify milder cases. Usually, more severe cases coexisting with language delays and intellectual disability are detected earlier (Christensen et al., 2019), while those with less severe symptoms often remain underdiagnosed until later ages and may be under-represented among these studies (Hyman, Levy & Myers, 2020). Beyond ASD diagnoses, we have not found epidemiological studies that specifically address the prevalence of the subclinical or broad autism phenotype.

In the literature, sex differentiation has been the most studied socio-demographic factor, demonstrating a male-to-female ratio of between 3-4.3:1 (Loomes, Hull & Mandy, 2017; Maenner et al., 2020). Several studies report a higher risk of ASD for children from economically disadvantaged families or among the immigrant population, particularly for low functioning profiles (Delobel-Ayoub et al., 2015; Magnuson et al., 2012; Russel et al., 2014). Other studies have not found an association between ASD and the mother's country of birth or

ethnicity groups (Maenner et al., 2020; Wang, Geng, Liu & Zhang, 2016), stating that this effect is unclear and could be reflecting multiple confounding factors (Kawa et al., 2016). However, first born children seem to be at greater risk of ASD than those born later (Gray & Billock, 2017; Sharman Moser, Davidovitch, Rotem, Chodick, Shalev & Koren, 2019). In addition, the families of children with ASD tend to have fewer offspring (Ugur, Tonyalia, Goker and Sukran Uneri, 2019) and there is a higher proportion of single parents (Randall et al., 2016), although the evidence is not clear when other sociodemographic factors are analysed (Kuja-Halkola et al., 2019). Concerning other contextual characteristics, it has commonly been described that urbanicity at birth has an effect on the incidence of several psychiatric disorders, including ASD (Hoang et al., 2019; Peen, Schoevers, Beekman & Dekker, 2010; Vassos, Agerbo, Mors & Pedersen, 2016).

Prevalence data in Spain and southern Europe is generally lower than in other developed countries and studies are mostly based on administrative records. Sociodemographic factors, other than age and gender, have not been specifically addressed. Moreover, data on the prevalence of ASD symptoms and subclinical diagnosis are required in order to plan necessary supports. Thus, the aim of the present report is to provide cross-sectional data on the estimated prevalence of ASD in the entire province of Tarragona, Spain, expanding the epidemiological information on ASD in the school population estimated in the northern region of the same province (Morales-Hidalgo et al., 2018). We also present the ASD prevalence according to severity level in two age groups, and explore the relation of ASD to several sociodemographic factors. Comparisons are also made with previous diagnoses and the clinical and educational service use data.

Method

Study design and procedure

The Neurodevelopmental Disorders Epidemiological Research Project (EPINED) was a cross-sectional two-phase study performed between 2014 and 2019 in the province of Tarragona, Spain. The main objective of the study was to estimate the prevalence of ASD and Attention-Deficit/Hyperactivity Disorder (ADHD) in children from mainstream schools. The study protocol was validated by the Ethics Committee at the Sant Joan University Hospital (13-10-31/10proj5).

Details of the sample size estimation, procedure and assessment methods have been broadly described in Morales-Hidalgo et al. (2018). In the first phase, ASD symptoms were screened through parents and teachers using the questionnaires CAST (Scott, Baron-Cohen, Bolton, & Brayne, 2002) and EDUTEA (Morales-Hidalgo et al., 2017). Those children with previous diagnoses or scoring above the cut-off score in one or both questionnaires, as well as a control group paired by age, sex and school, were invited to participate in the second

phase. Diagnostic assessment of ASD was performed by specially trained clinicians in the schools, and involved both the children and their families. The Autism Diagnostic Interview-Revised (ADI-R; Rutter, Le Couteur, & Lord, 2003) and the Autism Diagnostic Observation Schedule, Second Edition (ADOS-2; Lord, Rutter, DiLavore, Risi, Gotham, & Bishop, 2012) were used for this purpose.

Sociodemographic information about the child, their families and the context was collected in the first and second phases of the study from questionnaires created ad-hoc. The information obtained about the child included variables such as sex, age, ethnicity and place of birth, psychopathological antecedents, the presence of previous diagnoses or problems, and psychiatric, psychological and educational service use. Information concerning the families included parental age at childbirth and current marital status, ethnicity, number of offspring, education level and occupation. Data about school classification (public or private) and population type according to number of inhabitants and economic activity was also collected. In order to ensure adequate data collection, we guaranteed specific support to families that had problems understanding the questionnaires due to lower linguistic competence or other difficulties through teachers, municipal government translators and/or other family members with greater linguistic competence. Once the assessment had been completed, families received a comprehensive report of the results and were referred to public mental health services when a clinical diagnosis was found.

Participants

The potential sample was composed of 6921 children from 86 public and private schools randomly selected by areas in the province of Tarragona, Spain, which has two health areas: the northern regions (*Camp de Tarragona*) and the southern regions (*Terres de l'Ebre*). The study assessed two different age groups, one corresponding to the intermediate stage of preschool education (4-5 years old) to detect ASD early at school, and other corresponding to the last stage of primary education (10-11 years old) in order to know previous ASD diagnoses and to identify those children with less severe profiles non previously detected. In the first phase, information was collected from 6894 teachers (5555 in northern regions and 1339 in southern regions; participation rate 99.6%) and 3727 families (2776 in the northern regions and 951 in the southern regions; participation rate 53.9%). An agreement with the Education Department of the Catalan Government permitted us to obtain anonymous information from teachers regarding the presence of ASD symptoms or previous diagnoses in children from non-participating families (46.1%). In the second phase, only those students with informed consent from their parents were able to participate, and a total of 781 children (556 and 225, respectively) were individually assessed.

As far as the community involvement is concerned, special education teachers participated in the development of the ASD screening questionnaire for the school population. Also teachers of all the participants gave us feedback of the results and helped to get families more involved in the project.

Case definition and prevalence estimates

Diagnoses of ASD were considered positive when the child's score reached or exceeded the threshold in all the ADI-R diagnostic algorithm domains and in the ADOS-2 calibrated score of severity (score ≥ 4), or when a consensus in diagnosis was reached by two researchers considering the information from the two instruments. The ASD diagnosis was considered subclinical when the child obtained subthreshold scores in both the ADI-R and ADOS-2 and a clinical consensus was also reached. The above case definitions were used to obtain the estimated prevalence of subclinical ASD and ASD. Conversely, the ratio of previous ASD was obtained considering the diagnoses performed by mental health professionals (early detection and stimulation centres, child and adolescent mental health centres, or centres specialized in diagnosing and treating ASD) and reported by teachers and parents in the entire sample (anonymous non-participant and participant children). The severity classification of autism symptoms was based on Gotham et al. (2009) approach, in which total ADOS-2 calibrated scores between 1-3 are considered "non-spectrum", 4-5 "ASD" and 6-10 "autism".

Statistical analyses

Statistical analyses were conducted using IBM SPSS 25 and EPIDAT 4.2. Sociodemographic characteristics were provided through descriptive statistics and comparisons were made by means of chi-squares, z-test and t-tests for independent samples, depending on the variable analysed. Prevalence estimates were weighted considering both the diagnoses in the screen-positive and screen-negative groups, providing a confidence interval of 95%. Cohen's kappa was used to assess the agreement between informants, and between risk symptoms and final diagnoses. ASD severity was described and compared by age and sex.

Results

Sociodemographic characteristics of the sample

The comparison of sociodemographic characteristics between the northern and southern regions in the participating sample and the entire sample, which also included data about anonymous nonparticipants, is presented in *Table 1*. Both samples had a homogeneous distribution in terms of sex, age and socioeconomic level by health area, but significant differences were observed in the remaining variables. The southern

population showed a higher participation, exhibited higher immigration rates (with a greater presence of families from Eastern Europe), lived mainly in smaller towns or cities, and depended more on agriculture for employment. When we considered the information from teachers, we found a higher ratio of children with ASD symptoms in the non-participating sample. This difference was significant in the northern regions (participating sample: 6.2%; non-participating sample: 4.8%; $p = .030$), but not in the southern regions (5.9% and 5.5%, $p = .740$). (Please insert Table 1 around here)

Rates of risk symptoms, prevalence estimates and registered previous diagnoses

Risk symptom rates and prevalence estimates of ASD in the mainstream school population are shown in Table 2. Cohen's kappa (k) analyses have not been listed in the table. Parents reported ASD symptoms in 3.88% of pre-schoolers and 4.42% of school-aged children. Teachers reported rates of 4.92 and 6.08% respectively. The ratio of ASD symptoms was significantly higher in boys. A fair agreement between parents and teachers was found in the identification of ASD symptoms in boys ($k = 0.35$) and a slight agreement in girls ($k = 0.19$) in both age groups. Therefore, the coincidence of parents and teachers gave a significantly lower prevalence (1.45%). Agreement between the ASD symptoms and the clinical diagnosis was fair when there was a single informant (teachers $k = 0.32$; parents $k = 0.39$) but increased substantially when both informants had a positive screening ($k = 0.70$). (Please insert Table 2 around here)

The overall estimated prevalence of ASD was 1.53% (95% CI 1.14-1.92); 1.78% (95% CI 1.17-2.39) in pre-schoolers and 1.30% (95% CI .79-1.80) in school-aged children. According to health areas, the estimated prevalence was 1.33% (95% CI .91-1.76) in northern regions and 2.10% (95% CI 1.19-3.01) in southern regions, and no statistically significant differences were found ($p = 0.095$). The estimated prevalence of subclinical conditions was 4.23% in pre-schoolers and 2.85% among school aged children. A total of 57 children received an ASD diagnosis (55 screened positive and 2 screened negative but had a previous diagnosis), and 50 children had a subclinical ASD diagnosis (37 screened positive and 13 screened negative). There were 57 previous ASD diagnoses registered in the entire sample, resulting in a ratio of 0.83% (95% CI 0.63-1.07) with values of 0.92% (95% CI 0.63-1.30) in preschool children and 0.74% (95% CI 0.48-1.08) in school-aged children. Significant differences were found between the northern (0.70%) and southern regions (1.34%; $p = 0.020$). Girls showed significantly lower prevalence estimates in all the conditions. The male to female ratio for the ASD estimated prevalence was 2.7:1 in pre-schoolers and 6:1 in school-aged children. The distribution of ASD severity profiles was 46% mild, 47% moderate and 7% severe, with no differences between age groups. Sex differences in relation to severity were only found in pre-schoolers, and girls showed the least impaired ASD profiles. A high

comorbidity was found in relation to ADHD among children with ASD (preschool: 18.8%, school-aged: 44.0%) and subclinical ASD (preschool: 25.0%, school-aged: 42.3%).

A total of 67% of children identified with ASD had been previously diagnosed by public health systems (63% in preschool and 72% in primary school). There was a high agreement between current and previously registered diagnoses ($k = 0.70$). Previous diagnoses were reported in 57% of the mild cases and in 74% of the moderate and severe profiles ($p = 0.188$) and were more frequent in children with ADHD symptoms (76% *versus* 59%, $p = 0.186$) and without intellectual impairment (68% *versus* 55%, $p = 0.433$), with no significant differences. The presence of speech or language delays was not relevant for further detection by the health services, whereas all non-verbal cases had a previous diagnosis ($p = 0.014$).

ASD and associated sociodemographic factors

Children with ASD (divided into mild and moderate/severe profiles), subclinical ASD and those without ASD were compared in relation to individual, family and contextual characteristics (see Table 3). Although we found some socio-demographic disparities between the northern and southern regions, the detailed analysis of these variables in the diagnostic groups did not reveal significant differences. For this reason, the samples of the two territories have been analysed together. (Please insert Table 3 around here)

Significant differences between groups were found for sex and Eastern European ethnicity. There was an upward trend in the proportion of boys as the severity of ASD increased and a much higher ratio of children from Eastern Europe with severe ASD than in the other groups (16% *versus* 2-4%). No relationships between ASD and socioeconomic level, family characteristics or contextual background were found. Nevertheless, children from rural and intermediate populations had more previous diagnoses than those from urban populations (81% *versus* 59%, $p = 0.081$), similarly to autochthonous families compared to foreigners (71% *versus* 50%, $p = 0.168$). Children with ASD were the firstborn in a slightly higher ratio than subclinical ASD and non-ASD comparison groups, although it was not statistically significant. The mother's age was slightly older in children with subclinical ASD and moderate or severe ASD. This contributed to setting a trend when it was calculated with subclinical, mild and moderate/severe ASD grouped together ($p = 0.058$).

Access to clinical and educational supports

Psychological intervention was received by 67% of the children with ASD and educational support was received by 65%, and language therapy was given to 51%. Children with the subclinical ASD condition received significantly less psychological (32%, $p = 0.001$) and educational support (40%, $p = 0.010$), but a similar ratio

of language therapy (44%, $p = 0.477$). A total of 37.5% of school-aged children were taking medication; none of the preschool children were receiving pharmacological treatment. The most used medications were stimulants (67%), followed by neuroleptics (22.2%) and antiepileptics (11.1%). A total of 19.2% children with subclinical ASD were receiving treatment with stimulant medication.

Children with previous diagnoses generally received more psychological intervention (79% versus 42%; $p = 0.005$), and this was the same for school-aged children (80% versus 56% $p = 0.059$). Although no significant differences were found, boys received 20% more psychological support and 13% more language therapy than girls, but a similar proportion of educational support. Children from rural or intermediate regions received 10-15% more support. Public schools provide a greater amount of educational support to children with ASD (72% versus 36%, $p = 0.027$) and, although not statistically significant, it was more frequently offered to more severe ASD profiles and those with comorbid conditions, such as ADHD or intellectual disability.

Discussion

The present manuscript describes the prevalence of ASD and associated sociodemographic factors in the province of Tarragona, Spain. We focused on a large community-based sample, which allowed us to analyse prevalence by sex and age, considering a wide spectrum of severity, from children with subclinical ASD to mild, moderate or severe ASD diagnoses and to make a comparison with children without ASD.

Prevalence estimates and registered previous diagnoses

The overall estimated prevalence was 1.53%, which lies at the mid-point of international approaches (0.2 and 2.5%) and is within the range of reports on children from Sweden (1.54%; Idring et al., 2015), Australia (1.55%; Randall et al., 2016) and the United States (1.68%; Baio et al., 2018; and 1.55%; Van Naarden et al., 2015) based on registered data. In Europe, our results are higher than those commonly reported by register based studies in central and southern European countries (Bachmann et al., 2018; Ferrante et al., 2015; Hansen et al., 2015; Nygren et al., 2012; Skonieczna-Żydecka et al., 2016 and Van Bakel et al., 2015), even in contrast with other Spanish regions (Carballal Mariño et al., 2017; Fortea et al., 2013). The current estimates are within the range of 0.55-1.85% registered by the Catalan public health system in 2009–2017 in our region (Pérez-Crespo et al., 2019). However, they are slightly higher than the overall average found (1.23%), which suggests that the ASD prevalence may be somewhat higher since not all children had previous diagnoses or were attending public health services. A high prevalence of subclinical ASD diagnoses (3.31%) was also found. It must be noted that 26% of these had a negative ASD screening but were included in the individual assessment as controls, or a

positive ADHD screening (a parallel aim of the EPINED project), which led to an increase in the prevalence estimate. Some of these children may be diagnosed later with ASD, when social demands increase, but others may show a decrease in ASD severity throughout development despite not receiving specific supports. These children often show challenging behaviours, ADHD or impaired competencies that are not supported or understood (Crehan, Baer, Althoff & Constantino, 2018).

Both clinical and subclinical prevalence estimates were higher among pre-schoolers than school-aged children (ASD: 1.78% versus 1.30%; subclinical ASD 4.23% versus 2.85%). The increased rates in preschool aged children suggest a possible secular increase in ASD. Similarly, recent epidemiological studies in Spain also report a threefold increase in the overall incidence between 2009-2017, which has been particularly pronounced in girls and at early ages (Pérez-Crespo et al., 2019). All the autism conditions analysed were more prevalent in boys than girls. Male-to-female ratios were noticeably different according to age, with twice as many girls diagnosed among pre-schoolers (0.67%, ratio 2.7:1) than school-aged children (0.39%; ratio 6:1). The ratio of the first group coincided with the Loomes, Hull & Mandy (2017) reports of 3:1, but the second one was much higher. The difference may be explained because girls may exhibit fewer repetitive behaviours or show different patterns of interest (Tilman et al., 2018), as well as develop compensatory or camouflage strategies with age (Allely, 2019; Dean, Harwood & Kasari, 2017) that makes ASD detection and diagnosis more difficult. In contrast with Christensen et al. (2019), the distribution of the autism phenotype severity found was similar according to age (45% mild, 47% moderate and 7% severe) and quite comparable to the 50-64% of mild ASD cases reported by Randall et al. (2016) in a community sample, but unlike Narzisi et al. (2020), who reported a much higher proportion of severely impaired profiles (63%).

Administrative data provide a significant undercount of ASD prevalence. The 0.83% registered prevalence is far from reality and would not allow an adequate management of the available supports to the ASD population. A slightly higher rate was found among pre-schoolers in comparison with school-aged children (0.92% versus 0.74%), which is consistent with the higher estimated prevalence found. These data may reflect an improvement in diagnostic processes or an increase in the number of cases, as reported by Pérez-Crespo et al. (2019) in 2-5 year old children. However, McDonnell, Bradley, Kanne, Lajonchere, Warren & Carpenter (2019) have found that ASD diagnosis becomes more complex with age, reducing clinicians' certainty of diagnosis, when the widely known warning signs are no longer so evident and the child has developed more skills, compensatory strategies or confounding emotional, behavioural or learning difficulties.

Previous ASD diagnoses were higher among moderate and severe cases, children with non-verbal characteristics, and to a lesser extent when ADHD symptoms were present, which may be related to a greater disability and impact on family and school contexts, which could lead to the search for assessment. Previous studies have reported that children with ASD and comorbid ADHD exhibit higher ASD severity and more co-occurrent problems than those without (Mansour et al., 2017; Sprenger et al., 2013). In contrast, Thurm, Garmer, Salzman, Lord & Bishop (2019) suggest that the presence of an intellectual disability seems to hinder the ASD diagnosis. In these circumstances, ASD may be difficult for parents and teachers to accept, perhaps because social and behavioural impairments are frequently attributed to low cognitive performance and not properly addressed (especially among girls and foreign pre-schoolers) or due to the stigma still associated with ASD in our country (Lozano-Segura, Manzano-Leon, Aguilera-Ruiz & Casiano, 2017).

ASD and associated sociodemographic factors

The estimated and registered prevalence of ASD was higher in the southern region of Tarragona (2.10% versus 1.33% and 1.34% versus 0.70%, respectively). The differences between areas may be due to different circumstances. On one hand, these data may support the secular increase in prevalence, since the southern area was assessed in 2017-19 and the northern area in 2014-17. On the other hand, they may be influenced by higher rates of participation as well as other socio-demographic aspects. In contrast to the northern population, *Terres de l'Ebre* has a higher proportion of rural and intermediate villages, with a greater dedication to agriculture, larger immigrant population and a different migrant distribution profile. Despite finding significant socio-demographic differences at a population level, we did not find such relevant disparities between children with autism conditions, possibly due to the lower sample size of the clinical population assessed.

Although it has been previously described that there are substantial challenges in diagnosing rural communities (Antezana, Scarpa, Valdespino, Albright & Richey, 2017), prior diagnoses were more common in rural and intermediate settings in our sample, which could be due to a lower saturation of the health service and closer educational supports. Although not significant, fewer children with ASD from foreign families had been previously diagnosed. Ethnic minority groups may have fewer opportunities to be diagnosed (Angell, Empey & Zuckerman, 2018; Baio et al., 2018; Lemay, Yohemas, Langenberger, 2018) and, as stated by Stahmer et al. (2019), it is often more difficult due to cultural and linguistic differences, as we experienced in our sample. In these cases, the diagnosis was also supported by qualitative information provided by teachers and natural context observations. It was remarkable that a significantly high rate of children from Eastern European families

were found in the most severe group of ASD, especially in the southern population. It has been suggested that environmental factors related to migration, such as stressful experiences or suboptimal pregnancy and birth conditions, may be associated with an increased risk of ASD, particularly in cases of comorbid ID or severe ASD (Crafa & Warfa, 2015; Kawa et al., 2017; Linnsand, Gillberg, Nilses, Hagberg & Nygren, 2020). We could also be facing an under-diagnosis of milder cases due to a lack of awareness of cultural differences in the screening and diagnosis. As stated by Tromans et al. (2020), there is a lack of knowledge of the cultural norms of minority ethnic groups and biases in the development of diagnosis instruments.

Sociodemographic differences in the severity profile between the three ASD groups highlighted an increase in the proportion of boys as the severity of ASD rises. These results are difficult to compare with the literature since most of the studies focus on sex ratio differences in ASD related to IQ, and suggest that the ratio is more homogeneous at higher levels of disability (Van Wijngaarden-Cremers et al. 2014); however, less information has been provided about differences according to the severity of the nuclear symptoms. In contrast to Randall et al. (2016) and Ugur et al. (2019), we did not find a higher divorce rate or fewer offspring among families of children with ASD. Although the association of ASD with being firstborn and with advanced parental age has been widely reported in the literature, in our sample, we could only find a nonsignificant trend probably due to the clinical sample size or the heterogeneity of the children with ASD.

Access to clinical and educational supports

The role of psychological and educational supports is key to improving ASD symptomatology and preventing future negative outcomes or problems. Having a confirmed diagnosis helped the family, child and school to provide support. A total of 79% of these children received psychological intervention, whereas lower rates were observed in children without a previous diagnosis (42%) or subclinical manifestations (32%). Therefore, despite being mainly profiles of less severity, their prognosis could be worse in the absence of support (Lai, Lombardo & Baron-Cohen, 2014). Although a higher level of psychological intervention was found in primary school children, an optimal health promotion strategy is needed to provide more support during childhood and thus improve children's future outcomes. McDonald et al. (2019) also found that children receiving educational or psychological support were half as likely to be given psychotropic medication. In comparison to other studies, in our population we found more psychological and educational support than speech therapy, although it is probably less intensive (Wei, Wagner, Christiano, Shattuck & Yu, 2014; McDonald et al., 2019).

Although it has been described that ethnic minority groups and children from low SES families have less access to care (Smith, Gehricke, Iadarola, Wolfe & Kuhlthau, 2020), in our sample children from foreign

families and those from rural and intermediate populations tended to receive more supports and no differences were observed in relation to SES. No sex differences were found in access to educational supports, but a sex bias in the access to psychological intervention was found with boys receiving 20% more supports, despite females in the spectrum showing equally high individual clinical needs and even more associated medical and psychological problems (Tint, Weiss & Lunskey, 2017). Finally, the rate of school-aged children receiving pharmacological treatment (37.5%) was somewhat lower than the 48.5% reported by Madden et al. (2017), but in the range of 34-57% referred to by the authors based on a literature review. No preschool children were receiving pharmacological treatment, in contrast to the 16.3% reported by Ziskind, Bennett Jawad & Blum (2020). As suggested by Madden et al. (2017), the most common medication was stimulants due to comorbidity with ADHD, and was somewhat lower than international reports, ranging from 59 to 86% (Joshi et al., 2017; Mansour, Dovi, Lane, Loveland & Pearson, 2017; Rau et al., 2020).

Limitations and future directions

Several limitations should be considered in the present study. Although we have studied the prevalence of ASD in an entire province, we do not know whether this is representative of the entire Spanish population. As we have focused on two specific age groups, we do not have data on the 7-9-year-old population. In addition, we have not been able to include in the ASD prevalence estimates those children attending special education schools. Possible biases derived from including in the estimates only children whose parents provided consent also need to be considered.

In Spain, it is important to unify the protocols of detection and diagnosis, as well as create national/regional population-based registries and integrate them with data from community studies. The implementation of school screening protocols could help to improve the detection of those cases that are under-diagnosed due to less ASD severity, sex or ethnic/cultural differences. It is also important to assess deeper the clinical course of children with subclinical ASD to better understand their clinical and educational needs and provide them with the necessary support.

Conclusion

The EPINED study contributes up-to-date data on ASD epidemiology in southern Europe and is one of the few cross-sectional design studies in Spain that uses gold standard instruments for ASD diagnosis and DSM-5 criteria. We found an estimated prevalence of 1.53% with a severity distribution of 46% mild, 47% moderate

and 7% severe, and a high comorbidity with ADHD. The difference with the registered prevalence (0.83%), indicates a current under-diagnosis in public health services. Around 65% of the children were receiving psychological and educational support, while 37.5% of the school-aged children were taking medication. We found a very large group of children with subclinical ASD (3.31%) who received a much lower level of support. No relationships between ASD and socioeconomic level, family characteristics or contextual background were found. In terms of access to services, public schools provided more support and rural areas had more pre-diagnoses. Diagnosis was more difficult to obtain for girls and ethnic minority groups. In the future, protocols need to be developed to improve ASD detection and diagnosis, including milder or subclinical profiles, female phenotypes and minority ethnic groups.

Table 1. Sociodemographic characteristics of the sample

	ENTIRE SAMPLE (n = 6894)			PARTICIPATING SAMPLE (n = 3727)		
	North regions (n = 5555)	South regions (n = 1339)	p	North regions (n = 2776)	South regions (n = 951)	p
	N (%)	N (%)		N (%)	N (%)	
Participation agreement (*)	2776 (49.97)	951 (71.02)	.001	556 (20.03)	225 (23.67)	.001
Gender, male	2793 (50.28)	681 (50.86)	.703	1322 (47.62)	476 (50.05)	.196
Age group						
Preschool-age children	2736 (49.3)	637 (47.6)	.291	1360 (49.0)	442 (46.5)	.181
School-age children	2819 (50.7)	701 (52.4)		1416 (51.0)	509 (53.5)	
Ethnicity: autochthonous population	4494 (80.90)	1038 (77.52)	.005	2375 (85.55)	760 (79.92)	.001
Ethnicity: foreign population	1061 (19.10)	301 (22.48)		401 (14.45)	191 (20.08)	
Asian countries	57 (5.37)	19 (6.31)	.001	21 (5.24)	12 (6.28)	.001
East European countries	184 (17.34)	103 (34.22)		60 (14.96)	71 (37.17)	
African countries	632 (59.57)	136 (45.18)		253 (63.09)	86 (45.03)	
Centre and South American	188 (17.72)	43 (14.29)		67 (16.71)	22 (11.52)	
Socioeconomic status (**)						
Low	856 (20.58)	229 (20.05)	.664	447 (16.30)	169 (18.29)	.093
Medium	2404 (57.82)	677 (59.28)		1616 (58.96)	556 (60.17)	
High	898 (21.60)	236 (20.67)		678 (24.74)	199 (21.54)	
School classification, public	4118 (74.13)	1096 (81.9)	.001	2032 (73.20)	796 (83.70)	.001
Environment, habitants						
Rural (< 2000)	114 (2.05)	68 (5.08)	.001	93 (3.35)	54 (5.68)	.001
Intermedium (2000 to 10 000)	1484 (26.71)	651 (48.62)		717 (25.83)	455 (47.84)	
Urban (> 10 000)	3957 (71.24)	620 46.30)		1966 (70.82)	442 (46.48)	
Economic sector						
Agriculture	251 (4.52)	191 (14.26)	.001	129 (4.65)	148 (15.56)	.001
Industrial	678 (12.20)	74 (5.53)		348 (12.53)	32 (3.37)	
Services	4626 (83.28)	1074 (80.21)		2299 (82.82)	771 (81.07)	

(*) In the entire sample, the agreement to participate refers to the screening procedure and in the participant sample, to the diagnostic procedure. (**) The sample size for this variable was lower: entire sample (North regions: 4158, South regions: 1142), participant sample (North regions: 2741; South regions: 924). Significant differences in bold ($p \leq .05$).

Table 2. Estimated prevalence ASD, subclinical ASD of ASD, subclinical ASD, previous diagnosis and rates of risk symptoms by age and sex

	PRESCHOOL AGED CHILDREN				SCHOOL AGED CHILDREN				<i>p_b</i>	TOTAL SAMPLE
	Boys	Girls	<i>p_a</i>	Total	Boys	Girls	<i>p_a</i>	Total		
ASD overall estimated prevalence (95% CI)	2.89 (1.79-3.98)	.67 (.13-1.20)	.001	1.78 (1.17-2.39)	2.34 (1.35-3.33)	.39 (.10-.77)	.001	1.30 (.79-1.80)	.236	1.53 (1.14-1.92)
Mild severity profiles, N (%)	10 (38.46)	5 (83.33)	.047	15 (46.88)	9 (42.86)	2 (50.0)	.792	11 (44.00)	.829	26 (45.61)
Moderate to elevate severity profiles, N (%)	16 (61.54)	1 (16.67)		17 (53.12)	12 (57.14)	2 (50.0)		14 (56.00)		31 (54.39)
ASD subclinical estimated prevalence (95% CI)	6.91 (5.25-8.56)	.78 (.20-1.35)	.001	4.23 (3.30-5.16)	4.66 (3.28-3.47)	.39 (.01-.77)	.001	2.85 (2.10-3.59)	.007	3.31 (2.73-3.88)
ASD rate of registered diagnoses (95% CI)	1.41 (.91-2.10)	.42 (.17-.86)	.002	.92 (0.63-1.30)	1.24 (.78-1.87)	.23 (.06-.59)	.001	.74 (0.48-1.08)	.409	.83 (.63-1.07)
ASD symptoms prevalence (95% CI)										
Reported by parents	5.44 (4.06-7.13)	2.33 (1.45-3.54)	.001	3.88 (3.04-4.88)	7.02 (5.43-8.89)	2.14 (1.35-3.23)	.001	4.42 (3.54-5.53)	.417	4.16 (3.54-4.85)
Reported by teachers	6.84 (5.68-8.14)	2.98 (2.22-3.91)	.001	4.92 (4.21-5.70)	9.06 (7.77-10.49)	3.04 (2.29-3.96)	.001	6.08 (5.31-6.92)	.035	5.51 (4.99-6.08)
Reported by parents <i>or</i> teachers	10.00 (8.12-15.15)	4.55 (3.28-6.12)	.001	7.27 (6.11-8.57)	12.14 (10.07-14.46)	3.99 (2.88-5.38)	.001	7.79 (6.63-9.08)	.546	7.54 (6.71-8.43)
Reported by parents <i>and</i> teachers	2.22 (1.36-3.41)	.67 (.24-1.44)	.006	1.44 (1.95-2.10)	2.90 (1.90-4.21)	.19 (.02-.70)	.001	1.45 (.97-2.10)	.976	1.45 (1.09-1.87)

Estimates and rates have been compared by sex (*p_a*) and age (*p_b*), significant differences in bold ($p \leq .05$). Severity rates have been compared throughout Chi-square test, while prevalence estimates have been compared by means of the independent samples Z-Test. CI: Confidence Interval.

Table 3. Individual, familial, and contextual differences between diagnostic groups

	Non-ASD (n = 516)	Subclinical ASD (n = 50)	Mild ASD (n = 26)	Moderate and severe ASD (n = 31)	<i>p_a</i>	<i>p_b</i>	<i>p_c</i>
Individual and familial characteristics							
Sex, male, N (%)	294 (56.98)	39 (78.00)	19 (73.08)	28 (90.32)	.001	.001	.001
Ethnicity, autochthonous, N (%)	426 (82.56)	44 (88.00)	22 (84.62)	23 (74.19)	.454	.238	.499
Eastern Europe	20 (3.88)	1 (2.00)	1 (3.85)	5 (16.13)	.010	.002	.022
Socioeconomic status, N (%)							
Low	85 (16.47)	12 (24.00)	4 (15.39)	6 (19.36)			
Medium	326 (63.18)	28 (56.00)	16 (61.54)	18 (58.07)	.893	.844	.866
High	105 (20.35)	10 (20.00)	6 (23.08)	7 (22.58)			
Number of children in the family, mean (SD)	2.13 (.93)	2.31 (1.07)	1.79 (.59)	2.03 (.75)	.136	.585	.125
First born child, N (%)	262 (50.78)	24 (48.00)	17 (65.39)	20 (64.52)	.274	.276	.070
Mother age (≥ 35 at childbirth), mean (SD)	119 (23.06)	18 (36.00)	5 (19.23)	11 (35.48)	.070	.092	.409
Father age (≥ 37 at childbirth), mean (SD)	134 (25.97)	15 (30.00)	5 (19.23)	11 (35.48)	.992	.278	.928
Divorced or separated parents, N (%)	110 (21.32)	10 (20.00)	5 (19.23)	3 (9.68)	.481	.120	.197
Contextual background							
School classification, public, N (%)	433 (83.92)	40 (80.00)	19 (73.08)	27 (87.10)	.422	.638	.534
Environment, habitants, N (%)							
Rural (< 2000)	31 (6.00)	4 (8.00)	0 (0.00)	1 (3.23)			
Intermedium (2000 to 10 000)	168 (32.56)	16 (32.00)	10 (38.46)	10 (32.26)	.849	.805	.409
Urban (> 10 000)	317 (61.43)	30 (60.00)	16 (61.54)	20 (64.52)			
Industry economic sector, N (%)	44 (8.53)	7 (14.00)	1 (3.85)	3 (9.68)	.466	.824	.696
Agriculture economic sector, N (%)	52 (10.08)	4 (8.00)	2 (7.69)	1 (3.23)	.603	.210	.242

Comparisons have been made using the Chi-square test and the t-test for independent samples (or the analysis of variance when comparing the three groups), respectively.

Rates or means have been compared between Non-ASD and the other three groups (*p_a*), between Non-ASD and moderate and severe ASD conditions (*p_b*) and between Non-ASD and all the ASD conditions together. Significant differences in bold ($p \leq .05$).

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