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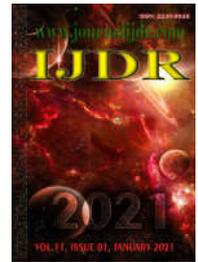
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RESEARCH ARTICLE

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## AUTISM SPECTRUM DISORDER DIAGNOSIS AGE AND ASSOCIATED FACTORS IN A NORTHERN MINAS GERAIS POPULATION

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### ABSTRACT

Early diagnosis and intervention are determining factors for the best prognosis for people with Autism Spectrum Disorder (ASD), with significant and lasting gains for their development. However, even though ASD can be diagnosed safely at 24 months of age, many children are still diagnosed late. The present study aimed to investigate the age of diagnosis of ASD in children and adolescents from the north of Minas Gerais. 221 children/adolescents with ASD participated in this study, aged between two and 14 years of age. The estimated average age of diagnosis of ASD was 3.6 years (SD = 2.6). It was found that younger children were diagnosed earlier, with a mean age of 2.4 years (SD = 1.5). The following factors were associated with the age of diagnosis of ASD: advanced maternal age and mothers who declared themselves to be white. Children/adolescents in this study tended to be diagnosed, at around three and a half years of age, differing from previous studies that pointed to a later age of diagnosis. Recommended capacitation about this disorder, both for education and health professionals, as they will be instrumental in promoting early referrals for diagnosis, better prognosis, and more effective inclusive practices.

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## INTRODUCTION

The number of diagnoses of Autism Spectrum Disorder (ASD) has grown considerably in recent decades (Fombonne, 2009). A study carried out in the United States with eight-year-old children, in 2002, estimated the prevalence of one case to 150 (Centers for Disease Control and Prevention, 2007), however, in 2014, this number changed to a case of ASD for 59 children (Developmental Disabilities Monitoring Network Surveillance Year and Centers for Disease Control and Prevention, 2014), and in 2016, the prevalence increased again, reaching one case for 54 children. (Maenner, 2020). In Brazil, there has also been an increase in the prevalence of this disorder. A

study carried out in 2011, in the city of Atibaia, in the interior of the state of São Paulo, with children, between seven and 12 years old, found a prevalence of 0.88% (Paula *et al.*, 2011). Another study carried out in 2017 in the metropolitan regions of Goiânia, Fortaleza, Belo Horizonte, and Manaus, including children and adolescents from six to 16 years old, found a prevalence of 1% (Portolese *et al.*, 2017). Early diagnosis and intervention are determining factors for the best prognosis for people with ASD, with significant and lasting gains for their development (Martinez-Morga *et al.*, 2018). From the neurobiological aspect, ASD is related to changes in the pattern of formation of circuits and synaptic contacts in brain regions involved in social behavior, especially in the prefrontal cerebral cortex (Martinez-Morga *et al.*, 2018). This formation of circuits occurs during the final stages of prenatal development and in the first months

after birth (Martinez-Morga *et al.*, 2018), which could justify the gains from early diagnosis. Thus, the identification and early TEA intervention should be public health priority (Pierce *et al.*, 2016). Because the early detection can lead to early treatment (Rogers *et al.*, 2014), and consequently, improve skills cognitive and language disabilities, as well as other characteristics of this disorder (Clark *et al.*, 2018). Although ASD can be diagnosed at 18 months of age (Hyman *et al.*, 2020), many children are still diagnosed late and not before school (Daniels and Mandell, 2013). In a review of studies published between 1990 and 2012, the authors pointed out that the average age of diagnosis of ASD ranged from 32 to 120 months (Daniels and Mandell, 2013). In a meta-analysis carried out between the years 2012 and 2019, the average was 60.5 months for the general population and 43.2 for children aged  $\leq 10$  (van't Hof *et al.*, 2020). In a study conducted with Brazilian children, it was found that they tend to be diagnosed around the age of five. The present study aimed to investigate the age of diagnosis of ASD in children and adolescents from the north of Minas Gerais and the possible associated factors.

## MATERIALS AND METHODS

This research, which was developed in Montes Claros (MG) - Brazil, is part of a case-control study entitled 'Autism Spectrum Disorder in Montes Claros: a case-control study', which investigated the possible associations between the ASD and prenatal, perinatal and postnatal factors (Maia *et al.*, 2018; Maia *et al.*, 2019; Cezar *et al.*, 2020). This project was approved by the Research Ethics Committee (CEP) of the State University of Montes Claros (opinion n° 534.000 / 14), and all those responsible for the children/adolescents signed the Free and Informed Consent Form. Montes Claros is the main urban center in the North of Minas Gerais, presenting characteristics of a regional capital. It constitutes the reference center in diversified areas of medicine and education, covering the macro-regions of northern Minas and part of southern Bahia, which represents a population of more than 1.5 million inhabitants (Instituto Brasileiro de Geografia e Estatística. Brasil, 2011). 221 mothers of children diagnosed with ASD participated in this study, identified in the Associação Norte Mineira de Apoio à Autista (ANDA) and eight clinics specialized in the care of children and adolescents with ASD, among these, six with private care, or health insurance, and two public ones. Children and adolescents with a diagnosis confirmed by qualified professionals, based on the diagnostic criteria for ASD proposed by the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), whose mother answered the question of the instrument for collecting data "Does your child have a diagnosis of ASD?". In addition to the previous question, the instrument adopted to carry out this study, also had questions sociodemographic characteristics of the participants. These were divided into four groups: child/adolescent data (sex and birth order), mother (age, education, skin color, and marital status) and father (age and education), and family (income and class socioeconomic situation, assessed according to the Brazil Economic Classification Criterion (Associação Brasileira de Empresas de Pesquisa, 2016). Also included in the data collection instrument was the question "How old was the child when he was diagnosed?" For a sample description, the frequency distribution of the analyzed variables was used. Descriptive measures were calculated, such as mean, standard deviation, median, interquartile range, maximum and minimum values for the age of diagnosis. The Mann-Whitney and Kruskal-Wallis non-parametric tests were used to compare the age at which the diagnosis was made according to the characteristics of the children, parents, and family, at a significance level of 5%. Statistical analyzes were performed using the statistical software Statistical Package for the Social Sciences - SPSS version 23.0 (IBM - Chicago, USA).

## RESULTS

221 children and adolescents aged between two and 14 years old participated in this study, with an average age of 6.6 years ( $\pm 3.5$ ).

The highest percentage of these children/adolescents was concentrated in the age group of two to five years of age, followed by the age group of 6 to 10 years, and the lowest percentage with 11 to 14 years of age (Figure 1). Most participants were male (83.3%) and belonged to socioeconomic class B or C (81.9%). The age at which the diagnosis of ASD was performed was, on average, equal to 3.9 years ( $\pm 2.6$ ), with the majority of children diagnosed up to three years of age (Figure 2). There is a significant percentage of diagnoses made since 2009 (Figure 3). When the age of diagnosis was assessed, by year of birth, it was observed that the youngest children had their diagnosis made earlier, with an average of 2.4 years ( $\pm 1.5$ ). On the other hand, it was found that older children were diagnosed with an average age of 7.7 years ( $\pm 3.2$ ) (Table 1). There was a significant association between age at diagnosis and mother's age at delivery, as well as maternal skin color. Younger mothers who declared themselves to be white had a higher mean age at diagnosis of their child.

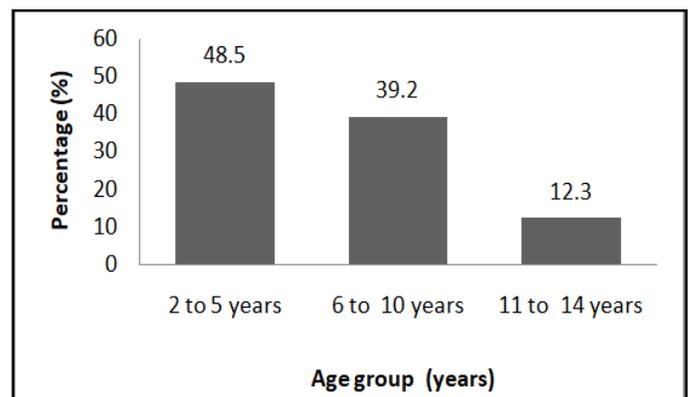


Figure 1: Distribution of children/adolescents with ASD according to age group. Montes Claros, MG, Brazil, 2016

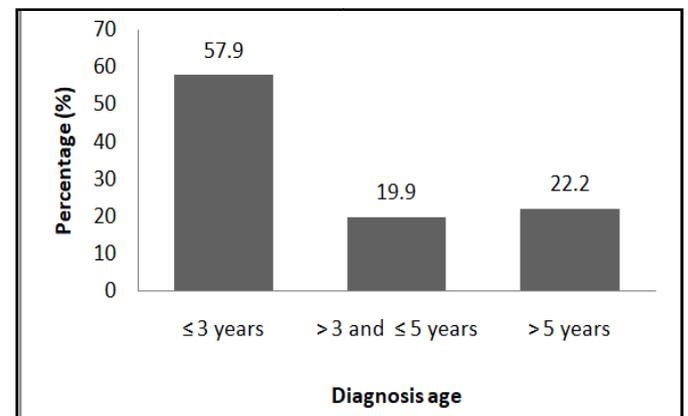


Figure 2: Distribution of children/adolescents with ASD according to age at diagnosis. Montes Claros, Minas Gerais, Brazil, 2016

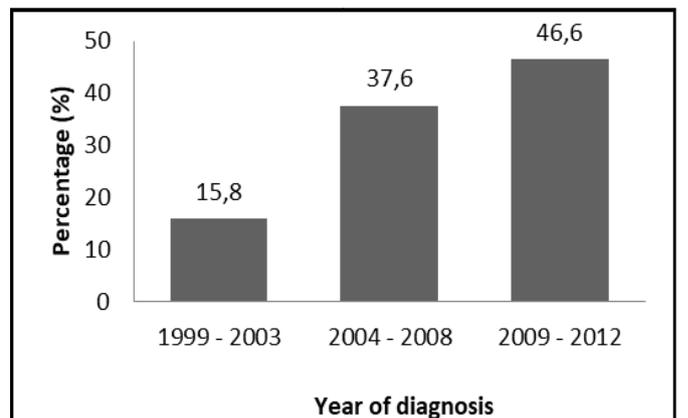


Figure 3: Distribution of children/adolescents with ASD according to the year of diagnosis. Montes Claros, MG, Brazil, 2016

**Table 1. Descriptive measures of the age of diagnosis according to socioeconomic and demographic characteristics of children/adolescents and family, Montes Claros, Minas Gerais, Brazil, 2016.**

Variables	Mean (SD)	Median (IQ)	Min - Max	P-value
<b>Children's data</b>				
<b>Sex</b>				0.078 *
Male	3.9 (2.6)	2.5 (3.0)	2.0-4.0	
Female	4.6 (2.7)	4.0 (4.0)	2.0-11.0	
<b>Birth order</b>				0.158 *
First-born	4.3 (2.9)	2.5 (4.0)	2.0-14.0	
Not firstborn	3.6 (2.1)	2.5 (3.0)	2.0-13.0	
<b>Mother's data</b>				
<b>Age (childbirth)</b>				<b>0.030 **</b>
≥35	3.3 (1.6)	2.5 (3.0)	2.0-8.0	
25 to 34	3.9 (2.5)	2.5 (3.0)	2.0-14.0	
<25	5.16 (3.6)	4.0 (6.0)	2.0-13.0	
<b>Education</b>				0.131 **
University education	3.7 (2.6)	2.5 (3.0)	2.0-13.0	
High school	4.2 (2.6)	2.5 (3.0)	2.0-14.0	
Elementary School	4.4 (2.8)	4.0 (3.0)	2.0-13.0	
<b>Skin color (self-reported)</b>				<b>0.034 *</b>
White	4.2 (2.4)	3.3 (4.0)	2.0-11.0	
Not white	3.9 (2.7)	2.5 (3.0)	2.0-14.0	
<b>Mother's marital status</b>				0.214 *
Married / stable relationship	4.0 (2.6)	2.5 (3.0)	2.0-14.0	
Single / divorced / widowed	4.16 (2.5)	2.5 (4.0)	2.0-10.0	
<b>Father's details</b>				
<b>Age (childbirth)</b>				0.272 *
<35	4.1 (2.7)	2.5 (4.0)	2.0-14.0	
≥35	3.1 (2.5)	2.5 (3.0)	2.0-13.0	
<b>Education</b>				0, 885 **
University education	3.7 (2.4)	2.5 (3.0)	2.0-13.0	
High school	4.2 (2.8)	2.5 (4.0)	2.0-13.0	
Elementary School	4.0 (2.5)	4.0 (3.0)	2.0-14.0	
<b>Family income***</b>				0.232 **
> 6 minimum wages	3.5 (2.2)	2.5 (2.0)	2.0-10.0	
2-6 minimum wages	4.2 (2.9)	2.5 (3.0)	2.0-14.0	
<2 minimum wages	4.1 (2.6)	2.5 (4.0)	2.0-13.0	
<b>Socioeconomic class</b>				0, 249 **
THE	4.4 (2.9)	2.5 (4.0)	2.0-13.0	
B and C	3.9 (2.5)	2.5 (3.0)	2.0-14.0	
D and E	4.8 (2.8)	4.3 (5.0)	2.0-9.0	

\*Mann-Whitney; \*\* Kruskal-Wallis;\*\*\* Current minimum wage: R \$ 880.00.

## DISCUSSION

The present study aimed to investigate the age of diagnosis of children and adolescents with ASD in a population in northern Minas Gerais and its possible associated factors. It was found that the average age of diagnosis in this population was lower than that found in previous studies (Zanon *et al.* 2017; Daniels and Mandell, 2013; van't Hof *et al.*, 2020) and that has decreased over the years. It was also observed that the diagnosis of ASD was earlier in the children of mothers who were older at the time of delivery and who declared themselves non-white. In this study, although the general average age of ASD diagnosis was 3.9 ( $\pm$  2.6), there was a constant drop in the average over the years, of 7.7 years ( $\pm$  3.2) for children born between 1999 and 2003 to 2.4 years ( $\pm$  0.8) for those born between 2009 and 2012. King and Bearman (2011), Daniels and Mandell (2013), Zanon *et al.* (2017) also observed a consistent drop in the mean of ASD diagnosis with time. This finding is encouraging, as it suggests that more children are being identified early enough to confer the greatest benefit from intervention services (Daniels and Mandell, 2013). Zanon *et al.* (2017) in a study also carried out with a Brazilian population, found an average age of diagnosis of 5.9 years. The authors reported that few people were diagnosed before 36 months of age, being limited, in most cases, to large centers where specialized professionals existed. These authors also suggest that families with low socioeconomic status and who live in small towns in the interior of the states have greater difficulty in accessing these professionals. Even though the present study was carried out in one of the poorest regions of the state of Minas Gerais, the average age of diagnosis was less than 36 months for children born between the years 2009 to 2012. These findings can be justified by the fact that, since 2014, actions have been developed

with the State University of Montes Claros to guide educators to identify the signs of TEA in children enrolled in early childhood education. In addition to these actions, this group also makes a diagnostic assessment of children identified with possible signs of ASD. This assessment is performed by a multi-professional team specialized in ASD. These actions reinforce the importance of training professionals on the main signs of the TEA for greater awareness on the topic and, consequently, King and Bearman (2011) suggest that specialized knowledge is necessary for diagnosis. Colbert *et al.* (2016) reinforce that, even if a person has low socioeconomic status but has adequate knowledge about ASD, they may still not have access to ASD-related services. And also that even if parents identify symptoms of ASD in their children, and if the availability of services is limited, diagnosis may be delayed (Colbert *et al.*, 2016). What draws attention to the importance of qualified professionals who are specialists in ASD in the different regions of the country, and not only in large centers. Evaluation and early diagnosis are important not only for better intervention and management of symptoms but also for strengthening the support network, which is composed of the family (Rocha *et al.*, 2019). Thus, when the diagnosis of ASD is late, the possibility of providing interventions, important for the child's prognosis, during a critical period of development is lost (Daniels and Mandell, 2013). Thus, early diagnosis can increase the potential of children with ASD (Dawson *et al.*, 2010) and can also help parents cope better. In the studied population, the possible factors statistically associated with the early diagnosis of ASD were: the maternal age was greater than or equal to 35 years, and the mothers' white skin color. The association presented the mother's age maybe because older women tend to have a higher level of knowledge and, consequently, greater access to available diagnostic services. Russel *et al.* (2011) pointed out that the higher maternal age in more favored contexts could also play an important role in the early recognition of ASD.

And that for the same level of severity of autistic traits, the diagnosis of ASD was lower in children of younger or primiparous mothers (Russel *et al.*, 2011). The association of white maternal skin color and age at diagnosis observed in the present study differed from the results found in previous studies, which pointed African-American children predispose to be diagnosed after white children (Rosenberg *et al.*, 2011; Valicenti-McDermott *et al.*, 2012). And studies that did not find significant associations between the child's race and the age of the ASD diagnosis (Wiggins *et al.*, 2006; Adelman, 2010). It is noteworthy that variables such as the presence of an older sibling, parental education level, family income, and socioeconomic class may reflect the greater knowledge of parents about their child's typical or atypical development, which would explain an influence for the early diagnosis of ASD. However, in this study, these variables were not associated with the age of diagnosis, as in previous studies (Adelman, 2010; Valicenti-McDermott *et al.*, 2012; Rosenberg *et al.*, 2011; Zanon *et al.*, 2017). The sex of the child also did not show any association with the age of diagnosis of ASD, diverging from other studies. (Wiggins *et al.*, 2006; Goin-Kochel *et al.*, 2006). Although it was not investigated in this study, religion was identified as possibly related to the age of diagnosis of ASD (Colbert *et al.*, 2016). Colbert *et al.* (2016) suggested that parents with religious beliefs are more likely to accept a child's limitations, and therefore are less likely to seek early diagnosis and treatment. Also, seeking care through religious paths, such as a healer or prayer, could lead to less use of health care, so that individuals are less likely to find information about ASD in conventional medical settings. This study had limitations as the age of the participants was collected in years, as well as, the degree of TEA of the participants was not classified. It was found that the average age of diagnosis for ASD was lower than that of previous studies and that decreased over the years, suggesting that the signs of ASD are being observed, recognized, and evaluated earlier. Being the children of mothers who declared themselves to be white and who were older at the time of delivery were factors associated with the older age of diagnosis of ASD. Recommended care about this disorder, both for education and health professionals, as they will be instrumental in promoting early referrals for diagnosis, which may contribute to better prognosis and more effective inclusive practices.

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