J Autism Dev Disord
DOI 10.1007/s10803-012-1656-z

Sex Differences in the Timing of Identification Among Children and Adults with Autism Spectrum Disorders

Sander Begeer · David Mandell · Bernadette Wijnker-Holmes · Stance Venderbosch · Dorien Rem · Fred Stekelenburg · Hans M. Koot

Abstract To examine differences by sex in the timing of identification of individuals with autism spectrum disorders (ASD), survey data were collected in the Netherlands from 2,275 males and females with autistic disorder, Asperger's syndrome and PDD-NOS. Among participants <18 years of age, females with Asperger's syndrome were identified later than males. Among participants ≥18 years of age, females with autistic disorder were identified later than males. In more recent years, girls with Asperger's syndrome are diagnosed later than boys, confirming earlier findings. In adults, the delayed timing of diagnosis in females with autistic disorder may be related to changing practices in diagnosis over time. Strategies for changing clinician behaviour to improve recognition of ASD in females are needed.

Keywords Autism · Identification · Sex · Asperger's syndrome · Diagnosis

S. Begeer (✉)
School of Psychology, University of Sydney, Sydney, NSW 2006, Australia
e-mail: S.Begeer@vu.nl

S. Begeer · H. M. Koot
Department of Developmental Psychology, VU University Amsterdam, Amsterdam, The Netherlands

D. Mandell
University of Pennsylvania, Philadelphia, PA, USA

B. Wijnker-Holmes · S. Venderbosch · D. Rem · F. Stekelenburg
Nederlandse Vereniging voor Autisme, Bilthoven, The Netherlands

D. Rem
Utrecht University, Utrecht, The Netherlands

Introduction

Autism spectrum disorders (ASD) have a consistent male predominance ranging from 4:1 among individuals with autistic disorder to 9:1 among individuals with Asperger's disorder (Fombonne 2003; CDC 2012). The reasons for the higher prevalence of ASD among males are unclear. It has been suggested that ASD are primarily diagnosed in girls when accompanied by cognitive impairments (Lord et al. 1982; Wing 1981). Indeed, worse social, communicative and cognitive functioning has been found in females with ASD than in males with ASD (McLennan et al. 1993; Crick and Zahn-Waxler 2003; Carter et al. 2007; Banach et al. 2009). However, recent findings increasingly show that core symptoms of ASD do not differ by sex (Hartley and Sikora 2009; Horovitz et al. 2011; Mayes and Calhoun 2011; Rivet and Matson 2011a). Parents also may expect more socially desired behaviour from girls, and pressure them more to act in more socially appropriate ways than boys. This "interpreting bias" among parents could mask ASD symptoms in girls (Holtmann et al. 2007). However, it may also lead to higher expectations of social behavior in girls, therefore causing earlier concern about their social behavior. Furthermore, while female sex may be protective against social disability, perhaps the later diagnosis of ASD reflects a later onset rather than a lack of detection in girls. The identification of ASD in girls is thus complicated by a number of factors that may lead to delayed or missed diagnoses. The current study examines sex differences in the timing of identification of ASD in males and females.

Early identification of the diagnosis is crucial for the well being of those affected with ASD. It leads to early educational interventions, which have been linked to better long-term prognoses (Lord 1995), and it allows early treatment entry, which is associated with the best treatment

Published online: 22 September 2012

outcomes, specifically during childhood (Lord 1995; Reichow 2012). Furthermore, it enables the coordination and early streamlining of family centered care. Among the many benefits of early treatment, better communication skills and lower rates of problem behavior are particularly important, but secondary benefits also include a strong reduction of stress in parents (Baird et al. 2011). Smaller studies, ranging from 11 to 150 females with ASD, have not shown sex differences in age of ASD diagnosis (Wiggins et al. 2006; Ouellette-Kuntz et al. 2009; Mandell et al. 2005). This finding may result from a lack of statistical power. However, even larger studies have demonstrated inconsistent findings regarding sex differences in age of ASD diagnosis. While a study including as many as 491 females with ASD indicated a later age of diagnosis in females than males with ASD (Shattuck et al. 2009), two related surveys, including 3,000 girls with ASD from the USA (Fountain et al. 2011) and including 300 girls with ASD from Japan (Fujiwara et al. 2011) found no sex differences in the age of diagnosis. To date, sex differences in ASD diagnosis have not been studied based on large scale samples in Europe.

An additional factor related to delayed ASD identification is a higher IQ (Shattuck et al. 2009). Higher IQ may allow individuals with ASD to cognitively compensate for their social impairments (Klin et al. 2003), thus decreasing their chances of being detected. However, it could also be that lower IQ individuals with ASD have more obvious delays in language and development, which causes earlier detection in this group. Indeed, in toddlers with ASD and varying cognitive abilities, girls showed a lower age of first concern than boys (Horovitz et al. 2012), while an average or above average IQ decreased the likelihood of an ASD diagnosis in girls more than in boys (Giarelli et al. 2010). There are no data about whether sex differences in the time of identification differ among the subtypes of autistic disorder, Asperger's syndrome and PDD-NOS. Since average or above average IQ decrease the likelihood that females will receive an ASD diagnosis, females with Asperger's syndrome may have a specific risk for late identification.

In the current study, we attempted to replicate findings regarding the delay in the identification of ASD in females in the US (Shattuck et al. 2009) by using data collected in the Netherlands, and extend prior findings by examining sex differences in the timing of ASD diagnosis by diagnostic subtype. We rely on a large national sample of individuals with ASD to examine specific sex differences in the timing. We hypothesized that females with ASD would receive their diagnosis at a later age than males. In addition, we hypothesized that this difference would be exacerbated among individuals with Asperger's syndrome and PDD-NOS.

Methods

Participants

The sample included 2,275 children (aged 0–18) and adults (aged 18–85) with ASD (1,843 males (81 %) and 432 females (19 %)) who returned surveys distributed to the members of the Dutch Autism Society (Nederlandse Vereniging voor Autisme, NVA; see Table 1). Membership of the NVA represents the general population of individuals with ASD. While we had no explicit information regarding the socio-economic status of the families that participated in the survey, all 12 provinces of the Netherlands were equally represented in the participating sample (NVA 2008; CBS 2008). Furthermore, the distribution of age, subtypes of ASD, cognitive ability and gender were similar to findings from international epidemiological studies (CDC 2012). Among those who returned surveys (18 % of the total membership), 10 book prizes of 50 Euro were allotted.

Surveys were completed by parents (n = 1,796), next of kin (n = 86) or individuals with ASD themselves (n = 202). Eight percent of surveys (n = 191) was excluded from the analyses due to missing information on diagnoses, date of birth, or age of diagnosis. No differences were found between the excluded participants and the rest of the sample in terms of sex, but excluded participants were more likely to have intellectual disability ($p < .001$). Characteristics of the remaining 2,084 participants are presented in Table 1.

Survey

The survey was developed by the Dutch National Autism Association [Nederlandse Vereniging voor Autisme (NVA)] to examine the experience of individuals with autism in the Netherlands regarding diagnostic procedures, treatment, daily functioning and education. The survey included 53 questions regarding a wide range of topics, including diagnostic process, treatment, residential situation, schooling and employment.

Analysis

A series of stepwise linear regression analyses was conducted with age of diagnoses as the dependent variable. Current age was entered in the first step of the model, followed by sex in the second step, and age of first parental concern in the third step. We analysed the child and adult groups separately because of secular changes in diagnostic procedures and criteria.

Table 1 Details of the participants' age of first concern, age of ASD diagnosis, and delay between concern and diagnosis (means, *SD*s)

	Male					Female				
	N	%	Age of first concern	Age of diagnosis	Delay between age of first concern and diagnosis	*N*	%	Age of first concern	Age of diagnosis	Delay between age of first concern and diagnosis
Children (0–18 years; n = 1,354)										
All cases	1,150	84.9	5.1 (3.0)	6.6 (3.0)	1.5 (1.9)	204	15.1	5.5 (3.6)	7.1 (3.7)	1.6 (2.1)
Diagnosis										
Autistic disorder	361	86.9	3.8 (2.5)	5.3 (2.8)	1.5 (1.8)	55	13.1	3.6 (2.8)	4.7 (2.9)	1.1 (1.5)
Asperger's syndrome	277	90.6	6.5 (3.1)	7.9 (2.9)	1.4 (1.8)	29	9.4	7.5 (3.9)	9.7 (3.5)	2.2 (2.4)
PDD-NOS	512	80.9	5.3 (2.9)	6.8 (2.8)	1.6 (2.0)	120	19.1	5.9 (3.6)	7.5 (3.5)	1.7 (2.3)
Adults (18–85 years; n = 730)										
All cases	547	74.9	16.7 (15.6)	19.5 (15.6)	2.8 (5.4)	183	25.1	16.1 (12.2)	19.3 (12.1)	3.3 (5.9)
Diagnosis										
Autistic disorder	127	76.5	12.8 (15.0)	15.3 (15.4)	5.0 (15.4)	39	23.5	11.6 (12.6)	16.2 (13.2)	4.5 (6.6)
Asperger's syndrome	194	80.2	23.5 (16.4)	26.4 (16.1)	2.9 (5.9)	48	19.8	22.9 (12.7)	25.5 (12.3)	2.6 (4.8)
PDD-NOS	226	70.2	13.1 (13.2)	15.9 (13.1)	2.8 (5.1)	96	29.8	14.4 (10.3)	17.6 (10.6)	3.1 (6.1)

Results

Based on all participants in the current sample, the average time between first signs and identification was longer for females ($M = 2.3$ year, SD 4.4) than males ($M = 1.9$ year, SD 3.5), $F_{(1,\ 2{,}082)} = 5.24$, $p < .05$, $\eta^2 = .003$. However, this finding is difficult to interpret, given the influence of current age on average age of diagnosis (adults versus children), with adults diagnosed an average of 12.76 years later than children ($p < .001$). Because only adults had the opportunity to be diagnosed at older ages, and unequal follow up times can be problematic in this type of research (Hertz-Picciotto and Delwiche 2009), we stratified the sample into child and adult groups, and controlled for current age in the analyses on both samples.

Within the child group, children with autism were diagnosed earliest ($M = 5.2$, $SD = 2.9$), followed by children with PDD-NOS ($M = 6.9$, $SD = 3.0$) and Asperger's syndrome ($M = 8.0$, $SD = 3.0$; $p < .001$). Among adults, there was no statistically significant association between diagnostic category and age of diagnosis.

In the child group, female sex was associated with a 1.8-year delay in age of diagnosis in the Asperger group, $\Delta F_{(1,303)} = 14.67$, $p < .001$, $R^2 = .36$, $f^2 = .56$. No effect of sex on age of diagnosis was found in the PDD-NOS or autistic disorder groups. In the adult group, female sex was associated with a 4.3-year delay in age of diagnosis in the Autism group $\Delta F_{(1,163)} = 5.08$, $p < .05$, $R^2 = .53$, $f^2 = 1.13$. There was no effect of sex on age of diagnosis in the PDD-NOS or Asperger groups (See Table 1). These results persisted in analyses adjusting for age of first parental concern.

The adult group showed a wide variation in age of diagnosis, with 300 participants diagnosed younger than 12 years, 142 who were diagnosed between 12 and 18 years, and 730 who were diagnosed when they were older than 18 years. However, no sex difference was found in the age of diagnoses of adults, when analysed according to whether they were diagnosed as children (0–12 years), adolescents (12–18 years) or adults (>18 years).

Conclusion

The current study confirmed that girls are identified later than boys among children with Asperger's syndrome. We found no delayed identification for girls with autistic disorder or PDD-NOS. In contrast, in the adult group, females with autistic disorder were diagnosed later than males, but no delay was found for adult females with Asperger's syndrome of PDD-NOS. The age at first parental concern did not affect these sex differences, confirming findings from the US (Giarelli et al. 2010). Also replicated was the finding that the ASD diagnosis frequently occurred years after the age at which the symptoms generally are evident (Barbaro and Dissanayake 2009), and on average 2 years after caregivers expressed concerns. Based on all participants in the current sample, the average time between first signs and identification was slightly longer for females than males, which was particularly due to delayed identification of girls with Asperger's syndrome and women with autistic disorder.

The later diagnosis of Asperger's syndrome in girls than boys may be related to the late general timing of diagnosis

in Asperger's, on average at 8 years of age, 1 year later than children with PDDNOS (mean age of diagnosis of 7) and 3 years later than children with autism, who were diagnosed on average at around 5 years of age. The late timing of Asperger diagnosis is compatible with the lack of gender difference in the Fountain study, since they only included children diagnosed between 2 and 8 years old (Fountain et al. 2011). Unfortunately, their finding of a positive impact of socioeconomic status on the age of diagnosis could not be validated in the current study since we did not have this information. The specific delayed diagnoses of girls with Asperger's syndrome could be linked with IQ. While the exact relationship of delayed diagnosis with IQ, gender and ASD needs to be addressed further (Rivet and Matson 2011b), recent practical guidelines emphasize that both high verbal ability and female sex may cause clinicians to fail in their recognition of ASD (Baird et al. 2011). This speaks to our current findings. In addition, girls with ASD may deviate in their presentation of social problems. For instance, a recent study showed that boys with ASD were more likely than girls to lack best friends, while girls on the other hand more often interacted with younger children (Kopp and Gillberg 2011). Empirical findings on these gender differences in social play behaviour and other related gender differences in social and ritualistic behaviour (Holtmann et al. 2007) may be used to improve early detection of girls with ASD.

In the adult sample, autistic disorder was diagnosed later in females than in males. This may be related to a historical change in the diagnostic procedures. Of the adults with autistic disorder, 23 % received their diagnosis prior to 1987, compared to only 1 % of adults with Asperger's syndrome and 3 % of adults with PDD-NOS. This means that relatively more adults with autistic disorder were diagnosed according to DSM-III criteria, which were more specific than the broader criteria that were introduced with the DSM-III-R in 1987 (Volkmar et al. 1988). Autistic disorders may thus have been suspected in girls much less decades ago, just like Asperger's disorder is suspected less now.

In both male and female individuals, autistic disorder was generally identified at the youngest ages, followed by PDD-NOS and Asperger's syndrome. The early identification of autistic disorder in both boys and girls is beneficial to girls' chances of receiving adequate treatment in time. However, the general delay in the identification of PDD-NOS and Asperger's syndrome is still problematic. The DSM-5 (www.dsm5.org) will likely integrate PDD-NOS and Asperger's syndrome into one Autism Spectrum Disorder. While using a single spectrum that reflects the severity of pathology may still give rise to gender disparities, the subsequent development of dimensional instruments that are sensitive to female presentations of autistic symptoms may improve the diagnostic procedures (Kopp and Gillberg 2011). Possible deviations in specific presentation of social and verbal abilities in boys and girls with ASD, as well as variations in the frequency of specific types of co morbid disorders seem important topics to consider. They may add to the explanation for the longer delay between parental concern and diagnosis in girls with Asperger's syndrome.

The current study has several limitations. Diagnostic categories were based on self or parent report. The study also relied on respondent's recall about events (such as age of first suspicion) that happened long ago, which may have affected findings, especially in the adult group. Furthermore, there were differences in the proportion of ASD subtypes in the child and adult groups. Most notably to our current findings, the proportion of females/males with Asperger' syndrome was 1/10 in the child cohort, but 1/5 in the adult cohort. While these findings can be explained by a delayed identification of Asperger's syndrome in girls, the disproportionate number of girls warrants caution for the interpretation of the current findings. Also, no information on ethnicity and socio-economic status (SES) was collected. SES (Emerson 2012) and ethnicity (Begeer et al. 2009) may influence the timeliness of ASD diagnoses. We are currently collecting longitudinal data including full background information and direct diagnostic and cognitive assessments. This will enable the replication of the current findings.

Despite these limitations, there are important implications related to the current data, which is among the largest samples collected to date (Giarelli et al. 2010). The benefits of early identification of ASD autism have been widely recognized, mainly to increase access to early intervention and to decrease family stress (Wiggins et al. 2006; Filipek et al. 1999; Dawson 2008). As expected, the delayed identification particularly affected girls with Asperger's syndrome. Strategies are needed to increase clinician's sensitivity to improve recognition of PDDNOS and Asperger's syndrome in females. This goal can be achieved by alerting clinicians to a possible bias against diagnosing autism in girls. The recently published recommendations from the National Institute for Health and Clinical Excellence (NICE) from the UK (Baird et al. 2011), indeed includes the explicit recommendation that autism may be under diagnosed in girls. Furthermore, diagnostic instruments may be developed that are sensitive to "female" presentations of ASD. The recently developed Autism Spectrum Screening Questionnaire (ASSQ)-Revised Extended Version (ASSQ-REV; Kopp and Gillberg 2011) is an example of a parent questionnaire that may be better suitable for detecting ASD in girls, because some questionnaire items are more often endorsed in girls with ASD than in boys. Both recent examples highlight possible

solutions to the currently reported delayed diagnoses of girls with Asperger's syndrome.

Acknowledgments This work was supported by Stichting Nuts Ohra [SNO-T-0702-78] and Fonds PGO [S03881/2007U01363/TB07], The Netherlands.

References

Baird, G., Douglas, H. R., & Murphy, M. S. (2011). GUIDELINES recognising and diagnosing autism in children and young people: Summary of NICE guidance. *British Medical Journal, 343*, d6360.

Banach, R., Thompson, A., Szatmari, P., Goldberg, J., Tuff, L., Zwaigenbaum, L., et al. (2009). Brief report: Relationship between non-verbal IQ and gender in autism. *Journal of Autism and Developmental Disorders, 39*, 188–193.

Barbaro, J., & Dissanayake, C. (2009). Autism spectrum disorders in infancy and toddlerhood: A review of the evidence on early signs, early identification tools, and early diagnosis. *Journal of Developmental and Behavioral Pediatrics, 30*, 447–459.

Begeer, S., El Bouk, S., Boussaid, W., Terwogt, M. M., & Koot, H. M. (2009). Underdiagnosis and referral bias of autism in ethnic minorities. *Journal of Autism and Developmental Disorders, 39*, 142–148.

Carter, A. S., Black, D. O., Tewani, S., Connolly, C. E., Kadlec, M. B., & Tager-Flusberg, H. (2007). Sex differences in toddlers with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 37*, 86–97.

Centers for Disease Control and Prevention. (2012). Prevalence of autism spectrum disorders–autism and developmental disabilities monitoring network, United States, 2008. *MMWR, 61*, 1–19.

Centraal Bureau voor de Statistiek. (2008). *Provincie op maat*. Den Haag: CBS.

Crick, N. R., & Zahn-Waxler, C. (2003). The development of psychopathology in females and males: Current progress and future challenges. *Development and Psychopathology, 15*, 719–742.

Dawson, G. (2008). Early behaviorial intervention, brain plasticity, and the prevention of autism spectrum disorder. *Development and Psychopathology, 20*, 775–803.

Emerson, E. (2012). Deprivation, ethnicity and the prevalence of intellectual and developmental disabilities. *Journal of Epidemiology and Community Health, 66*, 218–224.

Filipek, P. A., Accardo, P. J., Baranek, G. T., Cook, E. H., Dawson, G., Gordon, B., et al. (1999). The screening and diagnosis of autistic spectrum disorders. *Journal of Autism and Developmental Disorders, 29*, 439–484.

Fombonne, E. (2003). Epidemiological surveys of autism and other pervasive developmental disorders: An update. *Journal of Autism and Developmental Disorders, 33*, 365–382.

Fountain, C., King, M. D., & Bearman, P. S. (2011). Age of diagnosis for autism: Individual and community factors across 10 birth cohorts. *Journal of Epidemiology and Community Health, 65*, 503–510.

Fujiwara, T., Okuyama, M., & Funahashi, K. (2011). Factors influencing time lag between first parental concern and first visit to child psychiatric services in children with autism spectrum disorders in Japan. *Research in Autism Spectrum Disorders, 5*, 584–591.

Giarelli, E., Wiggins, L. D., Rice, C. E., Levy, S. E., Kirby, R. S., Pinto-Martin, J., et al. (2010). Sex differences in the evaluation and diagnosis of autism spectrum disorders among children. *Disability and Health Journal, 3*, 107–116.

Hartley, S. L., & Sikora, D. M. (2009). Sex differences in autism spectrum disorder: An examination of developmental functioning, autistic symptoms, and coexisting behaviour problems in toddlers. *Journal of Autism and Developmental Disorders, 39*, 1715–1722.

Hertz-Picciotto, I., & Delwiche, L. (2009). The rise in autism and the role of age at diagnosis. *Epidemiology, 20*, 84–90.

Holtmann, M., Bolte, S., & Poustka, F. (2007). Autism spectrum disorders: Sex differences in autistic behaviour domains and coexisting psychopathology. *Developmental Medicine and Child Neurology, 49*, 361–366.

Horovitz, M., Matson, J. L., & Sipes, M. (2011). Gender differences in symptoms of comorbidity in toddlers with ASD using the BISCUIT-Part 2. *Developmental Neurorehabilitation, 14*, 94–100.

Horovitz, M., Matson, J. L., Turygin, N., & Beighley, J. S. (2012). The relationship between gender and age of first concern in toddlers with autism spectrum disorders. *Research in Autism Spectrum Disorders, 6*(1), 466–471.

Klin, A., Jones, W., Schultz, R., & Volkmar, F. (2003). The enactive mind, or from actions to cognition: Lessons from autism. *Philosophical Transactions of the Royal Society of London. Series B, Biological sciences, 358*, 345–360.

Kopp, S., & Gillberg, C. (2011). The autism spectrum screening questionnaire (ASSQ)-revised extended version (ASSQ-REV): An instrument for better capturing the autism phenotype in girls? A preliminary study involving 191 clinical cases and community controls. *Research in Developmental Disabilities, 32*, 2875–2888.

Lord, C. (1995). Follow-up of two-year-olds referred for possible autism. *Journal of Child Psychology and Psychiatry, 36*, 1365–1382.

Lord, C., Schopler, E., & Revicki, D. (1982). Sex-differences in autism. *Journal of Autism and Developmental Disorders, 12*, 317–330.

Mandell, D. S., Novak, M. M., & Zubritsky, C. D. (2005). Factors associated with age of diagnosis among children with autism spectrum disorders. *Pediatrics, 116*, 1480–1486.

Mayes, S. D., & Calhoun, S. L. (2011). Impact of IQ, age, SES, gender, and race on autistic symptoms. *Research in Autism Spectrum Disorders, 5*, 749–757.

McLennan, J. D., Lord, C., & Schopler, E. (1993). Sex-differences in higher functioning people with autism. *Journal of Autism and Developmental Disorders, 23*(2), 217–227.

Nederlandse Vereniging voor Autisme (NVA). (2008). *Een plek om te leven. Een onderzoek naar de leefsituatie van mensen met autisme* (A place to live. A study on the daily circumstances of individual with autism). Bilthoven: NVA.

Ouellette-Kuntz, H. M. J., Coo, H., Lam, M., Yu, C. T., Breitenbach, M. M., Hennessey, P. E., et al. (2009). Age at diagnosis of autism spectrum disorders in four regions of Canada. *Canadian Journal of Public Health-Revue Canadienne de Sante Publique, 100*, 268–273.

Reichow, B. (2012). Overview of meta-analyses on early intensive behavioral intervention for young children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 42*, 512–520.

Rivet, T. T., & Matson, J. L. (2011a). Gender differences in core symptomatology in autism spectrum disorders across the lifespan. *Journal of Developmental and Physical Disabilities, 23*, 399–420.

Rivet, T. T., & Matson, J. L. (2011b). Review of gender differences in core symptomatology in autism spectrum disorders. *Research in Autism Spectrum Disorders, 5*(3), 957–976.

Shattuck, P. T., Durkin, M., Maenner, M., Newschaffer, C., Mandell, D. S., Wiggins, L., et al. (2009). Timing of identification among

children with an autism spectrum disorder: Findings from a population-based surveillance study. *Journal of the American Academy of Child and Adolescent Psychiatry, 48*, 474–483.

Volkmar, F. R., Bregman, J., Cohen, D. J., & Cicchetti, D. V. (1988). Dsm-Iii and Dsm-Iii-R diagnoses of autism. *American Journal of Psychiatry, 145*, 1404–1408.

Wiggins, L. D., Baio, J., & Rice, C. (2006). Examination of the time between first evaluation and first autism spectrum diagnosis in a population-based sample. *Journal of Developmental and Behavioral Pediatrics, 27*, S79–S87.

Wing, L. (1981). Sex-ratios in early-childhood autism and related conditions. *Psychiatry Research, 5*, 129–137.