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Intellectual disability in Autism Spectrum Disorder: Investigation of prevalence in an Italian sample of children and adolescents

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1. Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized from early developmental period by the presence of persistent deficits in social communication and social interaction, and restricted and repetitive patterns of behaviour, interests or activities that cause clinically significant impairment in several areas of functioning (American Psychiatric Association, 2013). The clinical expression of this disorder varies greatly, depending on the severity of autistic symptoms and on the developmental level. Literature studies have highlighted that specify the intellectual profile and language abilities of individuals with ASD is essential in clinical practice considering that these features are reported to be the most important predictors of adult outcomes (Begovac, Begovac, Majić, & Vidović, 2009; Volkmar & Pauls, 2003). Intellectual Disability (ID) is a developmental disorder characterized by intellectual and adaptive functioning deficits (American Psychiatric Association, 2013). Intellectual functioning, including reasoning, problem solving, planning, abstract thinking, judgment, learning from instruction and experience, and practical understanding, is measured through psychometric valid tests of intelligence. Conventionally, individuals with ID scores two standard deviations (SD) or more below the population mean (mean = 100, SD = 15). However, intelligence quotient (IQ) scores are not sufficient to determine the level of support required, therefore a comprehensive evaluation of adaptive functioning is needed, and the Diagnostic and Statistical Manual-fifth edition (DSM-5) defines the levels of ID severity on the basis of this criteria (American Psychiatric Association, 2013). The assessment of both intellectual abilities and adaptive skills seem to be particularly relevant in individuals with ASD. In fact, the discrepancy between cognitive level and adaptive functioning skills is often large in people

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with autism due to the impairment that these individuals exhibit in the socialization and communication domains (Bolte & Poustka, 2002).

1.1. Studies exploring prevalence of ID in autism

Several researches have shown that ID and autism frequently co-occur, and a common genetic substrate of these disorders has been described (Bolte & Poustka, 2002; Bonora et al., 2014; Charman et al., 2011; Deth, 2012; Fombonne, 2003, 2009; Mefford, Batshaw, & Hoffman, 2012; Nicholl et al., 2014; Srivastava & Schwartz, 2014). However, studies published so far have reported highly variable rates of ID prevalence in ASD, ranging from 16.7% to 84% (Baird et al., 2000, 2006; Bertrand et al., 2001; Bolte & Poustka, 2002; Bolte, Dziobeck, & Poustka, 2009; Carlsson et al., 2013; Centers for Disease Control and Prevention, 2014; Chakrabarti & Fombonne, 2005; Charman et al., 2011; De Bildt, Systema, Kraijer, & Minderaa, 2004; Fombonne, 2003; Gillberg, Steffenburgand, & Schaumann, 1991; Keen & Ward, 2004; La Malfa, Lassi, Bertelli, Salvini, & Placidi, 2004; Magnusson & Saemundsen, 2001; Matson & Shoemaker, 2009; Miller et al., 2012; Oliveira et al., 2007). It is worth to note that most of these studies investigated the epidemiology of ASD in general, and not specifically the prevalence of ID in ASD. For instance, a recent study of the Centers for Disease Control and Prevention (CDC) on the prevalence estimates of ASD, reported that among the 3.604 children with ASD included in their sample, 31% had been classified in the range of ID, and 23% were in the borderline range (Centers for Disease Control and Prevention, 2014). On the other hand, in a sample of 75 children with ASD drawn from the Special Needs and Autism Project (SNAP) cohort, Charman et al. (2011) reported a slightly higher prevalence of ID in ASD (55%) (Charman et al., 2011). Moreover, findings related to the occurrence of ID in autism consistently report that females with ASD have lower average cognitive ability than males, and the male to female ratio in ASD is highest when ID is not present (Fombonne, 2009; Nicholas et al., 2008; Bryson, Bradley, Thompson, & Wainwright, 2008). Finally, studies on the prevalence rates of comorbid ID in ASD in Italy are still lacking. In fact, to our knowledge so far only one study conducted in Italy investigated the co-occurrence of ASD and ID (La Malfa et al., 2004). However, this study explored a completely different aim. In more detail, La Malfa et al. (2004) assessed the prevalence of PDD in an Italian sample of 166 residents with ID through a scale of Pervasive Developmental Disorder (PDD) in mentally retarded persons, and reported a PDD rate in people with ID of 39.2% (La Malfa et al., 2004). Therefore, new insights on the prevalence of ID in ASD in this country are needed in order to better understand the rates of comorbidity and their implication for treatment.

1.2. Current aim

Based on the aforementioned argument, the aim of the present study was to investigate the prevalence of ID analyzing developmental and cognitive test data [Griffiths Mental Developmental Scale-Extend Revised (GMDS-ER) and the Leiter International Performance Test-Revised (Leiter-R)] in a large sample of children and adolescents with ASD referred to an Italian National Children Hospital tertiary referral center from January 2010 to December 2013. Moreover, we further characterized comorbid ID in ASD by gender and by level of functioning (i.e., IQ/DQ and adaptive functioning levels).

2. Materials and methods

2.1. Sampling procedure

All children and adolescents referred from January 2010 to December 2013 to the Child Neuropsychiatry Unit of the Bambino Gesu' Children's Hospital in Rome (Italy) were included in the present study. The Bambino Gesu' Children's Hospital is a National Children Hospital tertiary referral center which include a Child Neuropsychiatry Unit and accepts referrals from anywhere in Italy.

All children and adolescents referred to the Child Neuropsychiatry Unit for a diagnostic assessment: first diagnosis and/or diagnostic follow-up. All of them underwent a complete diagnostic evaluation throughout a multidisciplinary team (i.e., pediatric neuropsychiatrists and psychologists, pediatricians and speech therapists). Diagnoses were recorded from the individual's files and not assigned for the aim of the present study. All psychiatric disorders were clinically assessed according to DSM-IV-TR criteria (American Psychiatric Association, 2000). For the aim of this study, ASD and ID were evaluated. However, all psychiatric conditions were also monitored [including Attention-Deficit/Hyperactivity Disorder (ADHD), anxiety disorders, trauma and stressor related disorders, etc.].

2.2. Autism diagnostic evaluation

The ASD diagnosis were based on clinical assessment, and in the majority of cases were corroborated by the Autism Diagnostic Observation Schedule-Generic (ADOS-G) performed by a licensed clinician (Lord, Risi, Lambrecht, Cook, & Leventhal, 2000). The ADOS-G is a semi-structured, standardized, play-based assessment measure evaluating current autistic behaviors. The ADOS-G is divided into four separate modules. Each module is aimed at a specific level of expressive language ability. The choice of modules is based on the child's expressive language level. The use of different

modules reduces possible biasing effects of differences in language skills. Scoring is done immediately after administration of the ADOS-G. Each item is scored on a 0–3 scale (0 = no evidence of abnormal behavior to 3 = markedly abnormal behavior) and each module has a specific diagnostic algorithm. Items used in the algorithms are divided into four areas: Communication, Social Interaction, Play/Creativity, and Restricted/Repetitive Behaviors or Interests (RRB). The total score for communication and social interaction provides a cut-off for diagnosis at various "levels of ASD".

2.3. Developmental and cognitive ability and adaptive functioning assessment

To assess the developmental and cognitive ability we used the Griffiths Mental Developmental Scale-Extend Revised (GMDS-ER) and the Leiter International Performance Test-Revised (Leiter-R) (Leiter, 1979; Griffiths, 2006; Roid & Miller, 1997). Our choice of the use of the GMDS-ER (which assess the developmental ability) was driven by previous literature reports which used this measure to evaluate cognitive abilities for children from birth to 8 years (Begovac et al., 2009; Giovagnoli et al., 2015; Hedvall et al., 2013; Kothari, Rosinska, Treasure, & Micali, 2014; Sutcliffe, Soo, & Barnes, 2010). As reported in previous studies, the Griffith's Developmental Quotients (DQs) for the total scores obtained were converted to IQ equivalents in order to obtain a score corresponding to intelligence quotient points.

An individual received the GMDS-ER or the Leiter-R according to age: GMDS-ER from birth to 8 years and Leiter-R from 2–18 years. Given that both measures were available for 2 to 8 years children, the choice of the test was based on the ability of each child to perform it. In more detail, for all 2–8 years old children included in the study, we initially tried to perform the Leiter-R, which is a structured, standardized assessment that requires the ability to perform a structured activity. All of children that were not able to seat at the table, maintain attention and interest, and follow the non-verbal instructions of the Leiter-R, completed the GMDS-ER.

Furthermore, given that the new the DSM-5 defines the levels of ID severity on the basis of adaptive functioning level, children's adaptive skills were assessed. In more detail, parents of the participating children were interviewed by a trained and experienced clinician through the Vineland Adaptive Behavior Scale-Survey Form (VABS-SF) (American Psychiatric Association, 2000, 2013; Balboni & Pedrabissi, 2003; Sparrow, Balla, & Cicchetti, 1984).

The GMDS-ER assess the child's strengths and weaknesses in all developmental areas, and can be used to measure the rate of development for children from birth to 8 years of age. The six areas of development measured by the scales include: (A) Locomotor, measuring the gross motor development; (B) Personal-Social, examining the social and daily living skills; (C) Hearing and Speech, measuring impressive and expressive language; (D) Eye-Hand Coordination, focusing on fine motor skills, manual dexterity and visual monitoring skills; (E) Performance, focusing on manipulation of objects; (F) Practical Reasoning, measuring the mathematic ability and abstract reasoning. Each subscale provides a different developmental quotient and a diagnostic indication of individual problems in early childhood. Griffith's six subscales are expressed as quotients to constitute the Developmental Quotient (DQ). The DQ is derived from the average of quotients resulted from the six subscales assessed. The test scores are transformed into Developmental Ages (DA) and then into Quotients according to the following equation: Developmental Quotient (DQ) = DA $\times$ 100/Chronological Age (CA). DQs rather than mental age are used so as to make possible to compare children of different chronological ages and to compare a child's performance at different time periods.

The Leiter-R is a nonverbal intelligence test of cognitive abilities for children from 2 to 18 years (Roid & Miller, 1997). It consists of 2 nationally standardized batteries: 1. Visualization and Reasoning (VR) domains for measuring IQ; 2. Attention and Memory (AM) domains. In the present study, four subtests (Figure Ground, Form Completion, Sequential Order and Repetitive Pattern) of the VR domains were administered. Based on these four subtests, the Leiter–R yields a standardized nonverbal Brief IQ score. Each of the subtests used and Brief IQ scores has shown excellent validity and reliability.

The VABS-SF is a standardized parent interview of everyday adaptive functioning, designed to measure adaptive behaviors in children from birth to 18 years. It consists of 297 items divided in four general domains of functioning: Communication, Daily Living, Social and Motor Development. The communication domain assesses receptive, expressive, and written skills according to age level. The daily living domain taps personal, domestic, and community skills. For the social domain, the child is rated on interpersonal relationship skills, socialization during play and leisure time, and coping skills. The motor domain includes development of gross and fine motor skills. This domain is used to assess motor skills until age 5. An adaptive behavior composite score for each of the four domains was attained for all participants and transformed into Equivalent Ages (EA) basing on published Italian norms (Balboni & Pedrabissi, 2003).

2.4. Data analysis

The data were analyzed using the Statistical Software Package (SPSS), Version 20.0. Descriptive analyses were used, and variables are presented as either mean $\pm$ SD, or frequency. Prevalence rates of Table 1 were calculated on the total number of patients referred for a first diagnosis. 95% confidence intervals are provided for estimating proportions. Prevalence rates of developmental and cognitive ability were calculated on the total number of children assessed. Moreover, chi-square tests were performed for dichotomous variables, and independent sample *t*-test for continuous variables. An alpha level of 0.05 was set for statistical significance.

Table 1
Number of cases and prevalence rates of diagnostic categories for patients ($N = 5375$) referred for a first diagnosis from January 2010 to December 2013.

	2010			2011			2012			2013			2010-2013		
	Males	Females	Age	Males	Females	Age	Males	Females	Age	Males	Females	Age	Males	Females	Age
	N (%)		Mean ± SD[a]	*N* (%)		Mean ± SD	*N* (%)		Mean ± SD	*N* (%)		Mean ± SD	*N* (%)		Mean ± SD
ASD[b]	193 (3.59)	42 (0.78)	5.62 ± 3.08	174 (3.23)	42 (0.78)	6.14 ± 3.77	152 (2.82)	35 (0.65)	5.81 ± 3.44	24 (0.44)	4 (0.07)	6.13 ± 2.78	543 (10.1)	123 (2.28)	5.92 ± 3.26
ADHD[c]	121 (2.25)	24 (0.44)	8.25 ± 2.56	106 (1.97)	20 (0.37)	8.51 ± 2.52	103 (1.91)	30 (0.55)	8.70 ± 2.65	33 (0.61)	7 (1.13)	8.12 ± 3.00	363 (6.75)	81 (1.50)	8.39 ± 2.68
Anxiety disorders	78 (1.45)	79 (1.46)	10.0 ± 3.97	65 (1.20)	49 (0.91)	10.9 ± 3.90	50 (0.93)	19 (0.35)	10.7 ± 3.40	27 (0.50)	15 (0.27)	10.3 ± 3.15	220 (4.09)	162 (3.01)	10.4 ± 3.60
Trauma and SRD[d]	39 (0.72)	37 (0.68)	9.64 ± 4.04	28 (0.52)	25 (0.46)	8.57 ± 4.40	31 (0.57)	38 (0.70)	7.15 ± 3.95	5 (0.09)	1 (0.01)	9.87 ± 5.36	103 (1.91)	101 (1.87)	8.80 ± 4.43
CD[e]	208 (3.86)	76 (1.41)	5.15 ± 2.50	158 (2.93)	69 (1.28)	4.61 ± 1.81	163 (3.03)	82 (1.52)	5.08 ± 2.18	31 (0.57)	17 (0.31)	4.96 ± 2.03	560 (10.4)	244 (4.53)	4.95 ± 2.13
Feeding and ED[f]	26 (0.48)	123 (2.28)	13.5 ± 3.45	19 (0.35)	62 (1.15)	13.2 ± 3.78	37 (0.68)	87 (1.61)	12.7 ± 3.62	3 (0.05)	12 (0.22)	13.6 ± 3.06	85 (1.58)	284 (5.28)	13.2 ± 3.47
ID[g]	67 (1.24)	43 (0.8)	9.24 ± 3.91	64 (1.19)	41 (0.76)	9.55 ± 3.61	77 (1.43)	34 (0.63)	7.61 ± 3.54	26 (0.48)	15 (0.27)	9.29 ± 3.19	234 (4.35)	133 (2.47)	8.92 ± 356
OCD[h]	12 (0.22)	4 (0.07)	13.4 ± 3.21	6 (0.11)	7 (1.13)	13.0 ± 3.70	6 (0.11)	5 (0.09)	11.7 ± 3.48	–	–	–	24 (0.44)	16 (0.29)	12.7 ± 3.46
SLD[i]	246 (4.57)	170 (3.16)	10.0 ± 2.65	281 (5.22)	161 (2.99)	10.0 ± 2.76	282 (5.24)	169 (3.14)	10.0 ± 2.59	47 (0.87)	21 (0.39)	10.2 ± 2.67	856 (15.9)	521 (9.69)	10.0 ± 2.66
Motor disorders	15 (0.27)	5 (0.09)	9.94 ± 4.03	15 (0.27)	10 (0.18)	7.74 ± 4.05	7 (1.13)	3 (0.05)	8.48 ± 3.67	4 (0.07)	2 (0.03)	5.97 ± 2.61	41 (0.76)	20 (0.37)	8.03 ± 3.59
SSD[j]	4 (0.07)	3 (0.05)	14.7 ± 2.71	4 (0.07)	6 (0.11)	12.8 ± 2.32	13 (0.24)	8 (0.14)	13.6 ± 2.41	2 (0.03)	-	9.67 ± 9.19	23 (0.42)	17 (0.31)	12.6 ± 4.15
Mood disorders	19 (0.35)	13 (0.24)	12.7 ± 4.16	9 (0.16)	13 (0.24)	14.0 ± 2.63	12 (0.22)	14 (0.26)	12.5 ± 3.34	14 (0.26)	13 (0.24)	14.3 ± 2.90	54 (1.00)	53 (0.98)	13.3 ± 3.25
DC[k]	10 (0.18)	6 (0.11)	12.4 ± 3.04	34 (0.63)	10 (0.18)	11.0 ± 3.77	20 (0.37)	6 (0.11)	9.26 ± 4.46	3 (0.05)	2 (0.03)	10.5 ± 3.60	67 (1.24)	24 (0.44)	10.7 ± 5.42
Other[l]	99 (1.83)	63 (1.17)	9.20 ± 3.19	85 (1.58)	48 (0.89)	7.53 ± 1.11	57 (1.05)	30 (0.55)	8.78 ± 2.81	28 (0.52)	13 (2.24)	5.79 ± 0.93	269 (5.00)	154 (2.86)	8.16 ± 4.43

[a] Standard deviation.
[b] Autism spectrum disorder.
[c] Attention-deficit/hyperactivity disorder.
[d] Trauma and stressor related disorders.
[e] Communication disorders.
[f] Feeding and eating disorders.
[g] Intellectual disability.
[h] Obsessive compulsive and related disorders.
[i] Specific learning disorder.
[j] Schizophrenia spectrum and other psychotic disorders.
[k] Disruptive, impulse-control, and conduct disorders.
[l] Personality disorders, somatic symptoms and related disorders, elimination disorders, global developmental delay and genetic conditions.

3. Results

3.1. Study population

Recruitment procedure and participation rates are depicted in Fig. 1.

A total of 7927 children and adolescents (5185 males, mean age ± SD: 8.20 ± 3.84, and 2742 females, mean age ± SD: 9.37 ± 4.29) referred from January 2010 to December 2013 to the Child Neuropsychiatry Unit for a diagnostic assessment. Of them, a total of 5375 (68.8%) patients referred for a first diagnosis, and 2552 (32.2%) patients referred for a diagnostic follow-up.

Table 1 shows the demographic characteristics and prevalence rates of diagnostic categories for patients referred for a first diagnosis.

Overall, 666 cases were diagnosed with an ASD (12.3% of the referred patients for a first diagnosis, age range 2–17 years, mean age ± SD: 5.54 ± 2.84). All of them were assessed for the presence of ASD symptoms by an autism expert multidisciplinary team (i.e., pediatric neuropsychiatrists and psychologists, pediatricians and speech therapists) and received an ASD diagnosis according to DSM-IV-TR criteria (Table 1). Of them, 543 were males and 123 were females with a male: female ratio of 4:1. Of the total sample with a diagnosis of ASD, only 532 participants performed the ADOS-G with a licensed clinician: 372 participants Module 1 (296 males and 76 females; Total score: mean ± SD: 14.0 ± 4.79), 114 participants Module 2 (90 males and 24 females; Total score: mean ± SD: 12.3 ± 3.94), 45 participants Module 3 (42 males and 3 females; Total score: mean ± SD: 11.8 ± 4.25) and 1 male participant Module 4 (Total score: mean: 6.00).

3.2. Prevalence rate of ID in ASD

Of the 666 children with a diagnosis of ASD, only 592 participants performed a developmental and cognitive evaluation, and were included in our analysis. In more detail, 60.8% performed the GMDS-ER (mean age ± SD: 4.13 ± 1.61, age range 2–8 years; Males: mean age ± SD: 4.11 ± 1.61; Females: mean age ± SD: 4.20 ± 1.63; DQ: mean ± SD: 65.21 ± 22.04), and 39.2% performed the Leiter-R (mean age ± SD: 7.84 ± 3.19, age range 2–17 years; Males mean age ± SD: 7.81 ± 3.18; Females, mean age ± SD: 7.97 ± 3.25; Brief IQ: mean ± SD: 87.84 ± 24.55).

A total of 282 (47.6%, 95% CI: 43.6–51.6) reported a DQ/Brief IQ < 70: 225 participants (38%, 95% CI: 34.1–41.9) assessed through the GMDS-ER, and 57 participants (9.6%, 95% CI: 7.5–12.2) evaluated through the Leiter-R. Whereas a total of 310 (52.4%, 95% CI: 48.3–56.3) reported a DQ/Brief IQ > 70: 135 participants (22.8%, 95% CI: 19.6–26.3) assessed through the GMDS-ER, and 175 participants (29.6%, 95% CI: 26.0–33.3) evaluated through the Leiter-R.

Table 2 shows the distribution of developmental and intellectual quotients of the ASD sample with a developmental and cognitive evaluation.

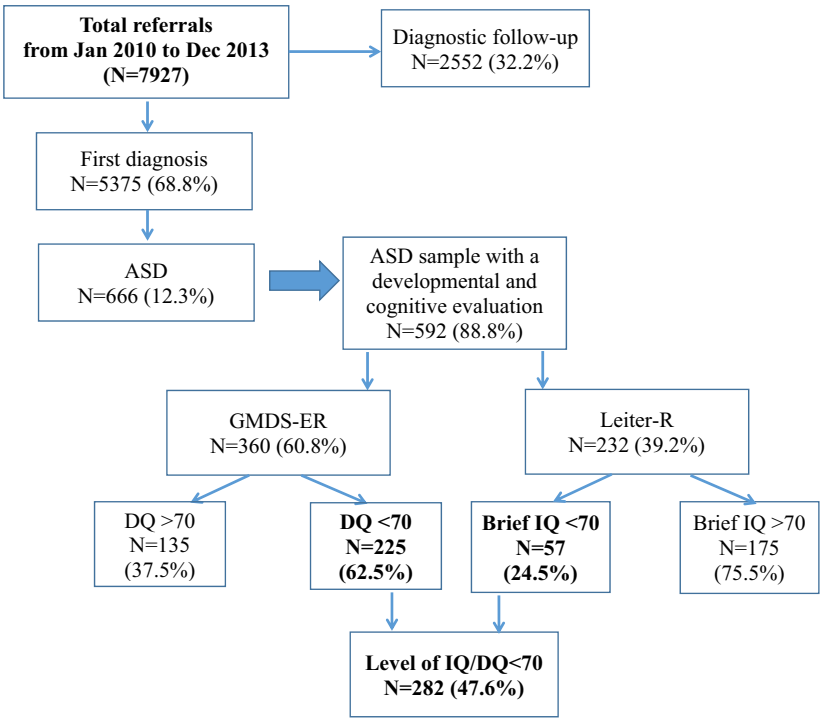

Fig. 1. Recruitment procedure and participation rates.

Table 2
Level of developmental and intellectual quotients of the ASD sample with a developmental and cognitive evaluation ($N = 592$).

	GMDS-ER ($N = 360$)[a]				Leiter-R ($N = 232$)[b]			Total sample ($N = 592$)			
	Males	Females	Total		Males	Females	Total	Males	Females	Total	
DQ and Brief IQ[c]	(N)%[d]	(N)%	(N)%	95% CI[e]	(N)%	(N)%	(N)%	95% CI	(N)%	(N)%	(N)% 95% CI
<40	(37) 10.2	(8) 2.22	(45) 12.4	9.4–16.3	(7) 3.01	(3) 1.29	(10) 4.30	2.3–7.7	(44) 7.44	(11) 1.86	(55) 9.30 7.2–11.9
40–54	(52) 14.4	(21) 5.83	(73) 20.2	16.4–24.7	(14) 6.03	(7) 3.01	(21) 9.04	6.0–13.4	(66) 11.1	(28) 4.73	(94) 15.8 13.1–19.0
55–69	(88) 24.4	(19) 5.27	(107) 29.6	25.2–34.6	(25) 10.7	(1) 0.43	(26) 11.1	7.7–15.9	(113) 19.1	(20) 3.38	(133) 22.5 19.2–26.0
70–84	(56) 15.5	(16) 4.44	(72) 19.9	16.1–24.4	(38) 16.3	(5) 2.15	(43) 18.4	14.0–24.0	(94) 15.8	(21) 3.55	(115) 19.4 16.4–22.8
85–114	(48) 13.3	(10) 2.77	(58) 16.0	12.6–20.2	(94) 40.5	(14) 6.03	(108) 46.5 40.2–52.9	(142) 24.0	(24) 4.10	(166) 28.1	24.5–31.7
>115	(2) 0.55	(3) 0.83	(5) 1.38	0.5–3.2	(20) 8.62	(4) 1.72	(24) 10.3	7.0–14.9	(22) 3.72	(7) 1.18	(29) 4.90 3.4–6.9

[a] Griffiths Mental Developmental Scale-Extend Revised;
[b] Leiter International Performance Test-Revised;
[c] General Developmental Quotient and Brief Intelligence Quotient;
[d] Actual number and weighted %;
[e] 95% Confidence Interval.

Table 3
Adaptive functioning of the ASD sample assessed through the VABS-SF.

	GMDS-ER ($N = 327$)[a]			Leiter-R ($N = 180$)[b]			Total sample ($N = 507$)		
	Males	Females	Total	Males	Females	Total	Males	Females	Total
VABS-SF[c]	Mean[d] ± SD[e]	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Communication Skills	1.94 ± 0.81	2.04 ± 1.13	1.96 ± 0.89	5.20 ± 2.83	4.43 ± 2.88	5.09 ± 2.84	3.15 ± 2.42	2.72 ± 2.09	3.07 ± 2.36
Daily living Skills	2.27 ± 0.60	2.28 ± 0.69	2.27 ± 0.62	4.66 ± 2.47	4.60 ± 2.86	4.65 ± 2.52	3.16 ± 1.49	2.94 ± 1.92	3.11 ± 1.95
Social skills	1.96 ± 0.48	1.92 ± 0.49	1.95 ± 0.48	3.70 ± 1.92	3.50 ± 2.54	3.67 ± 2.02	2.61 ± 1.49	2.37 ± 1.57	2.56 ± 1.51
Motor skills[f]	2.52 ± 0.69	2.49 ± 0.77	2.52 ± 0.71	3.26 ± 0.74	3.94 ± 0.75	3.32 ± 0.76	2.62 ± 0.74	2.58 ± 0.84	2.61 ± 0.76

[a] Adaptive functioning skills for the ASD sample evaluated though the Griffiths Mental Developmental Scale-Extend Revised.
[b] Adaptive functioning skills for the ASD group evaluated through the Leiter International Performance Test-Revised.
[c] Vineland Adaptive Behaviour Scale-Survey-Form.
[d] Mean equivalent ages.
[e] Standard deviation.
[f] Motor skills domain was evaluated for $n = 284$.

Furthermore, a total of 507 parents of children and adolescents with ASD completed the VABS-SF. Table 3 shows the adaptive functioning of the ASD sample assessed through the VABS-SF according to the developmental and cognitive evaluation performed.

All the parents of children with ASD and a DQ/Brief IQ < 70 who completed the VABS-SF ($N = 253$) reported their children as having an EA below their CA in the VABS-SF skill domains.

3.3. Comorbid ID in ASD: gender differences

There was no difference between gender either in the DQ (Males, $N = 283$: mean ± SD: 65.20 ± 21.26; Females, $N = 77$: mean ± SD: 65.23 ± 24.85; t:−0.013; $p = 0.990$) or in the Brief IQ (Males, $N = 198$: mean ± SD: 88.90 ± 23.92; Females, $N = 34$: mean ± SD: 81.65 ± 2750; t: 1.597; $p = 0.112$).

Moreover, there was no difference between individuals with an IQ/DQ < 70 ($N = 282$) or >70 ($N = 310$) according to gender (X^2:1.668, $p = 0.207$).

Differences between gender in individuals with ASD and a Brief IQ < 70 ($N = 57$), showed significantly higher score in males as compared to females on Brief IQ (mean ± SD: 56.02 ± 11.67 vs 47.45 ± 9.84, t: 2.246; $p = 0.029$). However, no difference between gender was found in individuals with ASD and a DQ < 70 ($N = 225$) on DQ (mean ± SD: 52.24 ± 13.20 vs 50.02 ± 12.62, t: 1.041; $p = 0.299$). Finally, no difference between genders was found in any VABS-SF skill domain.

4. Discussion

ASD is characterized by an extreme individual variability, and one of the most important factor that contributes to this heterogeneity is the intellectual ability. Given that the level of intellectual functioning could be considered as a clinical indicator of ASD subtypes, unifying cognitive characteristics in people with ASD is a matter of ongoing research. Moreover, literature studies have proven that intelligence in autism is a good predictor for adult outcome, thus essential in clinical practice in order to choose the most appropriate intervention (Begovac et al., 2009; Volkmar & Pauls, 2003). Even though there is a long-lasting belief that the vast majority of individuals with autism have a comorbid ID, recently this assumption was reconsidered. Confirming studies reporting that even less than half of individuals with ASD have a co-occurring ID, in our study we found a

prevalence of ID in children and adolescents with ASD of 47.6% (Baird et al., 2000; Bertrand et al., 2001; Bolte & Poustka, 2002; Carlsson et al., 2013; Chakrabarti & Fombonne, 2005; Charman et al., 2011). Moreover, in line with the proportion reported in previous studies only 25.1% had moderate to severe ID (IQ/DQ < 50), whereas 28.1% had average intelligence (114 > IQ/DQ > 85) and 4.9% had above average intelligence (IQ/DQ > 115) (Table 2) (Charman et al., 2011). Indeed, as reported in a previous study, we found no difference between genders on cognitive functioning (Postorino et al., 2015).

It is worth to note that intelligence estimates vary greatly in autism according to the instrument used for the assessment (Barbeau & Zeffiro, 2013; Soiulieres et al., 2011; Dawson, Soulie'res, Gernsbacher, & Mottron, 2007). Intelligence tests have been standardized using typical samples, thus they may not be appropriate for individuals with ASD. Undoubtedly, these issues have implications that definably affect the prevalence of ID in autism. In line with these observations, we found that the prevalence of ID in our sample of individuals with ASD varied according to the evaluation performed. Specifically, 62.5% of the individuals with ASD assessed through the GMDS-ER reported a DQ < 70, whereas only 24.5% of the individuals with ASD assessed through the Leiter-R reported a Brief IQ < 70. Regarding adaptive behavior level, research indicates that children with ASD need more support in the everyday management as compared to children with similar cognitive and developmental abilities without autism (Malhi & Singhi, 2015). Moreover, adaptive functioning seems to be related to levels of intellectual ability in children with ASD: children with ID generally show relative more strengths in their adaptive skills, despite their low IQs (Kanne et al., 2011; Malhi & Singhi, 2015). According to these data, we found that all the individuals with ASD and an IQ/DQ < 70 reported an EA below their CA in the VABS-SF skill domains. Moreover, previous studies reported that the assessment of adaptive functioning is particularly important in individuals with ASD due to the impairment that these individuals exhibit in the socialization and communication domains (Bolte & Poustka, 2002). In line with these results, we found that our ASD sample showed higher EA means in the daily living domain, lowest in socialization, and intermediate in communication. In fact, studies suggest that individuals with ASD need extensive support and generally have few close relationships failing to achieve a good outcome despite an average IQ (Engstrom, Ekstrom, & Emilsson, 2003; Eaves & Ho, 2008; Howlin, Savage, Moss, Tempier, & Rutter, 2014; Malhi & Singhi, 2015). Therefore, adequate treatments improving adaptive functioning abilities in individuals with autism are essential for better outcomes (Farley et al., 2009; Howlin et al., 2014).

To our knowledge, this study is the first epidemiological survey on the prevalence of ID in a large sample of Italian children and adolescents with ASD. In fact, to date only one previous study was conducted in Italy on the co-occurrence of ASD and ID (La Malfa et al., 2004). However, La Malfa et al. (2004), assessing the prevalence of PDD in sample of patients with ID, explored a completely different aim (La Malfa et al., 2004). Moreover, the results of our study are difficult to be compared with the results of La Malfa et al. (2004) due to the fact that they evaluated a consistently smaller sample through different intelligence measures relative to the measures we used.

These findings have to be interpreted in light of certain limitations. The first important limitation is the particular sampling framework that we adopted in this study. We only screened children and adolescents referred to a National Children Hospital tertiary referral center for a first diagnosis and/or a diagnostic follow-up. Thus, our sample was clinically referred and not intended to be representative of children with ASD in the general population. Since this is a cross-sectional study we are not able to understand how the profile of IQ/DQ and adaptive functioning levels change over time for individuals with ASD. Although the majority of studies suggest the stability of IQ scores, a very high variability of cognitive performance is known at the earliest ages (Begovac et al., 2009). Therefore, another important limitation is related to the fact that our sample included a large age range (2 to 17 years). Furthermore, is important to underline that part of the reason our findings of ID prevalence in ASD looks different from previous studies might be related to the fact that we used different measures to evaluate the development and cognitive ability compared to other researches. Therefore, it could be possible that if we had used more traditional measures we could have found similar results. Finally, given the fact that prevalence rates of ID in autism vary according to the instruments used for the assessment, our prevalence of ID in ASD could be affected by the use of two different measures (GMDS-ER and Leiter-R).

5. Conclusions

In conclusion, besides these limitations, our study has added new insight into the existing knowledge on the prevalence of ID in ASD, documenting the rates of a country for which these data were missing. Shedding light on the epidemiology of ID in ASD is a crucial issue for clinicians and researchers in order to better define methodological and conceptual problems that needs to be further addressed. Although one common view is that there is a high prevalence of association between ID and ASD, we found that even less than half of individuals with ASD have a co-occurring ID. Therefore, it is of fundamental importance the correct assessment of cognitive abilities in individuals with autism. In fact, underestimate intelligence ability in individuals with ASD could affect their long-term outcomes and have a negative impact on their opportunities in everyday life. For this reason, the choice of the appropriate intelligent measure to perform is an essential procedure in clinical practice, and the diagnostic challenges concerning intelligence measures have underlined the need of proper screening tools, specifically designed for this population. Finally, given that the majority of individuals with ASD need extensive support and fail to achieve a good outcome despite an average intellectual ability, recent studies have recognized that adaptive abilities play an important role in the diagnosis, treatment and prognosis of autism (Engstrom et al., 2003; Eaves & Ho, 2008; Howlin et al., 2014; Malhi & Singhi, 2015). Therefore, further researches are needed in order to understand the relationship between adaptive skills, intelligence ability and severity of autism symptoms, and to help clinicians to choose the most appropriate intervention and develop adequate treatment strategy.

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