**Developmental outcomes in adolescence of children with autism spectrum disorder without intellectual disability: a systematic review of prospective studies**

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1. **Introduction**

Autism spectrum disorder (ASD) is a complex neurodevelopmental disorder characterized by persistent difficulties with social communication and interactions, as well as restrictive, repetitive, and stereotyped patterns of behavior, activities, and interests (APA, 2013). Despite the variability in the data across different geographical areas, epidemiological studies indicate a global increase in the prevalence rates of ASD. Recent reviews of studies performed in different countries estimated an average prevalence for the whole ASD spectrum of 0.7-1% (Fombonne, 2009; Elsabbagh et al., 2012; Hill et al., 2014). Moreover, the percentage of cases in 8-year-old children has increased in the US from 1 in 68 in 2012 to 1 in 59 in 2014 according to reviews of health and educational records. Such increase has occurred mainly in the ASD subgroup without intellectual disability (ID), that is, high functioning autism and its prevalence corresponds to approximately two-thirds of the population with ASD (25% in the borderline range, IQ= 71-85, and 44% with IQ scores in the average to above-average range, IQ > 85) (Baio et al., 2018).

Intellectual functioning has potential value in examining the considerable variability in the behavioral expression of the disorder and providing information about the ASD phenotype in the subgroup without ID. A growing body of literature reports that cognitive, social and behavioral impairments is likely to occur in persons with ASD of various levels of intellectual functioning (Matson and Williams, 2013). Despite having an ~~normal~~ average or above IQ ~~on average~~, many children and adolescents with autism have difficulties to initiate and maintain relationships, marked lack of interest in their peers, and their social interactions are more impaired (MacIntosh and Dissanayake, 2006). In line with the adaptive/social difficulties, the rates of comorbid depression and anxiety disorders seem higher in children with ASD-without ID than in children with low-functioning autism (Greenlee et al., 2016; Kurzius-Spencer et al., 2018; Mayes et al., 2011; Rai et al., 2018). Moreover, the variability in the performance of individuals with autism across the spectrum and across academic areas is quite noteworthy. Even though many children at the high end of the spectrum show areas of strength, they underperformed in other areas, particularly in reading comprehension (Keen et al., 2016).

In terms of theories on the neuropsychological deficit underpinning ASD, there has bene a particular focus on executive functioning (EF), theory of mind (ToM), and central coherence (CC). EF, defined as a complex network of mental processes that enable self-regulation and self-directed behaviors, has been shown to be part of the broader endophenotype in ASD (Ozonoff, 1995). Executive dysfunction in children and adolescents with ASD-without ID is characterized by moderate impairments in verbal and spatial working memory, flexibility, planning, and generativity (Lai et al., 2017). ToM deficits, expressed as considerable difficulties in making inferences about other people's mental states (Baron-Cohen, 1995), have been found also in children and adolescents with ASD-without ID (Bühler et al., 2011; Cantio et al., 2016). These problems have been identified on structured ToM tests and in multidimensional real-life situations which require more complex and ecological skills, suggesting a complex meta-representational deficit (Hutchins et al., 2016). Finally, another cognitive description of ASD refers to “weak central coherence”, characterized by bias toward a processing focused on details to the detriment of the whole (Happe and Frith, 2006). CC problems are more prevalent in children and adolescents with ASD-without ID than in typically developing individuals, although findings are contradictory (Burnette et al., 2005; Lam, 2013) due to factors such as the type and complexity of the task used for the assessment (Van Eylen et al. 2018) or the presence of clues and instructions that influence performance variability (López et al., 2004).

In summary, cross-sectional studies have provided valuable information about the

clinical profile of children and adolescents with ASD-without ID. However, it is essential to better define the trajectories of their development across time and identify risk factors and early predictors associated with the outcomes. Prospective studies may allow us to better understand the developmental pathways of ASD. Various systematic reviews of longitudinal studies of people with autism in adulthood published in the past decade (e.g., Howlin and Magiati, 2017; Magiati et al., 2014; Steinhausen et al., 2016) highlighted poor outcomes in general and especially with regards to social integration, job prospects and mental health comorbidity. Despite the potential interest of this topic, to our knowledge, no systematic review of prospective studies has focused on the transition of children with ASD-without ID from childhood to adolescence. This developmental period is highly relevant as it carries a special vulnerability for individuals with ASD, given significant changes in behavior, neural organization and the increase of social demands (see Picci & Scherf, 2015). Therefore, the purpose of the present study was to explore the trajectories of children with ASD-without ID during a fundamental period of their adaptive, interpersonal, and academic development which in the majority of Western societies corresponds to mandatory education (Primary and Secondary stages). The specific aims of this systematic review of longitudinal studies were: (1) to describe the participants’ demographic and clinical characteristics; (2) to report on the outcomes in different domains of functioning, such as ASD symptoms severity, IQ, cognitive explanations for ASD (ToM, EF, and CC), adaptive/social behavior, comorbidities, and academic functioning; and (3) to examine possible childhood predictors of later outcomes across the studies. The review of this body of literature could potentially help to better understand essential factors in the development of the largest subgroup within the spectrum of autism, i.e., ASD children without ID, and inform possible modifications to care plans tailored to meet specific needs. Given the exploratory nature of our systematic review, no a priory hypotheses on predictors of outcomes were made.

**2. Methods**

We followed the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines (Moher et al., 2009) to develop this systematic review and pre-registered the protocol in PROSPERO (CRD42020189029).

**2.1 Literature search**

The search, developed with the support of a librarian at the Imperial College, London, was limited to empirical, original studies published in English in peer-reviewed journals between January 1st 2010 and January 1st 2020.The start date for the search was chosen after that a scoping search conducted while we were planning the systematic review found no relevant papers published before 2010 (see appendix A in the supplemental material). We searched PubMed, PsycINFO and Educational Resources Information Centre (ERIC). Several combinations of the following keywords were used: (autis\* or "autistic disorder" or "pervasive developmental disorder" or "autism spectrum disorder" or "Asperger syndrome" or "high functioning autism") and (child\* or adolescen\* or teen\*) and ("follow-up" or "longitudinal study")
 ~~(autis\* or “autistic disorder” or “pervasive developmental disorder” or “autism spectrum disorder” or “Asperger syndrome” or “high functioning autism”), combined with (child\* or adolescen\* or teen\*) and (“follow-up” or ”longitudinal study”).~~ Additional details on the search strategy are reported in Appendix B. ~~As per published protocol,~~ .We did not search the grey literature ~~as this was beyond the scope of the present work~~.

The first author carried out the initial search in the electronic databases with the advice of the specialist librarian from Imperial College, London. Two authors (RR, AM) independently screened titles and abstracts of each study, using the program Covidence (https://www.covidence.org/). Disagreements between authors were resolved by consensus in regular meetings held to ensure agreement.

**2.2 Eligibility Criteria**

*Inclusion criteria*: 1) Longitudinal studies published in English with at least one follow-up assessment during mid-childhood or adolescence (mean age at follow-up < 18 years old); 2) Studies with data allowing us to evaluate possible changes in ASD symptoms, IQ, cognitive skills, adaptive/social skills, comorbidity or academic competence; 3) Participants with a clinical diagnosis of ASD, Asperger’s Syndrome, autism, or Pervasive Developmental Disorders Not Otherwise Specified (PDD-NOS), according to the ICD-10, DSM-IV, DSM-IV TR, DSM-5, ADOS, and/or ADI-R; 4) Participants without Intellectual Disability (mean IQ equal to or > 70).

*Exclusion criteria*: 1) Publications without data and a clear peer-review process: editorials, extended abstracts, doctoral dissertations, symposium papers, research abstracts, book chapters, or proceedings, systematic reviews, and survey papers; 2) follow-up studies of pharmacological or psychoeducational interventions; 3) follow-up studies assessing physical or neurological conditions; 4) Case series with fewer than 10 participants because the representativeness of the studies, as well as the validity and generalizability of the findings, can be negatively affected by small sample sizes (Magiati et al., 2014).

**2.3 Data extraction**

Two authors (RR, AM) extracted data from the full text and compared their extraction to assure accuracy; any disagreement was resolved by consensus. Data extracted was organized in three sections; 1) addressing the characteristics of the participants, 2) the contents of the articles included regarding outcomes in adolescence (ASD severity, IQ, ToM, EF, CC, adaptive/social functioning, psychiatric comorbidities or academic performance), and 3) childhood predictors of later outcomes.

**2.4 Study quality assessment**

The quality of the reporting of each study was assessed according to a standardized and validated set of criteria based on the protocols of the “STROBE Reporting Guidelines for writing and reading observational studies in epidemiology” (von Elm et al., 2014). The screening evaluation followed included 19 items from STROBE related to the introduction (3 items), methods (9 items), results (2 items), and discussion (4 items) sections, as well as other information (1 item about ethics). For each criterion, two of the authors assigned scores of 2, 1, or 0, depending on whether it was completely fulfilled, partially fulfilled, or not fulfilled at all. Initial disagreement between authors was resolved by consensus.

**3. Results**

Initially, 4541 potentially relevant records were identified~~:~~ (2498 in PubMed, 1702 in PsycINFO, and 341 in ERIC) and loaded into Covidence (https://www.covidence.org/). Of these, 1366 were excluded due to duplication. Of the remaining 3175 references, studies were first screened by title or abstract independently by two authors (RR, AM), according to the inclusion and exclusion criteria: 3126 were eliminated because they dealt with contents that were not related to the topic (i.e., interventions; risk factors/causes; comorbidity with medical conditions; surgeries; diagnosis/evaluation; adults; prevalence/epidemiology; studies that were not longitudinal; or focus on family). In the next phase of the selection process, full-texts were examined by the authors (RR, AM) and the initial percentage of agreements for the 49 references was 92%. After consensus was reached through discussion, a total of 26 articles were selected and with the addition of two other articles that were located through references found in other publications, a total of 28 were identified eligible (Figure 1).

**-Insert Figure 1-** Fig. 1 PRISMA flowchart outlining the trial selection

**3.1 Study quality assessment**

The overall quality of the articles was as follows: one article met 100% of the criteria, ten articles met 90%, 13 articles met between 80%-90%, and four articles obtained scores indicating less than 80% agreement with the established criteria (Appendix C).

**3.2 Participant characteristics**

The following data on the participants characteristics in each study are reported in Table 1: (1) characteristics of participants with ASD at baseline: number of subjects and male/female proportion, ASD diagnostic criteria, mean age, and mean IQ; (2) time of the follow-up assessment and characteristics of participants with ASD at the follow-up: number of subjects, mean age, and mean IQ. Moreover, when the study provided this information, Table 1 also includes: (3) characteristics of participants with typical development (TD) at baseline: number of subjects, mean age, mean IQ; and (4) characteristics of participants with TD at follow-up: mean age and mean IQ.

**-Insert Table 1-**

The number of ASD participants at baseline ranged from 21 to 114, with a median sample size of 55. Two studies had fewer than 30 participants (Cantio et al., 2018; Mandy et al. 2016), and two studies had more than 100 (Eussen et al., 2015, 2016). In three studies, the male/female ratio was below 70% (Louwerse et al., 2015; May et al., 2014, 2015), whereas in 17, the ratio was above 80%. Due to the very small number of females included in most of the studies, only one study did examine gender as a fundamental factor in analyzing the outcomes (May et al., 2014). The age at intake assessment ranged from 3 years old (Asberg et al., 2019) to 13.2 years old (Scheren et al., 2019); in 12 studies, the participants were between 9 and 10 years old in the first assessment. The mean Full Scale IQ (FSIQ) at baseline, generally measured with the Wechsler Intelligence Scale for Children (WISC- R) or Wechsler Abbreviated Scale of Intelligence (WASI), ranged from 87.9 to 113.5.

There was inconsistency in the procedures to diagnose ASD, as well as in the terminology used: autism, high-functioning autism (HFA), Asperger’s syndrome (AS), and pervasive developmental disorder – not otherwise specified (PDD-NOS) (American Psychiatric Association, 2000, 2013). Thus, the diagnosis in 21 studies included cases of ASD, HFA, PDD-NOS, and/or AS, whereas in two studies, the participants were diagnosed exclusively as PDD-NOS (Louwerse et al., 2015; Verheij et al., 2015).

Only one-third of the studies (39,3%) included a control group with TD, matched on IQ and age with the ASD group (Andersen et al., 2015, 2017; Cantio et al., 2018; Grimm et al., 2018; Kouklari et al., 2019; May et al., 2014, 2015; Pellicano, 2010a; Titeca et al., 2014; Vogan et al., 2018; Weiss et al., 2019). The time elapsed until the follow-up evaluation varied greatly, ranging from one year (Kouklari et al., 2019; May et al., 2014, 2015) to 11 years (Kenny et al., 2019). Attrition was low, possible because in most of the studies the number of participants at initial assessment was matched with the number of participants at follow-up, even though the baseline samples often came from a broader study.

**3.3 Outcomes**

In the 28 follow-up studies selected, eight areas of outcome were identified: Adaptive/social abilities (5 studies), IQ (6 studies) and comorbidity (7 studies) are topics explored in fewer studies. The stability of the diagnosis /ASD symptoms severity and academic achievement produced the areas of outcome areas of outcome same number of studies (8). Finally, most of the research focused on cognitive processes of psychological theories of autism: ToM (8 studies), EF (13 studies), and CC (5 studies). A large number of studies combined contents from several different domains.

 Table 2 presents a summary of the information related to the objectives, the measures employed at baseline and follow-up, and the findings of the 28 selected studies.

* **Insert Table 2 -**

***3.3.1 Autism symptom severity and ~~symptom~~ stability***

Two studies explored the degree to which the symptomatology of ASD-without ID remained stable over time. According to Pellicano’s (2012) findings, after three years only 20% of participants no longer met the full criteria on the Autism Diagnostic Observation Scale (ADOS; Lord et al., 2000). Likewise, Louwerse et al. (2015) found a correlation of .51 for ASD symptoms severity between childhood and adolescence. In addition, in a seven-year time lapse, only 21% of the participants seemed to no longer meet the criteria for an ADOS ASD classification.

The studies by May et al. (2014) and Andersen et al. (2015) offered some information about the persistence of the severity of common autism symptoms, at least for relatively brief periods of time (one and two years, respectively); both showed no significant change in symptom severity over time, regardless of the assessment measures used (Repetitive Behavior Questionnaire, Social Responsiveness Scale, Children´s Communication Checklist and Autism Spectrum Screening Questionnaire). In addition, May et al. (2014) provided two interesting findings. They found no gender differences with regard to the stability in the core autism symptoms after one year. In addition, symptom stability was not predicted by the worsening of social deficits. However, due to the short follow-up time intervals in the cited studies, firm conclusions cannot be drawn.

 ***3.3.2 Intelligence Quotient***

Six studies reported IQ scores at baseline and at different follow-up assessment points, separated by periods of time ranging from 2-3 years (Andersen et al., 2015; Pellicano 2010a, 2012), 6 years (Estes et al., 2011; Louwerse et al., 2015) and 11 years (Kenny et al., 2019) (see Table 2). Likewise, these studies showed variability in the use of the tests administered to evaluate intelligence.

Only the participants in one study (Estes et al., 2011) showed an 8-point increase on General Conceptual Ability from the Differential Ability Scale at 6-year follow-up, although this increase cannot be considered significant. In another study (Andersen et al. 2015), the Full Scale Intelligence Quotient (FSIQ) scores on the WASI at baseline and follow-up were quite similar. In four other studies, the individuals’ Verbal IQ (measured with the Peabody Picture Vocabulary Test), and particularly their non-verbal IQ (as assessed by the Leiter Scale), showed a reduction over a brief (Pellicano 2010a, 2012) and a longer period of time (Kenny et al., 2019; Louwerse et al., 2015). However, the reductions in IQ scores reported in these studies could not be considered significant since they remained within the standard deviation of the mean.

***3.3.3 Cognitive theories of autism: ToM, EF, and CC***

The development of executive processes, assessed by the performance on neuropsychological tasks of inhibition and flexibility, improved over time. However, adolescents with HFA were still significantly impaired when compared to TD adolescents (Andersen et al., 2015). The same tendency was observed on both selective cool (working memory and inhibition) and hot (affective decision making) EF domains (Kouklari et al., 2019). The ecological assessment, based on parents’ accounts on the Emotional Regulation and Metacognition Indexes of the BRIEF (Behavior Rating Inventory of Executive Function; Gioia et al., 2000), confirmed that the EF impairments of ASD children persisted over time (Vogan et al. 2018). Therefore, regardless of the domains and assessment procedures used, EF problems in ASD-without ID had a general nature and extended to real-life activities. However, it is possible that some specific inhibition deficits, such as developing routine response patterns, become on average less pronounced when children with ASD grow older (Welss et al., 2019)

Parallel exploration of the complex development of EF, ToM, and CC was addressed in various studies. Cantio et al. (2018) administered EF tasks (verbal fluency, planning, flexibility, and working memory) and ToM tasks (strange stories and Frith-Happé animation tests) to ASD and TD groups at 10 years old and again at 14 years old. There were no differences between both groups in local bias processing at intake or at follow-up. Moreover, ASD participants´ performance on EF and ToM tasks improved at follow-up, but in different ways than the TD group: the EF impairment in the ASD group at follow-up was not detectable compared to TD, whereas the ToM difficulties were present at both assessment times.

Pellicano (2010a) also examined two groups of children, ASD and TD, in a three-year follow-up study. ToM development was measured by using first- and second-order false belief tasks; EF was measured with neuropsychological tasks of planning (Tower of London) and flexibility (set shifting); and CC was evaluated with the Children’s Embedded Figures Test (CEFT). At both assessment times, children with ASD had more difficulties than the children with TD on comprehension of false beliefs, planning, and cognitive flexibility, along with a tendency toward local processing of information. The EF and ToM skills of children with ASD progressed over time, whereas the CC did not show the same tendency.

The developmental interrelationship between ToM, EF, and CC has been explored in several studies. Pellicano (2010b) did not find longitudinal relationships between EF and CC, suggesting the independence of these processes in ASD. However, early EF and CC skills rated in preschool, partly explained the developmental increase in ToM skills three years later, regardless of age, language, nonverbal intelligence, and earlier ToM skills. Similarly, Kouklari et al. (2019) found that both early cool working memory and hot delayed discounting executive functions predicted later ToM abilities. The key role of EF in the development of ToM was also supported by the results of individuals with PDD-NOS in a follow-up study over an 11-year period (Kenny et al., 2019).

***3.3.4 Adaptive/Social skills***

Mandy et al. (2016) analyzed possible changes in different social factors in the transition from primary to secondary school in students with autism who were integrated in mainstream schools. More individuals than expected scored in the clinical range of the Vineland Adaptive Behavior Scales (VABS, Sparrow et al., 2005), according to their parents and teachers, on the two assessments carried out. In addition, parent data provided a perspective of continuity, reflected by significant correlations between socialization, daily living, and the adaptive behavior composite of the VABS when comparing primary and secondary schools. Teachers’ VABS data showed a slight worsening of the children’s communication skills during the transition to secondary school.

A recent study by Scheeren et al. (2019) focused on the social interaction style (SIS), showing that it generally remained stable between 14 and 17 years of age (in 69% of participants). The percentage of change was low: 18% of adolescents changed to a more typical or more active, but odd, SIS, and 13% changed to a less typical and less active SIS. Moreover, the decrease in symptoms was associated with a transition to a more typical and active SIS.

***3.3.5 Comorbid difficulties and disorders***

Seven studies provided information on comorbid psychiatric conditions in ASD-without ID (see Table 3). As in the other domains, the follow-up phase showed temporal variability, ranging between 1 year (Mandy et al., 2016; May et al., 2014) and 7 years (Verheij et al., 2015). A remarkable variety of instruments was used: the Diagnostic Interview schedule for Children (DISC) (Louwersen et al., 2015; Verheij et al., 2015), the Strengths and Difficulties Questionnaire (SDQ) (Mandy et al., 2016; Simonoff et al., 2012, 2013), or the Child Behavior Check List (CBCL) (Vogan et al., 2018). Despite the differences, most of the studies reported high rates of persistence of comorbid psychopathology at follow-up, although a general decline was noted.

Verheij et al. (2018) reported a reduction from childhood (81%) to adolescence (61%) in a set of comorbid disorders in individuals with PDD-NOS. The presence of at least one anxiety disorder was significantly higher in childhood (55%) than in adolescence (31%), with specific phobia being the most prevalent at both times. There was also a reduction in ADHD (45% versus 39%), ODD (35% versus 27%), and CD 10% versus 3%) in adolescence. However, the rate of major depression increased from 8.1% in childhood to 10.8% in adolescence.

In the study by Mandy et al. (2016), parents and teachers concurred in noting high levels of psychopathology in adolescents with autism and Asperger's. On the SDQ total problems, both informants identified a high percentage of participants in the clinical range at baseline and follow-up (10%). None of the problems were found to increase in the transition from primary to secondary education.

Simonoff et al. (2012) investigated the persistence and correlates of severe mood regulation problems (SMP) in adolescents with ASD, using information obtained from parents about rage, mood lability, or depressive thoughts. The research contributed several interesting findings. Thus, at age 12 and 16, SMP was associated with maternal mental health problems. The presence of psychiatric disorders at age 12 predicted SMP at age 16, but neither intellectual ability nor adaptive functioning predicted SMP. In addition, SMP was associated with identifying the facial expression of surprise, but not with other emotions. Finally, the relationship between SMP and EF tests of flexibility and inhibition disappeared when controlling for IQ.

In a subsequent publication, Simonoff et al. (2013) examined the persistence of psychiatric problems in a representative sample of the adolescent population with ASD. Both parents and teachers offered a view of the stability of the problems. However, the age-related reduction in the percentage of the prevalence of problems was not found when ASD-specific cut-off points on the SDQ were used. Hence, the authors recommend caution in using general measures in very specific populations without previously characterizing the properties of the instrument in that particular population. Few significant relationships emerged between risk factors and parental comorbidity, specifically parental affective disorder was a risk factor for the child's emotional symptoms, whilst family deprivation and parental emotional disorder were risk factors for hyperactivity.

Only one study reported possible gender differences in ASD comorbidity. According to May et al. (2014), there were no differences in ODD between males and females with ASD at baseline and follow-up. However, males were more hyperactive and received more help with school integration, and females were more socially anxious. It is possible that the lower level of hyperactivity in women contributed to their under-identification and reduced focus on their school integration.

***3.3.6 Academic Achievement***

The heterogeneity of reading profiles in the population with autism was shown in several studies. Asberg et al. (2019) identified three profiles in8 year-old children, based on word reading and comprehension tests: "poor readers", the most numerous group (almost 50%); "hyperlexic/poor comprehenders" (19%); and "skilled readers" (34%). "Poor readers" had more impairments than "Skilled readers" on non-verbal cognitive ability and phonological processing, as well as more severe ASD. In contrast, hyperlexic/poor comprehenders only had a lower level than “skilled readers” on oral language tests. Based on the information obtained in the 3-year follow-up assessment, the three subgroups of readers did not differ on social ability, IQ, or ASD symptoms severity. However, “poor readers” experienced low early oral language development.

In addition, Solari et al. (2019) identified four reading profiles: "global disturbance", "below average", "comprehension disturbance", and "average". These profiles showed stability in the linguistic skills, even though there had been changes in the individuals included in them. The profiles differed in the severity of ASD symptoms on the ADOS, with lower scores on the ADOS being associated with better reading performance. Figures for the overall prevalence of reading difficulties when many of the participants reached secondary school were concerning, although they improved somewhat (68.8% had difficulties in comprehension; 50.5% in word reading; 31.1% were average readers versus 80% of TD children).

Within the broader framework, the study by Grimm et al. (2018) provided comparative data on the trajectory of language and reading skills in adolescents with ASD and TD. Three assessments were conducted in 30 months, separated by 10-month periods. At the T1 assessment, children with ASD began with lower levels of oral language and reading comprehension than children with TD. Although the two skills had similar within-group development rates, the initial deficit of the ASD group persisted over time. These results are not consistent with those of May et al. (2015), who found no differences between the ASD and TD groups in their word reading levels. Several factors could explain this divergence; for example, in Grimm et al. (2018), the participants were older, the time lag between the baseline and follow-up assessments was longer, and the reading tasks were more varied and demanding.

***3.3.7 Childhood correlates and predictors of later outcomes***

Eight studies in the review addressed predictors of different outcomes, particularly academic performance, comorbidity, and social adjustment. Early EF was also identified as a key factor in the variation of social communication and repetitive behaviors of ASD children (Pellicano, 2013) and predicted a significant percentage of the variance in autistic features in late adolescence, beyond the variance attributable to age, intellectual ability and ToM skills (Kenny et al., 2019). Likewise, EF components of behavioral regulation have showed to be good predictors of emotional (anxiety, depression) and behavioral (aggressiveness/oppositionality) outcomes (Vogan et al., 2018). Improved scores on the metacognitive components of planning, WM and organization were associated with improved social functioning, whereas deficits were associated with poorer adaptive social skills. On the contrary, no relationship was found between increased performance on letter and number sequential memory tests and improvements in the time of depression symptoms in adolescents with ASD (Andersen et al., 2013).

The association between EF and instrumental learning (reading, writing, and mathematics) has produced moderate results. The performance of children with ASD on Spatial Reversal Test has been shown to have a later association with higher mathematics achievement, while the relationship with performance on spelling and word reading was not statistically significant (St John et al., 2018). Another study (May et al. 2015) found that performance on certain EF tasks, including short-term memory, attention switching, and sustained attention correlated with reading and math scores in children with autism. However, the scores on EF tasks were not able to predict the scores on mathematics or reading tests, controlling for the scores on these two skills in T1.

Typical autistic behaviors have also been found to predict the functioning of adolescents with PDD-NOS. Specifically a high level of stereotyped behaviors and reduced social interest in childhood were significant predictors of stable adolescent psychiatric comorbidity, both internalizing (e.g., anxiety and mood disorders) and externalizing disorders (e.g., disruptive disorders) (Verheij et al., 2015). Similarly, severity of ASD total symptoms had significant power to predict emotional and behavioral problems. (Andersen et al., 2017). In contrast, psychiatric comorbidity in childhood or adolescence did not seem to be associated with autism symptom severity on the ADOS in adolescence (Lowersen et al., 2015). In this regard, it has been evidenced that a detail-focused cognitive style in childhood is a good predictor of repetitive and restrictive behaviors and interest (RRBI) in adolescents with higher ASD symptom (Eussen et al., 2016), while increased attention to social stimuli, assessed in childhood on a face recognition test (FR), could predict lower ASD symptom severity in adolescence (Eussen et al., 2015),

Lastly, relatively limited conclusions can be drawn regarding the possible role of verbal and cognitive abilities in later outcomes. Performance on vocabulary, measured by the Peabody test, contributed to the variance in later ToM scores (Pellicano, 2010), but cognitive ability did not seem to have a main role in the identification of children with a stable ASD diagnosis (Pellicano, 2012). More consistency and clarity demonstrated cognitive skills in general, and language skills specifically, in predicting later performance on basic instrumental learning. In fact, non-verbal cognition and letter-sound knowledge of preschool-age children with ASD explained more than 50% of the variance in regular single-word reading at school age (Westerveld et al., 2018). Furthermore, verbal subitizing has proven to be the strongest predictor for mathematics achievement of first grade students with ASD (Titeca et al., 2014).

**4. Discussion**

Despite the number of recent review papers, the developmental trajectories of individuals with ASD-without ID from childhood to adolescence is still poorly understood. This systematic review examined outcomes of this age population with ASD-without ID, as reported in longitudinal studies. The results of the 28 selected articles were fairly consistent in the different areas of functioning identified.

The high stability of the diagnosis of ASD-without ID was confirmed in the few studies that provided baseline and follow-up ADOS scores. The specific figure, estimated around 80%, coincides with the percentages of stability reported in follow-up studies conducted in early childhood (Giserman-Kiss and Carter, 2019) and adulthood (Helles et al., 2015). The degree of severity of the core ASD symptoms also persisted over time, with the same trend found in both males and females. IQ scores experienced small changes, regardless of the time period between the baseline and follow-up assessments and the measurement instruments used.

Most of the research focused on constructs of the three dominant cognitive theories of ASD: EF, ToM, and CC. The performance of children with ASD-without ID on typical EF, CC, and ToM tasks improved over time, particularly on inhibition and flexibility. Despite within-group improvements, the initial impairments of children with ASD-without ID persisted so they did not reach the developmental level of neurotypical children. However, the profile of executive, mentalization and local dysfunctions in information processing at the group level in children with ASD-without ID could not be considered universal deficits due to the individual differences identified. With regards to the debate on the evolving nature of the relationship between EF and ToM, the present review noted the main role that executive processes have in the surface of ToM, suggesting that EF is a general and essential process for the functioning in other areas.

The few data available from the studies reviewed suggest the stability of difficulties in adaptive functioning and more specifically, an atypical social interaction style in adolescents with ASD-without ID. More information is offered by the analysis of the course of comorbid problems from childhood to adolescence. Taken together, the longitudinal findings showed a tendency toward a decrease in symptoms of anxiety, ADHD, ODD, and CD, and a slight increase in depression. However, despite the decline in absolute terms, comorbidity rates in ASD remained high. Parental affective disorder and family deprivation were identified as major environmental risk factors. In addition, the expression of comorbidity in children with ASD, similarly to what occurs in children with TD, was different depending on the gender; that is, hyperactivity was higher in males, and anxiety more common in females.

Data on learning achievement appeared consistent, with significant early reading impairments in the group with ASD lasting over time. Although language and reading skills increased in a similar way to those of adolescents with TD, the baseline language and reading deficits of students with ASD-without ID were maintained. The reading profiles (overall poor readers, poor comprehenders, and average readers), identified according to their level of oral language, memory and phonological processing, also showed stability, despite the slight changes in the group participants.

Finally, our findings show that it may be possible to identify predictors of outcomes for ASD-without ID in mid-childhood and adolescence, highlighting the potential of EF, symptom severity, and linguistic skills. EF and the detail-focused style showed predictive power across ASD symptom domains such as social communication, repetitive and restrictive behaviors/interests, and adaptive abilities. Behavioral regulation deficits and metacognitive deficits were also associated with emotional/behavioral problems and poor adaptive skills, respectively. Stereotyped behaviors and low social interest predicted stable psychiatric comorbidity, but contrary to expectations, initial comorbidity showed no association with the severity of the disorder in adolescence. Finally, early social and language skills explained performance on reading tasks at school age.

***Limitations***

This review has a number of limitations that need to be taken into consideration, some related to the quality of included studies and others to the systematic review per se.

Many of the reviewed studies were affected by some methodological limitations: the absence of follow-up assessment in the control group, reduced sample size and a short follow-up period. ~~The data on comparisons between the ASD group and the control group in the follow-up assessment were unusual (35.7%).~~ Only about a third (35.7%) collected data on the comparisons between the ASD group and the control group in the follow-up assessment. Likewise, few studies had ASD samples at baseline with a number of participants greater than 50 (39. 3%) and they did not exceed three years-time of follow-up (only 50%). The general use of parent scored assessment scales rather than multi-method assessments at follow-up assessment and for the prediction of outcomes is another limitation. On the other hand, the majority of the studies included participants who were diagnosed according to DSM-IV-TR (American Psychiatric Association, 2000), or earlier editions, with AS, Asperger’s Syndrome, autism, or PDD-NOS. The comparison of DSM-5 and DSM-IV criteria remain a matter for debate. However, more than 90% of children clinically diagnosed with pervasive developmental disorder (PDD) based on the DSM-IV criteria, continue to be diagnosed with ASD according DSM-5 criteria (Huerta et al., 2012).

Our systematic review also had limitations. In particular, due to limited funding, we could not include studies published in languages other than English and did not search for grey literature. Studies included in our systematic review also had some limitationFour studies had a global score < 80% of the maximum score, mainly due to issues with the methodology subsection of the STROBE, including study design setting , participants, variables, data sources and measurement, biased, study size , quantitative variables, statistical methods. However, it is important to highlight that these items were rated as less than optimal in terms of the study reporting , not necessarily in terms of the actual quality of the studies. It is possible that gathering additional unpublished information would have increased the quality of the rating, but this was beyond the scope of the present review and would have been challenging from a practical standpoint. . .

***Future research directions***

Future research should include information from school teachers and possible socio-environmental predictors. Given that there was a preponderance of male participants across the studies, at rates even higher than those reported in the DSM-5 (4:1), future studies may consider oversampling female participants to avoid a gender bias. Similarly, all the studies in this review recruited participants with average IQs or above average, so future systematic reviews may also want to focus on children or adolescents with autism and significant intellectual disability (ID). Furthermore, one matter that has hardly been addressed in the research articles reviewed is the analysis of possible changes in cognitive and behavioral profiles within ASD over time. This information would have clinical application and could facilitate the understanding of genetics and neuropsychopathology patterns of ASD. ~~Finally, a meta-analysis of the studies included in this systematic review, which was beyond its scope, should be considered in future research.~~

***Clinical Implications***

Despite the short period of time analyzed in this systematic review and the limitations mentioned above, several tentative clinical and educational implications can be extracted from the literature to date. Overall, even the more cognitive capable adolescents with autism, compared to their TD peers, tend to show poorer overall developmental trajectories on social, adaptive and academic domains as well as an increased vulnerability to different comorbidities, including depression, anxiety, and ADHD. Although the assessment of the effectiveness of the interventions and the support provided from different agencies were not the main objectives of the present review, the limited data provided emphasize the significant social and economic costs (see Louwersen et al., 2015).

EF especially stands out among the predictors of developmental outcomes in adolescents with ASD-without ID at compulsory education stages. Executive processes play an influential role in emotional and behavioral problems, as well as in social communication, repetitive and restrictive behaviors/interests, and adaptive abilities. Furthermore, although our review did not support a significant relationship between EF and performance on mathematical learning or reading, the results may be due to the low standards of the tests used in the assessment, which generally were not demanding in terms of executive resources. This is a pending issue for future research on ASD-without ID, in which it would be necessary to apply tasks that require deep and meaningful learning. There are relevant data supporting the importance of executive processes of planning, organizing skills, working memory, and cognitive flexibility in the academic progress of students with ASD (Dijkhuis et al., 2020). In addition, instruction in metacognitive strategies was found highly effective for increasing reading comprehension in ASD (Singh et al., 2020). Consequently, EF is a fundamental target for early childhood interventions in multiple contexts and domains of functioning, alongside other necessary behavioral and pharmacological treatments.

A final consideration refers to the need to establish a close connection between health and education professionals in order to improve educational and occupational activities for youth with ASD-without ID, which are generally lacking (Taylor and Seltzer, 2011). The development of an appropriate and individualized treatment package with the involvement of multidisciplinary professionals and families is key throughout the stages of primary and secondary education (Volmar et al., 2014). This care plan should reflect an accurate assessment of the child’s strengths and vulnerabilities, with explicit guidelines by health and educational services to establish the goals of treatment in all settings (at home, at school and with peers) and the procedures for monitoring the effectiveness of the interventions carried out.

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**Figure 1. PRISMA Flowchart outlining the trial selection**

**(See separate file)**

**Table 1. Summary of 28 studies included in the systematic review. Information for Autism Spectrum Disorder (ASD) and Typically Developing (TD) groups.**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | ASD Group | TD Group |
| Study | NM/F | Diagnosis and assessment | I. AgeX (SD) | I. IQX (SD) | F-up N | F-up AgeX (SD) | F-up IQX (SD) | N(M/F) | I. AgeX (SD) | I. IQX (SD) | F-up Age X (SD) |
| Andersen et al. 2015, 2017 (Norway) | 3428/682.4% |  |  | FSIQWASI99.9 (17.4) | 34 | 13.8 y (2)2 y later | FSIQWASI98.5 (16.9) | 45(29/16)64% | 11.4 y (1.5) | FSIQ104.5(13.1) | 13 .5 year(1.4) |
| Asberg et al. 2019 (Sweden) | 53 45/884.9% | ASD:ADOS.;C JudgDSM-IV | 3 years | DevelopmentalQuotient:80-82 | 53 | 8 years5y later | Matrix RS.Reade 49P.Reade 35 | - | - | - | - |
| Cantio et al. 2018 (Denmark) | 21 16/572% | HFA:ADOS; ADI-R;DSM-IV Clinic | 10.7 y(1.5) | FSIQ105.48(15.95) | 21 | 14.3 year(1.4)3y later | - | 30 (22/8)73.3% | 10.96 (1.53) | FSIQ109.47 (18.58) | 14.32 year (1.15) |
| Estes et al. 2011(USA) | 30100% | ASD:ADOS-GADI-R; DSM-IV | 6 years | GCA89.57(15.75) | 30 | 9 years3 y later | GCA97.57(14.5) | - | - | - | - |
| Eussen et al. 2015 Eussen et al.2016(Netherlands) | 114 102/1289.5% | PDD-NOS; Asperger Synd.:DSM-IV-TRCSBQ; Clinical | 9.2 v(1.8) | FSIQ95.8(14.4) | 87(76%) | 16 years6.9 y later | - | - | - | - | - |
| Grimm et al.2018(USA) | 6555/1084,6% | HFA; ASD:ASSQ, SCQADOS-2;SRS | AgeRange 8-16 | FSIQ98.34(14.9) | 65 | 3 Assessments in 30 Months | - | 3724/13 | AgeRange 8-16 | FSIQ115.30 | - |
| Kenny et al. 2019 (UK) | 28 26/292.8% | PDD-NOSAsperger SyndDSM-IV;ADI-R | 5.7 y(11 mo) | Verb IQ97 (10.7)NV IQ114 (13.7) | 28 | 17.1 year (13mo)11 y later | Verb IQ91.3 (20)NV IQ99.17 (19) | - | - | - | - |
| Kouklari et al. 2019(UK) | 4538/784.4% | ASDDSM-IV or 5ADOS ADI-R |   | FSIQ97.05(12.13 | 45100% | 10 y | - | 3735/2 | 9.03 y1.17 | FSIQ102.11(14.03) | 10 years |
| Louwerse et al. 2015(Netherlands) | 7449/25.66.9% | PDD-NOS:DSM-IV-TRADOS. Clinical | 9.2 y(1.8) | FSIQ96.4(14.1) | 7297.3% | 16.1 year(1.9)6.9 y later | FSIQ103.1 (12.6) | - | - | - | - |
| Mandy et al. 2016(UK) | 2825/389.3% | 8 Autism.4 Asperger SADOS | 11.3 y(0.40)Primary | FSIQ87.86(17.4) | 2825/3 | 12-13 ySecondary | - | - | - | - | - |
| May et al. 2014(Australia) | 6432/3250% | HFA:DSM-IV-TRSRS | 9. yRange:7-12 | FSIQBoys: 96.7Girls: 95.6 | 5628/2887.5% | 10.6 year1 y later | - | 4425/1972.5% | 9-7 yearRange 7-12 | FSIQBoys:109Girls:104.8 | 11.6 years |
| May et al. 2015(Australia) | 4020/2050% | ASD:AutismAsperger SDSM-IV-TRSRS | 9.6 yRange:7-12 | Verb IQ101(13)Perce IQ100 (15) | 4020/20 | 10.61y later | - | 4020/20 | 9.7Range7-12 | Verb IQ107(10)Percep IQ105 (14) | 11 years |
| Pellicano, 2010a(UK) | 4540/589% | ASD: AutismPDD-NOS; Asperger SDSM-IV ADI-R | 5.8 yRange:49-88 mo | Verb IQ101(13)NV IQ113(13.9) | 3733/482% | 8.4 year3 y later | Verbal IQ93.8 (17.8)NV104(12 | 3125/6 | 5.4 yearRange:48-88 | Verb IQ 99.6(10)NV IQ107(10) | 8.4 years |
| Pellicano,2010b; 20122013(UK) | 4540/589% | ASD: AutismPDD-NOSAsperger SDSM-IV ADI-R | 5.8 yRange:49-88 mo | Verb IQ97 (11.5)NV IQ113 (13.9) | 3733/482% | 8.4 year3 y later | Verbal IQ93.8(17.8)NV104.(12 | - | - | - | - |
| Scheren et al. 2019(Netherland | 5552/394.5% | ASD:DSM-IV-TR Multimethod | 13.2 y(3.03) | Verb IQ 104 (13.9)Range: 72-130 | 5552/3 | 17 years4 y later | - | - | - | - | - |
| Simonoff et al. 2012(UK) | 9183/891.2% | ASD:ICD-10ADI-R; SCQADOS-G | 12 years | - | 7987% | 15.6 years4 y later | FSIQHigh SMP80 (16)Low SMP85.8 (17.5) | - | - | - | - |
| Simonoff et al. 2013(UK) | 8175/692.6% | Autism /ASD:ICD-10; SCQ ADI-R; ADOS | 12 years | - | - | 16 years4 y later | FSIQ84.6 (17.4) | - | - | - | - |
| Solari et al.2019(USA) | 6452/1281.2% | ASDCommunity and ADOS-2 | 11.3 y(2.15)Range: 8-16 | FSIQ100.2 (14) | 6452/12 | 13.8 years30 month later | - | - | - | - | - |
| St John et al. 2018 (USA) | 32 | ASDADI-R; ADOS | 6 years | FSIQ>70 | 32 | 9.5 years3 y later | DAS99.16 (17) | - | - | - | - |
| Titeca et al. 2014 (Belgium) | 3327/681.8% | ASD-HFDSM-IV-TRSRS; ADOS | 6.27 y(.38) | FSIQ105.3 (13) | 33 | 6.87 y (.29)1 y later | - | 5431/2357.4% | 5.79 y(.35) | FSIQ111.4(11.9) | 6.63 y(.34) |
| Verheij et al. 2015(Netherlands) | 7465/988% | PDD-NOSIn Dep Child Psychiatry/Psc | 9 years(1.81)Ra 6-12 | FSIQ104.6 (13) | 7465/9 | 16 y1.9)7 y later | - | - | - | - | - |
| Vogan et al.2018(Canadá) | 3934/587.2% | ASDClinical judgeADOS-2 | 10.6 y(1.8)Ra:8-16y | FSIQ103.3 (14) | 3934/5 | 2.9 years2 y later | - | 3420/1458.8% | 11.2 y(2.1) | FSIQ115.4(11.7) | 13.3 years(2.1) |
| Weiss et al. 2019(Austria) | 15100% | Asperger SICD-10Clinic Judge | 11.2 y(2.8) | CFT113.5 (10) | 15 | 12.2 y (2.6)2.5 y later | CFT117.3(6.4) | 23100% | 10 y (2.8) | 114.1(11.1) | 12.2 y (2.6) |
| Westerveld et al. 2018 (Australia) | 5748/984.2% | ASDClinical judgeADOS-2; SCQ | 57.6 moRange: 49- 70m | DevelopentalQuotient:78,1 | 4135/672% | 73.3 mo1 ½ yearlater | - | - | - | - | - |

ADI-R= Autism Diagnostic Interview-Revised; ADOS-G= Autism Diagnostic Observation Schedule-Generic; ASSQ= Autism Spectrum Screening Questionnaire; CSBQ= Children´Social Behavior Questionnaire; CFT= Cultural Fair Intelligence Test; DAS= The Differential Ability Scales, FSIQ= Full Scale Intelligence Quotient; GCA= General Conceptual Ability; K-SADS-PL= Schedule for Affective Disorders and Schizophrenia for School Age Children/Present and Life Version; Matrix R= Matrix Reasoning; PDD-NOS=Pervasive Developmental Disorder –not Otherwise Specified; SCQ= Social Communication Questionnaire; SMP= Severe Mood Dysregulation and Problems; SRS= Social Responsiveness Scale; WASI= Wechsler Abbreviated Scale Intelligence; WISC-R= Wechsler Intelligence Scale for Children; y= Year

**Table 2. Aims, measures used at baseline and follow-up, and key findings of studies included in review (N= 28)**

|  |  |  |  |
| --- | --- | --- | --- |
| STUDY | OBJECTIVES | MEASURES AT BASELINEAND FOLLOW-UP | FINDINGS |
| *Andersen et al. 2015* | Course and association between self-reported and parental estimation of depression, ASD, and EF  | SMFQ; ASSQ; Color-Word Interference; Letter and Number Sequential Memory   | *Depression*: Children ASD more symptoms of depression at T1 and T2. The improvements were not associated with increase in WM. *ASD symptoms*: No change over time and were correlated with depression. *Inhibition and flexibility* improved at T2 but ASD group was significantly impaired |
| *Andersen et al. 2017* | Emotional and Behavioral problems prediction from ASD, verbal IQ, attention | Achenbach´s Child Behavior Check List ASSQ; ADHD Rating Scale IV; WASI | *Level of ASD symptoms* at baseline *predicted emotional and behavioral problems* (EBP) after 2 years, whereas verbal IQ did not. The level of attention problems significantly correlated with EBP, but had relatively small impact on model regression |
| *Asberg et al. 2019* | Associations between reading profiles and early and current ASD Language, Phonology | Reynell; PVT; Grammar Test; Sentence; Word repetition; Letter Knowledge; Reading; ADOS; ASSQ; VABS; WASI  | *Heterogeneous reader profiles*: Poor reading skills (47%); Hyperlexics/Poor Comprehenders (19%); Skilled readers (34%). Poor readers: More impairments in N-verbal IQ, ASD. Hyperlexic/PoorComprehenders and "Skilled readers" did not differ in ASD symptoms, N-Verbal IQ or phonology, but Hyperlexics had poorer oral language |
| *Cantio et al. 2018* | Development of ASD profile over time in ToM, EF, Local Bias skills | Strange stories**;** Frith-Happé Animations, Verbal Fluency, WM, Planning, Flexibility, CEFT**;** Hooper Visual Test | *ToM*: Improvements between 10 and 14 years in ASD, but deficits persisted in adolescence. *EF*: ASD group improves over time compared to the group with TD. *Local bias*: At neither of the 2 times there were differences between ASD and TD.ToM deficits affected children with ASD who did not have baseline EF deficits  |
| *Estes et al.**2011*  | Discrepancy achievement and IQ. Relationships between behavior problems and achievement | DAS; ConceptualAbilities; Basic Number Skills; Spelling; Word Reading; Social Skills; Aberrant Behavior Checklist | *60% of children showed discrepancy* between current and predicted academic performance, based on IQ. An equal number performed better than expected in at least one area. *Word reading and number skills* were related to IQ, but spelling was not. No relationship between behavior problems and performance |
| *Eussen et al. 2015* | ASD symptoms prediction from attention to social stimuli(Facial Recognition, and Emotion Identification  | WISC-R**;** Amsterdam Neuro Task**:** Facial Recognition (FR); Identification Facial Emotion (IFE); ADOS (Module 3 and 4) | *Better performance on FR* in T1 predicted less severity of ASD in adolescence, even adjusting for ASD symptoms in T1. IFE did not predict ASD symptoms in adolescence The results in FR test supports its prognostic value in the later symptoms severity of ASD in adolescence |
| *Eussen et al. 2016* | Possible prediction of ASD through a detail centered cognitive style  | WISC-R:Child Behavior Checklist**;** CEFT; ADOS (Module RRBI) | *Superior tendency for local processing* was associated with increased severity of symptoms in repetitive and restrictive behaviors and interests (RRBI). People with ASD tend to focus on details and this cognitive style predicts future ASD symptoms  |
| *Grimm et al. 2018* | Comparison of language and reading development in ASD and TD children | WASI-2**;** Auditory Reasoning Test; GORT-5 (Reading Accuracy and Comprehension) | The trajectory on *Reading comprehension* was almost identical in ASD and TD. The ASD group had lower linguistic and reading comprehension in T1 than their TD peers and this gap persisted over time. |
| *Kenny et al. 2019* | Predictive validity of EF and ToM on ASD features and adaptive behavior | PVT; Leiter; WASI-2; VABS; ADOS; ToM T; London Tower; Luria Inhibition; Teddy Bear  | *Early EF predicted* adaptive behavior and ASD features beyond age, verbal, N-verbal ability, and ToM. This long-term link between early EF and later outcomes was independent of ToM*.* EF, but not ToM, had a prognostic value in ASD adolescents. |
| *Kouklari et al. 2019* | Evolution of EF and ToM in ASD and TD. Study of longitudinal associations | WASI; Go/NGo; London Tower Digit Span; Affective Decision Delay Discounting, False Belief  | ASD group improved WM, inhibition and affective decision-making, but the gap with TD group persisted. Same results in ToM and mental state/emotion recognition. WM and delay discounting predicted ToM abilities, while ToM abilities did not predict EF. |
| *Louwerse et al.*2015 | ASD symptoms stability and its association in adolescence with societal burden and comorbidity | ADOS; DISC (Anxiety, Mood, Developmental and Disruptive Disorders); WISC-R; WASI; Societal Functioning. ADI-R  | *Diagnostic stability* 7 years later,ASD symptoms correlation .51. *Psychiatric comorbidity* in childhood was not associated with ASD in adolescence. Significant *societal burden*: 87% of individuals received mental services; 71% had Special Needs  |
| *Mandy et al. 2016* | Changes in comorbidity, adaptation, victimization of ASD students from Elementary to Secondary  | SDQ; VABS; Beck Youth Inventory self-inform (Anxiety, Depression): Peer victimization self-report and parents  | *Psychopathology.* Neither parents, teachers, nor children reported any increase with the transition, although the high level of psychopathology and adaptive problems persisted over the time. According to teachers (not according to parents) there was a significant decrease on the Vineland Communication Scale. *Victimization* decreased over time.  |
| *May et al. 2014* | Compare developmental trajectory of girls and boys with ASD in behavior, and educational placements | SRS; Repetitive Behavior; CCC-2(Children´s Communic Checklist); ADHD Symptoms ; Spence Children Anxiety | *No gender differences* in Social Skills, Repetitive Behavior, and Communication. The *severity of ASD* does not change for boys and girls. Boys were more hyperactive and received more help with integration. Females were more socially anxious |
| *May et al. 2015* | Evolution in children with ASD and TD on Word Reading, Numerical Operations, and Attention | Auditory Processing Test; Wilding Attention Task;Vigilant Computerized Test ; Wechsler (Word Reading and Operations)  | No *differences* between children with ASD and TD at T1 or T2 on *Word Reading or Number operations*. ASD, more errors on *Attention switching*, which were maintained over time. There were no differences in *Sustained attention* between groups, including IQ as covariate. EF correlated, but not predicted, *Reading and Math* in ASD children  |
| *Pellicano 2010a* | EF, ToM, CC persistence and predictors of changes in these three domains | PVT; MAP; Forward Memory; Sustained Attention; ToM task Teddy Bear; Set Shifting; London Tower; CEFT  | *Difficulties in* *False beliefs, Planning, Cognitive flexibility, Local Information processing* in children with ASD at T1 and T2. This profile was less marked at follow-up. There were significant improvement between T1 and T2 in children with ASD on EF and ToM, but no on CC. Early verbal ability explained some % of variance in later ToM, but was not associated with developmental improvements in planning |
| *Pellicano 2010b* | Longitudinal relationships between ToM, EF, and Central coherence (CC) in children with ASD | PVT; Leiter Scale;Task of False Beliefs; Tower of London; Mazes Test;Set Shifting; CEFT and Pattern Construction (CC)  | Early *EF skills* were associated with progress in ToM, predicting d*ifferences in* EF changes in ToM. *Central coherence* predicted ToM, but early ToM did not predict CC. EF and CC predicted changes in ToM skills. Problems in EF, ToM and CC do not seem independent, being EF an essential factor in developmental trajectories of ToM  |
| *Pellicano 2012* | Continuity of ASD . External and intrinsic contributing factors | PVT; Leiter non-Verbal IQ; ADI-R; SCQ; ADOS-G; Parents questionnaire on an intervention | 81% of children meet *ASD* criteria in T2. Child factors did not distinguish children with diagnostic stability initially or at follow-up. Children who received behavioral intervention from an early age improved more than children who started later.  |
| *Pellicano 2013* | Explanation at follow-up of restricted interests and communication by early scores of ToM, EF, CC.  | PVT; Leiter N-Verbal IQ; False Beliefs; London Tower; Mazes T; Set Shifting; CEFT; Pattern Construction ; ADOS-G;RBQ | *Differences in Early EF, but not ToM*, predicted children's social communication and variations in the degree of repetitive behaviors and interests at follow-up. There were no predictive relationships between early CC and children's insistence on sameness. Early variation in EF influences ASD social-communication and repetitive behaviors  |
| *Scheren et al. 2019* | Examination of stability and longitudinal change in the social interaction style (SIS) of individuals ASD | PVT (Verbal IQ); Social Interaction Style Questionnaire (SIS); SRS Questionnaire; | *Stability in SIS* over 4 years in 69% of participants. 18% switched to a more active SIS and 13% to a less active SIS. T*he change in ASD symptoms predicted the change in SIS*: decrease in symptoms was associated to a more active SIS. Neither age nor receptive verbal ability predicted changes in the SIS |
| *Simonoff et al. 2012* | Comparison of family psychiatric and cognitive correlates of severe mood problems of ASD and TD  | WISC-III; WASI; SDQ; CAPA; MGH; PONS; VABS; ICD-10; SRS; Emotion Recognition Task; Card Sort; Trail Making | *Severe Mood problems (SMP) were associated* with emotional problems at age 12 and 16. *Psychiatric disorders predicted SMP,* but not IQ or SMP. SMP in adolescents with ASD were associated with MGH and identification of surprise, but not with Card Sort and Trail Making when the IQ was controlled.  |
| *Simonoff et al. 2013* | Longitudinal analysis of the stability and specificity of psychiatric problems in adolescents with ASD  | WISC-III; WASI; SDQ; CAPA; VABS; Family and Contextual characteristics (Neighborhood, School, Family Deprivation) | *The % of problems varied* according to cut-offs on the SDQ (for general population or for ASD that decreases over time). Relationship between child emotional symptoms and parental affective disorders. No relationships between risk factors and psychiatric problems. The severity of ASD did not predict psychopathology. |
| *Solari et al. 2019* | Nature and stability of reading profiles in ASD and the influence of symptoms severity  | WASI; ADOS-2; PP; CTOPP (RAN, NWR, Elision); TOWRE-2; GORT; CLF-RS; WIAT-RV; TAPS-AR | *4 Reader Profiles in T1 and T2*: 1) Average; 2) Comprehension Reading Disturbance; 3) Below average/ Intact Receptive vocabulary; 4) Global Disturbance. The profiles were not completely stable: In T2, 68.8% on comprehension difficulties; 50.5 on word reading, 31.1% were average readers. Lower ASD severity related to better reading. |
| *St John et al. 2018* | Identification of early EF predictors of later math achievement and reading | DAS; Das Achievement Test (Number Skills, Spelling and Word Reading) EF (A-not-B and Spatial Reversal Task | *Better EF,* measured by a Spatial Reversal at age 6, was *related to higher math achievement at age 9*. Score on A-not-B was not related to mathematics performance. There were no relationships between the two EF tests *and Spelling or Word Reading* |
| *Titeca et al. 2014* | Predictive value of 5 early numerical competencies for four mathematical domains (MD)  | Early numerical competence: Subitizing, counting, magnitude ,estimation; MD (Number facts, problems, calculation, time) | Children with ASD scored similar to TD children on early numerical competences at preschool while they scored lower on 4 MD at first grade. However their mathematical proficiency was similar compared to the normed population. *Verbal subitizing* was the *strongest predictor for* mathematics in the ASD group; counting was for TD children |
| *Verheij et al. 2015* | Stability of comorbidities in ASD and the influence of IQ, age, mental health care and medication  | WISC-III; DISC-IV-P; YSR (Self-reported emotional and behavioral problems); CBSQ; Mental Health and Medication | *The Comorbid disorders descended from childhood* ((81%) to adolescence (61%). Anxiety (51% versus 31%); ADHD (45% versus 31%); ODD (35% versus 28%) CD (10% versus 3%). *Use of Mental Health and Medication* increased from 8% versus 11%. C*omorbidity stability predicted by* stereotyped behavior and less social interest |
| *Vogan et al. 2018* | EF profile and its associations with subsequent comorbidity and social functioning  | WASI-II; ADOS-2; SRS; BRIEF (Behavior Rating Inventory of EF); Child Behavior Check List (CBCL) | On *Emotional Regulation (BRI) and Metacognition (MI)* Indexes, children with ASD, showed more impairments than TD. *BRI* ratings of T1 predicted anxiety, depression, aggression, and opposition. Deficits in MI were associated with poor adaptive and social skills. Improvements in *MI* over time predicted advances in social functioning |
| *Welss et al. 2019* | Development of deficits in inhibition skills in adolescent with Asperger  | Inhibition of prepotent response sequences, evaluated by Mittenecker pointing test (MPT) | *Younger with AS* improved in response inhibition over time while older AS boys as well as TD boys maintained a stable level. AS children when they grow older reached TD children in relation to basic inhibition of developing routine response patterns |
| *Westerveld et al. 2018* | Predictors of reading word and text accuracy(language Nverbal cognition, RAN, phonological memory) in children with ASD | PVT; SCQ; Letter Sound Knowledge; Phonological Awareness; Name writing; RAN: NEPSY Phonological Memory; CELF-RF; YARK | *Non-verbal cognition and letter-sound knowledge* explained variance in word reading, with letter-sound knowledge being a single significant predictor. The average and poor reading groups on reading tests differed on all the precursors to preschool reading, except on ASD symptoms. Group membership was significantly predicted by p*reschool vocabulary, name writing, and RAN*, with high sensitivity and specificity. |

ASSQ= Child Behavior Checklist Autism Spectrum Questionnaire; CAPA= Child and Adolescent Psychiatric Assessment; CBSQ= Children´s Social Behavior Questionnaire; CEFT= Children Embedded Figures Test; CELF-RS= Clinical Evaluation of Language Fundamental-Recalling Sentences; CTOPP= Comprehensive Test of Phonological Processing; DAS= Differential Abilities Scale; DISC= Diagnostic Interview Schedule for Children; DISC-IV-P= Diagnostic Interview Schedule for Children IV. Parent Version; GORT= Gray Oral Reading Test; MAP=Matching Associated Pairs; MGH= Maternal General Health; NWR= Nonword Repetition; PONS= Profile of Neuropsychiatric Symptoms; PVT= Peabody Vocabulary Test; RAN= Rapid Automatized Memory; RBQ= Repetitive Behaviors Questionnaire; SCQ = Social Communication Questionnaire; SDQ= Strength and Difficulties Questionnaire; SMFQ: Short Moods and Feelings Questionnaire; SMP= Severe Mood Problems; SRS-= Social Responsiveness Scale; TAPS-AR= Test of Auditory Processing-Auditory Reasoning; TOWRE-2= Test of Word Reading Efficiency; VABS= Vineland Adaptive Behavior Scales; WASI= Wechsler Abbreviated Scale of Intelligence; WIAT RV= Wechsler Individual Achievement Test-Receptive Vocabulary; WM= Working Memory; YARK= York Assessment of Reading for Comprehension

**SUPPLEMENTAL MATERIAL**

**Appendix A. Scoping search in PubMed/MEDLINE from inception until 31st December 2009, limited to English.**

|  |  |
| --- | --- |
| **REFERENCES** | **REASON FOR EXCLUSION** |
| *Burns, 1964* | Content not related to the main topic (ASD) |
| *Rutter et al., 1967* | Focus on other mental health disorders |
| *Hackney et al., 1968* | Focus on physical/neurological/genetic conditions |
| *Creak et al., 1969* | Focus on other mental health disorders (psychosis) |
| *Lockyer et al., 1970* | Focus on other mental health disorders (psychosis) |
| *Rutter, 1970* | Adult population  |
| *Nielsen et al., 1973* | Focus on physical/neurological/genetic conditions |
| *Bender, 1974* | Focus on other mental health disorders  |
| *Lotter, 1974* | Diagnosis of autism does not meet our inclusion criteria |
| *Davids, 1975* | Focus on other mental health disorders (psychosis) |
| *Knobloch et al., 1975* | Autism with intellectual disability (ID) |
| *Rees et al., 1975* | Focus on other mental health disorders (psychosis) |
| *Sakuma, 1975* | Not a prospective study |
| *Cohen et al., 1976* | Not a prospective study |
| *O´Dell et al., 1977* | Focus on other mental health disorders (conduct dis.) |
| *Bemporad, 1979* | Case report |
| *Eggers, 1978* | Focus on other mental health disorders (psychosis) |
| *Kimura et al., 1978* | Focus on other mental health disorders (psychosis) |
| *Schroeder et al., 1978* | Focus on other mental health disorders (ID) |
| *Silverman, 1979* | Not a prospective study |
| *Nelson et al., 1980* | Focus on interventions/treatments |
| *Gillberg et al., 1981* | Case series |
| *Riikonen et al., 1981* | Focus on other mental health disorders |
| *Brightman et al., 1982* | Focus on interventions/treatments |
| *Kydd et al., 1982* | Focus on other mental health disorders (psychosis) |
| *McGonigle et al., 1982* | Focus on interventions/treatments |
| *Schepis et al., 1982* | Focus on interventions/treatments |
| *Shah et al., 1982* | Adult population |
| *Barabas et al., 1983* | Case report |
| *Carr et al., 1983* | Focus on interventions/treatments |
| *Dawson et al., 1983* | Focus on physical/neurological/genetic conditions |
| *Hagberg et al., 1983* | Focus on physical/neurological/genetic conditions |
| *Tsai et al., 1983* | Etiology/risk factors |
| *Shapiro et al., 1983* | Focus on other mental health disorders |
| *Aman, 1984* | Focus on other mental health disorders |
| *Gillberg, 1984* | Not a prospective study |
| *Handen et al., 1984* | Focus on interventions/treatments |
| *Kerbeshian et al., 1984* | Case report |
| *McGee et al., 1984* | Focus on interventions/treatments |
| *Petty et al., 1984* | Case series |
| *Richter, 1984* | Focus on interventions/treatments |
| *Skuse, 1984* | Etiology/risk factors |
| *Paul et al., 1984* | Focus on other mental health disorders |
| *Whitehouse et al., 1984* | Diagnosis of autism with DSM-III |
| *Creasey et al., 1986* | Focus on physical/neurological/genetic conditions |
| *Hill et al., 1986* | Focus on other mental health disorders |
| *Rutter, 1986* | Focus on other mental health disorders |
| *Verma et al., 1986* | Focus on physical/neurological/genetic conditions |
| *Wolf et al., 1986* | Baseline or follow-up assessment in adult population |
| *Burd et al., 1987* | Focus on physical/neurological/genetic conditions |
| *Gillberg et al., 1987* | Baseline or follow-up assessment in adult population |
| *Konstantareas et al., 1987* | Focus on interventions/treatments |
| *Fisch et al., 1988* | Focus on physical/neurological/genetic conditions |
| *Hennessy et al., 1988* | Focus on physical/neurological/genetic conditions |
| *Rice et al., 1988* | Focus on physical/neurological/genetic conditions |
| *Seifert, 1988* | Focus on interventions/treatments |
| *Cantwell et al, 1989* | Focus on other mental health disorders |
| *Clarke et al, 1989* | Adult population |
| *Eggers, 1989* | Focus on other mental health disorders |
| *Howlin et al., 1989* | Etiology/risk factors |
| *Mesibov et al., 1989* | Focus on assessment tools |
| *Sherman et al., 1989* | Focus on interventions/treatments |
| *Szatmari et al., 1989* | Baseline or follow-up assessment in adult population |
| *Carpenter et al., 1990* | Focus on physical/neurological/genetic conditions |
| *Collacott et al., 1990* | Focus on physical/neurological/genetic conditions |
| *Gillberg et al., 1990* | No follow-up in adolescence |
| *Goodman et al., 1990* | Focus on physical/neurological/genetic conditions |
| *Haenggeli et al., 1990* | Focus on physical/neurological/genetic conditions |
| *Harchik et al., 1990* | Focus on interventions/treatments |
| *Jacobson et al., 1990* | Baseline or follow-up assessment in adult population |
| *Kerbeshian et al., 1990* | Not a prospective study |
| *Koegel et al., 1990* | Focus on interventions/treatments |
| *Mesibov et al., 1990* | Adult population |
| *Varley et al., 1990* | Focus on interventions/treatments |
| *Akefeldt et al., 1991* | Case series |
| *Binyon et al., 1991* | Focus on physical/neurological/genetic conditions |
| *Freeman et al., 1991* | Baseline or follow-up assessment in adult population |
| *Gillberg, 1991* | Narrative review |
| *Hamdan, 1991* | Case report |
| *Jure et al., 1991* | Focus on physical/neurological/genetic conditions |
| *Kurita, 1991* | Not a prospective study |
| *Perry et al., 1991* | Focus on physical/neurological/genetic conditions |
| *Volkmar et al., 1991* | Not a prospective study |
| *Wollf et al., 1991 a* | Focus on other mental health disorders |
| *Wollf, 1991 b* | Focus on other mental health disorders |
| *Boiron et al., 1992* | Focus on assessment tools |
| *Kamps et al., 1992* | Focus on interventions/treatments |
| *Kobayashi et al., 1992* | Baseline or follow-up assessment in adult population |
| *Siegel et al., 1992* | Focus on physical/neurological/genetic conditions |
| *Venter et al., 1992* | Diagnosis of autism with DSM-III-R |
| *Werry, 1992* | Focus on other mental health disorders |
| *Volkmar, 1992* | Focus on other mental health disorders |
| *Berger et al., 1993* | Diagnosis of autism with DSM-III-R |
| *Eales, 1993* | Baseline or follow-up assessment in adult population |
| *Gonzalez et al., 1993* | Baseline or follow-up assessment in adult population |
| *Gregory et al., 1993* | Book chapter |
| *Holroyd et al., 1993* | Baseline or follow-up assessment in adult population |
| *Martos Perez et al., 1993* | Baseline or follow-up assessment in adult population |
| *McClellan et al., 1993* | Focus on other mental health disorders |
| *Morrow et al., 1993* | Book chapter |
| *Vvon Knorring et al., 1993* | Baseline or follow-up assessment in adult population |
| *Blackwood et al., 1994* | Focus on other mental health disorders |
| *Bryson et al., 1994* | Case report |
| *DeLong et al., 1994 a* | Focus on physical/neurological/genetic conditions |
| *DeLong, 1994 b* | Not a prospective study |
| *Gordon et al., 1994* | Focus on other mental health disorders |
| *Luiselli et al., 1994* | Focus on physical/neurological/genetic conditions |
| *Purdon et al., 1994* | Focus on interventions/treatments |
| *Rousseau et al., 1994* | Focus on interventions/treatments |
| *Sigafoos et al., 1994* | Focus on interventions/treatments |
| *Bailey et al., 1995 a* | Focus on physical/neurological/genetic conditions |
| *Bailey et al., 1995 b* | Not a prospective study |
| *Courchesne, 1995* | Focus on physical/neurological/genetic conditions |
| *Ghaziuddin et al., 1995* | Etiology/risk factors |
| *Gillberg et al., 1995* | Focus on other mental health disorders |
| *Heimann et al., 1995* | Focus on interventions/treatments |
| *Howlin et al., 1995* | Focus on assessment tools |
| *Kramer et al., 1995* | Focus on physical/neurological/genetic conditions |
| *Wolff et al., 1995* | Focus on other mental health disorders |
| *Ballaban-Gil et al., 1996* | Baseline or follow-up assessment in adult population |
| *Bebko et al., 1996* | Focus on interventions/treatments |
| *Bettison, 1996* | Focus on interventions/treatments |
| *Domachowske et al., 1996* | Focus on physical/neurological/genetic conditions |
| *Dykens et al., 1996* | Focus on physical/neurological/genetic conditions |
| *Fudenberg, 1996* | Focus on interventions/treatments |
| *Gena et al., 1996* | Focus on interventions/treatments |
| *Gillberg et al., 1996 a* | Focus on physical/neurological/genetic conditions |
| *Gillberg et al., 1996 b* | Focus on other mental health disorders |
| *Howlin et al., 1996* | Focus on other mental health disorders |
| *Kerbeshian et al., 1996* | Case report |
| *Nordin et al., 1996* | Autism with ID |
| *Roeyers, 1996* | Aetiology/risk factors |
| *Simon et al., 1996* | Case report |
| *Tsai, 1996* | Not a prospective study |
| *Aronson et al., 1997* | Aetiology/risk factors |
| *Kawasaki et al., 1997* | Focus on physical/neurological/genetic conditions |
| *Kientz et al., 1997* | Not a prospective study |
| *Landen et al., 1997* | Case report |
| *Larsen et al., 1997* | Baseline or follow-up assessment in adult population |
| *Panerai et al., 1997* | Focus on interventions/treatments |
| *Subramaniam et al., 1997* | Focus on physical/neurological/genetic conditions |
| *Chung, 1998* | Case report |
| *Ek et al., 1998* | Focus on physical/neurological/genetic conditions |
| *Ghaziuddin et al., 1998* | Not a prospective study |
| *Gralton et al., 1998* | Focus on interventions/treatments |
| *Gresham et al., 1998* | Focus on interventions/treatments |
| *Kazdin et al., 1998* | Focus on other mental health disorders |
| *Kumra et al., 1998* | Focus on other mental health disorders |
| *Larkin et al., 1998* | Case series |
| *Mouridsen et al., 1998* | Focus on other mental health disorders |
| *Nordin et al., 1998* | Narrative review |
| *Schreier et al., 1998* | Focus on interventions/treatments |
| *Zappella et al., 1998* | Focus on physical/neurological/genetic conditions |
| *Berney et al., 1999* | Focus on physical/neurological/genetic conditions |
| *Gelisse et al., 1999* | Focus on physical/neurological/genetic conditions |
| *Kurita, 1999* | Case report |
| *Mouridsen et al., 1999 a* | Focus on other mental health disorders |
| *Mouridsen et al., 1999 b* | Focus on physical/neurological/genetic conditions |
| *Mouridsen et al., 1999 c* | Focus on other mental health disorders |
| *Nilsson et al., 1999* | Focus on other mental health disorders |
| *Realmuto et al., 1999* | Not a prospective study |
| *Risch et al., 1999* | Focus on physical/neurological/genetic conditions |
| *Sandler et al., 1999* | Focus on interventions/treatments |
| *Sigman et al., 1999* | Autism with ID |
| *Beadle-Brown et al., 2000* | Focus on other mental health disorders |
| *Burd et al., 2000* | Case report |
| *Chez et al., 2000* | Focus on interventions/treatments |
| *Firth et al., 2000* | Focus on other mental health disorders |
| *Hou et al., 2000* | Not a prospective study |
| *Howlin et al., 2000* | Baseline or follow-up assessment in adult population |
| *Kadesjo et al., 2000* | Focus on other mental health disorders |
| *Klein et al., 2000* | Focus on physical/neurological/genetic conditions |
| *Korkmaz , 2000* | Baseline or follow-up assessment in adult population |
| *Nelson et al., 2000* | Focus on physical/neurological/genetic conditions |
| *Riva et al., 2000* | Focus on physical/neurological/genetic conditions |
| *Weber et al., 2000* | Focus on physical/neurological/genetic conditions |
| *Zwaigenbaum et al., 2000* | Case series |
| *Chang et al., 2001* | Focus on physical/neurological/genetic conditions |
| *Gilchrist et al., 2001* | Not a prospective study |
| *Luiselli et al., 2001* | Focus on interventions/treatments |
| *Park et al., 2001* | Focus on physical/neurological/genetic conditions |
| *Rastam et al., 2001* | Focus on other mental health disorders |
| *Akshoomoff et al., 2002* | Focus on physical/neurological/genetic conditions |
| *Beadle-Brown et al., 2002* | Autism with ID |
| *Caicedo et al., 2002* | Focus on interventions/treatments |
| *Casanova et al., 2002* | Focus on physical/neurological/genetic conditions |
| *Christensen et al., 2002* | Focus on other mental health disorders |
| *Descheemaeker et al., 2002* | Focus on physical/neurological/genetic conditions |
| *Fisch et al., 2002* | Autism with ID |
| *Ghaziuddin et al., 2002* | Focus on physical/neurological/genetic conditions |
| *Gillberg et al., 2002* | Focus on physical/neurological/genetic conditions |
| *Iqbal, 2002* | Focus on physical/neurological/genetic conditions |
| *Marshall, 2002* | Not a prospective study |
| *McDougle et al., 2002* | Focus on interventions/treatments |
| *Moes et al., 2002* | Focus on interventions/treatments |
| *Simeon et al., 2002* | Focus on interventions/treatments |
| *Sponheim et al., 2002* | Focus on interventions/treatments |
| *Strömland et al., 2002* | Focus on physical/neurological/genetic conditions |
| *Ahearn, 2003* | Case report |
| *Berger et al., 2003* | Baseline or follow-up assessment in adult population |
| *Eisermann et al., 2003* | Focus on physical/neurological/genetic conditions |
| *Gale et al., 2003* | Focus on interventions/treatments |
| *Geerts et al., 2003* | Focus on physical/neurological/genetic conditions |
| *King et al., 2003* | Focus on interventions/treatments |
| *Lahuis et al., 2003* | Focus on physical/neurological/genetic conditions |
| *Ogdie et al., 2003* | Focus on physical/neurological/genetic conditions |
| *Park, 2003* | Focus on physical/neurological/genetic conditions |
| *Rastam et al., 2003* | Focus on other mental health disorders |
| *Steele et al., 2003* | Autism with ID |
| *Strauss et al., 2003* | Focus on physical/neurological/genetic conditions |
| *Zappella et al., 2003* | Focus on physical/neurological/genetic conditions |
| *Indredavik et al., 2004* | Aetiology/risk factors |
| *Stephenson et al., 2004* | Focus on physical/neurological/genetic conditions |
| *Stringer, 2004* | Focus on physical/neurological/genetic conditions |
| *Von Tetzchner et al., 2004* | Case report |
| *Wong et al., 2004* | Focus on assessment tools |
| *Billstedt et al., 2005* | Baseline or follow-up assessment in adult population |
| *Chadwick et al., 2005* | Focus on other mental health disorders |
| *Constantino et al., 2005* | Diagnosis of autism does not meet our inclusion criteria |
| *Coplan et al., 2005* | Not a prospective study |
| *Danielsson et al., 2005* | Focus on physical/neurological/genetic conditions |
| *Fisher et al., 2005* | Focus on interventions/treatments |
| *Gornick et al., 2005* | Focus on other mental health disorders |
| *Krauss et al., 2005* | Adult population |
| *Kielinen et al., 2005* | Not a prospective study |
| *McGovern et al., 2005* | Baseline or follow-up assessment in adult population |
| *McLellan et al., 2005* | Focus on physical/neurological/genetic conditions |
| *Ritsner et al., 2005* | Focus on other mental health disorders |
| *Roberts et al., 2005* | Focus on physical/neurological/genetic conditions |
| *Sigman et al., 2005* | Baseline or follow-up assessment in adult population |
| *Troost  et al., 2005* | Focus on interventions/treatments |
| *Carminati et al., 2006* | Focus on interventions/treatments |
| *Feroz-Nainar et al., 2006*  | Focus on interventions/treatments |
| *Guzzetta et al., 2006* | Focus on physical/neurological/genetic conditions |
| *Herring et al., 2006* | Aetiology/risk factors |
| *Klin et al., 2006* | Baseline or follow-up assessment in adult population |
| *Lemery-Chalfant et al., 2006* | Focus on other mental health disorders |
| *Mazzone et al., 2006* | Focus on interventions/treatments |
| *Miller et al., 2006* | Focus on other mental health disorders |
| *Ohta et al., 2006* | Focus on physical/neurological/genetic conditions |
| *Valicenti-McDermott et al., 2006* | Focus on interventions/treatments |
| *Wong, 2006* | Focus on physical/neurological/genetic conditions |
| *Zappella, 2006* | Not a prospective study |
| *Anderson et al., 2007* | Focus on interventions/treatments |
| *Amminger et al., 2007* | Focus on interventions/treatments |
| *Baghdadli et al., 2007* | Intellectual quotient (IQ) was not formally assessed |
| *Billstedt et al., 2007* | Adult population |
| *Chez et al., 2007* | Focus on interventions/treatments |
| *Erickson et al., 2007* | Focus on interventions/treatments |
| *Gillberg et al., 2007* | Focus on other mental health disorders |
| *Goldsmith et al., 2007* | Focus on other mental health disorders |
| *Hara, 2007* | Focus on physical/neurological/genetic conditions |
| *Iavarone et al., 2007* | Not a prospective study |
| *Indredavik et al., 2007* | Focus on other mental health disorders |
| *Knoester et al., 2007* | Focus on other mental health disorders |
| *Mouridsen et al., 2007* | Aetiology/risk factors |
| *Rutter et al., 2007* | Focus on other mental health disorders |
| *Skovgaard et al., 2007* | Focus on other mental health disorders |
| *Skranes et al., 2007* | Focus on physical/neurological/genetic conditions |
| *Tavano et al., 2007* | Focus on physical/neurological/genetic conditions |
| *Tse et al., 2007* | Focus on interventions/treatments |
| *White et al., 2007* | Not a prospective study |
| *Allik et al., 2008* | Focus on physical/neurological/genetic conditions |
| *Andersen et al., 2008* | Focus on interventions/treatments |
| *Capone et al., 2008* | Focus on interventions/treatments |
| *Cederlund et al., 2008* | Baseline or follow-up assessment in adult population |
| *Chadwick et al., 2008* | Focus on other mental health disorders |
| *Colvert et al., 2008* | Focus on other mental health disorders |
| *Coskun et al., 2008* | Focus on interventions/treatments |
| *Danielsson et al., 2008* | Focus on interventions/treatments |
| *Esterberg et al., 2008* | Diagnosis of autism does not meet our inclusion criteria |
| *Friedman et al., 2008* | Focus on interventions/treatments |
| *Knerr et al., 2008* | Focus on physical/neurological/genetic conditions |
| *Lerman et al., 2008* | Focus on interventions/treatments |
| *Mandell et al., 2008* | Focus on interventions/treatments |
| *Montes et al., 2008* | Aetiology/risk factors |
| *Mouridsen et al., 2008* | Adult population |
| *Munesue et al., 2008* | Adult population |
| *Nyden et al., 2008* | Economic impact |
| *Ospina et al., 2008* | Focus on interventions/treatments |
| *Palmen et al., 2008* | Focus on assessment tools |
| *Smith et al., 2008* | Adult population |
| *Sprong et al., 2008* | Focus on other mental health disorders |
| *Wassink et al., 2008* | Aetiology/risk factors |
| *Webster et al., 2008* | Focus on physical/neurological/genetic conditions |
| *Williams et al., 2008* | Prevalence |
| *Young et al., 2008* | Focus on differential diagnoses |
| *Bombardieri et al., 2009* | Focus on physical/neurological/genetic conditions |
| *Burke et al., 2009* | Focus on physical/neurological/genetic conditions |
| *Cederlund et al., 2009* | Baseline or follow-up assessment in adult population |
| *Coffin et al., 2009* | Focus on physical/neurological/genetic conditions |
| *Constantino et al., 2009* | Of the 95 PDD participants, IQ scores were only available for 38 |
| *Cooper et al., 2009* | Adult population |
| *Coskun et al., 2009* | Focus on interventions/treatments |
| *Danielsson et al., 2009* | Focus on physical/neurological/genetic conditions |
| *Esbensen et al., 2009* | Not a prospective study |
| *Farley et al., 2009* | Baseline or follow-up assessment in adult population |
| *Galera et al., 2009* | Focus on other mental health disorders |
| *Hempel et al., 2009* | Focus on physical/neurological/genetic conditions |
| *Herbrecht et al., 2009* | Focus on interventions/treatments |
| *Hagberg et al., 2009* | Focus on other mental health disorders |
| *Hollander et al., 2009* | Focus on interventions/treatments |
| *Hudson et al., 2009* | Focus on interventions/treatments |
| *Ibrahim et al., 2009* | Focus on physical/neurological/genetic conditions |
| *Johnson et al., 2009* | Focus on interventions/treatments |
| *Laugeson et al., 2009* | Focus on interventions/treatments |
| *Lubisch et al., 2009* | Focus on interventions/treatments |
| *Masi et al., 2009* | Focus on interventions/treatments |
| *Mouridsen et al., 2009 a* | Baseline or follow-up assessment in adult population |
| *Mouridsen et al., 2009 b* | Aetiology/risk factors |
| *Oosterling et al., 2009* | Focus on assessment tools |
| *Rapoport et al., 2009*  | Focus on other mental health disorders |
| *Saha et al., 2009* | Aetiology/risk factors |
| *Thompson et al., 2009* | Aetiology/risk factors |
| *Wentz et al., 2009* | Focus on other mental health disorders |
| *Whitehouse et al., 2009 a* | Baseline or follow-up assessment in adult population |
| *Whitehouse et al., 2009 b* | Baseline or follow-up assessment in adult population |
| *Whittingham et al., 2009* | Focus on interventions/treatments |
| *Wong, 2009* | Focus on interventions/treatments |

**Appendix B. Additional details on search strategy**

The search strategy was developed by the first author in consultation with an expert librarian. Three databases were consulted (PubMed/MEDLINE, PsycINFO and Educational Resources Information Centre (ERIC)) and the results were limited to studies published between 1st January 2010 - 1stJanuary 2020, in English. Medical Subject Heading (MeSH) were used in PubMed and subject heading terms were used in PsycINFO, when appropriate.

***Search syntax***

1 child\* or adolescen\* or teen\*or child or adolescent; 2 “Autism Spectrum Disorder” or autis\* or autistic disorder or asperger\* or asperger syndrome or ASD or PDD or “pervasive developmental disorder”; 3 “follow-up stud\*” or “longitudinal stud\*” or longitudinal or follow up

1 and 2 and 3

**Appendix C. Quality assessment of the reporting of the included studies using 19 adapted items from STROBE.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Study | INTRODUCTION | METHOD | RESULT  | DISCUSSION | OTHER |  TOTAL |
| Andersen et al., 2015 | 5 | 17 | 3 | 7 | 2 | 34 (89.5%) |
| Andersen et al., 2017 | 5 | 17 | 3 | 6 | 2 | 33 (86.8%) |
| Asberg et al., 2019 | 6 | 17 | 4 | 8 | 2 | 37 (97.3%) |
| Cantio et al., 2018 | 5 | 17 | 4 | 6 | 2 | 34 (89.5%) |
| Estes et al., 2011 | 6 | 16 | 4 | 7 | - | 33 (86.8%) |
| Eussen et al., 2015 | 6 | 17 | 4 | 7 | 2 |  36 (94.7%) |
| Eussen et al., 2016 | 6 | 17 | 4 | 8 | 2 | 37 (97.3%) |
| Grimm et al., 2018 | 6 | 18 | 4 | 8 | 2 | 38 (100%) |
| Kenny et al., 2019 | 6 | 17 | 4 | 8 | 2 | 37 (97.3%) |
| Kouklari et al., 2019 | 6 | 17 | 4 | 7 | 2 | 36 (94.7%) |
| Louwerse et al., 2015 | 4 | 15 | 3 | 6 | 2 |  30 (78.9%) |
| Mandy et al., 2016 | 4 | 15 | 4 | 6 | 2 | 31 (81.6%) |
| May et al., 2014  | 6 | 14 | 4 | 8 | 2 | 34 (89.5%) |
| May et al., 2015 | 6 | 15 | 4 | 7 | 2 |  34 (89.5%) |
| Pellicano, 2010a | 6 | 18 | 4 | 7 | 2 | 37 (97.3%) |
| Pellicano, 2010b | 6 | 15 | 4 | 7 | 2 | 34 (89.5%) |
| Pellicano, 2012 | 6 | 16 | 4 | 7 | 2 | 35 (92.1%) |
| Pellicano, 2013 | 5 | 16 | 4 | 7 | 2 | 34 (89.5%) |
| Scheren et al., 2019 | 4 | 15 | 4 | 6 | 2 | 31 (81.6%) |
| Simonoff et al., 2012 | 4 | 16 | 4 | 7 | 2 | 33 (86.8%) |
| Simonoff et al., 2013 | 5 | 16 | 4 | 7 | 2 | 34 (89.5%) |
| Solari et al., 2019 | 5 | 15 | 4 | 7 | 2 | 33 (86.8%) |
| St John et al., 2018 | 3 | 14 | 4 | 6 | 2 | 29 (76.3%) |
| Titeca et al., 2014 | 6 | 15 | 4 | 8 | 2 | 35 (92.1%) |
| Verheij et al., 2015 | 4 | 14 | 3 | 7 | 2 | 30 (78.9%) |
| Vogan et al., 2018 | 5 | 17 | 4 | 7 | 2 | 35 (92.1%) |
| Welss et al., 2019 | 4 | 14 | 4 | 6 | 2 | 30 (78.9%) |
| Westerveld et al., 2018 | 6 | 16 | 4 | 8 | 2 | 36 (94.7%) |