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Maternal socioeconomic status based on occupation and autism spectrum disorders: a national case-control study

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Abstract

Background—The association between parental socioeconomic status (SES) and autism spectrum disorders (ASD) has been studied in several countries, but the results have been contradictory.

Aims—The aim of this study was to examine the association between maternal SES and subtypes of ASD in Finland.

Methods—A national case-control study was conducted. Children born in 1991–2005 and diagnosed with ASD by the year 2007 were identified from the Finnish Hospital Discharge Register (FHDR). Their matched controls were selected from the Finnish Medical Birth Register (FMBR). There were 3468 cases and 13 868 controls. The information on maternal SES was collected from the FMBR and categorised into upper white collar workers (referent), lower white collar workers, blue collar workers and “others” consisting of students, housewives and other groups with unknown SES. The statistical test used was conditional logistic regression.

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Disclosure of interests

The authors declare that they have no competing interests.

Results—The likelihood of ASD was increased among offspring of mothers who belong to the group “others” (adjusted OR 1.2, 95% CI 1.009–1.3). The likelihood of Asperger’s syndrome was decreased among offspring of lower white collar workers (0.8, 0.6–0.9) and blue collar workers (0.6, 0.5–0.7). The likelihood of PDD-NOS was increased among offspring of blue collar workers (1.5, 1.2–1.9) and “others” (1.3, 1.1–1.7). No association was found between maternal SES and childhood autism.

Conclusions—The association between maternal SES and ASD differs by ASD subtype. Socioeconomic groups might differ from each other by risk factors for ASD subtypes or by their service use.

Keywords

autism; epidemiology; risk factor; socioeconomic status

Background

Parents’ low income or low educational level have been associated with various psychosocial problems in offspring (1–4). It is unclear, however, whether parental socioeconomic status (SES) is also associated with neurodevelopmental problems such as autism spectrum disorders (ASD), which are assumed to have a largely biological etiology and an onset beginning by infancy. Specifically, it is not known whether parental SES has an impact on ASD prevalence in a country such as Finland, which is known for the relatively low level of economic inequality and for universal coverage of public health services. In a population-based survey there was no association between parental SES and the prevalence of psychosomatic symptoms or long-term diseases among Finnish children (5).

Previous studies on parental SES and ASD have shown no consistent pattern. A review of epidemiological studies of ASD published by the year 2001 concluded that the twelve studies on social class or parental education and ASD found no association except for four studies conducted before 1980 (6). The results from later population-based studies have been inconsistent. Associations between high maternal education and childhood autism (7) or ASD (8,9) as well as between high area-level SES and ASD (10,11) were found in studies conducted in the USA. In a British study, children with ASD were more likely to have fathers with a non-manual occupation, but no association was found with parents’ education level or maternal occupation and ASD (12). A Canadian study found an association between income support during the year of birth or early childhood and increased risk of ASD (13). In Sweden, low family income and manual occupation of parents were associated with higher risk of ASD, but no association was found between parental education and ASD (14). In Taiwan, parents’ low occupational level was associated with higher risk of childhood autism (15). An Australian study found an association between high area-level SES and ASD without intellectual disability although this relationship was not linear (16). No association was found between SES and ASD with intellectual disability (16). In a Danish study, no associations between parental wealth or maternal education and childhood autism were found (17).

The inconsistencies may be partly due to the methodological differences and limitations of previous studies. One source of variation is the use of diverse measures of SES. In addition, the studies have been conducted in various social contexts. It has often been emphasised that if an association between SES and ASD is observed, it may be explained by bias in case ascertainment. In other words, parents with high SES may have better access to services or professionals may be more likely to diagnose ASD in children whose parents have high SES (8,18–20). The bias may be more common in countries where the availability of services depends heavily on the wealth or employment status of parents. Of the study countries, Sweden, Denmark and the UK, in particular, and Canada and Australia to a lesser extent, cover most of the health care expenditures by governmental funds. In the USA, conversely, health coverage is based to a greater extent on other sources such as private insurance and out-of-pocket payments (21). Previous studies have also used different confounders. While most studies have included covariates such as birth factors and parental demographic characteristics, there are also a few studies in which this kind of individual-level data have not been available (10,11) or have not been used (12).

Some studies have included the entire group of ASD while others have focused on childhood autism only. However, most previous population-based studies have not examined the differences in associations between SES and the three main subtypes of ASD, namely childhood autism, Asperger's syndrome and other pervasive developmental disorder not otherwise specified (PDD-NOS). There is, however, one US study in which childhood autism was examined separately from PDD-NOS and Asperger's syndrome which were grouped together (9). In that study, high maternal education was associated with PDD-NOS or Asperger's syndrome in offspring (9). The direction of association was the same for childhood autism, but the result was not statistically significant (9). Four previous studies (8,10,14,16) have taken intellectual disability into account. Of these, studies conducted in the USA (10) and in Australia (16) suggested that high SES is associated with ASD without intellectual disability, but not with ASD and co-occurring intellectual disability. Another US study showed an association between high SES and ASD both with and without intellectual disability, but the relationship was weaker in the latter group (8). In a Swedish study the association between SES and ASD was very similar in the groups with or without comorbid intellectual disability (14). Taking ASD subtypes or comorbid conditions into account is important to increase the understanding of the clinical and etiological heterogeneity of ASD. It has been suggested that factors such as developmental pattern, gender, clinical phenotype or cognitive profile could help in identifying relevant ASD subgroups (22).

Acknowledging the inconsistent results of previous population-based studies from different countries, the aim of the present study is to examine the association between maternal SES based on occupation and ASD in Finland. A further aim is to study whether there are differential associations between maternal SES and ASD subtypes, namely childhood autism, Asperger's syndrome and PDD-NOS.

Material and methods

Study design

This study is part of the Finnish Prenatal Study of Autism and Autism Spectrum Disorders (FIPS-A), which is a nested case-control study based on a national birth cohort, and aims to identify early risk factors for ASD (23–27). An overview of the study has been presented previously (28). The study was authorised by the Ministry of Social Affairs and Health in Finland (STM/2593/2008) with the approval from the Ethics Committee of the Hospital District of Southwest Finland and the National Institute for Health and Welfare (THL), and approved by the Institutional Review Board of the New York State Psychiatric Institute. To assess the association between maternal SES and ASD, we conducted a register linkage for 3794 ASD cases and 15 111 matched controls.

Case and control identification

Children born as singletons in 1991–2005 and diagnosed with ASD by the year 2007 were identified from the Finnish Hospital Discharge Register (FHDR), a nationwide mandatory register maintained by THL. The register includes personal identification numbers, and covers diagnoses and dates of admission and discharge in all public and private inpatient care units in Finland since 1969. Since 1998, the FHDR has also covered all outpatient care in public hospitals. The diagnoses are based on the International Classification of Diseases and Related Health Problems (ICD). All diagnostic codes indicating ASD were collected according to the ICD-9 in 1991–1995 and ICD-10 in 1996–2007. The most recent registry diagnosis was used. The diagnostic categories included in this study were childhood autism (F84.0 in ICD-10), Asperger's syndrome (F84.5) and other pervasive developmental disorder including PDD-NOS (F84.8 and F84.9). Corresponding ICD-9 codes were also included, but only two cases had an ICD-9 code as the most recent one. A validation study (29) has shown that the specificity of the childhood autism diagnosis in the FHDR is very good: when a re-assessment using the Autism Diagnostic Interview-Revised was made, 96% of the cases with registry diagnoses of childhood autism met the diagnostic criteria.

For each case, four matched controls were selected from the Finnish Medical Birth Register (FMBR), which is also a mandatory national register maintained by THL. The FMBR covers information on maternal background, pregnancy, delivery and early outcomes of the newborn for all births in Finland. The register includes all maternal and child personal identification numbers, which can be linked to one another. The FMBR was started in 1987, and data on maternal SES has been collected since October 1990. Controls were matched to each case by date of birth (± 30 days), place of birth, sex and residence in Finland. The exclusion criteria for controls were ASD or severe/profound intellectual disability according to the FHDR. Five controls were excluded because of intellectual disability. An additional 65 children (one case and 64 controls) were excluded because they or their mother had an incorrect or incomplete personal identification number.

Maternal SES

The information on maternal SES was collected from the FMBR. Information on occupation is collected during prenatal care and latest at birth hospital. Some women give education

instead of occupation. The written text is automatically coded to SES according to national classifications. This process has been described in more detail in a study, which also showed that FMBR data can be used for studies on socioeconomic health differences in the perinatal period (30). Previously it has been shown that the information on occupation in the FMBR is of high quality. A study which compared the information in medical records and FMBR showed that there was a 95% agreement for the information on occupation (31).

Maternal SES was categorised into four groups following the Finnish national classifications on occupations and socioeconomic groups (32,33): upper white collar workers, lower white collar workers, blue collar workers and others. The classification is primarily based on occupational status. "Upper white collar workers" refers to people who are upper clerical workers and work for example as leaders, experts or teachers. "Lower white collar workers" refers to lower clerical workers such as people doing office work, who are not leaders or experts. "Blue collar workers" perform manual labor and "others" includes entrepreneurs and people outside the labor force such as students, homemakers and unemployed people. Women who report education instead of occupation are classified as upper white collar workers if they are known to have a university degree and as lower white collar workers if they are known to have a lower than university level vocational degree. In this cohort there were 326 cases (8.6%) and 1243 controls (8.2%), who did not have information on maternal SES, reducing the total number of subjects to 3468 cases and 13 868 controls.

Covariates

The inclusion of covariates was based on analyses of bivariate associations between: 1) selected register-based variables and ASD, and 2) these same variables and maternal SES among controls. The results of these analyses are shown in Table 1. The distribution of covariates among cases is provided as a supplement. All variables including maternal and paternal age at child's birth, parental psychiatric disorder or intellectual disability, maternal smoking, parity and weight for gestational age (WGA) were significantly associated with both ASD and SES.

Data on paternal age were collected from the Finnish Central Population Register, which is a computerised national register that contains basic information about Finnish citizens and foreign citizens residing permanently in Finland and includes the personal identification number of the mother as well as of the father when he has been identified. Data on maternal and paternal history of a psychiatric disorder were obtained from the FHDR. The remainder of the information was obtained from the FMBR. A three-level categorical variable was used for maternal and paternal age at birth: 24 years or below, 25–39 years (reference) and more than 40 years. Parents were classified as having had a psychiatric disorder if at least one parent had any psychiatric diagnoses (ICD-8 codes 291 or 294–308, ICD-9 codes 291–292 or 295–316 and ICD-10 codes F10–F69 or F80–F99) recorded in the FHDR during their lifetime between 1969 and 2007. Until 31 December 1997 only diagnoses given in hospital inpatient care were included. Similarly, parents were classified as having intellectual disability if at least one parent had any of the diagnostic codes 310–315 (ICD-8), 317–319 (ICD-9) or F70–F79 (ICD-10) recorded in FHDR during their lifetime between 1969 and 2007. Parental psychiatric disorder or intellectual disability was classified as a binary

variable indicating that at least one of the parents had received a diagnosis of either type of disorder. Information about maternal smoking was originally collected by maternity clinic nurses during routine obstetric visits, and documented in health records, which were subsequently forwarded to the hospital in which the delivery takes place. These data were transferred to a standardised form in use by the FMBR by hospital staff. Maternal smoking during pregnancy was classified as a binary variable (yes/no). A binary variable was also used for parity: 0–1 previous births and two or more previous births. WGA was estimated according to Finnish birth weight standards, which are based on a gender-specific weight distribution in a sample of children born in Finland ($n=75\,061$) (34). It was categorised into three groups: small for gestational age (SGA, < -2 SD), appropriate for gestational age (AGA, -2 SD – $+2$ SD) and large for gestational age (LGA, $> +2$ SD).

Sensitivity analyses

Additionally, information on children's diagnoses indicating intellectual disability was collected from the FHDR for a stratified analysis. Co-occurring intellectual disability can be considered as one indicator of the severity of ASD and we were interested in studying whether maternal SES is associated differently with ASD types of different severity. ICD-10 codes F70-F79 and their corresponding ICD-9 codes were included in the stratification of cases. Stratification was also conducted by sex, because it was hypothesised that the association between maternal ASD and SES might be different among boys compared with girls, who represent a minority of ASD cases.

Statistical analyses

Conditional logistic regression was used to examine the association between occupation-based maternal SES and the three ASD subtypes pooled together as well as individually. Unadjusted odds ratios (OR) and 95% confidence intervals (CI) were first calculated for maternal SES using the four-categorical variable. Additionally, a pairwise comparison was conducted between blue collar and white collar workers. Upper white collar workers was the reference category in all analyses. Covariates were included in adjusted analyses individually as well as combined in one model. Two additional sensitivity analyses were conducted: by gender and by intellectual disability. The proportions of cases and controls missing maternal SES were compared by χ^2 test, and no statistically significant difference was observed ($p=0.464$). In all analyses, a two-sided p -value of <0.05 was considered statistically significant. Statistical analyses were performed using SAS 9.3 (SAS Institute, Cary, NC, USA).

Results

The relationships between covariates and occupation-based maternal SES as well as between covariates and ASD are shown in Table 1. Young maternal and paternal age, parental psychiatric disorder or intellectual disability, maternal smoking during pregnancy and two or more previous births were more common among blue collar workers and “others” than among the two groups of white collar workers. Children of upper white collar workers were least often SGA or LGA, but differences between the other three SES groups were small. Older (40 years or more) maternal age as well as younger (<25 years) and older (40 years or

more) paternal age, parental psychiatric disorder or intellectual disability, maternal smoking during pregnancy, less than two previous births and SGA were associated with higher probability of ASD. Their associations with ASD including ASD subtypes have been described in more detail previously (23,25,27,35,36).

Unadjusted and adjusted odds ratios for the risk of ASD are shown in Table 2. All of the statistically significant associations remained significant following adjustment with each of the covariates and in the full model. When all three ASD subtypes were pooled together, an increased risk was found for the offspring of mothers who belong to the group “others” (adjusted OR 1.2, 95% CI 1.009–1.3); no differences were observed for any of the other groups. When the subtypes of ASD were studied separately no statistically significant association was found between maternal SES and childhood autism. The likelihood of having Asperger’s syndrome was significantly lower for offspring of lower white collar workers (adjusted OR 0.8, 95% CI 0.6–0.9) and blue collar workers (adjusted OR 0.6, 95% CI 0.5–0.7). The likelihood of having PDD-NOS was significantly higher for those whose mother was a blue collar worker (adjusted OR 1.5, 95% CI 1.2–1.9) or belonged to the group others (adjusted OR 1.3, 95% CI 1.1–1.7).

To test whether the risk of ASD differed between children of blue collar workers and lower white collar workers, pairwise comparisons were conducted. Relative to lower white collar workers, the risk of ASD among the children of blue collar workers was increased (unadjusted OR 1.1, 95% CI 1.01–1.2). For childhood autism, no significant associations were found. The risk of Asperger’s syndrome was decreased (unadjusted OR 0.7, 95% CI 0.6–0.9) and the risk of PDD-NOS was increased (unadjusted OR 1.6, 95% CI 1.3–1.8) among the children of blue collar workers relative to those of lower white collar workers.

Sensitivity analysis by sex

For boys, no significant associations were found between maternal SES and ASD or childhood autism. The likelihood of Asperger’s syndrome was decreased in children whose mother was a lower white collar worker (unadjusted OR 0.7, 95% CI 0.6–0.8) or a blue collar worker (unadjusted OR 0.5, 95% CI 0.4–0.6). The likelihood of PDD-NOS was increased in children whose mother was a lower white collar worker (unadjusted OR 1.3, 95% CI 1.04–1.6), a blue collar worker (unadjusted OR 1.9, 95% CI 1.5–2.5) or belonged to the group “others” (unadjusted OR 1.6, 95% CI 1.3–2.1). For girls, no significant associations were found between maternal SES and ASD or any of the subtypes.

Sensitivity analysis by intellectual disability

There was no significant association between maternal SES and ASD without intellectual disability. The likelihood of ASD with intellectual disability, however, was increased in children whose mother was a lower white collar worker (unadjusted OR 1.6, 95% CI 1.1–2.3), a blue collar worker (unadjusted OR 2.0, 95% CI 1.4–3.0) or belonged to the group “others” (unadjusted OR, 95% CI 2.2, 1.5–3.3). The number of cases with intellectual disability was relatively small and did not allow a separate analysis for ASD subtypes.

Discussion

This study showed that higher occupation-based maternal SES is related to an increased risk of Asperger's syndrome in offspring, while lower maternal SES was related to a higher risk of PDD-NOS among births in Finland. No association was found between maternal SES and childhood autism. Stratification by intellectual disability showed that there was an association only between maternal SES and ASD with co-occurring intellectual disability. When stratification was conducted by gender, the results for boys were very similar compared with those for the total sample. For girls, no significant associations were found, which may be related to their small number.

In most previous studies ASD subtypes have not been studied separately. The only exception of which we are aware is the California-based study by Croen et al. (9) in which PDD-NOS and Asperger's syndrome were grouped together and studied separately from childhood autism. In their study, high maternal education was associated with PDD-NOS or Asperger's syndrome and no significant association was found with childhood autism (9).

SES can be a proxy for many other factors that affect ASD risk. It is possible that differential distribution of ASD risk factors associated with SES explain the different results for maternal SES and ASD subtypes. Previous studies in this cohort have shown that parental psychiatric history (25), smoking (27) and young maternal age (35) are associated with PDD-NOS more strongly compared with other ASD subtypes. This study showed that these factors were more common among mothers with low SES, but controlling for them did not change any of the observed associations. Some other factors unavailable in this dataset may also be more common among mothers with low SES. For example, substance/alcohol use, exposure to other toxicants or nutrient deficiencies during pregnancy might increase the risk of PDD-NOS, which includes a wide range of developmental problems and is often comorbid with other mental disorders (37). Alcohol use, especially combined with poor nutrition, may also increase the risk of intellectual impairment (38,39).

There is also a considerable genetic contribution to ASD (40,41). Some genetic risk factors for ASD or environmental factors that interact with genes to increase ASD risk may be overrepresented among low-SES parents. Conversely, some children whose parents have high SES may also have a genetically increased risk of ASD if some traits related to ASD are beneficial in attaining high SES professions. For example, Baron-Cohen et al. suggested that the risk of Asperger's syndrome is particularly high in children whose parents are high systemizers, a trait which is useful in fields such as engineering, mathematics or physics (42).

It is possible that the socioeconomic groups also differ in their service use. In Finland, the quality of health services in the public sector is high, access to services is universal and provided for free and most prescribed medications are provided for a small fee. However, people with high SES might still be more able or willing to utilise these services. In addition, the use of private services, which are also available and ensures easy access to a specialist, is likely to be more common in high-SES families. In a survey conducted in all five Nordic countries it was shown that Finnish children with low-income parents use the

services of a general practitioner more often than those whose parents have high income, but that the use of specialists' services is least common among low-SES families when measured both by parents' level of income and their level of education (43). Of the three ASD subtypes included in this study, Asperger's syndrome generally causes the least impairment, suggesting that it may be the most often underdiagnosed. It is possible that Asperger's syndrome is less often diagnosed in children whose parents have low SES, because they make the least use of specialised services. High-SES parents might also be more aware of Asperger's syndrome and thus more active in having their child assessed even when symptoms are not particularly severe.

Strengths and limitations

The strengths of this study include the large sample size, good representativeness of the general population nationally, possibility to compare different ASD subtypes, reliable source of information for maternal occupation, and register-based design that minimises the amount of missing data and avoids the problems related to data collected for example by interviews.

There are also some limitations to this study. Although the measure of SES used in this study is well established in Finland, it is somewhat unspecific, especially for young people in reproductive age. In particular, the category "others", which represents a heterogeneous group of mothers, remains unspecified. Information on father's SES was not available, because all data on father is confidential and the FMBR is not allowed to collect these data. Maternal and paternal SES is correlated in Finland with a correlation coefficient around 0.5. Mother's SES has been shown to have a stronger influence for example on birth outcomes (44). In addition, the validity of register diagnoses of childhood autism was shown to be excellent, but those of Asperger's syndrome and PDD-NOS have not been validated by research interviews. However, the children who receive an ASD diagnosis in Finland are assessed in specialised units by multiprofessional teams using standardised methods and to obtain disability benefits; an independent evaluation by an external physician is also required. It is also possible that there are undiagnosed cases, but because of the high rate of coverage by universal primary health care, it is likely that at least children with moderate or severe symptoms are detected. The annual incidence rate of diagnosed ASD in this sample has been shown to be 53.7 per 10 000 children under age 10 and born in 1996–1998, which is similar or even higher than in similar studies conducted elsewhere (45). The lack of association between maternal SES and ASD without intellectual disability suggests that intellectual disability might explain the findings, but this could not be studied further.

Conclusion

In this study, higher maternal SES was related to an increased risk of Asperger's syndrome, while lower maternal SES was related to a higher risk of PDD-NOS. This may be accounted for by differences in risk factors co-varying by ASD subtype, or by differences in service use. When childhood autism, Asperger's syndrome and PDD-NOS were studied together, an increased risk was found only among offspring of mothers who belong to the group "others". The findings show the importance of studying subtypes of ASD separately when examining risk factors or assessing service use and they also question the supposed equality of the Finnish health service provision.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Lipman EL, Offord DR, Boyle MH. Relation between economic disadvantage and psychosocial morbidity in children. *CMAJ*. 1994; 151:431–437. [PubMed: 8055403]
2. Costello EJ, Keeler GP, Angold A. Poverty, race/ethnicity, and psychiatric disorder: a study of rural children. *Am J Public Health*. 2001; 91:1494–1498. [PubMed: 11527787]
3. Spencer N. Does material disadvantage explain the increased risk of adverse health, educational, and behavioural outcomes among children in lone parent households in Britain? A cross sectional study. *J Epidemiol Community Health*. 2005; 59:152–157. [PubMed: 15650148]
4. Carter AS, Wagmiller RJ, Gray SA, McCarthy KJ, Horwitz SM, Briggs-Gowan MJ. Prevalence of DSM-IV disorder in a representative, healthy birth cohort at school entry: sociodemographic risks and social adaptation. *J Am Acad Child Adolesc Psychiatry*. 2010; 49:686–698. [PubMed: 20610138]
5. Siponen SM, Ahonen RS, Savolainen PH, Hämeen-Anttila KP. Children's health and parental socioeconomic factors: a population-based survey in Finland. *BMC Public Health*. 2011; 11:457. [PubMed: 21658272]
6. Fombonne E. Epidemiological surveys of autism and other pervasive developmental disorders: an update. *J Autism Dev Disord*. 2003; 33:365–382. [PubMed: 12959416]
7. Croen LA, Grether JK, Selvin S. Descriptive epidemiology of autism in a California population: who is at risk? *J Autism Dev Disord*. 2002; 32:217–224.
8. Bhasin TK, Schendel D. Sociodemographic risk factors for autism in a US metropolitan area. *J Autism Dev Disord*. 2007; 37:667–677. [PubMed: 16951989]
9. Croen LA, Najjar DV, Fireman B, Grether JK. Maternal and paternal age and risk of autism spectrum disorders. *Arch Pediatr Adolesc Med*. 2007; 161:334–340. [PubMed: 17404129]
10. Durkin MS, Maenner MJ, Meaney FJ, Levy SE, DiGuseppi C, Nicholas JS, et al. Socioeconomic inequality in the prevalence of autism spectrum disorder: evidence from a U.S. cross-sectional study. *PLoS One*. 2010; 5:e11551. [PubMed: 20634960]
11. Thomas P, Zahorodny W, Peng B, Kim S, Jani N, Halperin W, et al. The association of autism diagnosis with socioeconomic status. *Autism*. 2012; 16:201–213. [PubMed: 21810908]
12. Williams E, Thomas K, Sidebotham H, Emond A. Prevalence and characteristics of autistic spectrum disorders in the ALSPAC cohort. *Dev Med Child Neurol*. 2008; 50:672–677. [PubMed: 18754916]
13. Dodds L, Fell DB, Shea S, Armson BA, Allen AC, Bryson S. The role of prenatal, obstetric and neonatal factors in the development of autism. *J Autism Dev Disord*. 2011; 41:891–902. [PubMed: 20922473]
14. Rai D, Lewis G, Lundberg M, Araya R, Svensson A, Dalman C, et al. Parental socioeconomic status and risk of offspring autism spectrum disorders in a Swedish population-based study. *J Am Acad Child Adolesc Psychiatry*. 2012; 51:467–476 e6. [PubMed: 22525953]
15. Chen CY, Liu CY, Su WC, Huang SL, Lin KM. Factors associated with the diagnosis of neurodevelopmental disorders: a population-based longitudinal study. *Pediatrics*. 2007; 119:e435–43. [PubMed: 17272605]

16. Leonard H, Glasson E, Nassar N, Whitehouse A, Bebbington A, Bourke J, et al. Autism and intellectual disability are differentially related to sociodemographic background at birth. *PLoS One*. 2011; 6:e17875. [PubMed: 21479223]
17. Larsson HJ, Eaton WW, Madsen KM, Vestergaard M, Olesen AV, Agerbo E, et al. Risk factors for autism: perinatal factors, parental psychiatric history, and socioeconomic status. *Am J Epidemiol*. 2005; 161:916–25. [PubMed: 15870155]
18. Cuccaro ML, Wright HH, Rownd CV, Abramson RK, Waller J, Fender D. Professional perceptions of children with developmental difficulties: the influence of race and socioeconomic status. *J Autism Dev Disord*. 1996; 26:461–469. [PubMed: 8863096]
19. Baird G, Simonoff E, Pickles A, Chandler S, Loucas T, Meldrum D, et al. Prevalence of disorders of the autism spectrum in a population cohort of children in South Thames: the Special Needs and Autism Project (SNAP). *Lancet*. 2006; 368:210–215. [PubMed: 16844490]
20. Wing L. Childhood autism and social class: a question of selection? *Br J Psychiatry*. 1980; 137:410–417. [PubMed: 7470767]
21. OECD. Health at a Glance 2011: OECD Indicators. 2011. http://www.oecd-ilibrary.org/sites/health_glance-2011-en/07/05/g7-05-01.html?contentType=&itemId=/content/chapter/health_glance-2011-64-en&containerItemId=/content/serial/19991312&accessItemIds=/content/book/health_glance-2011-en&mimeType=text/html
22. Lai MC, Lombardo MV, Chakrabarti B, Baron-Cohen S. Subgrouping the autism “spectrum”: reflections on DSM-5. *PLoS Biol*. 2013; 11:e1001544. [PubMed: 23630456]
23. Lampi KM, Lehtonen L, Tran PL, Suominen A, Lehti V, Banerjee PN, et al. Risk of autism spectrum disorders in low birth weight and small for gestational age infants. *J Pediatr*. 2012; 161:830–836. [PubMed: 22677565]
24. Cheslack-Postava K, Rantakokko PV, Hinkka-Yli-Salomäki S, Surcel HM, McKeague IW, Kiviranta HA, et al. Maternal serum persistent organic pollutants in the Finnish Prenatal Study of Autism: A pilot study. *Neurotoxicol Teratol*. 2013; 38:1–5. [PubMed: 23591055]
25. Jokiranta E, Brown AS, Heinimä M, Cheslack-Postava K, Suominen A, Sourander A. Parental psychiatric disorders and autism spectrum disorders. *Psychiatry Res*. 2013; 207:203–11. [PubMed: 23391634]
26. Brown AS, Sourander A, Hinkka-Yli-Salomäki S, McKeague IW, Sundvall J, Surcel HM. Elevated maternal C-reactive protein and autism in a national birth cohort. *Mol Psychiatry*. 2014; 19:259–64. [PubMed: 23337946]
27. Tran PL, Lehti V, Lampi KM, Helenius H, Suominen A, Gissler M, et al. Smoking during Pregnancy and Risk of Autism Spectrum Disorder in a Finnish National Birth Cohort. *Paediatr Perinat Epidemiol*. 2013; 27:266–274. [PubMed: 23574415]
28. Lampi KM, Banerjee PN, Gissler M, Hinkka-Yli-Salomäki S, Huttunen J, Kulmala U, et al. Finnish Prenatal Study of Autism and Autism Spectrum Disorders (FIPS-A): Overview and Design. *J Autism Dev Disord*. 2011; 41:1090–6. [PubMed: 21082229]
29. Lampi KM, Sourander A, Gissler M, Niemelä S, Peltonen L, VonWendt L. Validity of Finnish Registry-Based Diagnoses of Autism with the ADI-R – A Brief Report. *Acta Paediatrica*. 2010; 99:1425–1428. [PubMed: 20412100]
30. Gissler M, Meriläinen J, Vuori E, Hemminki E. Register based monitoring shows decreasing socioeconomic differences in Finnish perinatal health. *J Epidemiol Community Health*. 2003; 57:433–439. [PubMed: 12775790]
31. Gissler M, Teperi J, Hemminki E, Meriläinen J. Data quality after restructuring a national medical registry. *Scand J Soc Med*. 1995; 23:75–80. [PubMed: 7784857]
32. Statistics Finland: Classification of occupations. Handbooks. 14:1987.
33. Statistics Finland: Classification of socioeconomic groups. Handbooks. 17:1989.
34. Pihkala J, Hakala T, Voutilainen P, Raivio K. Characteristic of recent fetal growth curves in Finland. *Duodecim*. 1989; 105:1540–1546. [PubMed: 2680445]
35. Lampi KM, Hinkka-Yli-Salomäki S, Lehti V, Helenius H, Gissler M, Brown AS, et al. Parental Age and Risk of Autism Spectrum Disorders in a Finnish National Birth Cohort. *J Autism Dev Disord*. 2013; 43:2526–35. [PubMed: 23479075]

36. Cheslack-Postava K, Jokiranta E, Suominen A, Lehti V, Sourander A, Brown AS. Variation by Diagnostic Subtype in Risk for Autism Spectrum Disorders Associated with Maternal Parity among Finnish Births. *Paediatr Perinat Epidemiol*. 2014; 28:58–66. [PubMed: 24313668]
37. de Bruin EI, Ferdinand RF, Meester S, de Nijs PF, Verheij F. High rates of psychiatric co-morbidity in PDD-NOS. *J Autism Dev Disord*. 2007; 37:877–886. [PubMed: 17031447]
38. Behnke M, Smith VC, Committee on Substance Abuse, Committee on Fetus and Newborn. Prenatal substance abuse: short- and long-term effects on the exposed fetus. *Pediatrics*. 2013; 131:e1009–24. [PubMed: 23439891]
39. Guerrini I, Thomson AD, Gurling HD. The importance of alcohol misuse, malnutrition and genetic susceptibility on brain growth and plasticity. *Neurosci Biobehav Rev*. 2007; 31:212–220. [PubMed: 16908066]
40. Eapen V. Genetic basis of autism: is there a way forward? *Curr Opin Psychiatry*. 2011; 24:226–236. [PubMed: 21460645]
41. Ronald A, Hoekstra RA. Autism spectrum disorders and autistic traits: a decade of new twin studies. *Am J Med Genet B Neuropsychiatr Genet*. 2011; 156B:255–274. [PubMed: 21438136]
42. Baron-Cohen S. The hyper-systemizing, assortative mating theory of autism. *Prog Neuropsychopharmacol Biol Psychiatry*. 2006; 30:865–872. [PubMed: 16519981]
43. Halldorsson M, Kunst AE, Kohler L, Mackenbach JP. Socioeconomic differences in children's use of physician services in the Nordic countries. *J Epidemiol Community Health*. 2002; 56:200–204. [PubMed: 11854341]
44. Mortensen LH, Diderichsen F, Arntzen A, Gissler M, Cnattingius S, Schnor O, et al. Social inequality in fetal growth: a comparative study of Denmark, Finland, Norway and Sweden in the period 1981–2000. *J Epidemiol Community Health*. 2008; 62:325–331. [PubMed: 18339825]
45. Hinkka-Yli-Salomäki S, Banerjee PN, Gissler M, Lampi KM, Vanhala R, Brown AS, et al. The incidence of diagnosed autism spectrum disorders in Finland. *Nord J Psychiatry*. 2014; 68:472–80. [PubMed: 24359461]

Table 1
Covariates in relation to maternal SES in controls and in relation to risk of ASD

	Relationship between covariates and maternal SES				Relationship between covariates and ASD	
	Upper white collar workers, n (%)	Lower white collar workers, n (%)	Blue collar workers, n (%)	Others, n (%)	p-value*	p-value*
Maternal age						
14–24	44 (1.9)	714 (11.3)	678 (23.8)	757 (31.0)	<0.001	<0.001
25–39	2112 (93.2)	5385 (85.3)	2089 (73.4)	1610 (65.9)		
40–	11 (4.9)	212 (3.4)	81 (2.8)	75 (3.1)		
Paternal age[§]						
15–24	46 (2.0)	406 (6.4)	349 (12.3)	419 (17.2)	<0.001	<0.001
25–39	1905 (84.0)	5272 (83.5)	2245 (78.8)	1801 (73.8)		
40–	316 (13.9)	633 (10.0)	254 (8.9)	222 (9.1)		
Parental psychiatric disorder or intellectual disability	156 (6.9)	631 (10.0)	450 (15.8)	380 (15.6)	<0.001	<0.001
Maternal smoking[%]	117 (5.2)	836 (13.5)	759 (27.2)	452 (18.8)	<0.001	0.030
Parity (2 births)[§]	458 (20.2)	1474 (23.4)	711 (25.0)	864 (35.4)	<0.001	<0.001
Weight for gestational age[†]					0.039	<0.001
SGA	28 (1.2)	118 (1.9)	62 (2.2)	46 (1.9)		
AGA	2177 (96.2)	5973 (94.8)	2678 (94.2)	2298 (94.4)		
LGA	57 (2.5)	207 (3.3)	102 (3.6)	91 (3.7)		

* χ^2 test.

[§] Frequency missing = 84 cases, 163 controls.

[%] Frequency missing = 117 cases, 352 controls.

[§] Frequency missing = 16 cases, 60 controls.

[†] Frequency missing = 26 cases, 82 controls.

[†] SGA = small for gestational age, AGA = appropriate for gestational age, LGA = large for gestational age

Table 2

Unadjusted and adjusted odds ratios for maternal SES and different ASD categories

	Cases, n (%)	Controls, n (%)	Unadjusted OR (95% CI)	p-value	Adjusted* OR (95% CI)	p-value
Total ASD						
Upper white collar workers (ref)	550 (15.86)	2267 (16.35)	1.0		1.0	
Lower white collar workers	1490 (42.96)	6311 (45.51)	1.0 (0.9–1.1)	0.516	1.0 (0.9–1.1)	0.466
Blue collar workers	744 (21.45)	2848 (20.54)	1.1 (0.95–1.2)	0.239	1.0 (0.9–1.2)	0.552
Others	684 (19.72)	2442 (17.61)	1.2 (1.01–1.3)	0.032	1.2 (1.009–1.3)	0.036
Childhood autism						
Upper white collar workers (ref)	122 (13.68)	543 (15.37)	1.0		1.0	
Lower white collar workers	404 (45.29)	1598 (45.24)	1.1 (0.9–1.4)	0.367	1.1 (0.9–1.4)	0.418
Blue collar workers	192 (21.52)	729 (20.64)	1.2 (0.9–1.5)	0.246	1.2 (0.9–1.5)	0.282
Others	174 (19.51)	662 (18.74)	1.1 (0.9–1.5)	0.304	1.2 (0.9–1.6)	0.177
Asperger's syndrome						
Upper white collar workers (ref)	244 (20.15)	764 (15.60)	1.0		1.0	
Lower white collar workers	541 (44.67)	2265 (46.23)	0.7 (0.6–0.9)	0.003	0.8 (0.6–0.9)	0.005
Blue collar workers	179 (14.78)	1015 (20.72)	0.5 (0.4–0.7)	<0.001	0.6 (0.5–0.7)	<0.001
Others	247 (20.40)	855 (17.45)	0.9 (0.7–1.1)	0.209	1.0 (0.8–1.3)	0.836
PDD-NOS						
Upper white collar workers (ref)	184 (13.48)	960 (17.66)	1.0		1.0	
Lower white collar workers	545 (39.93)	2448 (45.02)	1.2 (0.98–1.4)	0.085	1.1 (0.9–1.3)	0.334
Blue collar workers	373 (27.33)	1104 (20.31)	1.8 (1.5–2.2)	<0.001	1.5 (1.2–1.9)	<0.001
Others	263 (19.27)	925 (17.01)	1.5 (1.2–1.9)	<0.001	1.3 (1.1–1.7)	0.018

OR = odds ratio, CI = confidence interval.

* Adjusted for maternal age, paternal age, maternal psychiatric disorder, paternal psychiatric disorder, parental intellectual disability, maternal smoking during pregnancy, parity and weight for gestational age.