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Autism Spectrum Conditions (ASC) refer to the syndrome of childhood onset neuro-developmental disorders characterised by impairments in social interaction and communication, and the presence of repetitive and stereotyped behaviours (Association Psychiatric Association, 2013). In the 1970s, ASC were considered rare, with prevalence estimate of autism around 2 per 10,000 (Gillberg & Wing, 1999; Kawamura, Takahashi, & Ishii, 2008; Waterhouse, 2008). However, the number of children reported as meeting modern ASC criteria has risen dramatically during the last decade (Windham, Zhang, Gunier, Croen, & Grether, 2006). In a UK study, the prevalence of ASC was estimated to be 157 per 10,000 (Baron-Cohen et al., 2009). The most recent CDC reported the prevalence of ASC in the US was 1 in 68 (Centre for Disease Control and Prevention, 2014). There are several factors of potential importance which underlie this increase: 1) changes in diagnostic criteria and screening instruments, 2) changes in study design, 3) more advanced and accessible knowledge about ASC, 4) improvements in public and professional awareness, 5) improved health services and 6) better acceptance of ASC by parents (Baron-Cohen et al., 2009).

Although there has been no definite explanation of the role play between these facts, children with ASC do require more care and support from within and outside families. Parents or those with parental responsibilities play a core role in the life of children with ASC in many regards. During the diagnostic process for ASC, parental recognition plays an important role (Baghdadli, Picot, Pascal, Pry, & Aussilloux, 2003). It can be a crucial factor as early parental awareness is likely to affect the age of recognition of ASC (De & Fombonne, 1998). Reported mean ages of first parental

concern range from 14.7 months (Chawarska et al., 2007) to 19.1 months (De & Fombonne, 1998).

By definition, for a diagnosis of ASC abnormalities should have appeared in early developmental period (Association Psychiatric Association, 2013). However, age at diagnosis is not the same as the age of onset (De & Fombonne, 1998; Howlin & Asgharian, 1999). One study in children with ASC reported that the mean age of first professional advice was 24.1 months. It also reported children with ASC whose parents were concerned about the child's other medical problems had a lower age of first professional advice (De & Fombonne, 1998). It found that the age of first parental concern was lower in girls than in boys.

The nature of parental concern has been suggested as potentially useful for clinical case evaluation in child psychiatric referrals (Firth, Grimes, Poppleton, Hall, & Richold, 2000). Studies on the nature of parental concern have indicated that parental concerns about a child's speech and language development are linked to a lower risk of autism than those children whose parents are worried most about other impairments (De & Fombonne, 1998). Two studies found that parents who already had an older child with ASC have been reported to pay more concern about their younger child (between 12 and 36 months) than those with no child with ASC.

Parental concern may also lead to early intervention, which can lead to better outcomes for children with ASC (Fenske, Zalenski, Krantz, & McClannahan, 1985). Children with autism pose considerable behavioural challenges for their parents and other family members on a daily basis due to the nature of their condition. Such children need help to develop skills in establishing their communication, receptive understanding and social interaction behaviours (Blum & Talib, 2006; Rogers, 1998a, 1998b). Chawarska and colleagues have suggested that a later age of parental

recognition is associated with worse outcomes (Chawarska et al., 2007), although this is yet to be fully confirmed through trials of early intervention. Reviews have indicated that most comprehensive programmes for young children with ASC explicitly involve parents in implementing the strategies (National Research Council, 2001). Studies have reported the potential benefit of parent-implemented early intervention (Rogers et al., 2012). Children in parental training groups have been found to have better social communication skills as rated using the ADI-R (Aldred, Green, & Adams, 2004). Children in parental training groups have been found to score higher on a IQ test than those in intensive behaviour analysis (ABA) groups (McConachie & Diggle, 2007).

It has been suggested that improved knowledge and acceptance of autism could be related to the increase in prevalence estimates when there are demands from those children and families (Williams & Brayne, 2006). Such awareness may well be related to socioeconomic status of the parents. Studies based on large population monitoring have provided inconsistent evidence for the association between socioeconomic status and the risk of ASC. In one site of autism and developmental disabilities monitoring (ADDM), using educational attainment as an indicator of socioeconomic status, the prevalence ratio for the highest to lowest education quintile was 2.6:1 (95%CI: 1.6, 4.5) where there was a pre-existing ASC diagnosis (Maenner, Arneson, & Durkin, 2009). In twelve ADDM sites using socioeconomic status (SES), the prevalence ratio for low to medium SES was 0.7 (95%CI: 0.64, 0.76) and that for high to medium SES was 1.25 (95%CI: 1.16, 1.35), regardless of whether a child had a pre-existing ASC diagnosis or not (Durkin et al., 2010). However, in the most recent study in Sweden, children of families with low incomes and parents with manual occupations were found to have a higher risk of ASC (odds ratio=1.4, 95%CI: 1.3-1.6) (Rai et al., 2012). Sweden has a low inequality index and it is possible that pattern associated with SES might be a better

reflection of the population findings rather than an identification of inequality of awareness and assess.

So far, little research has been conducted to investigate the association between parental concern and the risk of having ASC. The only way to examine the relationship between parental SES, education and the presence of ASC is to conduct the population based study rather than same band analyses or measure parental concern among studies.

Method

Screening instrument

The CAST was developed in the UK, specifically for primary school aged children (aged 4-11), because many children with ASC are often not identified prior to attending primary school (Williams, 2003). The CAST is a 37-item parent completed questionnaire, of which 31 items are scored. One point is assigned for an ASC-positive response and zero for an ASC-negative response on the scored items. Thus, the total score ranges from 0 to 31 (Baron-Cohen et al., 2009). Previous pilot and validation studies have demonstrated the CAST can be used as a screening instrument in large population-based epidemiological research for ASC (Scott, Baron-Cohen, Bolton, & Brayne, 2002b; Williams, Allison et al., 2006; Williams et al., 2005). Using a cut-off of 15, the sensitivity of the CAST is 100%, specificity is 97%, and positive predictive value (PPV) is 50% (Williams et al., 2005). The psychometric properties of the CAST were investigated in a Chinese population. Two factors were identified including social and communication, and inflexible/stereotyped language and behaviours (Sun et al., 2014).

Questions on parental concern

The SDQ is a relatively brief and user-friendly screening questionnaire for psychosocial problems that can be administrated to the parents and teachers of 4 to 17 years old and children themselves aged 11 or over (Goodman, 1997; Goodman, Ford, Simmons, Gatward, & Meltzer, 2000). It has 25 items. The first 20 items measure the following domains: emotional symptoms, conduct problems, hyperactivity and peer problems. The scores are summed to generate a total score ranging from 0 to 40 (Goodman & Goodman, 2012). There have been a number of studies to examine the validity and reliability of the SDQ as a screening instrument for developmental disabilities. A recent review concluded that the internal consistency, test-retest reliability and the inter-rater agreement of the SDQ were satisfactory for the parent version (Stone, Otten, Engels, Vermulst, & Janssens, 2010). The majority of the factor analysis studies of the SDQ found the five factors solution. They also found the correlations with other measures of psychopathology and the screening ability of the SDQ were sufficient (Stone et al., 2010).

Parental concern was examined by using the other 5 items and 8 sub-questions on the SDQ. Each sub-question has a minimum score of 0 and a maximum score of 3 to categorize the degree of parental concern about their child (Table 1). The maximum score for parental concern is 24.

The first question asks whether parents had concerns about their child in terms of their emotions, concentration, behaviour or getting along with others. If the parent answers no (score 0: indicating the parent had no concerns about their child), they did not need to continue through the whole questionnaire. The scores for the parental concern questions are divided into three categories: no concern=0, minor concern=1-12, great concern=13-24.

[insert Table 1]

Study design and sample

In this study, data on parental concern and the risk of ASC were collected during a prospective screening study, the Social and Communication Research and Epidemiology study (SCORE). The study had full ethical approval from the Ethics Committee of the University. The SCORE study used the Childhood Autism Spectrum Test (CAST) to screen for ASC in 5-10 year-old children in Cambridgeshire. In total, 136 mainstream schools within the county of Cambridgeshire, including Cambridge City, East Cambridgeshire, South Cambridgeshire and Fenland, were invited to participate in this study (Baron-Cohen et al., 2009). The first section of the CAST pack consisted of the CAST (37 items), some questions asking about medical conditions or developmental disorders (15 items) and parental concern questions from the SDQ (Goodman, 1997). Section 2 consisted of questions about the parents. Section 3 consisted of questions about the education and occupations of the parents which were used to categorize their socioeconomic status. After the collection of the CAST pack, the children were divided into three score groups (≤11, 12-14, ≥15). All the children above the cut-point of 15 (≥15) and a randomly selected 33% of the borderline group (12-14) were invited for a detailed diagnostic assessment to identify potential cases of ASC in the general population. No child in low score group (≤11) was invited because no children with ASC had been identified among low score group, no children in low score group were diagnosed with ASC (Scott, Baron-Cohen, Bolton, & Brayne, 2002a; Williams et al., 2005). The diagnostic battery of the detailed assessment included the Autism Diagnostic Observational Schedule (ADOS; Lord, Rutter, DiLavore, & Risi, 2001) (ADOS) and the Autism Diagnostic Interview-Revised (ADI-R; Lord, Rutter, & Le Couteur, 1994).

A total of 11,635 CAST packs were distributed via class registration and returned to the research centre by parents. The pack was distributed to participating schools in six batches between February 2003 and March 2004. In total, 3,404 questionnaires (response rate =29%) were returned for analysis.

Confirmation of children with ASC

Cases were identified through two different routes: the questionnaires through mainstream schools and records from Special Educational Needs (SEN) registration. Population-based screening was conducted in Cambridgeshire. Children who were reported having a diagnosis of ASC based on their records in the SEN register received an estimation of their ASC diagnostic sub-grouping using ICD-10 (World Health Organisation, 1993). Those children were considered to be cases without further assessment.

After screening, the ADOS and ADI-R were used as diagnostic instruments. Previous research suggested that using the ADI-R and ADOS alone can be less reliable in detecting milder cases on the autism spectrum. Because the agreement between the ADOS and ADI-R is not 100% and the ADI-R only provides diagnostic cut-off for classic autism (de et al., 2004; Le Couteur, Haden, Hammal, & McConachie, 2008). Thus, a consensus diagnosis based on information gathered through the ADOS and ADI-R and the clinical judgment of members of the research team was adopted. The following subtypes were included into the diagnosis of ASC: classic autism, Asperger syndrome and PDD-NOS. For all children who were given a diagnosis of ASC, their assessment data was re-examined and reviewed according to ICD-10 (World Health Organisation, 1993). The ADOS and ADI-R were administrated by members of the research team who were fully trained in the use of these instruments to reliability levels for research purposes (Baron-Cohen et al., 2009). The examiners had been working in

our research centre for a number of validation and prevalence studies (Allison et al., 2007; Scott et al., 2002a, , 2002b; Williams et al., 2005; Williams, Higgins, & Brayne, 2006).

Statistical analyses

Analyses were conducted using STATA 10.0 statistical software. In order to examine the potential confounding effects, the following variables were extracted from the dataset: an anonymous identification number for each child, age of the child, sex, parental concern question score, socioeconomic status, maternal age at birth, father's age at birth, mother's age when left education, father's age when left education, birth order and the number of children in the family.

The socioeconomic status of this sample was generated using the self-coded National Statistics Socio-economic Classification (NS-SEC) as follows (Office for National Statistics): 1) Managerial and professional occupations, 2) Intermediate occupations, 3) Small employers and own account workers, 4) Lower supervisory and technical occupations and 5) Semi-routine and routine occupations. The lowest three categories were combined, thus there were three categories: Manager, Intermediate and Lower.

The distributions of all the variables were examined using histograms or box plots and the following were categorized: parental concern, maternal age at birth, father's age at birth, maternal age when left education, father's age when left education.

The associations between parental concern and each of the other variables were examined using chi-square tests. The unadjusted associations between each variable and the risk of ASC were examined using logistic regression. The variables that associated with both ASC and parental concern were put into an unconditional logistic regression model. The association between parental concern and the risk of ASC was

examined by adjusting all the other variables in the model using unconditional logistic regression. The interaction between parental and other variables was examined. The odds ratios and 95% confidence intervals (CI) and *p*-values were computed for all variables.

Results

Characteristics of participants

Within the 3,404 returned questionnaires, 3,329 records (97.8%) were available for analysis and 75 records (2.2%) were excluded due to missing data on the SDQ. After screening and standardized diagnostic assessment in mainstream schools, 9 children from mainstream schools were given a research diagnosis of ASC. There were 37 children who were reported to have an existing diagnosis of ASC according to schools' SEN registers. Thus, altogether there were 46 children with ASC and 3,283 children without ASC.

A total of 2,260 parents (66.4%) indicated that they had no concerns about their child, 866 (25.4%) had minor concerns and 226 (6.6%) had great concerns. In 52 (1.5%) questionnaires, the data on parental concern were missing. The process of case identification is shown in Figure 1. The characteristics of the children with ASC and without ASC are shown in Table 2.

[insert Figure 1 and Table 2]

Parental concern and other variables

The Chi-square test indicated four variables that were associated with parental concern in this sample (Table 3): age, sex, socioeconomic status and maternal age when left education.

[insert Table 3]

Association between all variables and the risk of ASC

Compare children with ASC with children without ASC (the unadjusted odds ratio), three out of ten variables were associated with the risk of ASC: sex, parental concern and father's age at birth. The distribution of sex between cases and controls was different. The sex ratio (boys Vs girls) was more than 3:1, which showed a predominance of ASC in boys. The crude odds ratio of having autism among boys and girls was 3.2 (95%CI=1.6, 6.4; p=0.001). There was a highly significant association between gender and the risk of ASC. As there were no cases in the first category of parental concern (the no concerns group), the second category (minor concerns) was used as the reference to investigate the association between the degree of parental concern and the risk of ASC. The odds of having ASC among children whose parents had great concerns (scored 13-24) were 8.8 times greater than for children whose parents had minor concerns (scored >12) (crude odds ratio= 8.8; 95% CI: 4.7, 16.8; p<0.001). This suggests a highly significant association between parental concern and the risk of ASC. The higher the parental concern score, the more likely that the child would meet ASC criteria. The odds of having ASC when the father's age was between 30 and 34 at the time of the child's birth were significantly lower than for those whose fathers were younger than 30 when the child was born (crude odds ratio= 0.3; 95%CI=0.1, 0.9). The results of unadjusted association are shown in Table 4.

[insert Table 4]

Adjusted model

Only variables that were significantly associated with both the risk of ASC and parental concern were included in the unconditional logistic regression model. Thus, there were two variables in the model: sex and parental concern (Table 5). After adjustment for sex, the odds ratio for parental concern reduced to 8.5 (95%CI: 4.5, 16.2; p <0.001), so hardly changed (8.8 to 8.5).

For boys, the odds of having ASC among children whose parents had great concerns were 27.6 times greater than for children whose parents had minor concerns (95%CI: 5.8, 131.2; $p<0.001$). In girls, however, the odds ratio between children whose parents had great concerns and those whose parents had minor concerns was lower at 6.0 (95%CI: 2.9, 12.4; $p<0.001$). The odds of being a boy with autism were 1.7 times greater than the odds of being a girl with autism (95%CI: 0.8, 3.4; $p=0.15$). The interaction between parental concern and sex was found to fall short of significance ($p=0.08$).

In this final model, only parental concern was significantly associated with the risk of ASC. Thus, there was a highly statistically significant association between parental concern and the risk of ASC. This association was independent of socioeconomic status of parents and other potential confounders.

[insert Table 5]

Discussion

In this study, the degree of parental concern in a large population sample was determined through questions on the SDQ. A higher score on these questions indicated that parents considered their children's difficulties had more severe impact on their daily lives. The aim of this study was to explore the association between parental concern and the risk of having ASC. It was therefore possible to investigate whether more parental concern about their child's emotions, behaviour and getting on with others would lead to a higher chance of the child meeting ASC criteria for a diagnosis. This was the case in this sample. Socioeconomic status was also associated with parental concerns but not related to ASC diagnosis.

Limitations

There are a number of limitations of this study. The response rate for the screening study was low (29%), similar to other parent-report screening studies (Baron-Cohen et al., 2009; Williams, Allison et al., 2006). Since autism is a relatively rare condition, a few missing cases in non-responders could influence the results. In this study, differential response according to SES, parental concerns and ASC presence could impact the association.

There may be recall bias among parents. Parents answer the questions based on their memories, and parents whose children meeting ASC even if not diagnosed, might have had a much clearer memory for certain periods during their child's early development than those parents whose children do not meet the condition's criteria. The questions themselves could be seen to be part of the same interview and thus it is to be expected that there is a close relationship.

Since not all children who scored 12-14 on the CAST were invited to further assessment there may be potential cases among these children. In this study these potential children with ASC were considered as non-ASC. This could have resulted in an underestimation of the number of children with ASC and overestimation of the number of children without ASC. However, only one child who attended further assessment after scoring between 12 and 14 met criteria for ASC diagnosis. Thus, it is unlikely this could have greatly influenced the results.

In the diagnostic phase of this study, cognitive measurements or IQ tests were not adopted other than the two diagnostic instruments. Such measurements would have helped to better understand and recognize the children, especially those who were given a diagnosis of ASC. However, as these instruments are not for diagnosis, it is not likely their results could substantially influence the final consensus diagnosis.

There were only 46 cases compared to 3,283 controls during the unconditional logistic analysis and some reference groups (such as parental concern) had very small numbers. For a case-control study, the numbers should be equal to or larger than five in each group, so this might have partly exaggerated the effect of the risk factor. However, the purpose of this paper is not to conduct a case-control study which would require an even or similar children with ASC and children without ASC. The purpose was to intend to understand what would be the association between parental concerns, socioeconomic status, and the risk of having ASC in a general population. An even sample design would not provide sufficient or reliable information for our question. It is admitted that there is a large difference in the number of children with ASC and children without ASC in our sample. However, since the generally agreed prevalence of ASC in the general population is around 1% (Centres for Disease Control and Prevention, 2012; Fombonne, 2009), the prevalence of our sample should be acceptable and reasonable to fulfil the purpose of study design (prevalence of this study is around 1.4%). As the basic question is to understand the situation in a general population, the whole population sample was adopted. The statistical analyses were conducted within this sample rather than picking up fewer children without ASC to compare with children with ASC. Thus, to speak from a general population public health of view, using the sample from a general population would be more sensible than only compare even cases and controls. Since the number of cases depends on the prevalence of ASC, to have more children with ASC in such study, much larger sample sizes are needed in the future.

Cambridgeshire might not be representative of the UK as a whole, so caution should be employed when considering the national generalisability of these results. For

example, SES and parental education in Cambridgeshire are generally higher than in other regions of the UK (Baron-Cohen et al., 2009).

Parental concern and public health implications

According to these data, there were no cases in children whose parents who did not report concerns. In children whose parents who did report concerns, there was a highly significant association between parent-reported concern and the risk of ASC. As the closest carers of the child, parents have the most opportunities to recognise abnormalities in their children, but may themselves not easily pick up behaviours and styles which others may consider diagnostic.

Many clinical features of ASC gradually come to the notice of parents before the second birthday of the child (Chawarska et al., 2007). Children with ASC usually experience direct and indirect consequences related to social interaction and communication deficits. These social impairments are diverse and can involve speech, linguistic conventions and interpersonal interaction. Childhood serves to develop these skills in order to progress throughout the life course. If autistic children could be identified earlier and given proper help and guidance in their development, their outcomes might be improved. With this thought in mind, researchers have done a lot to achieve this goal. Both randomized controlled trials and controlled studies have been carried out in this field (Aldred, Green, Emsley, & McConachie, 2012; Howlin, Magiati, & Charman, 2009; Virues-Ortega, 2010). Outcomes of interventions have been measured with direct testing of socio-communication skills and IQ, as well as parent and teacher reports of adaptive skills and behavioural problems (McConachie & Diggle, 2007). This highly significant association between parental concern and autism risk, as well as the evidence on the effectiveness of parent-participated intervention and surveillance, suggest that this is an area for further exploration.

Parental concern and screening for ASC

Screening is the prospective identification of unrecognised disorders through the application of specific tests or examinations. Screening for ASC has been recommended in the USA for early detection with the goal of obtaining improved outcomes (Levy, Mandell, & Schultz, 2009). There is increasing agreement amongst clinicians that intervention in ASC is more effective if it commences before the age of four (Baron-Cohen et al., 2000; Dumont-Mathieu & Fein, 2005; Tanguay, 2000). Previous studies have provided evidence that combining screening instruments with asking about parental concerns can improve the utility and efficiency of the instruments (Baird et al., 2001; Glascoe, 1997; Glascoe, 2003; Glascoe & Sandler, 1995). Dietz's study on the screening programme for ASC in the Netherlands found that a large number of children were "lost" at each stage of the screening procedure because parents did not want to cooperate (Dietz, Swinkels, van Daalen, van Engeland, & Buitelaar, 2006). It also suggested that hesitation among parents could be reflected in the delay between screening and further examination of children. Sugiyama's study in Japan found that toddlers who failed a developmental check up at 18 months, and whose parents refused further investigations, showed more developmental problems at the 3-year follow up than the children who did participate in further investigations (Sugiyama & Abe, 1989). The present study included questions on parental concerns in screening in a general population in the UK. Our findings suggest that combining the observations of parents with the employment of screening tests might be valuable for early detection of potential cases of ASC.

Sex and parental concern

Sex was associated with both parental concern and the risk of ASC. The higher prevalence of ASC in boys compared to girls has been reported by previous studies and

the ratio is around 4:1 (Fombonne, 2009; Volkmar, Szatmari, & Sparrow, 1993). In this study, the odds of a boy having a diagnosis of ASC were 27.6 times higher in those children whose parental concern was great compared with those parents had minor concerns.

After adjustment for sex, the association between parental concern and the risk of ASC hardly changed.

Socioeconomic status and parental concern

Research regarding a possible association between socioeconomic status or social class and the risk of ASC can be traced back to 1943, when Kanner first described autism. He characterized high-risk families as highly intelligent and educated with good employment. Since then, many studies have used parental occupation, educational background or the level of intelligence to generate social class categories (Croen, Grether, & Selvin, 2002).

Early studies have agreed with Kanner's description (Hoshino, Kumashiro, Yashima, Tachibana, & Watanabe, 1982), while others have found no such association (Cialdella & Mamelle, 1989; Croen et al., 2002; Cryan, Byrne, O'Donovan, & O'Callaghan, 1996; Hoshino et al., 1982), suggesting that higher social class is not related to the risk of autism. Recent studies on the association between socioeconomic status and the risk of autism reported conflicted results (Durkin et al., 2010; King & Bearman, 2011; Rai et al., 2012). Inequality in access to service due to different SES status of parents is not unusual. Some researchers have argued that this observed association could also be explained by other factors such as better diagnosis and early referral to health institutions because parents with a higher socioeconomic status may have more access to health services (Croen et al., 2002; Wing, 1980). Other studies have suggested that the association results from different perceptions of autism among

the highly educated professionals and parents (Bhasin & Schendel, 2007; Cuccaro et al., 1996). The present study found that socioeconomic status was associated with parental concern but not with the risk of ASC in this population. If socioeconomic status is a confounder, it should be associated with both the risk of ASC and parental concern. Thus, the hypothesis that socioeconomic status might confound the association between parental concern and the risk of ASC is not supported by this study.

Conclusion

Parents with higher social class express more concerns than those from lower social classes. However, the concerns reported by parents in higher SES did not appear to be specific for ASC as there was no relationship between ASC and SES. Parental concern itself was strongly associated with a child meeting ASC criteria. The higher the degree of parental concern over their child in terms of emotions, concentration, behaviour or getting on with others, the more likely that the child will have ASC, independently of potential confounders. Conversely this study shows that where there is no parental concern expressed a child is extremely unlikely to meet diagnostic criteria. These findings should be of value in discussions related to which measures at what times are helpful in identifying children with ASC.

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