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Obstetric and Perinatal Factors as Predictors of Child Behaviour at 5 Years

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Objective: The Mater University Study of Pregnancy (MUSP) is a prospective cohort study of 8556 mothers enrolled in early pregnancy. The relationship of obstetric and perinatal factors, maternal lifestyle, age and gender of the child, and social disadvantage were examined as predictors of child behaviour in 5005 children completing a modified child behaviour checklist at 5 years. This checklist contained three independent groups of behaviour: externalizing, internalizing and SAT (social, attentional and thought problems).

Results: In the initial analysis, a limited number of associations were present. After adjusting for measures of social disadvantage, only number of antenatal admissions was associated with child behaviour in all three scales, while maternal cigarette smoking in pregnancy and male gender were associated with externalising and SAT behaviours.

Conclusions: Most common epidemiologic obstetric and perinatal risk factors were not independent predictors of behaviour problems in children at 5 years.

Keywords: behaviour, children; perinatal; pregnancy; cohort studies; disadvantage.

The development of sophisticated techniques for studying brain structure and function, especially in high risk children, and an increased understanding of brain development have led to a resurgence of interest in the biological contribution to behavioural and psychiatric disorders in children[1,2] and adults.[3] Structural and functional changes have been reported in the brains of children with autism,[4] attention deficit disorder,[5] developmental dysphasia,[6] obsessive compulsive disorder,[7] schizophrenia,[8] and an increased prevalence of birth complications[9] and viral illnesses during pregnancy[10] have been associated with risk of later schizophrenia.

Children with established neurological impairment have an increased prevalence of psychiatric disorder, though with the exception of an increased prevalence of hyperkinesis, there is not a specific brain damage syndrome.[11] The relationship between behaviour and perinatal risk, however, is more controversial.[12] In 1961 Pasamanick and Knobloch proposed the existence of a continuum of reproductive casualty with more severe injury leading to major neurological impairments and less severe brain injury to dysfunctions of learning and behaviour.[13] Longitudinal studies have generally reported limited relationships between perinatal hazards and later behaviour.[14-16] Prenatal and perinatal risk factors have been identified as of modest aetiological importance in children with hyperactivity,[17] attentional disorder[18] or criminal behaviour.[19] A number of long-term follow-up studies have reported an increased prevalence of attentional and behaviour difficulties in children born small for gestational age[20] or extremely premature. [21,22] Although perinatal risk factors are a strung focus of literature end clinical attention, they are not precise measures of actual brain damage. It remains uncertain whether associations between these risk factors and subsequent child behaviour are directly attributable to perinatal factors or whether they are mediated by cognitive impairment and social disadvantage. [23] A further weakness of many longitudinal studies has been the limited and often global measures of child behaviour especially in the preschool period. This study explores whether, after adjusting for social disadvantage, common epidemiologic risk indicators for maternal reproductive history and events in the pregnancy, delivery, and neonatal period, are predictors of three broad behavioural syndromes in children at 5 year.

METHODS

The Mater University of Queensland Study of Pregnancy (MUSP) involves 8556 women who attended the Mater Mother's Hospital between 1981 and 1984 and were enrolled at the time of the first hospital visit of their pregnancy, which was on average at 18 weeks' gestation.[24] Excluding stillbirths, neonatal and infant deaths, adopted children, multiple births, mothers changing address and delivery at other

centres, and 270 mothers who refused to participate in the study, there were 7357 children remaining in the study. Extensive information was collected at enrolment, shortly after the birth, and at 6 months after delivery regarding social characteristics of the family, biological measures of the pregnancy, birth and delivery, and psychological characteristics of the mother. Similar psychosocial questionnaires were administered and developmental, behavioural and health information obtained when the child was followed up at 5 years of age. At this time a total of 5021 mothers were contacted, and 5244 completed a modified Child Behavioural Questionnaire. Because of incomplete data in some instances, the study analysis was restricted to 5005 children. Those mothers lost to follow up tended to be younger, single and less well educated, and their babies were more likely to be of earlier gestation and lower birthweight.[25]

At time of follow up the mean age of the children was 5 years 6 months with a range of 4-6 years. Of the 5005 children, 2616 were male and 2389 were female.

Predictor variables

These included 12 pregnancy/perinatal risk factors, maternal lifestyle factors of cigarette and alcohol consumption in pregnancy, and number of previous maternal pregnancies and miscarriages (Table 1). Selection of factors was guided by the reliability of information recorded at birth and importance as markers of potential biological risk. Information was obtained from the medical chart after birth by obstetricians associated with that aspect of the project. [24] Small for gestational age status (SGA) was defined as birthweight less than the tenth percentile for gestation and gender within the sample. To allow for later adjustment for possible confounding especially by social disadvantage, maternal level of education, marital status, family income in early pregnancy and maternal age were also examined together with the child's gender and age.

Outcome measure

Child behaviour problems were measured using 31 items from the Child Behaviour Checklist (CBCL) of Achenbach. [26] (Table 2). Items were excluded because they were seen to occur infrequently in the 5 year age category or were less discriminating between problem and non-problem behaviours in younger children. Each item was coded as in the CBCL on a 3 point scale and summed to provide a total Behaviour Score for each of the three scales. Similar to the recommendation of Achenbach for the complete CBCL, the extreme 10% of subjects were classified as having a behaviour problem.

Table 1. Variables considered in analysis

Pregnancy and perinatal factors
Number of antenatal admissions*
Pre-eclampsia
Bleeds in pregnancy*
Presentation at delivery
Method of delivery
Foetal distress
Apgar 1 min
Apgar 5 min
Time to respiration
Gestation*
SGA
Days in ICU*
Maternal lifestyle
Cigarettes in pregnancy*
Alcohol in pregnancy
Maternal reproductive history
Number of previous pregnancies*
Number of previous miscarriages

*Factors significant in unadjusted analysis and included in Tables 3 and 4.

Table 2. Modified child behavioural questionnaire

Scale 1: Externalisation/aggression	
Argues a lot	
Demands a lot of attention	
Destroys his/her own things	
Destroys things belonging to others	
Disobedient at home	
Gets into many fights	
Lying or being dishonest	
Screams a lot	
Sudden changes in mood or feeling	
Stubborn, sullen or irritable	
Temper tantrums or hot temper	Cronbach alpha 0.84
Scale 2: Internalizing	
Cries a lot	
Feels worthless or inferior	
Likes to be alone	
Nervous, highly strung or tense	
Too fearful or anxious	
Feels too guilty	
Refuses to talk	
Sulks a lot	
Withdrawn, does not get involved with others	
Worrying	Cronbach alpha 0.84
Scale 3: Social, attentional and thought problems (SAT)	
Acts too young for his/her age	
Cannot concentrate, cannot pay attention for long	
Cannot get his/her mind off certain thoughts	
Cannot sit still, restless or hyperactive	
Clings to adults or too dependent	
Day dreams or gets lost in his/her thoughts	
Does not get along with other children	
Not liked by other children	
Poorly co-ordinated or clumsy	
Repeats certain acts over and over, has compulsions	Cronbach alpha 0.75

The 31 items in the modified CBCL were grouped according to the second order grouping of syndromes identified by Achenbach in the complete CBCL.[26] The externalising (aggressive) problems scale comprised 11 items with a Cronbach alpha of 0.84, the internalizing problems scale consisted of 10 items with a Cronbach alpha of 0.76, and the remaining scale of 10 items had a Cronbach alpha of 0.75. This latter scale contained items related to social, attentional and thought problems (SAT). The validity of the shortened form of the CBCL compared to the complete CBCL was examined in 76 selected mothers of 5-year-old children who completed the full CBCL. Correlations between the scales were 0.96 for the total problem score, 0.94 for the externalising scale, 0.89 for the internalizing scale and 0.96 for the S.A.T. scale.

Statistical analysis

For each predictor variable, the number of children with behaviour problems in each of the three scales was compared, and a Chi-squared test performed to determine the level of statistical significance. Strength of the association was expressed by the relative risk. All predictor variables found to be statistically significant in the initial analysis, including the measures of social disadvantage, were entered into three logistic regression models, with risk of behaviour problem in each of the three scales as the dependent variable. The adjusted odds ratios (OR) obtained from these logistic models measure the strength of the relationship between individual predictor variables and risk of child behaviour problems,

adjusting for the presence of other predictor variables. All computations were performed using the statistical packages SAS[27] and EGRET.[13]

RESULTS

The relationship between each of the pregnancy and perinatal factors and risk of child behaviour problem for the three behaviour scales of internalizing, SAT and externalising was examined. Factors significantly associated with child behaviour ($P<0.05$) in any of the three scales are shown in Table 3, together with the relative risk for each level of a factor compared to an indicated reference category. Number of antenatal admissions, gestation and number of days in the intensive care unit (ICU) were all associated with increased SAT and externalising behaviours. Bleeds in pregnancy was associated with SAT behaviours. No factor was associated with internalizing behaviours. Maternal reproductive history and lifestyle measures significantly associated with child behaviour problems are shown in Table 4, together with the associations between behaviour problems and the child's gender and age. Number of cigarettes per day was associated with an increased prevalence of behaviour problem in all three behaviour scales, while number of previous liveborn pregnancies was associated with an increased risk of SAT behaviours. Male gender was associated with an increased risk of externalising and SAT behaviours, while older age of the child was associated with increased risk of internalizing problems.

The relationship between maternal age, marital status, maternal education and family income at the time of the first visit in pregnancy and child behaviour problems is shown in Table 5. All four factors were significantly associated with child behaviour problems in all three behaviour scales.

Table 3. Pregnancy and perinatal factors and child behaviour problems at 5 years

	n	Externalising		Internalising		SAT	
	5005	%	RR	%	RR	%	RR
No. antenatal admissions							
0*	3597	10.2	1	11.0	1	11.5	1
1	1049	10.2	1.0	12.3	1.1	13.7	1.2
>1	359	14.5	1.4	14.7	1.4	17.0	1.5†
P		0.04		0.07		0.003	
Bleeds in pregnancy							
Nil*	4886	10.5	1	11.6	1	12.2	1
Yes	119	12.6	1.2	10.9	1.0	18.5	1.5†
P		0.4		0.82		0.04	
Gestation							
40+*	2777	9.5	1	10.9	1	11.8	1
38-39	1745	11.1	1.2	11.6	1.1	12.2	1.0.
36-37	126	12.0	1.3	14.0	1.3	14.6	1.2
21-35	357	18.2	1.9†	17.5	1.6†	22.2	1.9†
P		0.006		0.6		0.003	
Days ICU							
0*	4637	10.3	1	11.3	1	12.0	1
1-6	178	9.1	0.9	14.2	1.3	14.2	1.2
>7	192	18.7	1.6†	14.1	1.2	20.1	1.7†
P		0.02		0.3		0.01	

*Reference category; † 95% Confidence Interval of RR excludes ICU, intensive care unit.

To determine whether pregnancy, perinatal, maternal reproductive history and lifestyle factors shown in Table 3 and Table 4 were independent predictors of child behaviour, they were entered together with gender and age of the child, maternal age, marital status, level of education and income into three separate logistic regression models. Risk of internalizing, SAT or externalising behaviour problem was the dependent variable. Number of cigarettes smoked per day was included as a continuous variable because of

its relatively linear association with risk of child behaviour problem, and limits on the number of terms that could be included in the model.

The adjusted OR and 95% confidence intervals for factors significant in the adjusted analysis in any of the three behaviour scales are shown in Table 6. The only pregnancy and perinatal factor to remain associated with child behaviour problems at 5 years, was two or more antenatal admissions which was a risk factor for all three behaviour scales. The lack of a statistically significant association with bleeds in pregnancy in the adjusted analysis appeared to be due to its close association with number of antenatal admission, while number of previous liveborn children was associated with maternal age. Gestation and number of days in ICU were associated, though neither remained as independent predictors of child behaviour problems in the adjusted analysis.

The maternal lifestyle factor of number of cigarettes per day remained significant for the SAT and externalising scales and was almost statistically significant ($P=0.06$) for internalising behaviours. Female gender was associated with a lower risk of SAT and externalising behaviours while age of the child remained associated with internalising behaviours. Though less consistent than in the unadjusted analysis, maternal age, maternal education and family income though not marital status continued to be related to child behaviour.

Table 4. Maternal and child factors and child behaviour problems at 5 years

	n	Externalising		Internalising		SAT	
	5005	%	RR	%	RR	%	RR
No. previous pregnancies (liveborn)							
0*	2059	10.8	1	12.3	1	13.7	1
1	1566	11.3	1.1	12.3	1.0	12.8	0.9
2	870	9.5	0.9	9.3	0.8	10.3	0.8†
3-4	448	9.4	0.9	10.3	0.8	10.1	0.7†
>5	54	3.1	0.3	7.8	0.6	4.7	0.3
P		0.2		0.1		0.02	
Cigarettes per day							
0*	3238	8.3	1	10.8	1	10.6	1
1-0	805	11.2	1.4†	10.7	1.0	12.9	1.2
10-19	568	16	2.0†	14.8	1.4†	18.6	1.6†
20-29	323	18.6	2.2†	14.9	1.4†	20.1	1.9†
30+	40	20.0	2.4†	20.0	1.9	20.0	1.9†
P				0.006		0.001	
Child's gender							
Male	2616	12.4	1	11.8	1	14.2	1
Female	2389	8.8	0.7†	11.3	1.0	10.3	0.7†
P		0.004		0.6		0.001	
Child's age (years)							
4	167	9.6	0.9	9.1	0.8	15.0	1.2
5*	4177	10.6	1	11.1	1	12.3	1
6	641	10.0	0.9	15.4	1.4†	11.9	1.0
P		0.8		0.003		0.5	

*Reference category;†95% Confidence interval of RR excludes 1.

DISCUSSION

The aim of this study was to determine whether common epidemiological markers of possible adverse biological events during the pregnancy, delivery or newborn were independent predictors of subsequent behaviour problems in childhood. Limited associations were present in the univariate analysis, and after adjusting for measures of social circumstances, only male gender, number of antenatal admissions and cigarette smoking were predictive of externalising and- SAT behaviours at 5 years, while number of antenatal admissions was the only factor predictive of internalising child behaviour problems.

Male gender is known to be associated with an increased prevalence of externalising and SAT behaviours, and this finding was confirmed in our study. Proposed reasons for this association include genetic, hormonal, social and neurological differences.[29] In males Geschwind and Galaburda have suggested that left hemisphere development is slowed under the influence of testosterone, and that this slowing results in a longer period of potential vulnerability to injury.[30] These findings cannot be interpreted as providing support for an association between brain injury and later externalising, SAT or attentional difficulties, though the latter are increased in males.[31] Although the SAT scale has a high reliability coefficient, it includes conceptually different behaviours. Five SAT scale items belong to the Attention Problems scale of the complete CBCL, although do not themselves constitute a clinical diagnosis of attentional deficit disorder. The remaining items are concerned with obsessional and dependent behaviours.

Table 5. Social factors and child behaviour problems at 5 years

	n	Externalising		Internalising		SAT	
	5005	%	RR	%	RR	%	RR
Maternal age							
<20	680	14.3	1.3†	15.6	1.3†	15.9	1.2
20-24	1489	10.1	1.0	10.1	0.8	10.1 -	0.7†
25-29*	1919	10.6		12.1	1	13.8	1
30-34	687	8.7	0.8	9.9	0.8	10.8	0.85
>34	230	6.5	0.8	9.1	0.8	9.1	0.7
P		0.002		0.001		0.001	
Marital status							
Married*	4004	9.8		10.9	1	11.5	1
Single	417	12.5	1.3	12.7	1.2	16.3	1.4†
Living together	482	14.1	1.4†	14.9	1.41	15.4	1.3†
Other	102	13.7	1.4	17.7		16.7	1.5
P		0.009		0.009		0.002	
Maternal education							
Primary/Op	195	13.3	1.3	10.8	1.0	13.9	1.2
Start secondary	660	13.3	1.3†	15.9	1.4†	17.1 -	1.5†
Comp. Gr 10*	2748	10.6		11.0	1	11.6	1
Comp. Gr 12	466	10.5	1.0†	9.9	0.9	11.8	1.0
College/University	936	7.8	0.7†	11.0	1.0	11.2	1.0
P		0.004		0.6		0.001	
Income (dollars)							
>400	558	8.2	0.8	11.1	1.0	12.4	1.1
300-399	854	7.9	0.7†	8.7	0.8	9.0	0.8
200-299*	1888	10.9	1	11.0	1	11.6	1.0
100-199	1206	12.5	1.2	13.9	1.3†	15.1	1.3†
100	260	13.8	1.3	15.0	1.4	17.7	1.5†
Missing	239	8.8	0.8	11.3	1.0	11.3	1.0
P		0.002		0.004		0.001	

*Reference category; †95% Confidence Interval of RR excludes 1. Comp, completed; Op. opportunity.

The only pregnancy factor in this study independently related to later behaviour was two or more antenatal admissions. Though reasons for these admissions varied, and included bleeding in pregnancy, they

generally reflect concern regarding the progress of the pregnancy, and may be markers for processes that disrupt brain development. Again it is not possible to draw a definite conclusion, given the likely heterogeneous nature of admissions, their associated care, and the possibility that unrecorded aspects of the mothers' social environment may have influenced admitting practices.

Table 6. Factors predicting child behaviour at 5 years in the multivariate analysis

	Externalising		Internalising		SAT	
	%	RR	%	RR	%	RR
No. antenatal admissions						
0*	1		1		1	
1	1.0	0.8-1.2	1.1	0.9-1.4	1.2	0.9-1.4
≥2	1.4	1.0-1.9	1.3	1.0-1.8	1.4	1.0-1.8
LRS (2 d.f.)	*P*	0.13		0.20		0.07
Cigarettes per day						
	1.3	1.2-1.5	1.1	1.0-1.2	1.2	1.1-1.3
LRS (1d.f)	*P*	<0.001		0.06		<0.001
Child's gender						
Male*	1		1		1	
Female	0.7	0.6-0.8	0.9	0.8-1,1	0.7	0.6-0.8
LRS (1 d.f.)	P	<0.001		0.49		<0.001
Child's age						
	0.9	0.8-1.1	1.2	1.1-1.3	1.0	0.9-1.1
LRS (1d.f.)	*P*	0.43		0.006		0.6
Maternal education						
Primary/Op	1.4	0.9-2.2	1.0	0.6-1.6	1.3	0.8-2.1
Start Secondary	1.2	0.9-1.5	1.4	1.1-1.8	1.5	1.1-1.8
Comp. Gr 10*	1		1		1	
Comp. Gr 12	1.1	0.8-1.5	0.9	0.7-1.3	1.1	0.8-1.5
College/University	0.8	0.6-1.1	1.1	6.8-1.4	1.0	0.8-1.3
LRS (4d.f.)	*P*	0.15		0.08		0.05
Family income (dollars)						
<100	1.1	0.7-1.6	1.2	0.8-1.8	1.3	0.9-1.9
100-199	1.1	0.9-1.4	1.2	0.9-1.5	1.3	1.1-1.8
200-299*	1		1		1	
300-399	0.8	0.6-1.0	0.8	0.6-1.1	0.8	0.6-1.1
>400	0.8	0.6-1.1	1.1	0.8-1.5	1.1	0.8-1.5
Missing	0.7	0.4-1.2	1.0	0.6-1.5	0.9	0.6-1.4
LRS (5d.f.)	*P*	0.12		0.15		0.02
Maternal age						
<20	1.3	0.9-1.7	1.3	0.9-1.7	1.0	0.8-1.3
20-24	1.0	0.8-1.3	1.9	0.7-1.1	0.8	0.6-0.9
25-29*	1		1		1	
30-34	0.9	0.6-1.2	0.8	0.6-1.2	0.9	0.6-1.2
>34	0.6	0.3-1.1	0.8	0.5-1.3	0.7	0.4-1.2
LRS (4d.f.)	*P*	0.19		0.18		0.18

*Reference category; LRS, likelihood ratio statistic; Comp, completed; Op, opportunity.

A number of recent epidemiological studies have suggested an association between maternal cigarette smoking in pregnancy and subsequent child behaviour, particularly externalising behaviours. [32-33]

Possible explanations for this association include a direct constrictive effect on blood vessels, though there was no evidence of an association between child behaviour and either SGA status or preeclampsia and child behaviour in this study. Alternative possibilities would include an influence on acetylcholine neurotransmitter development, and smoking behaviour being a marker for other maternal characteristics directly influencing child behaviour. Cigarette smoking in this study was measured by maternal report, though this has generally been shown to correlate well with cotinine findings.[34-35] These issues are discussed more fully in a separate report on smoking in early and later stages of pregnancy being prepared for publication.

There was no evidence from this study to link perinatal or neonatal events to later behaviour. This overall lack of relationship between adverse perinatal factors and later externalising behaviour, supports the findings of Rantakallis *et al.* [36] Similar to a number of studies,[21,37] prematurity <36 weeks and intensive care admission were associated with behaviour in the unadjusted analysis. In our study, though not that of Speechley *et al.*[37] which was a follow-up at adolescence of an earlier neonatal intervention study, the association was no longer evident after adjusting for measures of social disadvantage. Though a number of studies have reported an increased prevalence of behaviour problem in premature infants, a recent report from this hospital found a similar prevalence of ADHD in extremely low birth weight (<1000 g) and control children of school age. [38] Neither Apgar score nor SGA status was significant in the unadjusted analysis, nor were they significant if they were included in the adjusted analysis. In the Dunedin Study[18] a cohort study similar to our study, SGA status was associated with global rating of behaviour problem in children with stable behaviour problems from 5 to 7 years, though the strength of this association varied with the level of family adversity. Studies of SGA infants have differed in their outcome findings which have varied from normal to subtle cognitive and motor impairments and attentional difficulties. This may be attributed to differences in entry selection criteria, definitions of SGA status and age to follow up.

Many studies have sought, generally unsuccessfully, for evidence of a relationship between disorders of attention in children and minimal brain damage[2] Chandola *et al.*[17] reported that compared to other children in a geographically defined birth cohort, 1 min Apgar score was associated with later referral for hyperactivity. The definition of hyperactivity was not, however, explicit, non-referred subjects were not assessed, and the magnitude of the effect was relatively weak. Gillberg and Rasmussen[18] reported that non-optimal events during the neonatal period, particularly dysmaturity, were associated more commonly (31% vs 10%) in children with marked fine or gross motor dysfunction, though the group of children with isolated attentional disorders showed no increase in adversity. In the Collaborative Perinatal Project[39] attention-impulsivity was rated clinically by the psychologist at the 7 year assessment, and only limited relationships with 5 minute Apgar scores were present. Low Apgar scores, however, have a variety of aetiologies in addition to asphyxia.[40] Although attention was not independently measured in this study, our findings provide no support for a minimal brain damage hypothesis as an explanation for later behaviour.

A weakness of this study is loss to follow up. Factors associated with loss to follow up in this and other similar studies[41] make it likely that those not attending follow up would have a higher prevalence of biological risk factors at birth, social disadvantage and subsequent behaviour problems. This should only bias the findings of this study if the relationship between risk factors and behaviour was very substantially different in those lost to follow up, from that of study children assessed at 5 years. Boyle *et al.*[42] suggest that losses to follow up of the magnitude seen in this study are unlikely to substantially bias the estimate of the effect where this is measured by the relative risk. Though an extensive list of possible risk factors are considered in this study and include most common epidemiological measures, the list is not exhaustive. It is possible, though unlikely, that other markers may be better predictors of child behaviour. The behavioural questionnaire used in this study has high internal reliability and provides separate measurement of internalising and externalising child behaviour. It is not, however, a complete Child Behaviour Checklist and as it does not include all nine subscales, it is possible that associations specific to one of these scales may have been missed. Finally, multiple statistical comparisons were made, and though this does increase the probability of chance associations, all involved testing **a** biologically plausible hypothesis.

Findings from this study suggest that for low risk infants, most commonly used epidemiological measures of adverse biological events in pregnancy and the perinatal period do not predict behaviour problems in later childhood.

REFERENCES

1. Casaer P, de Vries L, Marlow N. Prenatal and perinatal risk factors for psychosocial development. In Rutter M, Casaer P eds. *Biological Risk Factors for Psychosocial Disorders.* Cambridge University of Press, Cambridge, 1991; 139-74.

2. Worry JS. Brain and Behaviour. In Lewis M ed. *Child and Adolescent Psychiatry: A comprehensive textbook*. Williams and Wilkins, Baltimore, MD, 1991; 7686.
3. Michels R, Marzuk PM. Progress in Psychiatry. *N. Engl. J. Med.* 1993; 329: 552-60.
4. Hashimoto J, Jayama M, Miyazaki M, Murakawa K, Kuroda Y. Brainstem and cerebellar vermis involvement in autistic children. *J. Child Neurol.* 1993; 8: 149-53.
5. Cantwell DP. Attention Deficit Disorder. A review of the past 10 years. *J. Am. Acad. Child Adolescent Psychiatry*. 1996; 35: 978-87.
6. Cohen M, Campbell R, Yagmai F. Neuropathological abnormalities in developmental dysphasia. *Ann. Neurol* 1989; 25: 567-70.
7. Baxter LR. Jr. Positron emission tomography studies of cerebral glucose metabolism in obsessive compulsive disorder. *J. Clin. Psychiatry* 1994; 55: 54-9.
8. Pilowsky LS. Understanding schizophrenia. *BMJ* 1992; 305: 327-8.
9. Lewis SW, Murray RM. Obstetric complications, neurodevelopmental deviance and risk of schizophrenia, *J. Psychiatr. Res.* 1987; 21: 421.
10. Mednick SA, Machon RA, Huttunen MO, Bonett D. Adult schizophrenia following prenatal exposure to an influenza epidemic. *Arch. Gen. Psychiatry* 1988; 45: 192.
11. Rutter M, Graham P, Yule W. A neuropsychiatric study in childhood. *Clin. Dev. Med.* no. 35/36 SIMP/Heinemann, 1970.
12. Goodman R. Brain Disorders. In Rutter M, Taylor E, Hersov L eds. *Child and Adolescent Psychiatry Modern Approaches.* Blackwell Science, Oxford. 1994; 172-90.
13. Pasamanick B, Knoblock H. Epidemiologic studies on the complications of pregnancy and the birth process. In Caplan G ed. *Prevention of Mental Disorders in Children*. New York Basic, New York, 1961; 7494.
14. Samgroff AJ, Chandler MJ. Reproductive risk and the continuum of caretaker casualty. In Horowitz FD, Heatherington M, Scarr-Salatatek S, Siegel G eds. *Review of Child Development Research*, Vol. 4, University of Chicago Press, Chicago, 1985; 187244.
15. Werner EE. Stress and Protective Factors in Children's Lives. In Nicol AR ed. *Longitudinal Studies in Child Psychology and Psychiatry*. John Wiley and Sons Ltd, Chichester. 1985; 335-55.
16. McGee R, Silva PA, Williams S. Perinatal, neurological, environmental and developmental characteristics of seven-year-old children with stable behaviour problems. *J.Child Psychol. Psychiat.* 1984; 25: 573-86.
17. Chandola CA, Robling MR, Peters TJ, Melville-Thomas G, McGuffin P. Pre- and Perinatal Factors and the risk of subsequent referral for hyperactivity. *J. Child Psychol. Psychiat.* 1992; 33: 10.
18. Gillberg C, Rassmussen P. Perceptual, motor and attentional deficits in seven-year-old children. Background factors. *Dev. Med. Child Neurol.* 1982; 24: 752-70.
19. Kandel E, Mendick SA. Perinatal complications predict violent offending. *Criminology* 1991; 29: 519-28.
20. Walter FJ. Growth and development of term disproportionate small for gestational age infants at the age of 7 years. *Early Hum. Dev.* 1982; 18: 1-11.
21. Pharoah PO, Stevenson CJ, Cooke RW, Stevenson RC. Prevalence of behaviour disorders in low birthweight infants. *Arch. Dis. Child* 1994; 70: 271-4.
22. Khadilkar V, Tudehope D, Burns Y, O'Callaghan M, Mohay H. The long-term neurodevelopmental outcome of very low birth weight (VLBW) infants with 'dystonic' signs at 4 months of age. *J. Paediatr. Child Health* 1993; 29: 415-7.
23. Weisglas-Kuperus N, Kaot HM, Baerts W, Fetter WPF, Saver PJJ. Behaviour problems of very low birthweight children. *Dev. Med. Child Neurol.* 1993; 35: 406-16.
24. Keeping JD, Najman JM, Morrison J, Western JS, Andersen MJ, Williams D.N. A prospective longitudinal study of social, psychological and obstetric factors in pregnancy: Response rates and demographic characteristics of the 8556 respondents. *Br. J. Obstet. Gynaecol.* 1989; 96: 289-97.
25. Bor W, Najman JM, Anderson M, Morrison J, Williams G. Socioeconomic disadvantage and child morbidity: an Australian study. *Soc. Science Med.* 1993; 38: 11.
26. Achenbach TM. *Manual for the Child Behaviour Checklist Burlington VT*. University of Vermont, Department of Psychiatry, Burlington, 1991.
27. SAS Institute, Inc. *SAS User's Guide: Basics*, Version 5 edn SAS Institute, Inc., Cary, NC, 1On
28. Statistical and Epidemiology Research Corporation. *EGRET*. SERC, Seattle, 1990.
29. Lewis DO. The development of the symptom of violence. In Lewis M ed. *Child and Adolescent Psychiatry A Comprehensive Textbook*. Williams and Wilkins, Baltimore, MD, 1991; 331-40.
30. Geschwind N, Galaburda AM. Cerebral lateralisation: biological mechanisms, associations and pathology. A hypothesis and program for research. *Arch. Neurol* 1985; 42: 428654.
31. Taylor EA. Childhood Hyperactivity. *Br J. Psychiatry* 1986; 149: 562-73.
32. Rantakallio P, Laara E, Isohanni M, Mollanem L Maternal smoking during pregnancy and delinquency of the offspring: As association without causation? *Int. J. Epidemiol.* 1992; 21: 13.

33. McGee R, Stanton W. Smoking in pregnancy and child development to age 9 years. *J. Paediat. Child Health* 1994; 30: 263-5.
34. Bauman KE, Koch GC. Validity of self reports and descriptive and analytic conclusions: The case of cigarette smoking by adolescents and their mothers. *Am. J. Epi*. 1993; 118: 90-8.
35. Parazzini F, Davoli E, Rabalotti M el al. Validity of self-reported smoking habits in pregnancy: A saliva cotinine analysis. *Acta. Obstet. Gynecol. Scand.* 1996; 75; 352254.
36. Rantakallio P, Koiranen M, Mottonen J. Association of perinatal events, epilepsy and central nervous system disease with juvenile delinquency. Arch. Dis. Child 1992; 87: 11.
37. Speechley KN, Avison WR. Admission to a neonatal intensive care unit as a predictor of long term health: A 12 year follow-up. *Dev. Behav. Paediatr*. 1995; 16: 397405.
38. O'Callaghan MJ, Burns YR. Gray MPH, Haney JM, Mohay H. Rogers YM, Tudehope DI. School performance of ELBW childen: A controlled study. *Dev. Med Child. Neurol.* 1996; 38: 917-26.
39. Nichols PL, Chen Ta-Chuan. *Minimal Brain Dysfunction: A prospective study*. Lawrence Erlbaum Assoc, Hillsdale NJ, 1981.
40. Sykes GS, Johnson P, Ashworth F, Molloy PM, Gu W, Stirrat G.M. Do Apgar scores Indicate asphyxia. *Lancet* 1 1982; 494-6.
41. Kellmer Pringle ML, Butler NR, Davie R. *11 000 Seven year Olds First Report of the National Child Development Study (1958 Cohort)*. Longman, London, 1966.
42. Boyle MH, Offord OR, Racine TA, Catlin G. Ontario Child Health Study: Evaluation of sample loss. *J. Am. Acad. Child Adolesc. Psychiatry* 1991; 30: 449-56.