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Light drinking during pregnancy: still no increased risk for socioemotional difficulties or cognitive deficits at 5 years of age?

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ABSTRACT

Background This study examines the relationship between light drinking during pregnancy and the risk of socioemotional problems and cognitive deficits at age 5 years.

Methods Data from the nationally representative prospective UK Millennium Cohort Study (N=11 513) were used. Participants were grouped according to mothers' reported alcohol consumption during pregnancy: never drinker; not in pregnancy; light; moderate; heavy/binge. At age 5 years the strengths and difficulties questionnaire (SDQ) and British ability scales (BAS) tests were administered during home interviews. Defined clinically relevant cut-offs on the SDQ and standardised scores for the BAS subscales were used.

Results Boys and girls born to light drinkers were less likely to have high total difficulties (for boys 6.6% vs 9.6%, OR=0.67, for girls 4.3% vs 6.2%, OR=0.69) and hyperactivity (for boys 10.1% vs 13.4%, OR=0.73, for girls 5.5% vs 7.6%, OR=0.71) scores compared with those born to mothers in the not-in-pregnancy group. These differences were attenuated on adjustment for confounding and mediating factors. Boys and girls born to light drinkers had higher mean cognitive test scores compared with those born to mothers in the not-in-pregnancy group: for boys, naming vocabulary (58 vs 55), picture similarities (56 vs 55) and pattern construction (52 vs 50), for girls naming vocabulary (58 vs 56) and pattern construction (53 vs 52). Differences remained statistically significant for boys in naming vocabulary and picture similarities.

Conclusions At age 5 years cohort members born to mothers who drank up to 1—2 drinks per week or per occasion during pregnancy were not at increased risk of clinically relevant behavioural difficulties or cognitive deficits compared with children of mothers in the not-in-pregnancy group.

The link between heavy alcohol consumption during pregnancy and health and developmental problems in children is well established.[1] We recently reported that light alcohol consumption during pregnancy was not associated with an increased risk of behavioural difficulties or cognitive deficits at 3 years of age.[2] However, it is not clear whether these associations remain constant throughout childhood or change over time, and other work suggests possible 'sleeper' effects whereby developmental problems associated with maternal drinking during pregnancy may emerge later in childhood.[3][4]

In this paper we do two things to advance work in this area: first, we examine the relationship between light drinking during pregnancy and the risk of socioemotional problems and cognitive deficits at age 5 years; and second, we refine our analysis of maternal drinking during pregnancy by disaggregating the non-drinking category into two groups, those who never drink, that is 'teetotallers', and those who did not drink alcohol during pregnancy but otherwise drink. We used data from the Millennium Cohort Study (MCS).

METHODS
The Millennium Cohort Study

The MCS is a nationally representative longitudinal study of infants born in the UK. The sample was drawn from births in the UK between September 2000 and January 2002. The survey design, recruitment process and fieldwork have been described in detail elsewhere.[5] Briefly, 18 552 households agreed to participate in the first sweep of the survey, an interview response rate of 85%. Households were identified through the Department of Work and Pensions child benefit system and were selected on the basis of where the family was resident shortly after the time of birth. The sample has a probability design and is clustered at the electoral ward level such that disadvantaged residential areas are over-represented.

The first sweep of the survey involved home visits by interviewers when cohort members were aged 9 months. Questions were asked about mothers' drinking during pregnancy, other health-related behaviours, socioeconomic circumstances and household composition. Sweeps two and three of the survey took place when cohort members were aged approximately 3 and 5 years. At the age 5 years home visit cognitive assessments were carried out by trained interviewers and questions were asked about the cohort members' social and emotional behaviour, socioeconomic factors and the psychosocial environment of the family.

Ethical approval for the MCS was gained from the relevant ethics committees and parents gave informed consent before interviews took place, and separate written consent for cognitive assessments.

Mothers' drinking

During the first data sweep mothers were asked about whether they drank alcohol during pregnancy (every day, 5—6, 3—4, 1—2 days per week, 1—2 times per month, less than once per month, never). If the mother drank at least once or twice

per week she was asked: 'In an average week, how many units of alcohol did you drink?' If she drank once or twice per month or less than once per month she was asked: 'On the days when you did drink alcohol, on average how many units did you drink in a day?' Mothers were told: 'By a unit I mean, half a pint of beer, a glass of wine, or a single measure of spirit or liqueur.'

There are no widely agreed criteria on the levels of alcohol that constitute light or moderate drinking. We defined light and heavy/binge drinking on the criteria outlined by the National Alcohol Strategy.[6] Moderate drinking was defined as alcohol consumption at levels greater than light drinking, and less than heavy/binge drinking.

Another methodological concern comes from the observation that, in epidemiological studies drinking categories are heterogeneous in multiple ways. For example, in the current context non-drinkers are composed of mothers who never drink alcohol (so called 'teetotallers') and those that did not drink during their pregnancy but otherwise do drink alcohol. Moreover, in this particular context, if an experimental study design such as a randomised controlled trial were feasible, it would not necessarily make sense to include teetotallers in the study, and such a trial would only recruit participants who drank alcohol. In this scenario participants would be randomly assigned either to stop drinking or to be light drinkers. It follows that a more rigorous approach would be to refine the analysis of our observational data by disaggregating the non-drinkers into two groups: teetotallers and those who otherwise drink but not in pregnancy, and thus use the latter as the comparison group in multivariate analysis.

When cohort members were aged 9 months and 5 years mothers were asked about their current drinking patterns. We used these data to disaggregate the non-drinkers into two groups: never drinkers—reported not drinking in pregnancy, and when cohort members were aged 9 months and 5 years, and those who reported not drinking during pregnancy but did report drinking alcohol at the 9 month or 5 year interviews.

In this paper drinking categories are thus defined as follows:
► Never drinker (teetotallers)
► Not in pregnancy
► Light, not more than 1–2 units per week or per occasion
► Moderate, not more than 3–6 units per week or 3–5 units per occasion
► Heavy/binge, 7 or more units per week or 6 or more units per occasion.

Behavioural and emotional problems
When cohort members were approximately 5 years old, parents were asked to complete the strengths and difficulties questionnaire (SDQ) age 4–15 years version (http://www.sdqinfo.com). The SDQ asks questions about five domains of behaviour, namely: conduct problems; hyperactivity; emotional symptoms; peer problems and pro-social behaviour. The SDQ is a validated tool that has been shown to compare favourably with other measures for identifying hyperactivity and attention problems.[7 8] This paper focuses on aspects of behaviour, for example conduct problems and hyperactivity, previously linked to mothers' drinking during pregnancy.[3 9–14] Scores from the conduct problems, hyperactivity, emotional symptoms and peer problems subscales were summed to construct a total difficulties score. Clinically relevant cut points for problem behaviours were determined as the top 10% of all MCS children with SDQ data at age 5 years.[7] Cut points used were as follows: total difficulties ≥15; hyperactivity ≥7; conduct problems ≥4; emotional symptoms ≥4; peer problems ≥4.

Cognitive ability assessments
Cognitive ability at 5 years was assessed using widely validated, age-appropriate tests from the British ability scale (BAS): the naming vocabulary, picture similarities and pattern construction subscales.[15] The naming vocabulary subscale assesses expressive language and knowledge of names in English, the picture similarities subscale assesses pictorial reasoning and the pattern construction subscale assesses spatial skills. These subscales tap into the three most significant aspects of information processing: verbal reasoning, non-verbal reasoning and spatial abilities.[16] Mean age standardised T-score values for BAS subscales are reported. T-scores have a mean of 50 and SD of 10, and a range of 20 to 80. A cohort member with a T-score of 50 thus scored at the mean for the standardisation sample, while a cohort member with a T-score of 60 scored one SD above the mean and a cohort member with a T-score of 40 scored one SD below the mean for the standardisation sample. For the study sample gender-specific values were calculated for the mean and SD and these were used to generate Z-scores for each subscale. Z-scores were used in the analysis to aid model comparability.

Explanatory factors
Mother and infant, socioeconomic and family psychosocial factors that were hypothesised to confound or mediate the relationship between mothers' drinking and child behavioural and cognitive development were considered in explanatory models. Mother and infant confounding factors were: mother's age; number of children in the household at sweep 3; whether the pregnancy was planned; whether the mother smoked during pregnancy; the child's gender, birth weight and current age. Socioeconomic confounding factors were: highest parental occupation at sweep 1, highest parental educational qualification at sweep 1 and parental income at sweep 3. Family psychosocial markers hypothesised to mediate the relationship were from the sweep 3 interview: mother's current mental health (K6 questionnaire)[17]; parental discipline strategies (sum of frequency of ignoring, smacking, shouting, sending to the 'naughty chair', removing treats, telling off and bribing with response categories as never, rarely, sometimes ∼1/month, often 1–6/week, daily); competence (whether the mother felt she was: not very good at being a parent; a person who has some trouble being a parent; an average parent; a better than average parent; a very good parent); closeness to the child (how close the mother felt to her child: not very, fairly, very, extremely) and whether the child was made to follow instructions (how often parent makes sure that child follows instructions or requests: never/almost never, less than half the time, more than half the time, all the time); and whether or not the mother currently drank alcohol.

Data analysis
Behavioural and cognitive outcomes and drinking in pregnancy are known to be moderated by ethnicity and multiple births.[18 19] Therefore we analysed data for all white singleton infants whose mothers participated in sweeps 1 and 3 of the MCS for whom data on drinking during pregnancy were available (n=12 294). Behavioural outcome data at age 5 years were available for total difficulties (n=12 079), conduct problems (n=12 161), hyperactivity (n=12 125), emotional symptoms (n=12 149) and peer problems (n=12 132). Cognitive test data were available for: naming vocabulary (n=12 110), picture similarities (n=12 099), pattern construction (n=12 059) cohort members. Missing data for explanatory factors of interest for behavioural outcomes reduced the sample to: total difficulties (n=11 450; 94.8%); conduct problems (n=11 511; 94.7%); hyperactivity (n=11 485;

Table 1 Mother, infant, socioeconomic and psychosocial markers by patterns of mothers' drinking during pregnancy

	Category of drinking				
	Never n=680	Not in pregnancy n=6935	Light n=2981	Moderate n=633	Heavy/binge n=284
Infant's gender, %					
Male	53.6	50.6	51.8	49.6	51.1
Birth weight (kg), (mean)***	3.368	3.395	3.449	3.413	3.325
Mother's age at time of birth (years), %***					
13—19	7.8	9.1	4.8	7.0	13.1
20—24	17.7	17.4	10.2	13.0	21.3
25—29	31.4	29.1	27.5	23.5	23.3
30—34	27.1	29.6	36.4	33.2	22.4
35—39	14.0	13.2	18.5	19.0	17.5
40 plus	2.0	1.6	2.6	4.4	2.4
No of children in the household, %***					
1	12.7	17.8	14.7	13.7	27.5
2	40.0	50.5	54.8	42.8	44.5
3+	47.3	31.7	30.6	43.4	28.0
Mother smoked during pregnancy, %***					
Yes	33.2	23.1	16.8	29.9	44.6
Pregnancy planned, %***					
Yes	50.9	57.7	65.4	52.4	48.1
Family income, %***					
£52 000 or more	4.1	8.6	16.6	13.7	8.1
£32 200—51 999	14.8	21.4	27.7	24.5	18.4
£20 800—32 199	20.0	23.9	21.0	19.1	18.5
£10 400—20 799	32.0	24.9	17.9	22.8	25.4
Less than £10 400	19.5	13.9	9.1	12.9	20.7
Don't know	8.5	5.6	5.9	4.9	8.3
Refused	1.2	1.7	1.8	2.2	0.5
Highest parental educational qualification, %***					
Higher degree	3.8	5.1	11.1	7.2	6.0
First degree/diploma	26.9	35.2	46.4	38.8	31.9
A/AS levels	15.5	18.0	15.2	14.2	18.6
GCSE grades A—C	31.2	28.1	20.1	25.5	27.0
GCSE grades D—G	5.7	6.2	3.4	4.2	6.7
Other/overseas	3.0	0.8	0.7	0.8	0.6
None	14.0	6.4	3.2	9.2	9.3
Highest parental occupation, %***					
Managerial and professional	11.9	19.0	32.9	25.3	19.8
Intermediate	10.7	12.8	14.0	14.0	11.5
Small employer and self-employed	6.3	8.1	10.6	8.8	8.1
Low supervisory & technical	10.2	11.0	9.0	6.0	10.2
Semi-routine and routine	55.1	46.0	31.6	42.0	43.6
Never worked, long-term unemployed and other unclassified	5.8	3.1	1.9	3.9	6.8
Mother currently drinks, %***					
Yes	0.0	92.4	96.3	94.1	94.2
Mother's K6 score, (mean) ***	3.4	3.0	2.9	3.2	3.2
Parental discipline, (mean)***	10.5	11.5	12.0	11.9	12.2
Mother's parenting competence, %**					
Very good	35.1	31.7	26.0	27.6	31.0
Better than average	21.9	27.9	32.7	31.1	25.8
Average	39.0	36.8	37.5	38.5	38.7
Some trouble	3.3	3.2	3.4	2.5	4.4
Not very good	0.7	0.4	0.3	0.2	0.2
Mother makes sure child obeys instructions, %					
All of the time	53.8	54.9	51.5	48.9	55.4
More than half of the time	24.0	29.4	35.0	32.7	29.7
About half of the time	12.8	9.1	9.2	11.7	7.9
Less than half of the time	7.1	4.9	3.2	5.5	5.6
Never/almost never	2.3	1.6	1.2	1.3	1.5
Mother's closeness to child, %*					
Extremely close	71.6	72.8	69.8	66.8	70.0
Very close	25.0	24.4	27.3	30.2	26.5
Fairly close	3.2	2.6	2.9	3.0	3.4
Not very close	0.2	0.2	0.1	0.0	0.1

*p<0.05; **p<0.01; ***p<0.001.

94.7%); emotional symptoms (n=11 503; 94.7%) and peer problems (n=11 481; 94.6%); and for naming vocabulary (n=11 370; 93.9%), for picture similarities (n=11 360; 93.9%) and pattern construction (n=11 330; 93.9%).

Cohort members whose families participated in MCS sweep 1 but not in sweep 3 were more likely to be from disadvantaged backgrounds. Their mothers were younger, more likely to be lone parents, and have lower incomes compared with mothers who took part in both sweeps (appendix 1).

Multivariate analyses are based on the cases with complete data on relevant variables using Stata version 11.0. The SVY command was used together with survey weights throughout to take account of the clustered sample design, the unequal probability of being sampled and survey non-response.

Logistic regression models were used to investigate the relative importance of mother and infant, socioeconomic and family psychosocial factors on the likelihood of behavioural difficulties in children according to mothers' drinking in pregnancy category. Linear regression models investigate relationships between mother and infant, socioeconomic and family psychosocial factors to cognitive ability scores. There were gender differences in behavioural problems and cognitive ability scores and so models are presented for boys and girls separately. We hypothesised that mother and infant and socioeconomic factors would confound the association between mother's drinking and child outcomes, whereas psychosocial factors would mediate this relationship, so adjustment was done separately for different types of factors. Behavioural outcome models adjust for age at sweep 3, cognitive outcome models do not as individual scores are age standardised. Model A shows the unadjusted associations, model B additionally adjusts for mother and infant factors, model C for socioeconomic markers, model D for family psychosocial environment and model E simultaneously adjusts for all factors.

RESULTS
A total of 5.9% of mothers never drank alcohol, 60.2% did not drink in pregnancy and 25.9%, 5.5% and 2.5% were categorised as light, moderate and heavy/binge drinkers, respectively. Light drinkers were more socioeconomically advantaged compared with mothers in all other categories. The socioeconomic profile of mothers in the 'not-in-pregnancy' group was more advantaged than the 'never-drinker' group but less advantaged than the 'light' drinking group (table 1).

Boys were more likely than girls to have high total difficulties (9.3% vs 6.0%), conduct problems (11.2% vs 7.9%), hyperactivity (12.8% vs 7.1%) and peer problems (7.3% vs 5.1%) scores. Girls were more likely to have high emotional symptom scores compared with boys (9.5% vs 8.7%). Girls had higher mean cognitive ability test scores compared with boys, naming vocabulary (56.3 vs 55.7), picture similarities (56.2 vs 55.1) and pattern construction (52.0 vs 50.4).

Boys and girls born to light drinkers were less likely to have high total difficulties (for boys 6.6% vs 9.6%, OR=0.67, 95% CI 0.53 to 0.86; for girls 4.3% vs 6.2%, OR=0.69, CI 0.50 to 0.96) and hyperactivity (for boys 10.1% vs 13.4%, OR=0.73, CI 0.58 to 0.91; for girls 5.5% vs 7.6%, OR=0.71, CI 0.53 to 0.94) scores compared with those born to mothers in the not-in-pregnancy group (table 2). These differences were attenuated on adjustment for mother and infant, and socioeconomic factors and in fully adjusted models.

Boys born to light drinkers had higher mean cognitive test scores compared with those born to mothers in the not-in-pregnancy group: naming vocabulary (57.5 vs 55.1), picture similari-

ties (56.3 vs 54.6) and pattern construction (51.6 vs 50.0) and the differences for naming vocabulary and picture similarities remained statistically significant in fully adjusted models. Girls born to light drinkers compared with those born to mothers in the not-in-pregnancy group had higher mean scores on the naming vocabulary (57.6 vs 56.0) and pattern construction (53.0 vs 51.7) subscales, but differences were attenuated on adjustment for socioeconomic factors and in fully adjusted models (table 3).

DISCUSSION
Main findings
In this large nationally representative study of 5 year olds there appeared to be no increased risk of socioemotional difficulties or cognitive deficits in children born to light drinkers compared with children born to mothers in the not-in-pregnancy group. After adjustment for a range of confounding and mediating variables boys born to light drinkers had higher cognitive ability scores compared with those with mothers in the not-in-pregnancy group.

Strengths and limitations
We report findings from a large nationally representative sample of 5-year-old children, and these results are consistent with our previous work that suggested a U-shaped relationship between maternal drinking in pregnancy and developmental outcomes in 3-year-old children[2] and those from other studies.[11 20–22] The apparent U-shaped relationship between alcohol consumption and the risk of mortality and chronic disease in adults has been widely documented, and while the underlying relationship is not clear, it has been hypothesised that never drinkers are somehow different from others in their health and social profiles.[23] Data on drinking during pregnancy were collected when cohort members were aged 9 months, and although some studies report that retrospective recall of alcohol consumption is reliable,[24 25] it is possible that the measure used in this study was prone to recall bias. In addition, when not pregnant approximately 94% of our sample usually drank but only approximately 34% of mothers reported drinking during pregnancy, and it is not clear what proportion of women stopped drinking before conception or before pregnancy recognition. On the other hand, the current analysis also shows that children born to mothers in the heavy/binge drinking category were more likely to have hyperactivity, conduct and emotional problems compared with children born to mothers who did not drink during pregnancy, although cell sizes were small and statistical differences were attenuated on adjustment for confounding and mediating factors. This consistency with other studies[26 27] strengthens the validity of our findings.

The drinking categories used were heterogeneous in terms of the amounts of alcohol mothers reported consuming during pregnancy. We attempted to remove some of the inherent heterogeneity of the abstinent group by disaggregating into two groups: the teetotallers and those who did not drink during pregnancy but who otherwise did drink alcohol, and we used the latter as the baseline comparison group. Thereby, in terms of socioeconomic maternal and psychosocial profiles the baseline group were more comparable with the light drinking group than would be the case if the non-drinkers were combined. A clear strength of this study is that a wide range of hypothesised socioeconomic confounding and psychosocial mediating factors were accounted for in multivariate models. Children's social and emotional behaviours and cognitive abilities are heavily influenced by the social environment, and social gradients in markers of child development are evident.[28 29] The mechanisms through

Table 2 Prevalence (%) and OR (95% CI) for high behavioural difficulties scores

Boys	Prevalence	Model A		Model B		Model C		Model D		Model E	
Total difficulties, n=5864											
Never	14.6	1.61	(1.11 to 2.34)	1.51	(1.03 to 2.20)	1.31	(0.88 to 1.95)	1.27	(0.75 to 2.16)	1.29	(0.74 to 2.27)
Not in pregnancy	9.6	Ref		Ref		Ref		Ref		Ref	
Light	6.6	0.67	(0.53 to 0.86)	0.82	(0.64 to 1.04)	0.91	(0.71 to 1.17)	0.66	(0.50 to 0.85)	0.77	(0.59 to 1.01)
Moderate	10.7	1.15	(0.77 to 1.71)	1.19	(0.80 to 1.78)	1.32	(0.87 to 1.99)	1.07	(0.71 to 1.61)	1.10	(0.71 to 1.70)
Heavy/binge	15.7	1.76	(1.09 to 2.82)	1.40	(0.85 to 2.31)	1.63	(0.99 to 2.68)	1.86	(1.03 to 3.38)	1.63	(0.92 to 2.89)
Conduct problems, n=5896											
Never	14.8	1.42	(0.98 to 2.07)	1.27	(0.87 to 1.87)	1.18	(0.81 to 1.73)	1.45	(0.87 to 2.41)	1.50	(0.86 to 2.62)
Not in pregnancy	10.8	Ref		Ref		Ref		Ref		Ref	
Light	10.0	0.92	(0.74 to 1.15)	1.12	(0.89 to 1.40)	1.16	(0.93 to 1.45)	0.89	(0.70 to 1.14)	1.06	(0.83 to 1.35)
Moderate	14.7	1.43	(0.99 to 2.07)	1.45	(0.99 to 2.13)	1.59	(1.09 to 2.33)	1.32	(0.87 to 2.00)	1.34	(0.87 to 2.06)
Heavy/binge	18.1	1.82	(1.14 to 2.89)	1.51	(0.95 to 2.43)	1.69	(1.05 to 2.71)	1.82	(1.00 to 3.30)	1.55	(0.89 to 2.71)
Hyperactivity, n=5883											
Never	15.9	1.22	(0.84 to 1.77)	1.15	(0.79 to 1.67)	1.05	(0.71 to 1.57)	1.05	(0.67 to 1.65)	1.11	(0.69 to 1.78)
Not in pregnancy	13.4	Ref		Ref		Ref		Ref		Ref	
Light	10.1	0.73	(0.58 to 0.91)	0.86	(0.68 to 1.05)	0.90	(0.72 to 1.12)	0.69	(0.55 to 0.87)	0.81	(0.64 to 1.01)
Moderate	12.6	0.92	(0.61 to 1.39)	0.98	(0.64 to 1.48)	1.02	(0.68 to 1.54)	0.82	(0.54 to 1.23)	0.87	(0.57 to 1.34)
Heavy/binge	19.6	1.57	(1.05 to 2.34)	1.35	(0.90 to 2.02)	1.52	(0.99 to 2.31)	1.52	(0.95 to 2.43)	1.43	(0.91 to 2.26)
Emotional symptoms, n=5892											
Never	13.6	1.69	(1.16 to 2.46)	1.65	(1.12 to 2.43)	1.53	(1.03 to 2.27)	1.25	(0.73 to 2.12)	1.25	(0.72 to 2.17)
Not in pregnancy	8.5	Ref		Ref		Ref		Ref		Ref	
Light	7.4	0.87	(0.68 to 1.12)	0.97	(0.75 to 1.25)	1.01	(0.78 to 1.33)	0.90	(0.68 to 1.17)	0.95	(0.72 to 1.26)
Moderate	9.2	1.10	(0.67 to 1.80)	1.18	(0.73 to 1.91)	1.22	(0.74 to 2.01)	1.07	(0.65 to 1.75)	1.17	(0.71 to 1.93)
Heavy/binge	15.4	1.96	(1.18 to 3.23)	1.81	(1.08 to 3.02)	1.83	(1.10 to 3.06)	2.01	(1.14 to 3.56)	2.02	(1.16 to 3.52)
Peer problems, n=5882											
Never	10.9	1.46	(0.92 to 2.32)	1.37	(0.86 to 2.17)	1.22	(0.77 to 1.91)	1.29	(0.68 to 2.43)	1.20	(0.64 to 2.23)
Not in pregnancy	7.7	Ref		Ref		Ref		Ref		Ref	
Light	6.3	0.80	(0.62 to 1.03)	0.89	(0.69 to 1.14)	0.94	(0.73 to 1.21)	0.83	(0.64 to 1.08)	0.88	(0.68 to 1.15)
Moderate	5.2	0.66	(0.36 to 1.22)	0.65	(0.35 to 1.18)	0.71	(0.38 to 1.33)	0.62	(0.32 to 1.21)	0.62	(0.32 to 1.20)
Heavy/binge	5.6	0.71	(0.37 to 1.38)	0.59	(0.31 to 1.14)	0.62	(0.31 to 1.23)	0.70	(0.35 to 1.40)	0.59	(0.29 to 1.19)
Girls											
Total difficulties, n=5586											
Never	8.2	1.36	(0.82 to 2.25)	1.09	(0.64 to 1.87)	0.95	(0.57 to 1.59)	1.23	(0.60 to 2.52)	1.18	(0.54 to 2.58)
Not in pregnancy	6.2	Ref		Ref		Ref		Ref		Ref	
Light	4.3	0.69	(0.50 to 0.96)	0.88	(0.62 to 1.24)	1.01	(0.72 to 1.42)	0.67	(0.46 to 0.98)	0.89	(0.60 to 1.32)
Moderate	8.5	1.42	(0.92 to 2.20)	1.28	(0.82 to 1.99)	1.38	(0.88 to 2.16)	1.35	(0.85 to 2.14)	1.22	(0.74 to 1.99)
Heavy/binge	8.4	1.39	(0.68 to 2.85)	0.96	(0.45 to 2.04)	1.26	(0.58 to 2.74)	1.15	(0.56 to 2.37)	1.03	(0.47 to 2.27)
Conduct problems, n=5615											
Never	11.2	1.46	(0.97 to 2.21)	1.17	(0.77 to 1.79)	1.00	(0.64 to 1.59)	1.04	(0.55 to 1.96)	0.86	(0.45 to 1.67)
Not in pregnancy	7.9	Ref		Ref		Ref		Ref		Ref	
Light	6.6	0.81	(0.61 to 1.08)	0.99	(0.74 to 1.33)	1.13	(0.84 to 1.51)	0.81	(0.59 to 1.09)	1.00	(0.72 to 1.39)
Moderate	9.5	1.22	(0.80 to 1.86)	1.09	(0.71 to 1.66)	1.14	(0.75 to 1.73)	1.14	(0.67 to 1.91)	0.97	(0.57 to 1.65)
Heavy/binge	13.2	1.77	(1.01 to 3.11)	1.32	(0.70 to 2.48)	1.63	(0.86 to 3.07)	1.46	(0.79 to 2.72)	1.30	(0.64 to 2.62)
Hyperactivity, n=5602											
Never	8.7	1.16	(0.68 to 1.98)	1.01	(0.58 to 1.75)	0.82	(0.48 to 1.39)	0.72	(0.35 to 1.49)	0.67	(0.32 to 1.39)
Not in pregnancy	7.6	Ref		Ref		Ref		Ref		Ref	
Light	5.5	0.71	(0.53 to 0.94)	0.86	(0.65 to 1.15)	0.96	(0.72 to 1.28)	0.70	(0.52 to 0.95)	0.87	(0.64 to 1.18)
Moderate	7.0	0.92	(0.59 to 1.45)	0.88	(0.56 to 1.39)	0.91	(0.57 to 1.44)	0.84	(0.51 to 1.37)	0.83	(0.50 to 1.38)
Heavy/binge	10.2	1.38	(0.71 to 2.66)	1.04	(0.54 to 2.02)	1.28	(0.64 to 2.55)	1.19	(0.63 to 2.26)	1.05	(0.55 to 1.97)
Emotional symptoms, n=5611											
Never	12.1	1.29	(0.84 to 1.98)	1.17	(0.76 to 1.79)	1.07	(0.69 to 1.64)	1.28	(0.70 to 2.33)	1.26	(0.68 to 2.32)
Not in pregnancy	9.6	Ref		Ref		Ref		Ref		Ref	
Light	8.8	0.91	(0.72 to 1.16)	1.02	(0.80 to 1.29)	1.09	(0.86 to 1.40)	0.93	(0.72 to 1.19)	1.03	(0.79 to 1.34)
Moderate	9.6	1.00	(0.66 to 1.50)	0.95	(0.64 to 1.42)	0.98	(0.66 to 1.47)	0.96	(0.62 to 1.47)	0.93	(0.61 to 1.42)
Heavy/binge	9.9	1.01	(0.55 to 1.95)	0.91	(0.48 to 1.72)	0.96	(0.50 to 1.84)	0.92	(0.49 to 1.74)	0.89	(0.46 to 1.72)

Continued

Table 2 Continued

Boys	Prevalence	Model A		Model B		Model C		Model D		Model E	
Peer problems, n=5599											
Never	7.2	1.39	(0.80 to 2.43)	1.31	(0.75 to 2.31)	1.12	(0.63 to 1.98)	1.48	(0.72 to 3.03)	1.51	(0.72 to 3.19)
Not in pregnancy	5.3	Ref		Ref		Ref		Ref		Ref	
Light	4.2	0.78	(0.57 to 1.08)	0.88	(0.63 to 1.22)	0.97	(0.70 to 1.36)	0.79	(0.57 to 1.11)	0.91	(0.64 to 1.29)
Moderate	5.7	1.07	(0.56 to 2.05)	1.04	(0.54 to 2.01)	1.08	(0.56 to 2.07)	0.98	(0.51 to 1.89)	1.00	(0.52 to 1.91)
Heavy/binge	6.0	1.13	(0.49 to 2.64)	0.92	(0.39 to 2.14)	1.03	(0.43 to 2.48)	0.99	(0.43 to 2.29)	0.92	(0.40 to 2.12)

Model A adjusts for child's age.
Model B adjusts for child's age, birth weight, mother's age at time of birth, number of children in the household, mother smoked during pregnancy, pregnancy planned.
Model C adjusts for child's age, birth weight, parental income, highest parental educational qualification, highest parental occupation.
Model D adjusts for child's age, birth weight, mother's K6 score, parental discipline, child made to follow instructions, mother's parental competence, closeness of relationship between mother and child, mother's current drinking.
Model E adjusts for child's age, birth weight, mother's age at time of birth, number of children in the household, mother smoked during pregnancy, pregnancy planned, parental income, highest parental educational qualification, highest parental occupation, mother's K6 score, parental discipline, child made to follow instructions, mother's parental competence, closeness of relationship between mother and child, mother's current drinking.

Table 3 Mean and Z-scores (95% CI) for BAS cognitive ability tests

Boys	Mean test T-score	Model A		Model B		Model C		Model D		Model E	
Naming vocabulary, n=5815											
Never	51.3	−0.18	(−0.33 to 0.03)	−0.13	(−0.26 to 0.00)	−0.08	(−0.21 to 0.06)	0.00	(−0.18 to 0.18)	−0.02	(−0.18 to 0.14)
Not in pregnancy	55.1	Ref		Ref		Ref		Ref		Ref	
Light	57.5	0.23	(0.16 to 0.30)	0.15	(0.09 to 0.22)	0.09	(0.02 to 0.15)	0.20	(0.13 to 0.27)	0.08	(0.01 to 0.14)
Moderate	56.1	0.09	(−0.05 to 0.24)	0.08	(−0.07 to 0.23)	0.03	(−0.12 to 0.18)	0.08	(−0.06 to 0.22)	0.04	(−0.10 to 0.19)
Heavy/binge	55.9	0.07	(−0.13 to 0.27)	0.12	(−0.07 to 0.32)	0.10	(−0.09 to 0.29)	0.06	(−0.14 to 0.26)	0.08	(−0.11 to 0.26)
Picture similarities, n=5819											
Never	53.3	−0.14	(−0.27 to 0.00)	−0.12	(−0.24 to 0.01)	−0.09	(−0.22 to 0.05)	0.03	(−0.14 to 0.21)	0.00	(−0.17 to 0.18)
Not in pregnancy	54.6	Ref		Ref		Ref		Ref		Ref	
Light	56.3	0.16	(0.09 to 0.23)	0.12	(0.05 to 0.18)	0.07	(0.01 to 0.14)	0.15	(0.08 to 0.22)	0.08	(0.01 to 0.14)
Moderate	56.0	0.13	(−0.01 to 0.27)	0.11	(−0.03 to 0.25)	0.08	(−0.05 to 0.21)	0.13	(0.00 to 0.27)	0.09	(−0.04 to 0.23)
Heavy/binge	55.4	0.07	(−0.11 to 0.25)	0.10	(−0.09 to 0.28)	0.08	(−0.10 to 0.25)	0.08	(−0.10 to 0.26)	0.07	(−0.10 to 0.24)
Pattern construction, n=5796											
Never	49.1	−0.09	(−0.23 to 0.05)	−0.06	(−0.19 to 0.07)	−0.02	(−0.15 to 0.11)	0.06	(−0.13 to 0.24)	0.05	(−0.13 to 0.23)
Not in pregnancy	50.0	Ref		Ref		Ref		Ref		Ref	
Light	51.6	0.16	(0.09 to 0.23)	0.11	(0.04 to 0.17)	0.06	(−0.01 to 0.13)	0.14	(0.07 to 0.21)	0.06	(−0.01 to 0.13)
Moderate	50.7	0.08	(−0.06 to 0.21)	0.06	(−0.07 to 0.20)	0.02	(−0.12 to 0.16)	0.06	(−0.07 to 0.20)	0.04	(−0.10 to 0.18)
Heavy/binge	49.7	−0.02	(−0.23 to 0.18)	0.03	(−0.17 to 0.22)	0.01	(−0.19 to 0.21)	−0.01	(−0.22 to 0.19)	0.01	(−0.18 to 0.21)
Girls											
Naming vocabulary, n=5555											
Never	53.8	−0.23	(−0.38 to 0.08)	−0.14	(−0.28 to 0.01)	−0.10	(−0.23 to 0.04)	−0.10	(−0.29 to 0.08)	−0.06	(−0.24 to 0.11)
Not in pregnancy	56.0	Ref		Ref		Ref		Ref		Ref	
Light	57.6	0.16	(0.09 to 0.23)	0.09	(0.02 to 0.16)	0.02	(−0.05 to 0.09)	0.14	(0.07 to 0.21)	0.02	(−0.05 to 0.09)
Moderate	55.9	−0.01	(−0.15 to 0.13)	0.03	(−0.10 to 0.16)	−0.02	(−0.14 to 0.10)	0.01	(−0.12 to 0.14)	0.00	(−0.12 to 0.12)
Heavy/binge	54.3	−0.18	(−0.35 to 0.01)	−0.12	(−0.29 to 0.05)	−0.15	(−0.31 to 0.02)	−0.15	(−0.33 to 0.02)	−0.15	(−0.31 to 0.01)
Picture similarities, n=5541											
Never	56.0	0.00	(−0.15 to 0.15)	0.05	(−0.10 to 0.20)	0.08	(−0.06 to 0.22)	0.06	(−0.12 to 0.25)	0.09	(−0.09 to 0.28)
Not in pregnancy	56.0	Ref		Ref		Ref		Ref		Ref	
Light	56.7	0.07	(0.00 to 0.14)	0.04	(−0.03 to 0.11)	−0.01	(−0.08 to 0.06)	0.06	(−0.02 to 0.13)	−0.01	(−0.07 to 0.06)
Moderate	56.6	0.06	(−0.08 to 0.20)	0.09	(−0.05 to 0.23)	0.06	(−0.08 to 0.19)	0.07	(−0.07 to 0.21)	0.08	(−0.06 to 0.21)
Heavy/binge	54.4	−0.16	(−0.36 to 0.04)	−0.11	(−0.30 to 0.08)	−0.14	(−0.33 to 0.05)	−0.15	(−0.35 to 0.06)	−0.14	(−0.33 to 0.05)
Pattern construction, n=5534											
Never	50.0	−0.18	(−033 to 0.03)	−0.12	(−0.27 to 0.03)	−0.09	(−0.23 to 0.04)	−0.07	(−0.26 to 0.12)	−0.06	(−0.24 to 0.12)
Not in pregnancy	51.7	Ref		Ref		Ref		Ref		Ref	
Light	53.0	0.14	(0.07 to 0.20)	0.09	(0.03 to 0.15)	0.05	(−0.02 to 0.12)	0.12	(0.05 to 0.18)	0.05	(−0.01 to 0.12)
Moderate	52.3	0.06	(−0.07 to 0.19)	0.09	(−0.03 to 0.21)	0.06	(−0.05 to 0.17)	0.07	(−0.05 to 0.20)	0.08	(−0.04 to 0.19)
Heavy/binge	50.2	−0.16	(−0.35 to 0.03)	−0.09	(−0.28 to 0.10)	−0.12	(−0.31 to 0.06)	−0.14	(−0.33 to 0.06)	−0.11	(−0.29 to 0.08)

Model A is unadjusted.
Model B adjusts for birth weight, mother's age at the time of birth, number of children in the household, mother smoked during pregnancy, pregnancy planned.
Model C adjusts for birth weight, parental income, highest parental educational qualification, highest parental occupation.
Model D adjusts for birth weight, mother's K6 score, parental discipline, child made to follow instructions, mother's parental competence, closeness of relationship between mother and child, mother's current drinking.
Model E adjusts for birth weight, mother's age at the time of birth, number of children in the household, mother smoked during pregnancy, pregnancy planned, parental income, highest parental educational qualification, highest parental occupation, mother's K6 score, parental discipline, child made to follow instructions, mother's parental competence, closeness of relationship between mother and child, mother's current drinking.
BAS, British ability scales.

What is already known on this subject

The link between heavy alcohol consumption during pregnancy and health and developmental problems in children is well established. It has been reported that light alcohol consumption during pregnancy is not associated with an increased risk of behavioural difficulties or cognitive deficits in 3-year-old children. However, there may be 'sleeper' effects, whereby developmental problems associated with maternal drinking during pregnancy emerge later in childhood.

which the social milieu influence child development are complex but include the mental health of parents, interactions between care-giver and child and the learning environment (Kelly et al, unpublished findings).[30] In this study population light alcohol consumption during pregnancy is a marker of relative socioeconomic advantage. Given this, it is perhaps not surprising to find that in our paper and another recent report by Alati and colleagues[22] adjustment for socioeconomic markers did most to attenuate observed relationships between light drinking and developmental outcomes. Therefore, rather than the direct physicochemical nature of the intrauterine environment, it is likely that social circumstances[28–31] to a large part are responsible for the relatively low rates of subsequent behavioural difficulties and the cognitive advantage in children whose mothers were light drinkers.

Problem behaviours and cognitive deficits in early childhood have previously been shown to predict later behavioural and educational outcomes.[32 33] A strength of this study was that we examined data on objective measures, collected by trained observers, of cognitive ability for cohort members. On the other hand, data on child behaviour were only available from a parent report and it has been shown elsewhere that multi-informant measures are more reliable for the clinical identification of problem behaviours.[34] However, the SDQ is a validated tool, has been shown to discriminate cases diagnosed according to the Diagnostic and Statistical Manual of Mental Disorders, version IV,[35] and importantly we determined age-appropriate norms in the current study by using the large MCS cohort data rather than norms from a different age range. The cut points use the same greater than 90th percentile cut-off criterion for clinical relevance as used in the original norms.[7] However, future work may benefit from the use of more in-depth assessments of neuropsychological function.

CONCLUSION

The findings of this paper and our previous work[2] suggest that up to the age of 5 years there is no increased risk of poor socioemotional or cognitive developmental outcomes in children born to mothers who drank not more than 1 or 2 units of alcohol per week during pregnancy. However, causal inference based on observational data is limited, and further work to tease out aetiological relationships is needed.

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What this study adds

At age 5 years children born to mothers who drank up to one to two drinks per week during pregnancy were not at increased risk of clinically relevant behavioural difficulties or cognitive deficits compared with children born to mothers who did not drink during pregnancy.

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APPENDIX 1

Socioeconomic profiles of mothers lost to follow-up from sweep 1 of the MCS

	Complete data at sweeps 1 and 3	Lost to follow-up at sweep 3
Mother's drinking during pregnancy, %		
Never	63.3	68.3
Light	28.8	22.8
Moderate	5.5	5.8
Heavy/binge	2.4	3.1

Continued

	Complete data at sweeps 1 and 3	Lost to follow-up at sweep 3
Mother's age at the time of birth (years), %		
13—19	6.6	11.6
20—24	13.6	21.6
25—29	27.8	26.2
30—34	33.6	26.9
35—39	16.2	11.8
40 plus	2.2	2.0
Mother smoked during pregnancy, %		
Yes	20.6	28.7
Lone parenthood, %		
Yes	11.4	20.9
Family income, %		
£52 000 or more	7.6	5.5
£32 200—51 999	18.9	11.6
£20 800—32 199	23.3	16.4
£10 400—20 799	28.7	30.2
Less than £10 400	15.9	28.3
Don't know/refused	5.6	8.0
Highest parental educational qualification, %		
Higher degree	7.6	5.3
First degree/diploma	40.8	27.1
A/AS levels	16.8	16.7
GCSE grades A—C	24.5	29.4
GCSE grades D—G	4.6	8.0
Other/overseas	0.8	1.4
None	5.0	12.1
Highest parental occupation, %		
Managerial and professional	24.9	17.0
Intermediate	13.3	12.1
Small employer and self-employed	9.2	6.6
Low supervisory and technical	10.3	9.3
Semi-routine and routine	39.7	48.8
Never worked, long-term unemployed and other unclassified	2.5	6.2