

Correlation between Caesarean Birth and Vaginal Birth to Cognitive Development

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Received March 08, 2020; Accepted March 24, 2020; Published August 18, 2020

ABSTRACT

This research measured the variations in child cognitive performance at 11 to 12 years of age between cesarean-born and vaginally-born children (n=3750). We use multivariate regression to analyze the confounders correlated to perinatal risk factors and also the socio-economic advantage related to cesarean-born children. We discover that cesarean-born children perform considerably below vaginally-born children, by up to a tenth of a standard deviation in national examination test scores at the age of 11-12. Analyze result from a low-risk sub-sample and lower-bound analysis recommend that the relation is not associated with unobserved confounding. Low breastfeeding and low maternal health during childbirth cause a child with cesarean are found to explain less than a 3rd of the cognitive development gap, that points to the importance of other variables such as disturbed gut microbiota. The findings underline the necessity for a preventative approach in responding to requests for a planned cesarean once there are not any apparent elevated risks from vaginal birth.

Keywords: Maternal, Caesarean birth, Vaginal birth, Cognitive development, Child health

BACKGROUND

Cesarean birth is correlated with child cognitive development. The influenced may occur through established links between cesarean birth and child health conditions, including asthma, type I diabetes, allergies [1-3] and obesity [4] that are also corelated with lower academic achievement [5,6]. The cesarean procedures also influence the postnatal maternal health risks [7], which correlated with the child's development through altered mother-child interactions [8] and lower rates of breastfeeding [9]. The other correlation may occur through alterations to the infant's gut microbiota. The gut of cesarean-born children was seeded through contact with the mother's skin and hospital surfaces, this was different with vaginally born children whose gut was seeded by passing through the birth canal. After observed up until age seven, the gut microbiota affecting memory, motivation, mood and stress reactivity, raises questions about the long-term cognitive effects of disturbed microbiota composition at a sensitive time in brain development [10-17]. That process is thought to be a possible caused of cognitive disorders, like autism spectrum disorder (ASD) and attention deficit hyperactivity disorder (ADHD), among cesarean-born children [9].

METHODS

We study the correlation between cesarean birth and child cognitive development using data from the national

academic examination result in Jakarta, Indonesia, with doing cohort surveyed and multivariate regression analyzed. There are 3750 respondents participating in this research. The interviewer administered cognitive tests using the Peabody Picture Vocabulary Test (PPVT); Who Am I? (WAI) and the Matrix Reasoning test (MR) to analyze the cognitive level of the 11-12 years child as a second cognitive achievement measured. These research procedures send to the Public Health Committee to get review and ethical permit.

RESULT

We find that child cognitive outcomes are positively influenced with higher educated mothers (bachelor degree), who give birth at an older age, who are partnered, who have private health insurance, are employed and have fewer previous births. Consistent with previous studies, we find a

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Citation: Sahid MH & Pratiwi A. (2020) Correlation between Caesarean Birth and Vaginal Birth to Cognitive Development. J Womens Health Safety Res, 4(2): 183-187.

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positive correlation with gestational age and a negative correlation with low body weight (less than 2.5 kg). For the former, the correlation is only significant for school readiness for the letter and vocabulary at 11-12 years.

We also find significant negative influence between cesarean birth and measures of child cognitive development, up to a tenth of a standard deviation. Correlative results are shown in all variables, but only children who have grammar, numeracy, reading, and writing at age 11-12, problem solving (MR) and vocabulary (PPVT) at ages 11-12 are statistically significant at level 0, 1 or higher. To put the size of these relations into perspective, a tenth of a standard deviation is similar in magnitude to the estimated relation between gender and reading at age 8-9 and effects estimated from improving teacher quality by one standard deviation and reducing average grade 6 class sizes by ten.

The first stage analysis finds that cesarean birth is significantly associated with lower rates of breastfeeding and

higher rates of obesity and also related with ADD. Second stage results show that breastfeeding is significantly related with higher cognitive development, whereas ADD, ASD and obesity are significantly correlated with lower levels of cognitive development. Combining these results, breastfeeding, obesity and ADD are found to significantly influence the relation between cesarean birth and child cognitive outcomes, although the effects size and significance vary. Individually, the largest mediating effect is through reduced chances of breastfeeding, which explains 0.008 percentage points out of the 0.076 percentage point difference (or around 11%) of the gap in grade 6. The total analyzing result, generated from regressions when all of the variables are included together between 25% for reading (p=0.052) and 29% for numeracy (p=0.021) of the estimated difference in cognitive development. This still leaves at least 70% of the relations unexplained.

Table 1. Study of correlation based on mode of birth.

	Mode of birth				p-value of diff. ^a
	Cesarean	s.e.	Vaginal	s.e.	
	(n=1,170)		(n=2,580)		
Dependent variables^b					
<i>Survey-based measures</i>					
School preparedness (WAI), 4–5	65.2	5.9	65.7	6.1	[0.113]
Vocabulary (PPVT), 4–5	65.3	8.7	65.4	8.3	[0.782]
Vocabulary (PPVT), 6–7	74.6	5.2	74.5	5.1	[0.132]
Vocabulary (PPVT), 8–9	79.5	4.7	79.2	4.9	[0.142]
Problem solving (MR), 6–7	10.7	3.3	10.6	3.1	[0.603]
Problem solving (MR), 8–9	10.5	2.9	10.7	3.2	[0.674]
<i>Grade 6 National Examination Result</i>					
Numeracy	409.3	72.9	412.3	74.6	[0.357]
Reading	436.2	90.5	439.3	90.2	[0.396]
Writing	423.1	62.2	425.6	59.6	[0.314]
Spelling	419.2	78.3	420.8	77.8	[0.641]
Grammar	438.7	96.6	441.8	91.7	[0.480]
Controls^c					
<i>Family characteristics (socio-economic status (SES)) in year of birth</i>					
Maternal age at birth	31.76	4.82	30.44	5.16	[0.000]
Maternal age at birth squared	1032	308	951	316	[0.000]
Three or more older siblings	0.04	0.19	0.07	0.26	[0.000]

Female child	0.46	0.49	0.50	0.50	[0.018]
Either parent was born in a disadvantaged country ^d	0.05	0.21	0.07	0.26	[0.002]
Mother is single	0.05	0.22	0.07	0.25	[0.041]
Mother is not legally married to partner	0.80	0.39	0.77	0.42	[0.017]
Mother was employed	0.53	0.49	0.53	0.49	[0.97]
Mother's highest qualification					
High school diploma or below ^e	0.27	0.44	0.29	0.46	[0.022]
Vocational education qualification ^f	0.26	0.45	0.26	0.44	[0.889]
College (bachelor) degree or above	0.48	0.50	0.44	0.49	[0.031]
Private health insurance	0.59	0.49	0.49	0.50	[0.000]
Perinatal risk factors (PN)					
Low birthweight (<2.5 kg)	0.07	0.25	0.03	0.18	[0.000]
IVF treatment used	0.09	0.28	0.05	0.22	[0.000]
Multiple births	0.06	0.26	0.02	0.13	[0.000]
Head circumference of child (Z-score) ^g	-0.26	1.12	-0.33	0.88	[0.090]
Length of baby when born (Z-score) ^g	0.05	1.38	0.38	0.99	[0.000]
Blood pressure medication during pregnancy	0.03	0.17	0.03	0.14	[0.022]
Diabetes medication during pregnancy	0.02	0.14	0.00	0.08	[0.001]
Antibiotic medication during pregnancy	0.10	0.31	0.09	0.29	[0.345]
Weeks of gestation	38.56	2.08	39.46	1.69	[0.000]
State of residence					
South Jakarta	0.28	0.45	0.32	0.47	[0.014]
North Jakarta	0.28	0.45	0.27	0.46	[0.551]
West Jakarta	0.13	0.32	0.09	0.29	[0.092]
East Jakarta	0.21	0.41	0.20	0.40	[0.411]
South Tangerang	0.07	0.27	0.07	0.25	[0.59]
Depok	0.00	0.09	0.02	0.13	[0.029]
Bogor	0.03	0.16	0.02	0.16	[0.536]
Bekasi	0.34	0.48	0.38	0.48	[0.120]

DISCUSSION

We find correlation between cesarean birth and cognitive development in 7 to 9 years child after controlling for the socio-economic advantage associated with cesarean birth [1,3,9]. Our results are significant with results from the previous study [7], which found cesarean-born had a 14% higher risk of being cognitive disorder. Our estimated difference in outcomes is not large, up to a tenth of a standard deviation in national test scores in numeracy; they are large enough to warrant action. A 10 of a standard deviation in national examination scores is comparable in size to differences related to gender, class size and teacher quality that are the focus of policy effort. We suggest taking a precautionary approach about birth plans, especially when there are no health risks from vaginal birth. Informing the risks and benefits of cesarean birth should be a priority.

There are 2 important results of this study. First, the sensitivity analysis finding bias from unobserved confounding is unlikely to explain the results completely and that causal relations are plausible. This does not mean that there are causal relations because bias from unobserved confounding is still possible. Inheritable genetic traits as a perinatal risk was not controlled as a confounder, for example a lack of maternal height may drive both cesarean birth (due to a small pelvis size (cephalopelvic disproportion)) [9] and child cognitive outcomes [16]. Second, the periods of relations persist long-term and are not confined to children with problems. The results open the possibility that direct mechanisms, such as disturbed gut microbiota, may be important. However, this research cannot rule-out the possibility that at least some of the residual effect is due to measurement error, for example, under-reporting of the presence of health conditions by the care giver, was biased by unobserved confounding.

CONCLUSION

The result in this study should motivate more research that may focus instead on instrumental variables estimation using large-scale linked hospital and child development administrative records that exploits natural experiments. A limitation of this method is that the results only have a local treatment interpretation and cannot be generalized to those unaffected by the random event that led to assignment. A precautionary approach when formulating birth plans is important, especially when there are no health risks from vaginal birth. The medical practitioners have to informing of the risks and benefits of cesarean birth, which may be formalized by incorporating education sessions into practitioner's procedure.

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