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Parental age and cognitive disability among children in the United States

Author :

Philip N. Cohen
University of Maryland

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By Philip N. Cohen

University of Maryland, College Park

pnc@unc.edu

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The objective of this study was to assess the relationship between children's cognitive disability and parents' age at birth. I conducted an analysis of data from the 2008-2010 American Community Survey for children aged 5 to 11 living with married parents, estimating cognitive disability rates by parents' age at birth, controlling for other demographic characteristics. Cognitive disability rates according to parental age ranged from 0.8% to 6.8%, with an overall rate of 2.3%. Rates were much more strongly related to mothers' age at birth than to fathers' age at birth. The odds of cognitive disability were highest for children whose mothers were age 45 or higher at the time of their birth (odds ratios about 2.5 relative to age 30-34) and lowest for those born to mothers in their early 30s. Although mothers' age had similar effects on boys and girls, fathers' age was only associated with the odds of boys' cognitive disability, once demographic controls were added. Some risks of having children at older ages are widely documented, but the pattern for all cognitive disabilities according to both mothers' and fathers' age is not well known. Recent attention has focused on children's disabilities that may result from *de novo* mutations occurring in men's sperm as they age, increasing the risk of such conditions as autism spectrum disorders and schizophrenia. However, these results demonstrate that overall risks are much more strongly associated with mothers' age at birth, consistent with the effects of mothers' health at birth on their children. Still, the effect of fathers' age on boy's cognitive disabilities is consistent with recent research on autism and schizophrenia, which are more common among boys.

Parental age and cognitive disability among children in the United States

Biological parents' age at birth has been linked to a wide variety of cognitive disabilities and mental health conditions for children. The incidence of autism spectrum disorders (ASD) is elevated when children are born to older biological mothers[1] or fathers[2], as is incidence of Down syndrome,[3] schizophrenia,[4] and behavioral problems[5]. Older mothers are more likely to have children with intellectual disabilities generally, partly through increased risk for lower birth weight.[6] Because the trend of increasing rates of ASD[7] coincides with rising parental age at birth, recent research suggests increased *de novo* mutations in men's sperm as they age may play a role in this trend.[8] However, many other health conditions also are related to parental age.

Most research about mothers' age concerns health during pregnancy and delivery, finding that older mothers are more likely to have preeclampsia,[9] stillbirths[10], and adverse perinatal outcomes.[11] In addition, mothers with health conditions such as diabetes, asthma and anemia are more likely to have children with intellectual disabilities and ASD.[12] (On the other hand, a variety of negative outcomes have also been associated with very young maternal age, although these may be the result of poor socioeconomic background.[13]) Because lower birth weight,[14] small-for-gestational-age[15] and perinatal complications[16] are risk factors for ASD and other conditions, these also may be pathways for mothers' age to influence cognitive disabilities.

Some studies have been able to find independent effects of both mothers' and fathers' age, for example on odds of low birth weight.[17] But ascertaining these independent effects poses a challenge, especially in studies with small samples, since mothers' and fathers' age are highly correlated – and many studies examine only one or the other. This study relied on a large sample of U.S. Census data (see below), which helps identify disability patterns associated with parental age at birth, but sacrifices detail about underlying medical conditions and different sources of cognitive disability.

Children's health is better on average in families with higher income[18] and parents with higher levels of education.[19] The prevalence of developmental disabilities[20] and intellectual disability[21] is thus higher in low-income families, although autism may be more often diagnosed in families with more highly-educated parents.[22] Some conditions, such as intellectual disability[23], Down syndrome[24] and cerebral palsy[25], are found at varying rates across racial/ethnic groups in the U.S., although the mechanisms for these patterns are unknown. In this study, mothers' and fathers' education, family income and race/ethnicity were controlled. Because the study was limited to married-couple families in which both parents were in their first marriage (see below), family structure was not controlled.

Some sources of cognitive disability are unevenly distributed by children's sex. Intellectual disabilities are more commonly diagnosed among boys[26], as are ASDs[27], and schizophrenia[28] (although sex differences in schizophrenia rates may develop after childhood[29]). In addition, fathers' age has been implicated in autism and schizophrenia in particular, due to *de novo* mutations.[30] Therefore, the analysis included tests for parental age effects separately for boys and girls.

Methods

The analysis used data from the 2008 to 2010 American Community Survey, conducted by the U.S. Census Bureau, pooling three years of data to increase reliability. The sample consisted of 389,992 children ages 5 to 11 (of whom 199,602 [51.8%] were boys) living with married parents. The sample was constructed to minimize several potential threats to validity.

Because the ACS does not include family histories, parents' age at birth must be ascertained from current ages of coresiding family members. To maximize the likelihood that children in the sample were the biological children of both mother and father in the household, the sample was restricted to those listed as "own children" of the householder, in households where the householder was married, and both husband and wife were in their first marriage. Under these conditions, in the vast majority of cases we may assume that the age difference between children and their parents represented the parents' age when the child was born (in 8% of cases, children in the sample were born before the marriage, and these may or may not be biological children of both parents present). Step, adopted, and foster children were excluded from the analysis, as were a very small number of children whose mother or father was greater than 49 years at birth.

The age range of 5 to 11 was chosen to maximize sample size without compromising the disability measure. The survey does not report on disability status for children under age 5. From age 5 to 11 the incidence of cognitive disability increases with age, presumably representing diagnoses occurring as children mature. As children age, the likelihood of disability resulting from lived experience increases (e.g., contracted illnesses, accidents); since the interest in this paper is on disabilities related to parents' age at birth, older children were excluded. An unknown number of children born with disabilities were excluded from this analysis if they are not living with both of their parents, or if they have died.

The ACS assesses cognitive disability with the following question: "Because of a physical, mental, or emotional condition, does this person have serious difficulty concentrating, remembering, or making decisions?" This question is based on a disability framework (from the World Health Organization's International Classification of Functioning, Disability and Health), rather than a diagnosis of disease. Therefore, people with disabilities are classified regardless of the origin of their condition. Survey questions regarding disability on the ACS were modified in 2008, rendering the data not strictly comparable with those from previous versions of the ACS or other national surveys.[31]

In order to isolate the potential effects of parental age, I controlled for children's age and age-squared; fathers' educational attainment (as a continuous variable from no schooling [=0] to more than 4 years of college [=11]), and the difference between fathers' and mothers' educational attainment; family income (as the natural log of current dollars); and race/ethnicity (coded into mutually-exclusive categories for White, Latino, American Indian, Asian, Black and Pacific Islander). I first assessed the bivariate relationship between parental age at birth and children's disability rates, before estimating multivariate logistic regression models for the odds of having a reported cognitive disability. Because fathers' age at birth and mothers' age at birth are highly correlated ($r = .80$), separate models were estimated for each, before they were combined. This sequence was repeated with and without demographic covariates, allowing an assessment of the relative effects of fathers' and mothers' age, net of control variables.

Results

The sample yielded an overall rate of 2.3% of children with cognitive disabilities. This is somewhat lower than the 4.1% reported by the National Health Interview Survey for children in this age range who had "ever told they have mental retardation or any developmental delay."[32] The difference may result from divergent definitions and survey methods, as well as from the relatively privileged status of the sample used in this study, which included only children living with two married parents in the first marriage for each parent.

Children's characteristics, by fathers' and mothers' age at birth, are presented in Table 1. This confirms the importance of controlling for demographic variables in the analysis. The table shows a general pattern of lower income and education, and higher minority concentrations, among the children born to parents under age 30 and over age 44. For example, more than 65% of children born to parents in their 30s are White, compared with 57% or less among those born to parents under age 30 or over age 44.

The unadjusted relationship between mothers' and fathers' age and cognitive disabilities is presented in Figure 1, for boys and girls combined. Children born when either their mothers or fathers were in their early 30s have the lowest cognitive disability rates, about 2%. There are higher disability rates for children born to parents under age 30, and then increasing rates of disability for parents older than 35 (for mothers) and 40 (for mothers and fathers). The unadjusted relationship between age and disability only differs between mothers and fathers above age 40, when the children of older mothers have higher disability rates than those of older fathers. Table 1 and Figure 1 do not distinguish between male and female children, which I did for the multivariate analysis that followed.

Logistic regression results are presented in Table 2, with separate models estimated for boys and girls. The first two models, which include fathers' age and mothers' age respectively – but include controls for the demographic covariates – are consistent with the unadjusted cognitive disability rates reported in Table 1, with the lowest odds found among children born to parents in their early 30s, and increased odds at both older and younger ages. However, fathers' age <30 has no significant effect on daughters. In addition, the likelihood ratio χ^2 allows comparison of the models, and shows that the models with mothers' age – for both boys and girls – are more robust.

Model 3, which includes both parents' ages, permits further examination of the relative contribution of mothers' and fathers' ages. The effects of mothers' age in Model 3 versus Model 2 are reduced only slightly. The effects of fathers' age, however, are reduced much more, and in three out of five cases they no longer are significant at conventional levels ($p < .05$). The remaining significant effects of fathers' age are found for boys only. The odds ratios from Model 3 are plotted in Figure 2.

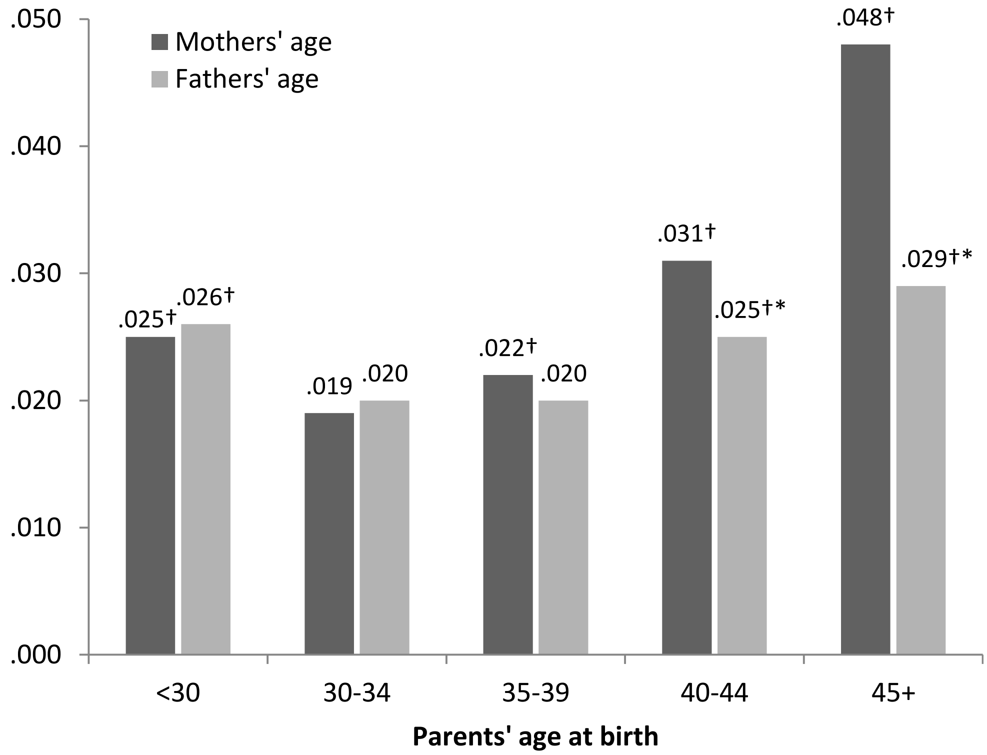
Discussion

Using a large, national sample from the U.S. Census Bureau's American Community Survey for 2008-2010, this analysis showed that rates of cognitive disability were associated with mothers' and fathers' age at birth, for boys and girls aged 5-11. The rates followed a J-shaped pattern, with lowest rates for children born to parents in their early 30s, and higher rates under age 30 and above age 35.The effects of mothers' age were larger and more robust statistically. After adjustment for demographic covariates, fathers' age had significant effects only on the odds of boys' disability.

There are many possible pathways for parental age to affect children's cognitive development, and many sources of cognitive disability. One limitation of this study is that the Census measure of disability is very broad, which does not permit identification of particular diseases or other causes of disability. On the other hand, because there is considerable ambiguity in some specific diagnoses for cognitive impairments[33], a broad measure is useful as well.

With the considerable attention that men's "biological clocks" have received recently[34], it is important to consider impacts of both men's and women's age when they have children. These results, for a broad measure of disability and considering mothers' and fathers' ages together, show that mothers' age is more consequential for the odds of children's cognitive disability. However, that fathers' age has a significant effect on the odds of their sons' cognitive disability – controlling for important demographic covariates – is consistent with the suggestion that *de novo* mutations in older men increase the risk of of conditions (such as autism spectrum disorders) that affect boys more than girls, and that may be triggered by such mutations.[35] Nevertheless, to the extent that mothers' age affects children's cognitive outcomes through mechanisms reflecting women's health at the time of their conception, pregnancy and delivery, this implies that an emphasis on improving maternal health generally would have greater implications than reducing the number of older men who conceive children.

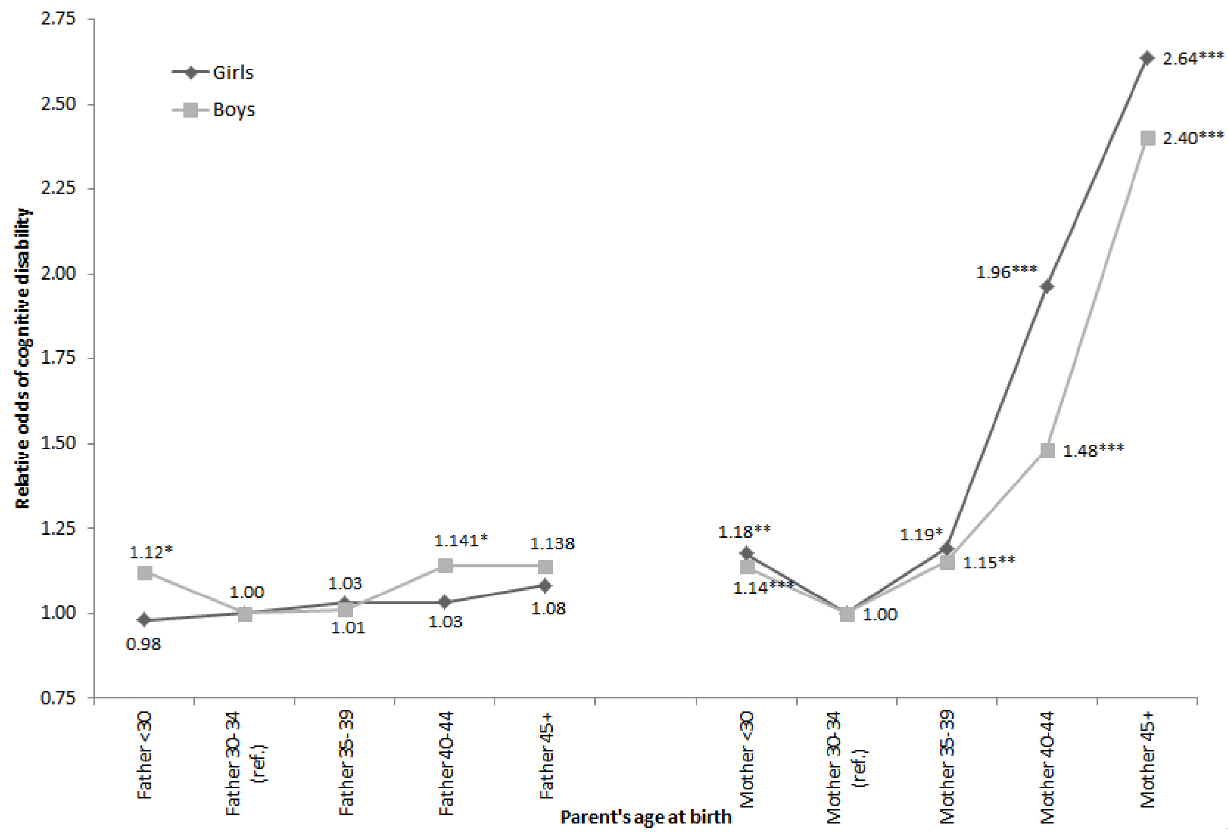
FIGURE 1 Proportion of children aged 5-11 with cognitive disabilities by mothers' and fathers' age at birth, 2008-2010 American Community Survey.



** = Difference between mothers' age and fathers' age proportions significant at* p *< .05.*

†= Difference from proportion for mother/father age 30-34 significant at p *< .05.*

FIGURE 2 Relative odds of cognitive disability, by parents' age at birth: Children ages 5-11



Note: Separate models for boys and girls. Models control for age, race/ethnicity, family income and parents' education.

** = Odds significantly different from age 30-34 at p < .05.*

*** = Odds significantly different from age 30-34 at p < .01.*

**** = Odds significantly different from age 30-34 at p < .001.*

Table 1 Distribution of children's characteristics, by fathers' and mothers' age at birth

Parameter (means)	**Mothers' age**									
	<30	**95% CI**	**30-34**	**95% CI**	**35-39**	**95% CI**	**40-44**	**95% CI**	**45+**	**95% CI**
Cognitive disability	.025	.024 - .026	.019	.018 - .019	.022	.020 - .023	.031	.028 - .035	.048	.036 - .060
Age	8.01	8.00 - 8.02	7.90	7.89 - 7.91	7.89	7.88 - 7.91	7.81	7.78 - 7.84	7.81	7.71 - 7.92
Father education	6.96	6.95 - 6.97	8.30	8.29 - 8.31	8.43	8.40 - 8.45	8.24	8.19 - 8.29	7.63	7.46 - 7.80
Father-mother education	.111	.102 - .120	.114	.103 - .125	.024	.008 - .041	-.050	-.086 - -.013	-.067	-.178 - .044
Family income (log)	10.929	10.924 - 10.933	11.398	11.393 - 11.403	11.474	11.466 - 11.482	11.424	11.406 - 11.443	11.324	11.261 - 11.386
White	.566	.564 - .568	.677	.674 - .679	.682	.678 - .686	.642	.633 - .650	.504	.476 - .531
Latino	.268	.266 - .270	.159	.157 - .161	.147	.144 - .149	.158	.151 - .164	.218	.195 - .240
Black	.086	.085 - .087	.061	.060 - .063	.067	.065 - .069	.078	.073 - .082	.118	.100 - .136
Asian/Pacific Islander	.069	.068 - .070	.096	.095 - .098	.099	.096 - .101	.115	.109 - .121	.144	.125 - .164
American Indian	.011	.011 - .012	.006	.006 - .007	.006	.005 - .006	.008	.006 - .009	.016	.009 - .023
Percent of total	51.6		30.6		14.5		3.1		0.3	

Parameter (means)	**Fathers' age**									
	<30	**95% CI**	**30-34**	**95% CI**	**35-39**	**95% CI**	**40-44**	**95% CI**	**45+**	**95% CI**
Cognitive disability	.026	.025 - .027	.020	.019 - .021	.020	.020 - .021	.025	.023 - .027	.029	.025 - .033
Age	8.02	8.01 - 8.03	7.93	7.92 - 7.94	7.91	7.90 - 7.92	7.85	7.83 - 7.87	7.76	7.72 - 7.81
Father education	6.80	6.79 - 6.82	8.08	8.07 - 8.09	8.28	8.26 - 8.30	8.12	8.09 - 8.16	7.69	7.61 - 7.76
Father-mother education	.185	.174 - .195	.094	.083 - .105	-.002	-.016 - .012	-.088	-.114 - -.063	-.100	-.156 - -.044
Family income (log)	10.889	10.884 - 10.894	11.319	11.314 - 11.324	11.396	11.389 - 11.403	11.344	11.332 - 11.356	11.230	11.203 - 11.257
White	.570	.567 - .572	.659	.656 - .662	.654	.651 - .658	.619	.614 - .625	.542	.530 - .554
Latino	.283	.281 - .285	.178	.175 - .180	.159	.156 - .161	.159	.155 - .163	.194	.184 - .203
Black	.087	.086 - .089	.061	.060 - .062	.069	.067 - .071	.087	.084 - .091	.106	.098 - .113
Asian/Pacific Islander	.048	.047 - .049	.095	.094 - .097	.112	.110 - .114	.127	.123 - .131	.150	.142 - .159
American Indian	.012	.012 - .013	.007	.007 - .007	.006	.005 - .007	.008	.007 - .009	.008	.006 - .011
Percent of total	38.9		32.3		20.1		7.1		1.7	

Cognitive disability refers to "serious difficulty concentrating, remembering, or making decisions." Cognitive disability and race/ethnic categories are 0/1 dummy variables, with proportions shown. Education ranges from no schooling [=0] to more than 4 years of college [=11]. Father-mother education is the difference in educational attainment between fathers and mothers. Family income is in the natural log of current dollars. Data are weighted. CI indicates confidence interval.

TABLE 2 Logistic regression for cognitive disability on parents' age at birth (odds ratios)

	Model 1				Model 2				Model 3			
Paremeter	*Girls*		*Boys*		*Girls*		*Boys*		*Girls*		*Boys*	
Father <30	1.04		1.18	***	--		--		0.98		1.12	**
Father 30-34 (ref.)	1.00		1.00		--		--		1.00		1.00	
Father 35-39	1.07		1.04		--		--		1.03		1.01	
Father 40-44	1.25	**	1.29	***	--		--		1.03		1.141	*
Father 45+	1.57	***	1.45	***	--		--		1.08		1.138	
Mother <30	--		--		1.15	**	1.21	***	1.18	**	1.14	***
Mother 30-34 (ref.)	--		--		1.00		1.00		1.00		1.00	
Mother 35-39	--		--		1.21	**	1.18	***	1.19	*	1.15	**
Mother 40-44	--		--		2.02	***	1.60	***	1.96	***	1.48	***
Mother 45+	--		--		2.77	***	2.62	***	2.64	***	2.40	***
Age	1.61	***	1.49	***	1.62	***	1.49	***	1.62	***	1.49	***
Age^2	0.98	***	0.98	***	0.98	***	0.98	***	0.98	***	0.98	***
Father education	0.91	***	0.94	***	0.91	***	0.94	***	0.91	***	0.94	***
Father-mother education	0.95	***	0.99		0.95	***	0.99		0.95	***	0.99	
Family income (ln)	0.87	***	0.88	***	0.87	***	0.88	***	0.87	***	0.88	***
White (ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Latino	0.71	***	0.64	***	0.71	***	0.64	***	0.71	***	0.64	***
American Indian	1.32	*	1.80	***	1.31	+	1.79	***	1.31	+	1.79	***
Asian	0.61	***	0.56	***	0.61	***	0.56	***	0.61	***	0.56	***
Black	1.04		1.03		1.03		1.03		1.03		1.02	
Pacific Islander	0.35	*	0.96		0.35	*	0.96		0.35	*	0.96	
Likelihood ratio χ^2	421.9		817.1		464.8		846.2		465.5		860.9	
Degrees of freedom	14		14		14		14		18		18	

N = 190,390 girls; 199,602 boys.

** = p < .05; ** p < .01; *** p < .001.*

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