

低体重出生 —原因と帰結—

東京大学発達保育実践政策学センター
学術フォーラム

2017/10/22

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問題の背景(1)

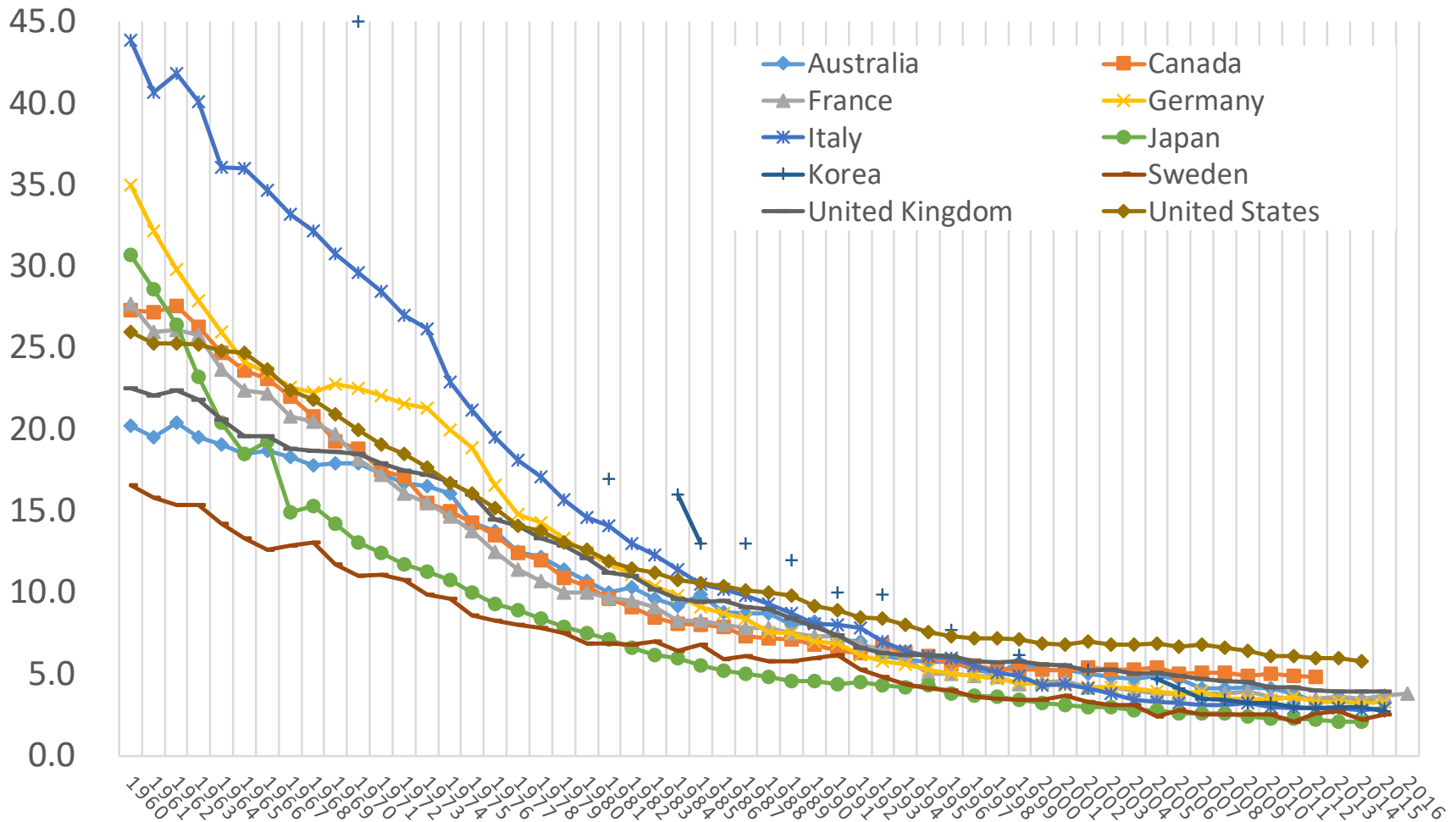
- 「胎児起源説(Fetal Origins Hypothesis)」
“Birth weight determines one's destiny.
Literature points to the fact that birth weight determines succeeding outcomes in our life such as academic performance, educational attainment, occupation, earnings, marriage, health status and life expectancy. The heavier the baby, the better the later outcomes” (cite works by Janet Currie etc.).

問題の背景 (2)

- Thanks to the improvement of maternal nutritional intakes, medical treatment, education, the birth weight of newly born babies have been increasing in most developed countries.
- In light of the accumulated knowledge on the birth weight as a positive determinant of later life outcomes, this increasing trend of birth weight is welcomed by specialists in the field of maternal medicine, public health and economics.
- An exceptional developed country that scored poorly on this ground is Japan.

乳幼児死亡率 (1960-2016)

INFANT MORTALITY PER 1,000 LIVE BIRTH

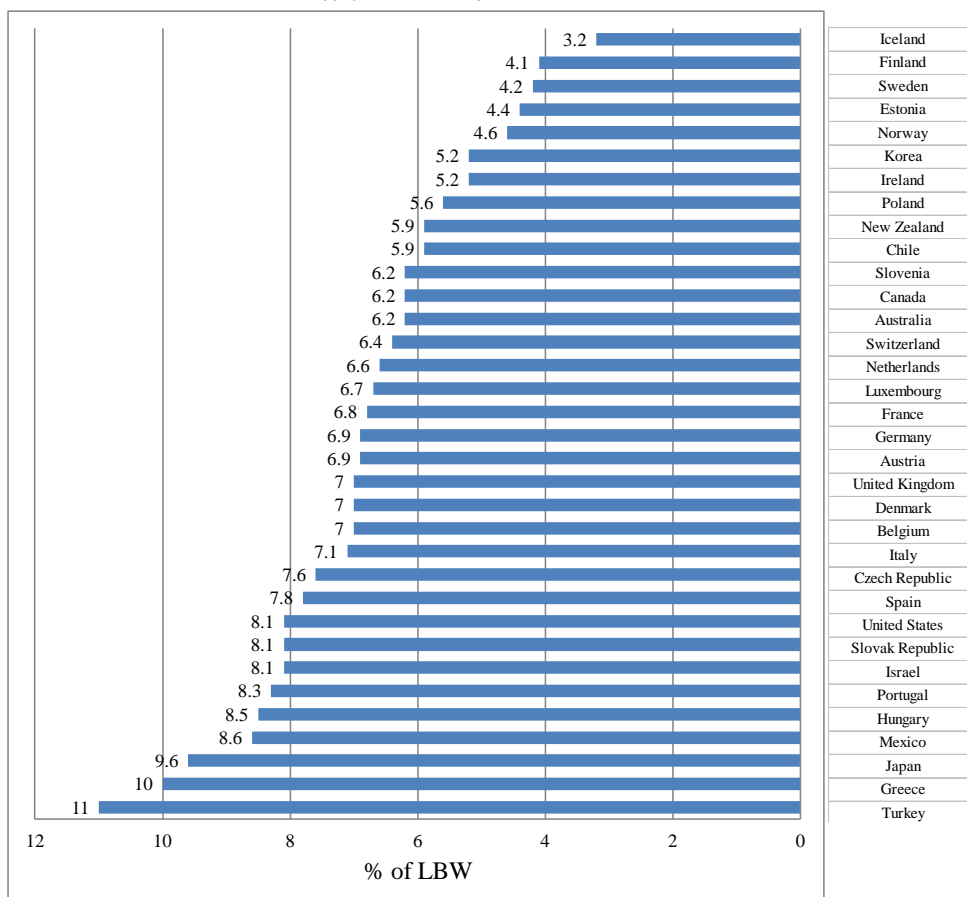


出所: OECD Health Data 2017, http://stats.oecd.org/index.aspx?DataSetCode=HEALTH_STAT

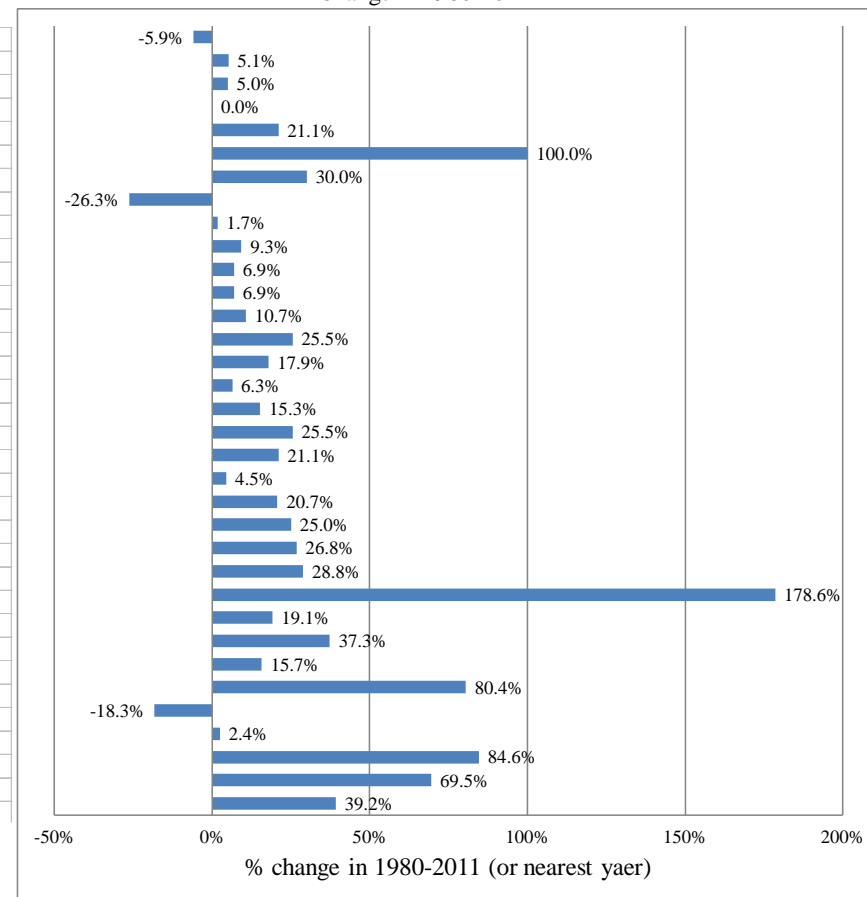
Low birth weight infants and change in proportion of low birth weight infants (1980-2011, or latest year) in OECD countries

Figure 1: Percent of LBW in OECD countries, 2011 and change 1980-2011 (or nearest year)

% of LBW in 2011



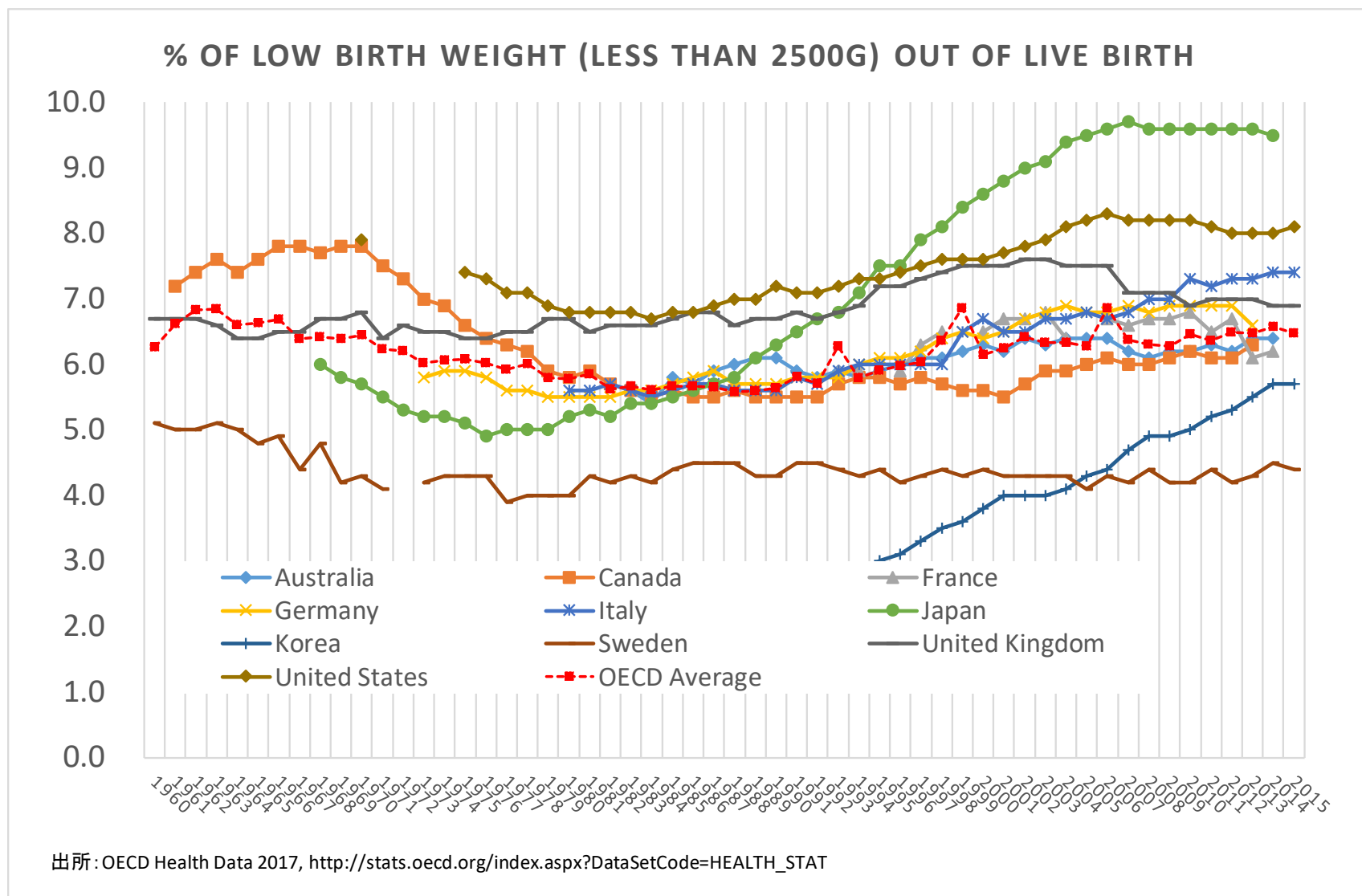
Change in 1980-2011



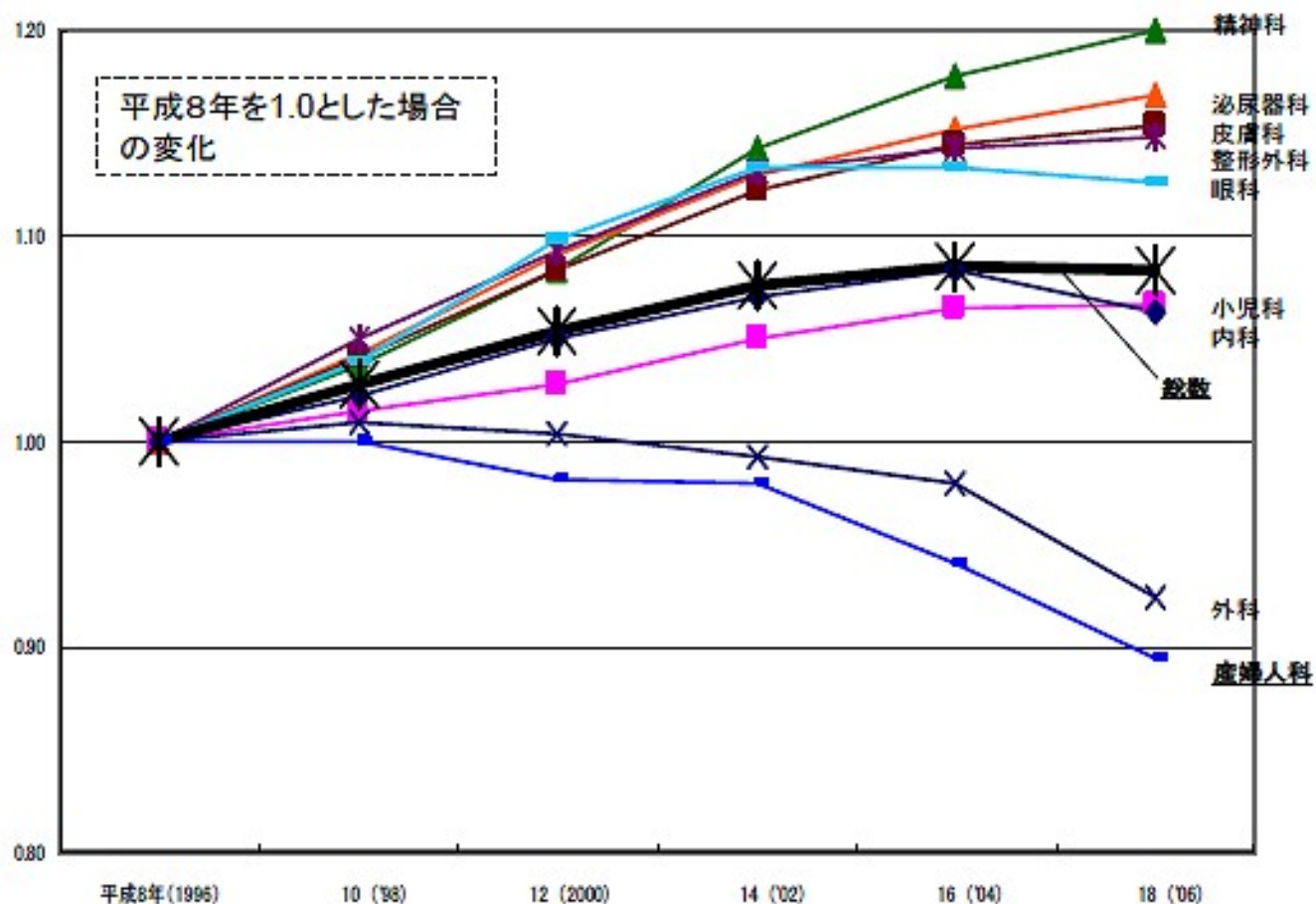
Source: OECD Health Data 2013

Note: % of LBW in 1980 are not available in Australia (1983), Belgium (1982), Chile (1990), Estonia (1992), France (1993), Ireland, Korea, Mexico, Netherlands, Slovenia, Spain, and Turkey;

低体重(2500g未満)出生比率 (1960-2015)



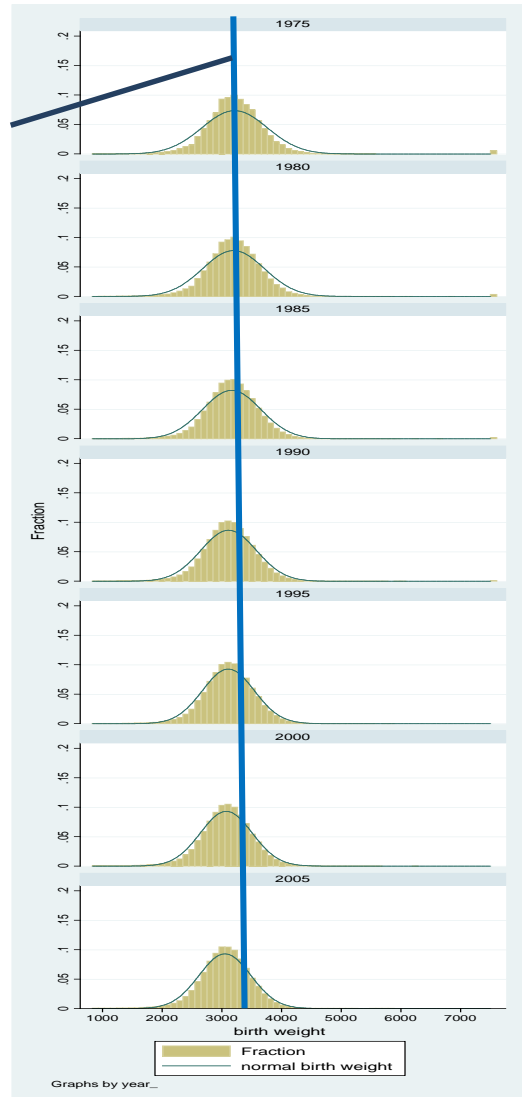
診療科で見た場合の医師の偏在



注1) 内科…内科、心療内科、呼吸器科、消化器科、循環器科、アレルギー科、リウマチ科、神経内科
 外科…外科、呼吸器外科、心臓血管外科、小児外科
 精神科…精神科、神経科 産婦人科…産婦人科、産科
 耳鼻いんこう科…耳鼻いんこう科、気管食道科 泌尿器科…泌尿器科、性病科、こう門科
 注2) 時系列での比較を行うため、平成18年度においては、研修医(14,402人、平成18年度以前は0)を総数から除いている。

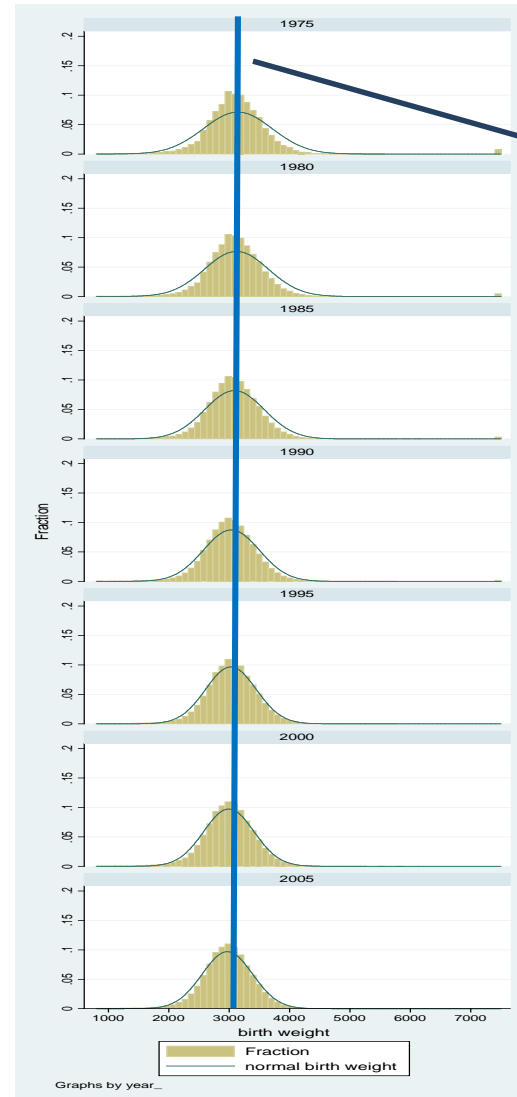
Change of distribution of birth weights in Japan by sex, 1975-2005 (Demographic Survey)

Median in 1990: 3100g



male

Median in 1990: 3000g



female

Relation between socio-economic status of parents and birth weights (1)

- Please see a great literature review by Currie (2009) from economics points of view. Also, Kiely et al. (1994) provides a great summary from clinical points of view.
- Currie and Hyson (1999): Using data from National Child Development Study in UK (follow-up survey for those born in 1958 through age 33), LBW has significant long-term effects on self-reported health status, educational attainments, and labor market outcomes. However, there is little evidence of variation in the effects of LBW by SES. An important exception is that high SES women of LBW are less likely to report that they are in poor or fair health than other LBW women.
- Currie and Moretti (2003), Carneiro et al. (2010), Chevalier and O'Sullivan (2007): Using the data in US or UK, find exogenous effects of lengthening mother's year of education are most likely to be positive on low birth weight.

Relation between socio-economic status of parents and birth weights in Japan (2)

- Nakamura (1995), Ohmi et al. (2001), Takimoto et al. (2005, 2007), Matsuda (1990): Using either an aggregated data based on demographic survey or a micro-based data in various years, mother's characteristics such as age, week of pregnancy, experience of pregnancy, smoking behavior, weights or BMI (body mass index) would impact new born weights.
- Ueda et al. (2000): Using a micro-based data in Kumamoto-prefecture, living in urban areas would increase the probability of low birth weight
- Kohara and Otake (2009): Using an aggregated data based on demographic survey, higher unemployment ratio within the regional area would increase the probability of low birth weight, in average.

Impacts of anti-poverty policies on birth weights

- Currie and Cole (1993): Aid to Families with Dependent Children (AFDC) may have a positive effects on birth weights among white poor.
- Almond et al. (2011), Baker (2008), Hoynes et al. (2012): Receiving food stamps would decrease the probability of low birth weight.
- Baker (2008), Hoynes et al. (2012): Receiving Earned Income Tax Credit (EITC) would decrease the probability of low birth weight.

Main objects

- Describe an change in distribution of newborn birth weight from 1990-2005 in Japan.
- Examine possible causes of the trend.
- Examine impacts of low-birth weights on some aspects of child development at age 2 and half/6 and half.

A couple of data sets

- Demographic statistics in 1975-2005.
 - Include entire population of newborn babies
 - Use every 5 years, because socio-economic characteristics like parents' working status has been surveyed.
- Longitudinal survey of babies in 21st century in 2001-2007
 - Include randomly chosen 47,000 newborn babies born from Jan/10-Jan/17 and July/10-July/17 in 2001
 - Follow-up these samples every year since 2001

**RESULTS BASED ON
DEMOGRAPHIC SURVEY, 1990-2005**

Mean of birth weight by percentile, for both sex

	Mean	10	25	50	75	90	N
1990	3073	2600	2800	3100	3300	3600	1214855
1995	3066	2568	2820	3076	3338	3584	1180361
	-0.22%	-1.23%	0.71%	-0.77%	1.15%	-0.44%	-2.84%
2000	3031	2534	2786	3042	3300	3546	1178737
	-1.36%	-2.54%	-0.50%	-1.87%	0.00%	-1.50%	-2.97%
2005	3007	2510	2764	3022	3280	3522	1063721
	-2.14%	-3.46%	-1.29%	-2.52%	-0.61%	-2.17%	-12.44%

Impacts of mother's age

Mother's age (%)

Mother's age	1990	1995	2000	2005
15-19	1.47	1.35	1.72	1.54
20-24	15.75	16.35	13.60	12.11
25-29	45.06	41.36	39.41	31.82
30-34	29.14	31.40	33.28	38.07
35-39	7.53	8.46	10.70	14.52
40-	1.05	1.08	1.28	1.95

Birth weight by mother's age (g)

Mother's age	1990	1995	2000	2005
15-19	3005.5	3013.9	3011.4	3008.0
20-24	3048.0	3051.9	3029.1	3023.5
25-29	3076.4	3076.0	3041.9	3026.4
30-34	3111.6	3098.5	3060.0	3030.0
35-39	3109.4	3101.6	3060.1	3023.3
40-	3060.2	3057.1	3018.1	2989.0

Impacts of decreasing # of children

Order of newborn babies (%)

	1990	1995	2000	2005
1 st baby	44.08	48.15	49.31	48.47
2 nd baby	37.41	36.10	36.46	37.46
3 rd <=	18.50	15.75	14.24	14.07

Birth weight by order (g)

	1990	1995	2000	2005
1 st baby	3029.7	3034.4	3010.0	2996.1
2 nd baby	3109.7	3110.2	3074.4	3049.0
3 rd <=	3158.7	3151.6	3107.0	3067.2

Impacts of mother's job status

Mother's job status (%)

	1990	1995	2000	2005
No job	77.88	78.11	77.56	72.01
Office/Management	13.83	14.32	15.07	16.22
Sales/service provider	3.67	3.52	3.55	4.56
Blue collar	3.80	2.76	2.11	1.95
Other/unknown	0.83	1.29	1.71	5.26

Birth weight by mother's job status (g)

	1990	1995	2000	2005
No job	3083.7	3080.6	3048.4	3028.2
Office/Management	3080.7	3076.0	3041.3	3016.7
Sales/service provider	3084.0	3083.7	3047.0	3031.6
Blue collar	3090.9	3090.3	3053.2	3027.8
Other/unknown	3073.0	3077.4	3043.7	3018.3

Impacts of father's job status

Father's job status (%)

	1990	1995	2000	2005
No job	0.64	0.91	1.57	1.71
Office/Management	38.91	38.50	45.39	39.64
Sales/service provider	21.99	21.56	21.28	21.79
Blue collar	35.62	35.03	26.31	27.48
Other/unknown	2.84	4.00	5.45	9.38

Birth weight by father's job status (g)

	1990	1995	2000	2005
No job	3047.2	3048.3	3018.6	3009.0
Office/Management	3085.8	3084.7	3050.9	3027.4
Sales/service provider	3080.7	3078.2	3047.2	3028.3
Blue collar	3085.0	3080.3	3047.3	3028.2
Other/unknown	3061.8	3055.1	3025.6	3010.9

Empirical strategy:

Simple multiple regression analysis and Oaxaka decomposition

$$y_{it} = x_{it}\beta_t + u_{it}$$

- y_{it} =birth weight of newborn babies
- x_{it} =sex, week of pregnancy, order, parents' characteristics (age, nationality, job status)
- u_{it} =residuals

$$\bar{y}_{2005} - \bar{y}_{1990} = \bar{x}_{2005}\hat{\beta}_{2005} - \bar{x}_{1990}\hat{\beta}_{1990} = (\bar{x}_{2005} - \bar{x}_{1990})\hat{\beta}_{1990} + \bar{x}_{2005}(\hat{\beta}_{2005} - \hat{\beta}_{1990})$$

Results (1): newborn characteristics

	1990	1995	2000	2005
Female	-101.23 (0.74)***	-106.90 (0.65)***	-106.37 (0.65)***	-107.27 (0.67)***
Week of pregnancy	511.35 (3.37)***	322.02 (0.63)***	321.21 (0.60)***	333.94 (0.64)***
(Week of pregnancy) ²	-5.01 (0.05)***	-2.37 (0.01)***	-2.36 (0.01)***	-2.45 (0.01)***
Second child	102.74 (0.88)***	108.24 (0.75)***	104.17 (0.74)***	102.07 (0.75)***
Third child or more	148.89 (1.17)***	151.87 (1.05)***	141.81 (1.05)***	131.63 (1.07)***

Results (2): mother's characteristics

	1990	1995	2000	2005
Age	-1.59	-0.13	-5.14	-5.73
	(0.98)	(0.82)	(0.76)***	(0.78)***
(Age) ²	0.06	0.02	0.10	0.10
	(0.02)***	(0.01)*	(0.01)***	(0.01)***
Foreign citizenship	77.91	90.99	110.04	118.27
	(4.34)***	(3.09)***	(3.06)***	(3.08)***
Office/management	-4.30	-2.72	-3.95	-6.15
	(1.11)***	(0.96)***	(0.93)***	(0.93)***
Sales/service provider	2.25	4.87	3.60	4.78
	(2.05)	(1.72)***	(1.79)**	(1.65)***
Blue collar	-4.64	1.51	5.15	2.00
	(2.01)**	(2.03)	(2.29)**	(2.46)
Other job/unknown	-0.29	0.74	-1.40	-2.98
	(5.13)	(3.45)	(2.95)	(2.05)

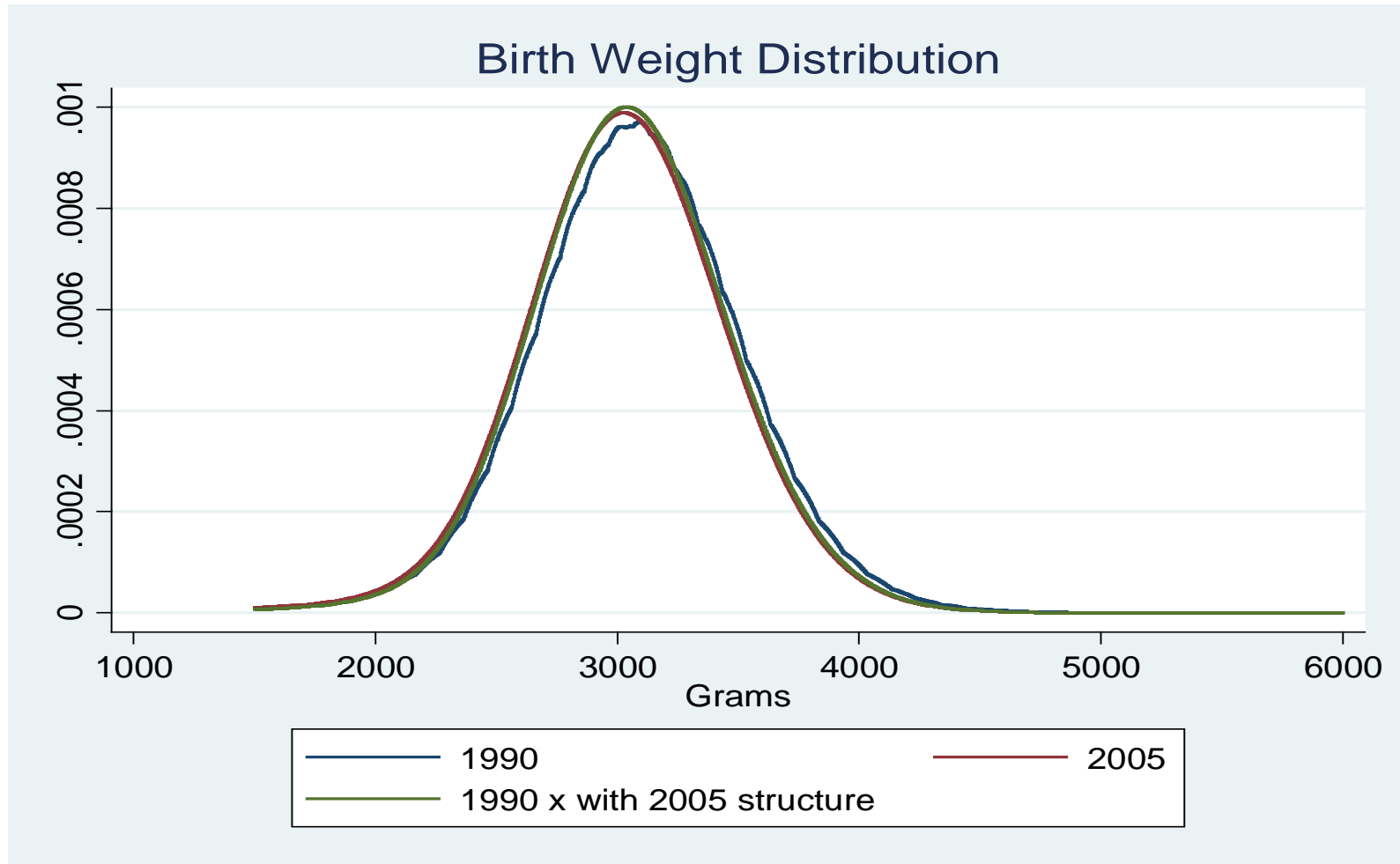
Results (3): father's characteristics

	1990	1995	2000	2005
Age	-0.11 (0.73)	1.00 (0.56)*	0.56 (0.50)	-0.99 (0.52)*
(Age) ²	0.01 (0.01)	-0.01 (0.01)	0.0005 (0.01)	0.02 (0.01)***
Foreign citizenship	57.75 (5.73)***	82.49 (4.26)***	96.73 (3.69)***	104.85 (3.61)***
Office/management	7.13 (4.68)	15.22 (3.45)***	18.04 (2.62)***	10.99 (2.61)***
Sales/service provider	7.96 (4.70)*	13.44 (3.48)***	16.41 (2.66)***	9.50 (2.65)***
Blue collar	9.58 (4.68)**	14.12 (3.45)***	15.76 (2.64)***	8.83 (2.63)***
Other job/unknown	11.87 (5.80)**	16.34 (4.13)***	17.33 (3.23)***	9.91 (3.07)***
Constant	-9,280.69 (64.34)***	-5,931.63 (18.69)***	-5,854.19 (17.69)***	-6,169.69 (18.35)***
R ²	0.24	0.32	0.33	0.36
Number of observation	1185040	1145155	1136234	1017891

Results (4): Oaxaca decomposition

	1990	1995	2000	2005
Mean birth weight	3084.2 (0.43)***	3081.3 (0.39)***	3048.5 (0.39)***	3027.2 (0.42)***
Difference between 1990 and each year		-2.90 (0.58)***	-35.68 (0.58)***	-57.01 (0.60)***
Effects of change in X		-12.45 (0.35)***	-20.24 (0.39)***	-22.30 (0.48)***
Effects of change in coefficients including constant		9.54 (0.53)***	-15.44 (0.56)***	-34.71 (0.63)***

Results (5): Effects of distribution of characteristics on birth weight, by DiNardo Fortin Lemieux decomposition



Conclusions

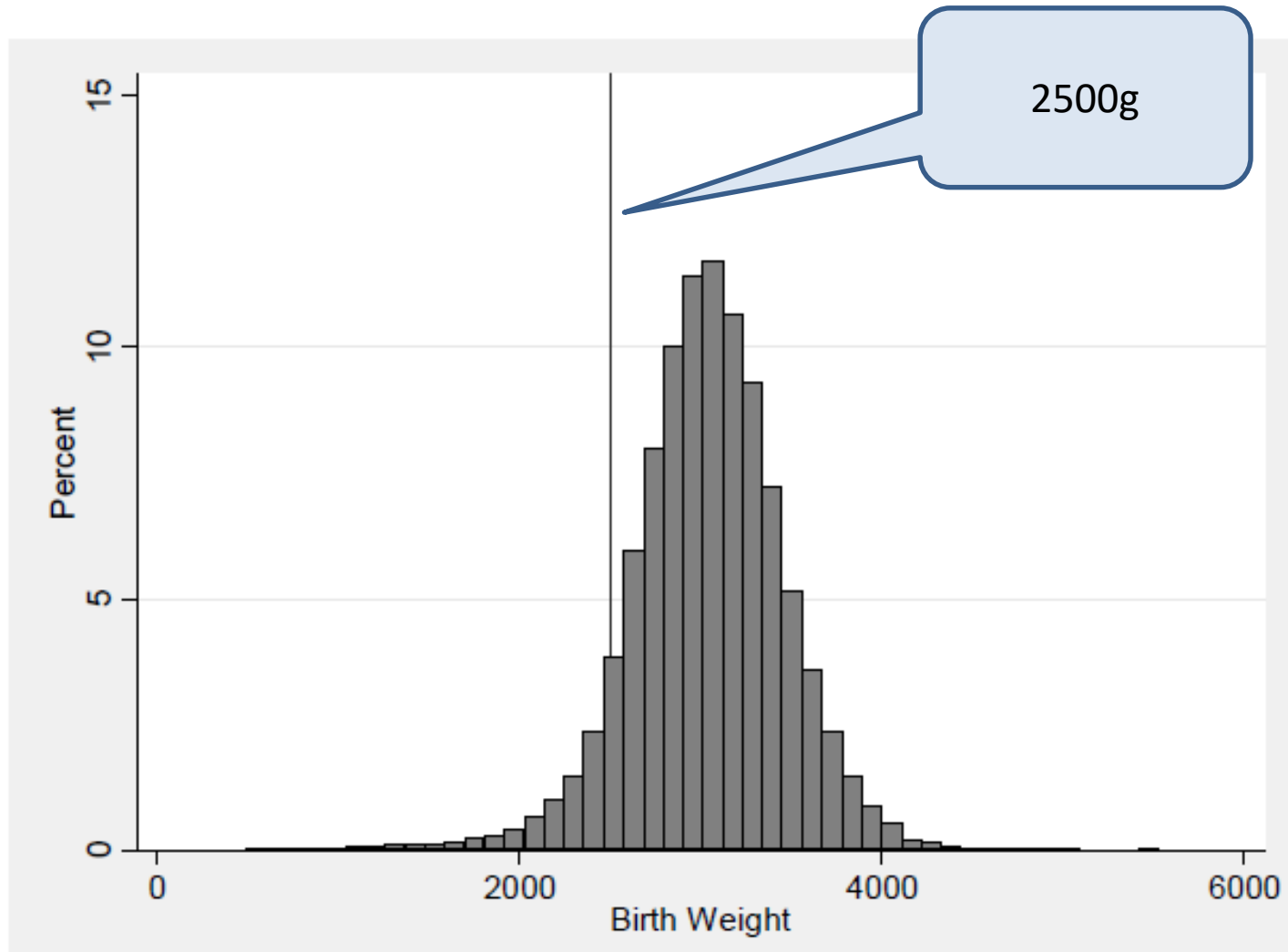
- As a results of examining causes of trend in decreasing average birth weight from 1990-2005 in Japan, observational parents' SES can explain less a half amounts of the decrease in birth weights.
- Within a group with the same characteristics, newborn average birth weights have decreased, probably because of previous clinical guidelines on mother's weight control and increasing trend of mother's smoking, based on previous studies.

Further research questions

- We did not adjust place of birth such as hospitals (53.3%), clinics (45.5%), midwife's home and home (1.2%), which would decrease birth weight by 56-216g in average, based on basic stats. Place of birth may bias the results because of endogeneity.
- Including area-specific characteristics such as presence of medical facilities where people deliver children.

RESTULS BASED ON LONGITUDINAL SURVEY OF BABIES IN 21ST CENTURY IN 2001-2007

Distribution of birth weights in Japan for both sex, 2001 (Longitudinal survey of babies in 21st century)



Statistics related to distribution among samples

Percentile

Number of obs	40121	1%	1786
Mean	3037	5%	2360
Std Dev	429	10%	2546
Variance	184320	25%	2792
Skewness	-0.514	50%	3046
Kurtosis	5.387	75%	3302
% of less than 2500g	8.25%	90%	3546
		95%	3706
		99%	4018

Basic statistics by parents' SES

Variables	Total	<2500g	>=2500g
Female	0.48	0.53	0.48
Mother's age	30.00 (4.33)	30.40 (4.44)	30.05 (4.32)
Mother: college and professional school	0.42	0.41	0.42
Mother: university or higher education	0.14	0.14	0.14
Mother: smoker	0.15	0.17	0.15
Mother: full-time worker 6 months before delivery	0.32	0.36	0.32
Mother: part-time worker 6 months before delivery	0.17	0.19	0.17
Mother: self-employee 6 months before delivery	0.04	0.04	0.04
Father's age	32.21 (5.47)	32.63 (5.66)	32.17 (5.45)
Father: college and professional school	0.16	0.15	0.16
Father: university or higher education	0.37	0.36	0.37
Father: smoker	0.62	0.63	0.62
Household income	5,718,256 (3,734,725)	5,766,596 (3,500,098)	5,713,890 (3,755,205)
Number of obs	40,121	3,323	36,798

Empirical strategy:

Simple multiple regression analysis,
quantile regression, and probit estimates

$$E(y|x) = x\beta$$

- y =birth weight of newborn babies
- x =sex, parents' characteristics (age, educational attainments, job status)

$$\text{Quant}_{\tau}(y|x) = x\beta(\tau)$$

$$\tau = 0.1, 0.25, 0.5, 0.75, 0.9$$

$$\Pr(y < 2500|x) = x\gamma$$

Results (1):baby's sex and mother's characteristics

	OLS	10%	25%	50%	75%	90%	Probit (<2500g)
	Quantile regression						
Female	-76.70 (4.27)	-54.05 (8.36)	-69.54 (6.57)	-86.97 (4.89)	-90.84 (5.75)	-93.18 (7.26)	0.0168 (0.0027)
Mother's age	-0.31 (0.70)	-2.81 (1.46)	-0.92 (0.85)	-0.56 (0.95)	1.19 (1.04)	2.98 (0.85)	0.0013 (0.0004)
Mother: college and professional school	-6.10 (4.92)	8.99 (6.74)	-2.05 (4.80)	-0.06 (5.02)	-10.29 (6.57)	-22.76 (9.00)	-0.0038 (0.0031)
Mother: university or higher education	-9.00 (7.32)	7.23 (14.79)	-14.90 (7.92)	3.79 (9.35)	-23.08 (8.67)	-33.66 (12.15)	-0.0062 (0.0045)
Mother: smoker	-38.83 (6.30)	-24.71 (11.80)	-41.11 (9.22)	-29.14 (5.42)	-38.32 (8.70)	-44.53 (8.53)	0.0100 (0.0042)
Mother: full-time worker 6 months before delivery	-43.35 (5.19)	-64.48 (9.11)	-42.36 (5.35)	-36.61 (4.52)	-32.76 (4.99)	-43.63 (6.98)	0.0244 (0.0036)
Mother: part-time worker 6 months before delivery	-28.36 (6.08)	-49.97 (11.24)	-27.03 (8.87)	-22.15 (5.68)	-21.11 (7.37)	-15.42 (8.46)	0.0204 (0.0043)
Mother: self-employee worker 6 months before delivery	0.14 (10.92)	-28.00 (22.25)	3.58 (11.44)	-5.51 (13.90)	16.59 (13.61)	22.74 (22.22)	0.0125 (0.0076)

Results (2):baby's father's characteristics

	OLS	10%	25%	50%	75%	90%	Probit (<2500g)
		Quantile regression					
Father's age	0.42 (0.55)	-2.71 (1.06)	-0.61 (0.53)	1.24 (0.68)	1.97 (0.87)	3.16 (0.93)	0.0010 (0.0003)
Father: college and professional school	13.77 (6.33)	28.55 (9.61)	7.75 (6.52)	7.96 (6.81)	7.81 (6.83)	17.71 (12.30)	-0.0086 (0.0039)
Father: university or higher education	6.83 (5.45)	3.17 (9.15)	11.46 (5.97)	0.50 (7.04)	-1.59 (7.49)	-0.82 (8.03)	-0.0030 (0.0035)
Father: smoker	2.12 (4.71)	-4.53 (10.01)	-0.29 (4.78)	1.22 (6.06)	4.25 (7.60)	13.48 (8.11)	0.0012 (0.0030)
Household income (log)	-1.40 (4.07)	19.51 (7.95)	3.59 (4.64)	-2.54 (4.63)	-10.22 (4.34)	-18.23 (5.76)	-0.0052 (0.0025)
Constant	3,113.99 (59.62)	2,470.32 (114.51)	2,839.62 (69.85)	3,122.31 (65.55)	3,424.87 (71.27)	3,703.92 (84.78)	-
R-square	0.01	-	-	-	-	-	-
Number of obs	40,121	40,121	40,121	40,121	40,121	40,121	40,121

Development indices at age 2 and half/6 and half

● At age 2 and half

- Pronounce own name ;
- Teethbrushing alone ;
- Out of diapers during daytime;
- Wish to be dressed and/or undressed alone

● At age 6 and half

- Average number of playmates after school
- Average length of studying at home (min)
- Average number of picture books and/or novels per month

Results at age 2 and half: based on probit estimates

	Mean	Low weight-non low weight	Adjusted by regression	Number of obs
Pronounce own name	0.89	-0.07 (0.01)	-0.07 (0.01)	37,985
Teethbrashing alone	0.83	-0.02 (0.01)	-0.02 (0.01)	37,992
Out of diapers during daytime	0.28	-0.06 (0.01)	-0.06 (0.01)	37,853
Wish to be dressed and/or undressed alone	0.79	-0.02 (0.01)	-0.04 (0.01)	38,003

Results at age 6 and half (1): based on multivariate logistic reg

	(1)	(2)	(3)	(4)	(5)	(6)
	Number of playmates after school		Length of studying at home (min)		Number of books per month	
<2500g	-0.06 (0.03)	-0.05 (0.03)	1.34 (0.55)	1.23 (0.55)	-0.06 (0.10)	-0.10 (0.09)
Female		-0.18 (0.02)		2.66 (0.30)		1.35 (0.05)
Mother's age		0.00 (0.00)		-0.32 (0.05)		-0.02 (0.01)
Mother: college and professional school		0.05 (0.02)		1.12 (0.35)		0.64 (0.06)
Mother: university or higher education		0.03 (0.03)		0.34 (0.51)		1.40 (0.09)

Results at age 6 and half (2): based on multivariate logistic reg

	(1)	(2)	(3)	(4)	(5)	(6)
	Number of playmates after school		Length of studying at home (min)		Number of books per month	
		(0.03)		(0.51)		(0.09)
Mother: full-time worker 6 months before delivery		0.14		0.72		0.29
		(0.02)		(0.37)		(0.06)
Mother: part-time worker 6 months before delivery		0.07		0.67		0.29
		(0.03)		(0.43)		(0.07)
Mother: self employee 6 months before delivery		-0.08		1.27		0.24
		(0.05)		(0.77)		(0.13)
Mother: smoker		0.18		-0.80		-0.75
		(0.03)		(0.47)		(0.08)

Results at age 6 and half (3): based on multivariate logistic reg

	(1)	(2)	(3)	(4)	(5)	(6)
	Number of playmates after school		Length of studying at home (min)		Number of books per month	
Father's age		(0.03) -0.01		(0.47) 0.09		(0.08) -0.02
Father: college and professional school		(0.00) 0.00		(0.04) 0.04		(0.01) 0.20
Father: university or higher education		(0.03) -0.05		(0.45) 1.05		(0.08) 0.76
Father: smoker		(0.02) 0.06		(0.38) -1.30		(0.07) -0.42
Household income (log)		(0.02) 0.02		(0.33) 0.82		(0.06) 0.14
Constant	1.94 (0.01)	2.00 (0.27)	40.80 (0.16)	33.22 (4.35)	4.75 (0.03)	2.49 (0.75)
Number of obs	31,417	31,417	33,428	33,428	33,186	33,186

Conclusions (1)

- Based on “Longitudinal survey of babies in 21st century in 2001-2007”, we obtain a consistent result as the one of demographic survey.
- Mother’s smoking behavior and full-time status 6 months before delivery would increase the probability of low birth weight. In particular, full-time status has a significant negative effect on newborn babies’ birth weight, increasing the probability of being less than 2500g by 2.4 % points (mean of prob. of being <2500g is 8.25%).

Conclusions (2)

- Further, low birth weight (<2500g) would have negative effects on child development indices at age 2 and half, but we do not observe statistically significant effects on those at 6 and half.
- Rather than low birth weight, parents' SES such as educational attainments and/or household income would have significant effects on development indices at age 6 and half when child enter elementary school.