

# Birthweight and the Risk for Type 2 Diabetes Mellitus in Adult Women

Janet W. Rich-Edwards, DSc; Graham A. Colditz, MBBS; Meir J. Stampfer, MD; Walter C. Willett, MD; Matthew W. Gillman, MD; Charles H. Hennekens, MD; Frank E. Speizer, MD; and JoAnn E. Manson, MD

**Background:** Previous reports have suggested an association between birthweight and type 2 diabetes mellitus.

**Objective:** To investigate the association between birthweight and type 2 diabetes in a large cohort of adult women, taking into account potential explanatory factors in childhood and adult life.

**Design:** Cohort study. Birthweight was ascertained at the end of follow-up.

**Setting:** The Nurses' Health Study, a cohort of 121 701 U.S. women born from 1921 to 1946 who have been followed since 1976.

**Participants:** 69 526 women in the Nurses' Health Study who were free of diabetes at baseline and reported their own birthweight on the 1992 questionnaire.

**Measurement:** 2123 cases of confirmed type 2 diabetes diagnosed from 1976 to 1992.

**Results:** Low birthweight was associated with increased risk for type 2 diabetes. Age-adjusted relative risks suggested a reverse J-shape association between birthweight and risk for type 2 diabetes. However, after adjustment for adult body mass index and maternal history of diabetes, an inverse association across the entire range of birthweight became apparent; compared with the reference group, relative risks by ascending birthweight category were 1.83 (95% CI, 1.55 to 2.16) for birthweight less than 5.0 lb, 1.76 (CI, 1.49 to 2.07) for birthweight 5.0 to 5.5 lb, 1.23 (CI, 1.11 to 1.37) for birthweight 5.6 to 7.0 lb, 0.95 (CI, 0.82 to 1.10) for birthweight 8.6 to 10.0 lb, and 0.83 (CI, 0.63 to 1.07) for birthweight of more than 10 lb ( $P$  for trend < 0.001). Adjustment for ethnicity, childhood socioeconomic status, and adult lifestyle factors did not substantially alter this association. The association between birthweight and risk for type 2 diabetes was strongest among women whose mothers had no history of diabetes.

**Conclusions:** Birthweight is inversely associated with risk for type 2 diabetes during adulthood. Examination of prenatal nutrition and other potential in utero determinants of both birthweight and risk for type 2 diabetes may yield new means to prevent type 2 diabetes.

Evidence of an association between impaired fetal growth and increased risk for subsequent type 2 diabetes mellitus is mounting in such populations as middle-aged white men and women (1–4) and young adult Pima Indians (5). Supporting evidence also comes from an inverse association between birthweight and glucose tolerance among children in Great Britain (6), Jamaica (7), and India (8). Most of these studies have had too few participants to quantify risks accurately at the extremes of birthweight or have had limited information on potential confounding and modifying factors in childhood and adulthood. We assessed the association of birthweight with type 2 diabetes during adulthood in a large cohort of U.S. women born from 1921 to 1946, accounting for year of birth, ethnicity, parental history of diabetes, childhood and adult socioeconomic status, and adult body size and lifestyle factors.

## Methods

In 1976, the Nurses' Health Study was established when 121 701 married, female registered nurses in the United States, 30 to 55 years of age, responded to a mailed questionnaire about their medical history and lifestyle (9). The questionnaire requested information about such factors as age, current weight and height, current and past cigarette smoking, parental occupation when the participant was 16 years of age, and reproductive history. Follow-up questionnaires have been mailed every 2 years to elicit updated information on most of these variables and the incidence of type 2 diabetes and other major illnesses. In 1982 and 1988, women reported whether their mother or father had diabetes mellitus. Women were asked to measure and record waist and hip circumference on the 1986 questionnaire. In 1992, the women were asked their birthweight in categories of pounds (not sure, <5 lb, 5.0 to 5.5 lb, 5.6 to 7.0 lb, 7.1 to 8.5 lb, 8.6 to 10.0 lb, and >10 lb; 1 lb = 0.45 kg) and whether they were full-term, 2 or more weeks premature, or part

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of a multiple birth (hereafter referred to as “twins”). In 1992, participants also reported their ethnicity and whether or not they were breast fed as infants.

### Validation of Self-Reported Birthweight

The validity of self-reported birthweight was assessed among a cohort of female nurses 27 to 44 years of age in the Nurses' Health Study II (10). Birthweight was obtained from state birth certificates for 220 randomly chosen women and was classified according to the five categories of birthweight that were reported on the 1991 Nurses' Health Study II questionnaire. Seventy percent of Nurses' Health Study II participants reported the same birthweight category as that listed on their birth certificate. The Spearman correlation coefficient between categories of self-reported and certificate-derived birthweight was 0.74. Although recall of birthweight might be expected to be less reliable among Nurses' Health Study participants who were 46 to 71 years of age when they reported their birthweight, Nurses' Health Study II participants who were 27 to 34 years of age and 35 to 44 years of age recalled their birthweight with similar accuracy.

### Ascertainment of Type 2 Diabetes Mellitus

A supplementary questionnaire about symptoms, diagnostic tests, and hypoglycemic therapy was mailed to participants who reported a diagnosis of diabetes on any biennial questionnaire. A case of diabetes was considered confirmed if at least one of the following was reported on the supplementary questionnaire: 1) at least one classic symptom (excessive thirst, polyuria, weight loss, hunger, or pruritus) and a fasting plasma glucose concentration of at least 140 mg/dL (7.8 mmol/L) or a random plasma glucose concentration of at least 200 mg/dL (11.1 mmol/L); 2) at least two elevated plasma glucose concentrations on different occasions (a fasting concentration of at least 140 mg/dL [7.8 mmol/L], a random plasma glucose concentration of at least 200 mg/dL [11.1 mmol/L], or a concentration of at least 200 mg/dL after 2 or more hours on oral glucose tolerance testing) in the absence of symptoms, or 3) treatment with hypoglycemic medication (insulin or oral hypoglycemic agent). These criteria are consistent with the diabetes classification criteria of the National Diabetes Data Group (11). All women were at least 30 years of age at diagnosis of type 2 diabetes. Women who began taking insulin within 1 year of their diagnosis, who were still taking insulin, and who had a history of ketoacidosis or more than 2+ ketonuria were considered to have type 1 diabetes and were excluded. Of a random sample of 84 participants classified by the supple-

mentary questionnaire as having confirmed type 2 diabetes, 71 gave permission for their medical records to be reviewed, and records were obtained for 62. An endocrinologist blinded to the information reported on the supplementary questionnaire reviewed the records according to National Diabetes Data Group criteria. In 61 of 62 (98%) women, the diagnosis of type 2 diabetes was confirmed (12).

### Analytic Sample

We excluded 2402 women who had prevalent diabetes at baseline in 1976, 144 with insulin-dependent diabetes (5 of whose report of incident diabetes proved to be gestational diabetes only), and 714 women who reported incident diabetes of other or unspecified type. We also excluded 5147 otherwise eligible participants who died before 1992 (of whom 149 had incident, confirmed type 2 diabetes). Of the eligible women who were alive to answer the 1992 questionnaire, 11 697 did not respond, 14 266 responded to an abbreviated form of the questionnaire that did not include the birthweight question, and 17 800 did not know their birthweight. Thus, our analysis includes the 69 526 participants who were free of diabetes in 1976 and reported their birthweight in 1992. Analyses that included the prevalent cases of type 2 diabetes in 1976 yielded similar results; to enable adjustment for body mass index at the time of diagnosis (which was unknown for the prevalent cases), only incident cases are reported here.

### Statistical Analysis

The means and prevalence of baseline characteristics were age standardized by using direct standardization to the overall age distribution in years (13). Incident cases of type 2 diabetes were assigned to the birthweight categories, with follow-up dating from the return of the baseline forms in 1976 to the date of diagnosis of type 2 diabetes or 1 June 1992, whichever came first. The odds ratio was used to estimate the relative risk for type 2 diabetes for women in a given birthweight category compared with that of women in the reference birthweight category of 7.1 to 8.5 lb. To quantify a linear trend across birthweight categories, birthweight was represented in proportional hazards models by an ordinal variable in which each birthweight category was assigned a value representative of that category (4.75 lb for birthweight > 5.0 lb, 5.25 lb for birthweight 5.0 to 5.5 lb, 6.25 for birthweight 5.6 to 7.0 lb, 7.75 for birthweight 7.1 to 8.5 lb, 9.25 for birthweight 8.6 to 10.0 lb, and 10.25 lb for birthweight > 10.0 lb; 1 lb = 0.45 kg);  $\beta$ -coefficients and two-sided *P* values from these trend analyses are presented. The 95% CI is provided for each relative risk.

All analyses were adjusted for age in years as a continuous variable. Multivariate relative risks were derived from pooled logistic regression models that closely approximate proportional hazards models (14), including variables for age, time period, and other covariates specified in the text and tables. Interactions between birthweight and other risk factors were examined by comparing risk estimates derived from stratified analyses as well as by examination of cross-product interaction variables. The variables for age, body mass index, parity, cigarette smoking, and physical activity were updated to reflect changing exposure status as reported on each biennial questionnaire. Cross-sectional analyses in which covariates were held constant at baseline were similar. Because information on physical activity was first collected in 1980, analyses considering physical activity include follow-up from 1980 to 1992. Similarly, analyses using waist circumference or waist-to-hip ratio include follow-up from 1986 to 1992. Parental history of diabetes was first reported on the 1982 questionnaire and was updated in 1988. The effect of maternal history of diabetes on the relative risk estimates of the association between birthweight and type 2 diabetes was similar in analyses that included follow-up from 1976 to 1992 (with maternal history backdated as “ever maternal history reported in 1982 or 1988”) and analyses that included follow-up only after 1982 (for which the report of maternal history predated the participant’s diagnosis of type 2 diabetes). Because the backdating of maternal history of diabetes did not affect the results, the reported analyses included follow-up from 1976 to 1992, adjusted for “ever” maternal history of diabetes as reported by the participant in 1982 and 1988.

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## Results

The distribution of birthweight and selected risk factors for type 2 diabetes by birthweight, after age adjustment, are shown in **Table 1**. As noted previously in this cohort (15, 16), women who had higher birthweight tended to be older and have a higher adult body mass index than women who were small at birth. Although paternal history of diabetes was not associated with birthweight, maternal history of diabetes was a strong predictor of increased birthweight. Childhood socioeconomic status, as measured by the proportion of participants whose father was a manager or professional when the participant was 16 years of age, was inversely associated with birthweight.

From 1976 to 1992, 2123 confirmed cases of type 2 diabetes were ascertained in the cohort. After adjustment for age, the relative risk for type 2 diabetes was elevated for women with low birthweight (<5.0 lb and 5.0 to 5.5 lb) compared with women of median birthweight (7.1 to 8.5 lb) (**Table 2**). The age-adjusted risks for type 2 diabetes between 30 and 70 years of age were 13.4% for birthweight less than 5.0 lb, 10.9% for birthweight 5.0 to 5.5 lb, 8.1% for birthweight 5.6 to 7.0 lb, 7.6% for birthweight 7.1 to 8.5 lb, 7.9% for birthweight 8.6 to 10.0 lb, and 8.1% for birthweight more than 10.0 lb. Although age-adjusted statistics suggested a small

**Table 1. Age-Adjusted Prevalence of Characteristics of Participants in the Nurses’ Health Study, by Birthweight Category\***

Characteristic	Birthweight Category					
	<5.0 lb (<2.25 kg)	5.0–5.5 lb (2.25–2.48 kg)	5.6–7.0 lb (2.49–3.15 kg)	7.1–8.5 lb (3.16–3.82 kg)	8.6–10.0 lb (3.83–4.50 kg)	>10.0 lb (>4.50 kg)
Women, <i>n</i>	3271	4297	21 585	31 091	7649	1633
Mean age in 1992, <i>y</i>	58.9	57.1	57.8	57.9	58.9	60.9
Premature, %†	57.9	18.5	2.8	0.6	0.3	0.3
Breast fed, %‡	45.7	55.0	61.8	66.8	69.6	73.8
Maternal history of diabetes, %§	12.6	11.1	11.6	12.4	15.3	22.9
Paternal history of diabetes, %§	10.8	11.5	10.5	10.2	9.9	9.8
High socioeconomic status at 16 years of age, %	23.8	27.9	27.6	26.9	24.6	19.7
Mean adult body mass index in 1976, <i>kg/m</i> <sup>2</sup>	23.8	23.3	23.2	23.7	24.1	24.5
Cigarette smoker in 1976, %	30.4	31.2	30.7	30.4	32.1	32.5
Exercise ≥1 times per week in 1980, %¶	47.2	48.0	47.1	47.8	46.1	45.3

\* Age adjusted by 5-year intervals.

† Proportion of respondents to the 1992 questionnaire who indicated that they were born 2 or more weeks premature.

‡ Proportion of participants who indicated that they had been breast fed as infants among respondents to the 1992 questionnaire who knew whether they had been breast fed.

§ Proportion of participants who indicated on the 1982 or 1988 questionnaire that their mother or father (or both) had received a diagnosis of diabetes.

|| Father’s occupation was manager or professional when the participant was 16 years of age.

¶ Proportion of participants who indicated on the 1980 questionnaire that they exercised “long enough to work up a sweat” at least once a week.

**Table 2. Relative Risk for Type 2 Diabetes Mellitus by Birthweight Category among Participants in the Nurses' Health Study, 1976–1992**

Variable	Birthweight Category						P Value for Trend ( $\beta$ -Coefficient)
	<5.0 lb (<2.25 kg)	5.0–5.5 lb (2.25–2.48 kg)	5.6–7.0 lb (2.49–3.15 kg)	7.1–8.5 lb (3.16–3.82 kg)	8.6–10.0 lb (3.83–4.50 kg)	>10.0 lb (>4.50 kg)	
Women, <i>n</i>	3271	4297	21 585	31 091	7649	1633	–
Cases of type 2 diabetes mellitus, <i>n</i>	175	174	619	856	238	61	–
Relative risk (95% CI) adjusted for*							
Age	1.88 (1.59–2.21)	1.55 (1.32–1.83)	1.05 (0.95–1.16)	1.0 (referent)	1.07 (0.93–1.24)	1.17 (0.90–1.52)	<0.001 (–0.07)
Age and adult body mass index	1.82 (1.55–2.15)	1.73 (1.47–2.04)	1.23 (1.11–1.36)	1.0 (referent)	0.98 (0.84–1.13)	0.91 (0.70–1.18)	<0.001 (–0.13)
Age and maternal history of diabetes	1.87 (1.59–2.20)	1.58 (1.34–1.86)	1.06 (0.96–1.18)	1.0 (referent)	1.04 (0.90–1.20)	1.03 (0.79–1.34)	<0.001 (–0.08)

\* Relative risks are derived from proportional hazards models that included age (in years), adult body mass index (in deciles of kg/m<sup>2</sup>, updated with every biennial questionnaire), and maternal history of diabetes (reported on the 1982 or 1988 questionnaires).

elevation in risk for type 2 diabetes for women with the highest birthweight (>10.0 lb), further adjustment for adult body mass index or maternal history of diabetes eliminated this increase (Table 2). Simultaneous adjustment for age, body mass index, and maternal history of diabetes revealed an inverse association between birthweight and type 2 diabetes that extended across the entire range of birthweight (Figure). Compared with women who weighed 7.1 to 8.5 lb at birth, women who weighed less than 5.0 lb at birth had a relative risk for type 2 diabetes of 1.83 (95% CI, 1.55 to 2.16) and women who weighed more than 10.0 lb had a relative risk of 0.83 (CI, 0.63 to 1.07). This represents a more than twofold gradient in risk across the entire range of birthweight.

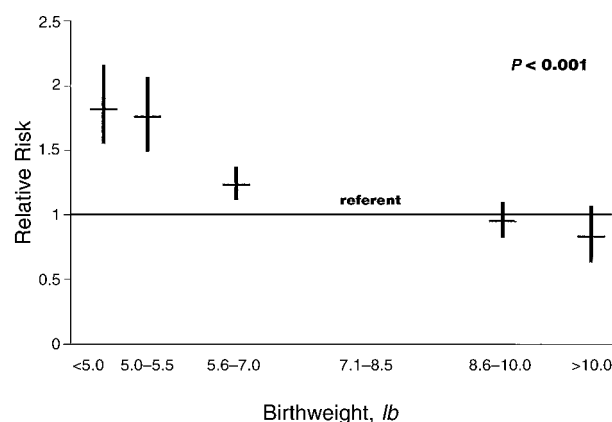
Further adjustment for prematurity, multiple birth, mother's age at the participant's birth; history of having been breast fed; participant's ethnicity (9 categories); the occupation of the participant's parents when she was 16 years of age (10 categories each for maternal and paternal occupation); paternal history of diabetes; and the participant's adult height, parity, cigarette smoking, and physical activity had no material effect on relative risks. The inclusion of waist circumference (but not waist-to-hip ratio) slightly strengthened the inverse association between birthweight and risk for type 2 diabetes.

The association between birthweight and type 2 diabetes seemed to be stronger among the 52 695 women (1199 cases of type 2 diabetes) who reported no parental history of diabetes (Table 3). An almost fourfold gradient in risk for type 2 diabetes was seen across the range of birthweight in this stratum, which included 79% of the cohort. The statistical test for multiplicative interaction between birthweight and maternal history of diabetes was statistically significant ( $P = 0.04$ ), but that for the interaction between birthweight and paternal history of diabetes was not ( $P = 0.16$ ). The inverse associ-

ation between birthweight and type 2 diabetes was apparent within each of three strata of adult adiposity (body mass index <25, 25 to 29.9, or  $\geq 30$  kg/m<sup>2</sup>) (data not shown). The association was robust across three categories of birth year selected to correspond to three periods in U.S. history: the 1920s (1921 to 1929), the Great Depression (1930 to 1940), and World War II (1941 to 1946). The multivariate-adjusted relative risk for type 2 diabetes for women with low birthweight (<5.5 lb) compared with women who weighed 5.5 lb or more at birth was similar for full-term singletons (relative risk, 1.75 [CI, 1.51 to 2.03]) and premature singletons (relative risk, 1.51 [CI, 1.01 to 2.46]). There were too few twins to examine any relations (40 cases of type 2 diabetes among 1227 women).

## Discussion

In this cohort of women born between 1921 and 1946, those with a low birthweight ( $\leq 5.5$  lb [ $\leq 2.48$



**Figure.** Adjusted relative risks (95% CIs) for type 2 diabetes mellitus by birthweight category. Relative risks are derived from a proportional hazards model that included age (in years), adult body mass index (in deciles of kg/m<sup>2</sup>, updated with each biennial questionnaire), and maternal history of diabetes (as reported on the 1982 and 1988 questionnaires).

kg)) were at significantly increased age-adjusted risk for type 2 diabetes compared with women of median birthweight. After adjustment for adult adiposity, a moderate, graded inverse association emerged across the entire range of birthweight. Within each category of adult adiposity, the risk for type 2 diabetes was the highest among those who had been the lightest newborns. Although the absolute risk for type 2 diabetes was highest among women who had low birthweight and grew to be obese adults, the magnitude of the relative risk associated with birthweight was similar among lean, moderate, and obese women, suggesting independent effects of in utero growth and adult body habitus on risk for type 2 diabetes.

Our age-adjusted data are consistent with the U-shaped association between birthweight and type 2 diabetes described among Pima Indians that has been attributed in part to gestational diabetes (5), which is itself associated with increased risk for type 2 diabetes in adult offspring (17). In our data, adjustment for maternal history of diabetes eliminated the suggestion of a higher risk for diabetes among women who weighed more than 10 lb (4.5 kg) at birth, probably in part because maternal history of diabetes served as a rough proxy for gestational diabetes. The strong inverse association we observed among women with no parental history of diabetes may better reflect the general association between in utero growth and later risk for diabetes.

Small size at birth has been associated with increased risk for type 2 diabetes (1–5), impaired glucose tolerance (1, 2), and elevated serum insulin levels in adults (2). These reports have stimulated a new variation on Neel's "thrifty genotype" hypothesis, proposed in 1962, which stated that the high

prevalence of diabetes mellitus in modern times is an artifact of natural selection for heightened insulin response during humankind's feast-or-famine, hunter-gatherer history (18). A "thrifty phenotype" hypothesis, proposed by Hales and Barker (3), posits an effect of prenatal nutrition on fetal development that becomes evident in later life. Animal experiments support this hypothesis. When pregnant rats are fed an isocaloric, protein-restricted diet, their offspring have lower birthweights, reduced  $\beta$ -cell mass, reduced islet vascularization (19), and impaired insulin response (20). Some of the damage seems to be irreversible; provision of a normal diet after birth does not completely restore normal insulin response by adulthood (20). Furthermore, these first-generation rats go on to have diabetic pregnancies, and their offspring, exposed to hyperglycemia in utero, are more likely to become diabetic adults (21). Thus, an initial in utero nutritional insult induces endocrine dysfunction across two generations of rats. The tendency of type 2 diabetes to run through the maternal line of human families (22–24) and the higher incidence of type 2 diabetes among children of women who had type 2 diabetes while they were pregnant compared with those whose mothers developed type 2 diabetes after pregnancy (23) support the influence of the in utero environment in determining future risk for type 2 diabetes.

Our study, like previous studies of perinatal predictors of adult disease, does not represent an intact birth cohort with complete enumeration of birthweight. Women who died before they might have been enrolled in the Nurses' Health Study, as well as the small number of eligible cohort members (4.3%) who died before we collected birthweight

**Table 3. Adjusted Relative Risk for Type 2 Diabetes Mellitus by Birthweight Category and Parental History of Diabetes: Nurses' Health Study, 1976–1992\***

Variable	Birthweight Category						P Value for Trend ( $\beta$ -Coefficient)
	<5.0 lb (<2.25 kg)	5.0–5.5 lb (2.25–2.48 kg)	5.6–7.0 lb (2.49–3.15 kg)	7.1–8.5 lb (3.16–3.82 kg)	8.6–10.0 lb (3.83–4.50 kg)	>10.0 lb (>4.50 kg)	
No parental history of diabetes							
Women, n	2549	3389	17 173	24 565	5877	1142	–
Cases of diabetes, n	113	105	347	480	135	19	–
Relative risk (95% CI)	2.10 (1.71–2.55)	1.86 (1.50–2.30)	1.24 (1.08–1.43)	1.0 (referent)	0.99 (0.82–1.20)	0.55 (0.35–0.87)	<0.001 (–0.17)
Maternal history of diabetes							
Women, n	412	470	2475	3817	1168	374	–
Cases of diabetes, n	36	42	172	247	78	28	–
Relative risk (95% CI)	1.34 (0.94–2.22)	1.58 (1.13–2.20)	1.17 (0.96–1.43)	1.0 (referent)	0.95 (0.73–1.22)	0.91 (0.61–1.35)	<0.001 (–0.08)
Paternal history of diabetes							
Women, n	351	507	2279	3213	754	155	–
Cases of diabetes, n	33	37	145	172	40	19	–
Relative risk (95% CI)	1.74 (1.19–2.54)	1.65 (1.15–2.37)	1.31 (1.04–1.64)	1.0 (referent)	0.87 (0.61–1.23)	1.57 (0.97–2.56)	<0.001 (–0.10)

\* Relative risks are derived from proportional hazards models that included age (in years) and adult body mass index (in deciles of kg/m<sup>2</sup>, updated with every biennial questionnaire). Information on paternal and maternal history of diabetes was reported on the 1982 and 1988 questionnaires. The analysis of women with a maternal history of diabetes includes adjustment for paternal history of diabetes, and the analysis of women with a paternal history of diabetes includes adjustment for maternal history of diabetes. There were 125 cases of type 2 diabetes among the 1162 women with both a maternal and a paternal history of diabetes.

information in 1992, were lost to the study. However, for early mortality to produce the observed association between birthweight and type 2 diabetes, a positive association would have to exist between birthweight and risk for type 2 diabetes among the women who died. Many eligible participants did not respond to the 1992 questionnaire or responded only to the abbreviated form of the questionnaire (which lacked the birthweight question). Although these women tend to be less healthy than respondents to the full questionnaire, we know of no reason to suspect that their birthweight distribution differs from those who responded to the full questionnaire. Women who responded to the full questionnaire but did not know their birthweight tended to be older and to have had mothers who were older at the participant's birth; except for being of advanced age, the women who did not know their birthweight were not at increased risk for type 2 diabetes (data not shown). As is the case with early mortality, for missing data to explain the inverse association between birthweight and type 2 diabetes, the missing women would have to have had a disproportionately low birthweight and be free of type 2 diabetes or have had a high birthweight and type 2 diabetes.

In our study, information about birthweight was ascertained after the diagnosis of type 2 diabetes. It is possible that a participant's diagnosis of type 2 diabetes generated discussion with her mother about the participant's birthweight. If the participant's type 2 diabetes diagnosis prompted her mother to recall a diabetic pregnancy and its consequent macrosomia, participants with type 2 diabetes may have been more likely to report high birthweights. However, this would have biased our findings toward the null.

Our data support an inverse association between birthweight and risk for type 2 diabetes in adulthood that is not confined to the smallest infants. The plausibility of an association between prenatal growth and adult disease is enhanced by the findings, reported in this and other cohorts, that birthweight is inversely associated with incidence of adult hypertension (4, 15, 25–27) and cardiovascular disease (16, 28–30) and is positively associated with the incidence of adult breast cancer (31, 32). The similar association reported between birthweight and glucose intolerance in children born in Great Britain (6) and India (8) in the 1980s suggests that the underlying mechanisms remain operative to the present day, at least in some populations.

None of our findings indicates that birthweight causes type 2 diabetes; rather, they hint at factors affecting both prenatal growth and future risk for type 2 diabetes. Birthweight may be a weak proxy for considerably stronger prenatal risk factors. An-

imal models show that maternal diet during pregnancy may permanently alter pancreatic endocrine function. Potential mechanisms include prenatal hormone and growth factors, particularly insulin-like growth factor 1 and its binding proteins (33). As long as the causal mechanisms underlying the statistical association observed between birthweight and the risk for adult chronic disease remain obscure, it is premature to recommend changing current guidelines for maternal diet and weight gain during pregnancy. Furthermore, the same prenatal factors that reduce the risk for type 2 diabetes and cardiovascular disease could increase the risk for some cancers. However, these findings provide impetus to examine the diet and hormone levels of pregnant women in relation to glucose tolerance in their children, in search of factors to illuminate the association between birthweight and future risk for type 2 diabetes.

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*Requests for Reprints:* Janet W. Rich-Edwards, DSc, Nurses' Health Study, Channing Laboratory, 181 Longwood Avenue, Boston, MA 02115.

*Current Author Addresses:* Drs. Rich-Edwards and Gillman: Department of Ambulatory Care and Prevention, 126 Brookline Avenue, Suite 200, Boston, MA 02115.

Drs. Colditz, Stampfer, Willett, Speizer, and Manson: Nurses' Health Study, Channing Laboratory, 181 Longwood Avenue, Boston, MA 02115.

Dr. Hennekens: Division of Preventive Medicine, Brigham and Women's Hospital, 900 Commonwealth Avenue East, Boston, MA 02215.

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