# Association of Birth Weight and Type 2 Diabetes in Rochester, Minnesota

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There is renewed interest in the relationship between birth weight and type 2 diabetes. Previous case-control studies (1) of elderly European residents showed a linear association between low birth weight and type 2 diabetes. More recent cohort studies (2) in Pima Indians have shown a U-shaped curve between birth weight and diabetes, where both low and high birth weight were shown to increase the risk for developing type 2 diabetes. In addition, a few studies (3,4) found an association between high birth weight and type 2 diabetes in Caucasian populations. Using the resources of the Rochester Epidemiology Project (REP), we examined the association of birth weight and type 2 diabetes in individuals who were born and developed type 2 diabetes while residing in Rochester, Minnesota.

## RESEARCH DESIGN AND METHODS

— The unique resources of the REP were used to construct the Rochester Diabetes Incident cohort. As described elsewhere (5,6), case assignment was determined by retrospective review of each patient's complete (hospital and ambulatory) medical records by trained nurse abstractors under the direction of an endocrinologist (P.J.P.). The records were reviewed for all laboratory glucose values and for evidence of any antidiabetic medication over the entire duration of residence in the community. Standardized case criteria were applied that approximated the National Diabetes Data Group recommendations, and adjustments were made for temporal changes in laboratory methods (7). Individuals who failed to meet the above glycemic criteria but used oral agents or insulin for at least 2 weeks or until death also qualified as case subjects. The study was approved by the Mayo Medical Center and the Olmsted Medical Center Institutional Review Boards, and in accordance with a Minnesota State statute, individuals who refused authorization for use of their medical records in research were excluded (8).

This study was limited to all 1945–1994 incident type 2 diabetes case subjects who were born locally and for whom information on birth weight, number of births, and gestational age was available. Likely type 1 diabetic case subjects who met each of the following criteria were excluded: BMI $<30$ kg/m$^2$ as of the date criteria were met, on insulin within 1 year of that date, and on insulin when last seen. Birth information was available beginning in 1922. Birth information was found in birth books for subjects born at local hospitals from 1922 to 1938, from birth certificates for Olmsted County residents born after 1939, and from their mother's medical records for the remainder of the case subjects. Analyses were limited to term and singleton births. Term pregnancies were determined by examining birth books for mention of preterm delivery and by excluding individuals with birth certificates indicating pregnancies of $<38$ weeks. Two nondiabetic control subjects were selected. The control subjects were registered at the Mayo Clinic in the year ($\pm$ 2 years) that the case subject met the criteria for type 2 diabetes. Case and control subjects were matched for sex and age as of the date that the subject met type 2 diabetes criteria.

A two-sample *t* test was used to compare mean birth weights in case and control subjects. A $\chi^2$ test, with birth weight defined as $<6.5$, 6.5–8.49, or $\geq 8.5$ lb, was used to compare proportions. Lastly, a logistic regression model adjusted for sex and year of birth was used to compare the effects of high or low birth weight on the odds of developing type 2 diabetes.

## RESULTS

— There were 170 individuals who first met the criteria for type 2 diabetes in 1945–1994 and were born locally on or after 1922 (52% men; mean age of onset of diabetes was 44.7 $\pm$ 11.4 years). There was no significant difference in mean birth weight between case and control subjects (7.40 $\pm$ 1.08 vs. 7.49 $\pm$ 0.96 lb, $P = 0.238$). The distribution of birth weight in type 2 diabetic case and control subjects reveals that case subjects were more likely to have birth weights in the low and high categories, while control subjects were more likely to have birth weights in the normal category ($\chi^2 = 0.009$) (Fig. 1).

After adjusting for sex and birth year, low birth weight ($<6.5$ lb) was associated with a 2.10 (95% CI 1.29–3.41, $P = 0.003$) increased risk of developing type 2 diabetes when compared with the referent (6.5–8.49 lb) category. High birth weight ($\geq 8.5$ lb) was associated with a 1.36 (0.81–2.27, $P = 0.246$) increased risk of developing type 2 diabetes when compared with the referent category.

## CONCLUSIONS

— This study took advantage of the longitudinal population-based resources of the REP to examine the association of birth weight and type 2 diabetes in residents of Rochester, Minne-

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**Abbreviations:** REP, Rochester Epidemiology Project.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

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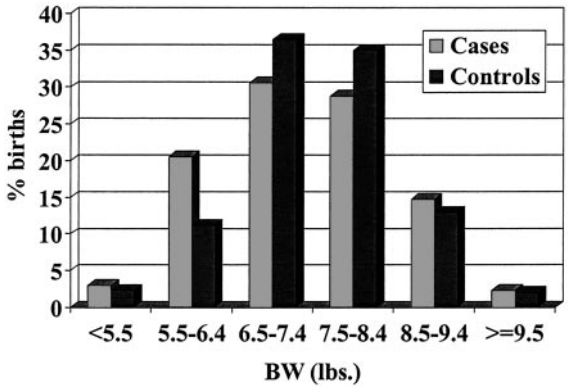


**Figure 1**—*Birth weight distributions in type 2 diabetic case and control subjects.*

sota. A significant association was identified between low birth weight and type 2 diabetes. In addition, an elevated, but not statistically significant, association was seen between high birth weight and type 2 diabetes.

A few other studies have suggested an association between high birth weight and type 2 diabetes. A reversed J-shaped association between birth weight and diabetes was found in 69,526 women participating in the Nurses' Health Study (3). For birth weights 8.6–10 lb, the age-adjusted relative risk of developing diabetes was 1.07 (95% CI 0.93–1.24) compared with the referent category (7.1–8.5 lb). After adjustment for age, along with adult BMI or history of maternal diabetes, the relative risks dropped to <1.0 for high birth weight. A longitudinal study of 8,760 subjects born in Helsinki from 1934 to 1944 with type 2 diabetes identified through a national register found that babies with above-average birth weights (>7.7 lb) and who had slow growth in length between birth and 3 months of age had a significantly increased risk of developing type 2 diabetes (4). In addition, a study in Pima Indians (4) and Taiwanese school children (9) found U-shaped associations between birth weight and type 2 diabetes.

Although our study did not find a significant association between high birth weight and type 2 diabetes, it is suggestive of such an association. A possible reason the association failed to reach statistical significance is the small number of case subjects in the very-high-weight category (≥9.5 lb, $n = 4$).

In summary, we found that low birth weight was significantly associated with the risk of developing type 2 diabetes in individuals residing in Rochester, Minnesota. High birth weight was associated with an increased but not statistically significant risk of developing type 2 diabetes. These associations were independent of sex and birth year. We conclude that our data suggest a reversed J-shaped curve association between birth weight and type 2 diabetes in residents of Rochester, Minnesota.

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