Incidence and Prevalence of Diabetes in Children Aged 0–14 Years in Manitoba, Canada, 1985–1993

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OBJECTIVE — To estimate the incidence and prevalence of type I diabetes among Manitoba children aged 0–14 years from 1985–1993.

RESEARCH DESIGN AND METHODS — The Manitoba Diabetes Database (a population-based database of individuals diagnosed with diabetes based on Manitoba's health insurance system) was used to estimate the annual incidence of diabetes for the years 1985–1993 and the point prevalence of diabetes at 31 March 1993 for Manitoba children aged 0–14 years. The Diabetes Education Resource for Children and Adolescents program database was used to correct incidence and prevalence rates for ascertainment using the two-source capture-recapture method.

RESULTS — The overall ascertainment rate of the Manitoba Diabetes Database was 95% for incident cases and 93% for prevalent cases. The average annual incidence was 20.4 per 100,000 for children aged 0–14 years. The annual incidence appears to be stable for all age-groups 0–14 years over the past decade. The point prevalence of diabetes among children was 120.4 per 100,000.

CONCLUSIONS — The incidence of type I diabetes in children aged 0–14 years in Manitoba is higher than reported previously in other urban regions of Canada, but similar to population-based estimates from Prince Edward Island. The incidence appears stable in Manitoba over the past decade even in the 0–4 year age-group. The Manitoba Diabetes Database appears to be a highly accurate population-based source of data on the epidemiology of diabetes in children.

The increasing worldwide interest in the epidemiology of type I diabetes in childhood has been fueled by the intense search for its pathogenesis. Wide variations in incidence of type I diabetes have been found depending on the geographic and ethnic distribution of the population (1–3).

The highest reported incidence of type I diabetes has been from Finland where the annual incidence from 1965–1984 was 38.4 per 100,000 for boys and 32.2 per 100,000 for girls aged 0–14 years with a north-south gradient (4). Several reports from European countries have indicated an increase in the incidence rate over the past 20 years, but these findings have not been consistent worldwide (1). Population-based studies from North America and populations of lower latitude have not observed increasing incidence (1). Studies in South Korea (5), Japan (6), and Colorado (7), which are all regions between latitudes 30°–45° in the northern hemisphere, reported no increase in the incidence of type I diabetes despite wide variations in rates (0.7/100,000, 2/100,000, and 15.2/100,000, respectively).

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DER-CA, Diabetes Education Resource for Children and Adolescents. ICD-9, *International Classification of Diseases*, 9th revision.

In Canada, three studies of the incidence of type I diabetes in children have been published (Table 1). Two are based on urban tertiary hospital populations in Montreal (8) and Toronto (9). The other is population-based, using data collected from the provincial drug registry in the province of Prince Edward Island (10). The incidence rates reported in these three studies vary by almost threefold despite similar latitude and multiethnic populations.

Despite its importance for health care planning, few studies have estimated the prevalence of type I diabetes in childhood because of the difficulty of longitudinal follow-up, different study periods, and variable case ascertainment (2). The prevalence estimates from Europe range from 25–300 per 100,000 (11). In Canada, the reported age-adjusted prevalence rate in 1977 in Prince Edward Island was 50 per 100,000 in children less than 10 years of age and 240 per 100,000 for those aged 10–19 years (10).

We have used data from a comprehensive health insurance system and a provincial diabetes education program for children and adolescents in the province of Manitoba, Canada, to create a population-based database of children with diabetes. We have used this database to estimate the incidence of type I diabetes among children aged 0–14 years from 1985–1993 and to estimate the point prevalence of type I diabetes in children in 1993.

RESEARCH DESIGN AND METHODS

— Manitoba is a province in western Canada with a stable population of ~1.1 million people. More than half of the population lives in urban areas within 100 kilometers of the Canada-U.S. border. The population is ethnically diverse, and ~10% of the population are of aboriginal origin.

The diverse terrain of Manitoba includes prairies in the south and arctic tundra in the north. It is situated at 49°–65° latitude, similar to countries of northern Europe.

Data sources

The Manitoba Department of Health (Manitoba Health) provides universal health insurance for Manitoba residents and main-

Table 1—*Studies of the incidence of type I diabetes among children in Canada*

Location (reference)	Years	Age-group (years)	Annual incidence per 100,000	Sources of data	Validation	Estimated completeness of data (%)
Montreal (8)	1971–1985	0–14	9.8	Hospital	Summer camp	94
Toronto (9)	1976–1978	0–19	9.0	Hospital	None	Not available
Prince Edward Island (1)	1975–1986	0–14	23.9	Provincial Drug Registry	Pharmacies	99
Manitoba (present study)	1985–1993	0–14	20.4	Manitoba Health Diabetes Database	DER-CA	95

tains computerized records based on the use of health services (including physician and hospital services) by individuals enrolled in the insurance system. Since residents are not obliged to pay premiums, nonparticipation in the system is minimal. For each physician service, the patient's identification, date of service, diagnosis (a three-digit ICD-9-CM code, *International Classification of Diseases*, 9th revision) and service tariff code are entered into a "physician claims" database. Similarly, after each hospital separation, Manitoba hospitals submit an abstract to Manitoba Health, which includes the patient's identification, dates of admission and discharge, and up to 16 ICD-9-CM diagnoses. A longitudinal record of health service utilization for an individual can be created because each physician claim and hospital separation abstract contains a unique personal health identification number. The accuracy of these administrative health data has been previously documented (12). Using these databases, we created a new Manitoba Diabetes Database, which includes all people in the province who have had a physician claim or hospital separation for which a diagnosis of diabetes (ICD-9-CM 250.xx) was given (13).

In 1985, a provincial education resource for children and adolescents with diabetes was established with funding from Manitoba Health. The Diabetes Education Resource for Children and Adolescents (DER-CA) provides education and care for children with type I diabetes in Manitoba. A computerized database for clients of the Manitoba DER-CA was created, which includes the clients' identification and diagnosis date along with clinical and education information. The proportion of children with diabetes who are referred to the DER-CA has increased steadily since the early years of operation, and now the vast majority of Manitoba children with diabetes are enrolled in the program.

Case definition

To develop an appropriate case definition for cases of clinically diagnosed diabetes among children in the Manitoba Diabetes Database, the Manitoba Diabetes Database was linked to the DER-CA database by Manitoba Health registration number, sex, and year and month of birth. The physician claims histories of children who were clients of the DER-CA (and known to have type I diabetes) were analyzed to determine criteria for the identification of children with diabetes in the Manitoba Diabetes Database. A total of 354 DER-CA clients aged 0–14 years who were diagnosed from 1985–1993 were registered with Manitoba Health. Of these children, none had no physician claims, only four children (1.1%) had one or two separate physician claims (i.e., on different days), four children (1.1%) had three or four separate physician claims, and 346 children (97.7%) had five or more separate claims. All but one of the DER-CA children with fewer than five claims had been registered with Manitoba Health for less than 2 years. Among the 2,004 children aged 0–14 years in the Manitoba Diabetes Database, 1,347 (67.2%) had only one isolated physician claim from 1985–1993. A further 180 (9.0%) had only two separate claims, and 52 (2.6%) had three or four claims. Based on these results, the case definition for children with diabetes in the Manitoba Diabetes Database included children with five or more separate physician claims for diabetes and children with three or four separate physician claims who were registered with Manitoba Health for less than 2 years. To exclude children with type II diabetes, we excluded from analyses any children who were known to be "Treaty Indian." The term Treaty Indian refers to any member of a band of Indians that signed a Treaty with the Government of Canada. It does not preclude genetic admixture. Based on the experience of the DER-CA, ~1.5% of children with Type I diabetes are Treaty Indian whereas 100% of the known children with Type II diabetes are Treaty Indian. Since hospitalization for diabetes occurred almost exclusively among children with more than 5 physician claims it was not included as part of the case definition. Using these criteria, 434 children aged 0–14 years from the Manitoba Diabetes Database were classified as having diabetes with an initial physician claim from 1985–1993. Of these, 9 children (2.1%) had 3 or 4 claims and the remaining 425 (97.9%) had 5 or more claims.

Ascertainment rates, incidence rates, and point prevalence

Two-source capture-recapture methods were used to assess the ascertainment rates for the Manitoba Diabetes Database and to compute ascertainment-corrected incidence rates and point prevalence (14). The ascertainment rate is the percentage of DER-CA cases that were also defined as cases (i.e., "recaptured") in the Manitoba Diabetes Database. The ascertainment rates of the Manitoba Diabetes Database for cases from the DER-CA database were calculated for all incident cases from 1985–1993 by age-group (0–4, 5–9, and 10–14 years) and time period (1985–1987, 1988–1990, and 1991–1993). Average annual incidence rates were calculated by age-group and sex for three time periods (1985–1987, 1988–1990, and 1991–1993), using the ascertainment-corrected number of incident cases and the average mid-year population from the Manitoba Health population registry. The point prevalence was calculated based on the ascertainment-corrected number of prevalent cases on 31 March 1993, using the 1993 mid-year population.

RESULTS

Ascertainment rates

The overall ascertainment rate of the Manitoba Diabetes Database for incident cases of diabetes from 1985–1993 in the DER-

Table 2—*Incident cases of diabetes from the Manitoba Diabetes Database and the DER-CA database and the rate of ascertainment of the Manitoba Diabetes Database, by age-group and time period*

Time period and age (years)	Manitoba Diabetes Database	DER-CA database	Both databases	Ascertainment rate (%)
1985–1987				
0–4	27	21	21	100
5–9	52	46	44	96
10–14	74	46	45	98
All	153	113	110	97
1988–1990				
0–4	24	21	19	90
5–9	47	41	39	95
10–14	56	45	43	96
All	127	107	101	94
1991–1993				
0–4	28	29	26	90
5–9	50	48	43	90
10–14	76	71	68	96
All	154	148	137	93
All years (1985–1993)				
0–4	79	71	66	93
5–9	149	135	126	93
10–14	206	162	156	96
All	434	368	348	95

CA database was 95% (Table 2). The ascertainment was slightly higher for children aged 10–14 years than for children aged <10 years (96 and 93%, respectively). The ascertainment was also slightly higher from 1985–1987 (97%) than it was for 1988–1990 (94%) or 1991–1993 (93%).

Incidence rates

The average annual ascertainment-corrected incidence rates of diabetes by age-group, sex, and time period are shown in Table 3. Overall, the average annual incidence rate from 1985–1993 for boys and girls aged 0–14 years was 20.4 per 100,000 (95% CI; 16.2–24.5). The estimated average annual incidence rate was higher among boys (22.1 per 100,000) than among girls (18.5 per 100,000), although this difference was not statistically significant. The incidence of diabetes increased with age among both boys and girls. The average annual incidence was 11.1 per 100,000 for ages 0–4 years, 21.5 per 100,000 for ages 5–9, and 28.8 per 100,000 for ages 10–14. There did not appear to be a consistent temporal trend in incidence rates among either boys or girls. The average incidence rates in the three time periods were 20.9 per 100,000 (1985–1987), 18.0 per 100,000 (1988–1990), and 22.1 per 100,000 (1991–1993).

Prevalence

The ascertainment rate of the Manitoba Diabetes Database for prevalent cases of diabetes on 31 March 1993 and the point prevalence of diabetes by age-group are shown in Table 4. The overall ascertainment rate for prevalent cases was 93% with little difference between the age-groups. The overall prevalence of diabetes among children aged 0–14 years was 120.4 per 100,000. The prevalence rose sharply with age. The highest prevalence was among those aged 10–14 years (239.5 per 100,000) followed by those aged 5–9 years (107.7 per 100,000) and 0–4 years (21.0 per 100,000).

CONCLUSIONS — We have used comprehensive administrative health data to make population-based estimates of the incidence and prevalence of type I diabetes in children. There are a number of potential problems with this approach. Our data are not able to provide a clear distinction between type I and type II diabetes. Over the last 10 years, we have seen an increasing number of aboriginal children developing type II diabetes. The exclusion of Treaty-status Indian children diagnosed with diabetes should reduce this potential bias but may not eliminate it completely. Children with diabetes who have recently immigrated to Manitoba may be missed or erroneously defined as incident cases in the Manitoba Diabetes Database, which could affect our incidence estimates.

Our capture-recapture analyses indicates that the Manitoba Diabetes Database is highly sensitive, with 95% case ascertainment. The sensitivity could have been improved slightly by including children with new-onset diabetes and only one to

Table 3—*Average annual ascertainment-corrected incidence of diabetes by time period, sex, and age among Manitoba children, 1985–1993*

	1985–1987	1988–1990	1991–1993	All years (1985–1993)
Boys				
0–4	10.8	12.9	11.4	11.7 (8.6–14.7)
5–9	23.0	20.4	22.5	22.2 (15.7–28.8)
10–14	33.0	29.2	35.5	32.8 (27.3–38.3)
All	22.5	21.0	22.9	22.1 (16.7–27.6)
Girls				
0–4	10.6	8.0	12.7	10.4 (8.8–12.0)
5–9	20.9	19.1	22.2	20.7 (19.1–22.4)
10–14	26.2	17.5	29.7	24.6 (19.6–29.6)
All	19.1	14.8	21.3	18.5 (15.7–21.3)
Both				
0–4	10.7	10.5	12.1	11.1 (8.7–13.4)
5–9	22.0	19.8	22.3	21.5 (17.2–25.8)
10–14	29.9	23.9	32.7	28.8 (23.4–34.2)
All	20.9	18.0	22.1	20.4 (16.2–24.5)

Average annual incidence rate is per 100,000, with 95% CI for all years in parentheses.

Table 4—*Prevalent cases of diabetes from the Manitoba Diabetes Database and the DER-CA database, the ascertainment rate of the Manitoba Diabetes Database, and the ascertainment-corrected prevalence (per 100,000) of diabetes by age-group, 31 March 1993*

Age (years)	Prevalent cases of diabetes: Manitoba Diabetes Database	DER-CA database	Both databases	Ascertainment rate (%)	Prevalence* per 100,000	95% CI†
0–4	17	15	14	93	21.0	16.3–25.7
5–9	83	79	73	92	107.7	87.3–128.0
10–14	181	162	152	94	239.5	193.5–285.4
All	281	256	239	93	120.4	96.8–144.0

*Ascertainment-corrected prevalence. †95% CI of ascertainment corrected prevalence per 100,000.

two physician claims for diabetes, but this would have reduced the specificity to an unacceptable level by including too many children without diabetes. Other possible reasons for differences between the two databases include incorrect matching data and the likelihood that some older adolescents with diabetes may not have been referred to the DER-CA, particularly in the earlier years of operation.

Although the specificity of the case definition used for the Manitoba Diabetes Database was not assessed directly, there is evidence that it is quite high. In the later years of operation (1991–1993), when a high proportion of children with diabetes were referred to the DER-CA, the number of incident cases from the Manitoba Diabetes Database exceeded the number in both databases by only 17 cases (154 vs. 137) (Table 2). Therefore, during this time period, the maximum false-positive rate of the Manitoba Diabetes Database would have been 12% (17/137). Because not all children are referred to the DER-CA and some records may be mismatched, the true false-positive rate is likely lower.

We report an overall incidence rate of 20.4 per 100,000 children aged 0–14 years in Manitoba. This is almost double the incidence reported for the same age-groups in Montreal (8) and Toronto (9) in the 1970s (Table 1). The data source for both studies was tertiary hospital admissions, which may have yielded falsely low rates. Our higher incidence may be due to a different ethnic mix, but we do not have data to substantiate this. The incidence rate for Manitoba is similar to Prince Edward Island for children aged 0–14 years (10). It is slightly higher than published reports in the north central states of Minnesota (17.1 per 100,000) and North Dakota (18.9 per 100,000) (1).

The global pattern of incidence reveals a relationship to latitude, with higher incidence rates in the northern part of the northern hemisphere (3). The incidence rate in Manitoba and its latitude are intermediate between those of Finland and those of Japan, southern Europe, or the midwestern U.S. (1). The Manitoba population is concentrated in the southern portion of the province, so no regional north-south gradient could be studied. Our data do not show the trend for increasing incidence of diabetes that has been found in Europe, especially in the 0–4 age-group (3). We observed an apparent increase in younger males in the late 1980s (Table 3), which was also reported in Allegheny County, Pennsylvania (15).

Estimation of prevalence is important in determining the overall burden of illness and the need for health services. We report an overall prevalence of 120.4 per 100,000 children aged 0–14 years in Manitoba in 1993. Our prevalence estimates are higher than Prince Edward Island (63.5 vs. 50 per 100,000) (10) for children aged 0–9 years but lower than Finland's rate for children aged 0–14 years (120.4 vs. 211 per 100,000) (4).

The availability of an accurate population-based database on diabetes in children in Manitoba will allow future tracking of trends in the incidence and prevalence of diabetes among children for health care resource allocation. The ready availability of the data will also allow for routine surveillance to detect outbreaks of type I diabetes in Manitoba. Linkage of the database to other hospital and physician service records also provides an opportunity to examine the occurrence of future diabetic complications and the use of health care services among children with diabetes.

References

1. Karvonen M, Tuomilehto J, Libman I, LaPorte R: A review of recent epidemiologic data on the worldwide incidence of type I (insulin-dependent) diabetes mellitus. *Diabetologia* 36:883–892, 1993
2. LaPorte RE, Matsushima M, Chang Y-F: Prevalence and incidence of insulin-dependent diabetes. In *Diabetes in America*. 2nd ed. Harris MI, Cowie CC, Stern MP, Boyko EJ, Reiber GE, Bennett PH, Eds. Washington, DC, National Institutes of Health, 1995, p. 37–46 (NIH publ. no. 95-1468)
3. Dahlquist G: Epidemiologic studies of childhood insulin dependent diabetes. *Acta Paediatr Scand* 80:583–589, 1991
4. Tuomilehto J, Lounamaa R, Tuomilehto-Wolf E, Reunanen A, Virtala E, Kaprio EA, Akerblom HK: Epidemiology of childhood diabetes mellitus in Finland: background of a nationwide study of increasing trend in type I (insulin-dependent) diabetes mellitus. *Diabetologia* 35:70–76, 1992
5. Ko KW, Yang SW, Cho NM: The incidence of IDDM in Seoul from 1985–1988. *Diabetes Care* 17:1473–1475, 1994
6. Japan IDDM Epidemiologic Study Group: Lack of regional variation in IDDM risk in Japan. *Diabetes Care* 16:796–800, 1993
7. Hamman RF, Gay EC, Cruickshanks KJ, Cook M, Lezotte DC, Klingensmith GJ, Chase HP: Colorado IDDM Registry: incidence and validation of IDDM in children aged 0–17 years. *Diabetes Care* 13:499–506, 1990
8. Siemiatycki J, Colle E, Campbell S, Dewar R, Aubert D, Delmonte MM: Incidence of IDDM in Montreal by ethnic group and by social class and comparisons with ethnic groups living elsewhere. *Diabetes Care* 37:1096–1102, 1988
9. Erhlich RM, Walh LJ, Falk JA, Middleton PJ, Simpson NE: The incidence of type I (insulin-dependent) diabetes in Toronto. *Diabetologia* 22:289–291, 1982
10. Tan MH, Wornell MC, Beck AW: Epidemiology of diabetes mellitus in Prince Edward Island. *Diabetes Care* 4:519–524, 1981
11. Rewers M, LaPorte RE, King H, Tuomilehto J: Trends in the prevalence and incidence of diabetes: IDDM in childhood. *World Health Stat Q* 41:179–189, 1988
12. Roos LL, Mustard CA, Nicol JP: Registries and administrative data: organization and accuracy. *Med Care* 31:201–212, 1993
13. Blanchard JF, Ludwig S, Wajda A, Dean H, Anderson K, Kendall O, Depew N: Incidence and prevalence of diabetes mellitus in Manitoba, 1986–1991. *Diabetes Care* 19:807–811, 1996
14. Laporte RE, McCarty D, Bruno G, Tajima N, Baba S: Counting diabetes in the next millennium: application of capture-recapture technology. *Diabetes Care* 16:528–534, 1993
15. Dokheeh T, for the Pittsburgh Diabetes Epidemiology Research Group: An epidemic of diabetes in the United States? Evidence from Allegheny County, PA. *Diabetes Care* 16:1606–1611, 1993