

Incidence and prevalence of Type 1 (insulin-dependent) diabetes mellitus in Icelandic children 1970–1989

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Summary. Through use of primary and secondary data sources for registration and validation, the incidence and prevalence of Type 1 (insulin-dependent) diabetes mellitus in children aged 0–14 years in Iceland has been completely ascertained for the years 1970–1989. The age-adjusted mean annual incidence per 100,000 for the 20-year period was 9.4 (95% confidence interval 7.8–11.3); similar for boys (9.9; 7.7–12.7) and girls (8.8; 6.7–11.5). Between 1970–1979 the incidence was 8.0 (6.0–10.6) and between 1980–1989 it was comparable at 10.8 (8.4–13.8) ($p > 0.10$). By Poisson regression analysis the variation in incidence was related to age at diagnosis ($p < 0.001$), while a linear trend for calendar year at diagnosis did not reach statistical significance ($p = 0.07$). A

quadratic curve, however, better described the temporal variation in incidence ($p < 0.05$). The total prevalence per 1,000 by the end of 1979 and 1989 was similar, 0.45 (0.30–0.65) and 0.57 (0.40–0.79), respectively. In conclusion, this study confirms that both the incidence and prevalence of childhood Type 1 diabetes in Iceland are low compared to the other Nordic countries. The findings may suggest a causative role for environmental factors that are not related to latitude or ambient temperature.

Key words: Type 1 (insulin-dependent) diabetes mellitus, children, epidemiology, incidence, prevalence, Iceland.

Standardized epidemiological research methods have shown an unusually wide geographic variation in the incidence of childhood Type 1 (insulin-dependent) diabetes mellitus in patients 0–14 years of age [1–4]. In particular, an inverse correlation between the average yearly temperature and diabetes incidence has been suggested [1]. This implies that childhood diabetes may be associated with viral infections or environmental factors prevalent in cold climates. However, ethnic and genetic variables confound the comparison between populations in these studies.

Four of the five Nordic countries, Finland, Sweden, Norway and Denmark, all have a high incidence of childhood diabetes [5–8]. Comparative data from Iceland have been lacking. Iceland was inhabited more than 1,100 years ago, primarily by Norwegians, and comparative population studies using HLA-, blood groups and several protein markers, indicate that these two nations are genetically remarkably similar [9]. Furthermore, Reykjavik and the central west coast of Norway share the same latitude, and have similar average yearly temperatures [10]. Therefore, any marked differences in the pattern of childhood diabetes in the two countries are likely to be due to causative factors that may not be linked to genetic composi-

tion, latitude or average yearly temperature. We have ascertained the incidence of childhood Type 1 diabetes in Iceland during the last 20 years and compared this to data from the other Nordic countries, with particular reference to Norway [5].

Subjects and methods

Population and the National Health Service in Iceland

From an epidemiological viewpoint the disadvantage of the small population of Iceland, of 250,000 inhabitants, is compensated for by a number of favourable factors such as the ethnic uniformity in a stable, well-educated population with living standards comparable to those of the other Nordic countries. There is a census at the beginning of each decade and the data are updated yearly on a national computerised register. The National Health Service is completely responsible for diabetic medical care. Type 1 diabetic patients are treated by physicians specializing in the disease. All children aged 0–14 years with suspected diabetes are hospitalized without exception. Subsequent treatment and follow-up is carried out either at the admission unit or at the only established diabetic clinic in the country. Insulin can be obtained only on prescription and is free of charge. Furthermore, diabetic patients are issued a card by the National Insurance Institution which entitles them to a 50–90% discount on all

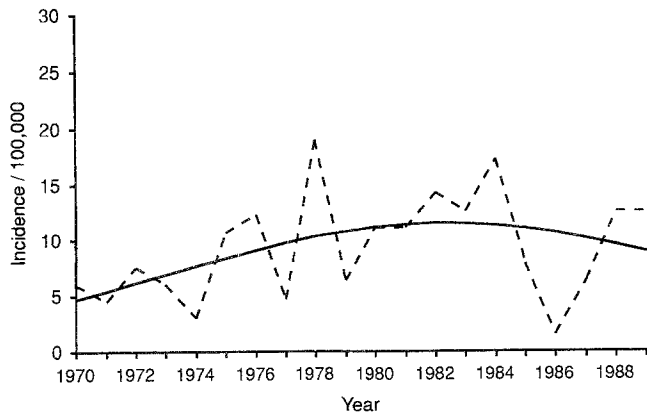


Fig. 1. Age-adjusted annual incidence per 100,000 of Type 1 (insulin-dependent) diabetes in Icelandic boys and girls combined (----) aged 0–14 years at diagnosis during 1970 to 1989. A calculated quadratic trend curve (—) is superimposed

treatment equipment, including glucometers. Since 1 January 1985 the Institution has kept a computerized register of all diabetic patients receiving such benefits.

Collection of data

There are only two towns with more than 10,000 inhabitants, Reykjavik and Akureyri; the rest of the country is rural. The data have been collected in different ways for each of the two 10-year periods, 1970–1979 and 1980–1989. For 1970–1979 data were collected retrospectively in 1980 as part of a comprehensive survey of Type 1 diabetes in Iceland [11]. Primary case ascertainment was from the following sources: case records from all four general hospitals; independent information from physicians treating childhood diabetes in these hospitals; the register of the Diabetic Association, of which nearly 70% of all diabetic children are members; children with diabetes known to patients already attending the diabetic clinic. Finally, this was supplemented by post-mortem records, including medico-legal findings and death certificates.

Validation of these methods came from three sources. For Reykjavik and its suburbs, with a population of over 130,000 (more than one-half of the entire population), all prescriptions issued in the last 6 months of 1979 were checked and those for insulin noted. For the Akureyri medical district, which has nearly 17,000 inhabitants and one hospital, the source was the local branch of the Diabetic Association, which is informed whenever a newly-diagnosed child is admitted to hospital. For rural areas all family practitioners, the doctors working in the two rural hospitals manned by consultant physicians, and all local pharmacists were questioned at least once. The primary sources identified 52 incident and 28 prevalent cases, which were validated and no additional cases were identified.

For 1980–1989 newly-diagnosed children have been identified in several ways. Since 1980 a prospective registration of new cases has been conducted by the diabetic clinic by collaborating physicians at the four hospitals and other contact persons. The majority of children were listed at diagnosis or shortly after; those remaining were subsequently identified by direct enquiry to the physicians. This was checked with the register of the Diabetic Association. The degree of ascertainment was derived by comparing the register of the diabetic clinic and that of the secondary source, the National Insurance Institution. The diabetic clinic register identified 68 incident and 36 prevalent cases. All but two incident cases were found in the insurance register which did not identify any cases not registered by the clinic. Thus, for 1970–1989, validity tests have revealed a degree of ascertainment of 100%.

A total of 120 children developed Type 1 diabetes before their 15th birthday during the 20-year period studied. Additionally, two cases of maturity onset diabetes of the young (positive family history, one patient with absence of islet cell antibodies, no insulin treatment required to prevent ketosis for 7 and 9 years, respectively) were identified and excluded from further analysis.

Statistical analysis

The age-standardization assumed the reference population for both sexes to be distributed in one-thirds between the 5-year age groups 0–4, 5–9, and 10–14 years. A 95% confidence interval (CI) for data was derived by using a Poisson distribution [12]. The ratio between two incidence figures was tested by assuming its logarithm to be normally distributed with a variance estimated as the sum of the reciprocals of the underlying numbers [13]. Temporal variation in incidence was further evaluated by using the statistical program package EGRET for Poisson regression analysis [14]. The independent variables tested were: calendar year at diagnosis of diabetes, age at diagnosis in three 5-year age-groups (0–4, 5–9 and 10–14 years), sex and the square of the year at diagnosis, together with the cross-products of the variables.

Results

During 1970 to 1989, the overall age-adjusted mean annual incidence per 100,000 of Type 1 diabetes was 9.4 (95% CI 7.8–11.3). The incidence was similar for boys and girls, 9.9 (7.7–12.7) and 8.8 (6.7–11.5), respectively. The age-adjusted year-to-year incidence for boys and girls combined is shown in Figure 1. A Poisson regression analysis was performed with incidence as the dependent variable and calendar year at diagnosis, age-group and gender as independent variables. Age was the only significant contributing factor ($p < 0.001$), while a linear trend for the calendar year at diagnosis was not ($p = 0.07$). No interaction between year at diagnosis, age and sex was found. However, testing the calendar year at diagnosis and its square value together revealed a significant quadratic trend ($p < 0.05$), which fitted the temporal pattern in incidence (Fig. 1). The unexpected low incidence in 1986 significantly differed from random variation ($p < 0.05$), while the peak in 1978 did not ($p < 0.10$).

Table 1. Mean annual incidence per 100,000 and 95% confidence intervals (CI) of Type 1 (insulin-dependent) diabetes in children 0–14 years of age in Iceland during 1970–1989

	1970–1979	1980–1989
<i>Boys</i>		
New patients (n)	31	34
Population at risk/year	33,675	32,459
Incidence (95% CI)	9.3 (6.3–13.2)	10.5 (7.3–14.7)
<i>Girls</i>		
New patients (n)	21	34
Population at risk/year	32,125	30,891
Incidence (95% CI)	6.6 (4.1–10.1)	11.1 (7.6–15.5)
<i>Both sexes</i>		
New patients (n)	52	68
Population at risk/year	65,800	63,350
Incidence (95% CI)	8.0 (6.0–10.6)	10.8 (8.4–13.8)

Population data from National Register of Iceland



Fig. 2. Age-adjusted (0–14 years) annual incidence per 100,000 of Type 1 (insulin-dependent) diabetes by age at diagnosis and sex during 1970 to 1989. Boys —; Girls ---

Table 2. Mean annual incidence per 100,000 of Type 1 (insulin-dependent) diabetes in children 0–14 years of age in the Nordic countries

Country	Study period	Cases per 100,000
Finland	1970–1979	28.6
	1983–1988	34.2
Sweden	1970–1975	19.6
	1978–1987	24.4
Norway	1973–1977	18.5
	1978–1982	22.7
Denmark	1970–1976	14.0
Iceland	1970–1979	8.0
	1980–1989	10.8

Based on references 5, 6, 8, 15–17, 21

The age-adjusted mean annual incidences for both sexes during 1970–1979 and 1980–1989 are shown in Table 1 and no significant differences were found. Figure 2 shows the age-adjusted incidence in relation to age at diagnosis and for the sexes separately for 1970–1989. Furthermore, for boys and girls together, the mean annual incidence per 100,000 for the age groups 0–4, 5–9, and 10–14 years, was 2.6 (1.3–4.7), 8.9 (6.3–12.2), and 16.5 (13.0–20.9), respectively. The total prevalence per 1,000 of Type 1 diabetes was similar by the end of 1979 and 1989; 0.45 (0.30–0.65) and 0.57 (0.40–0.79), respectively.

Table 2 shows the mean annual incidence of Type 1 diabetes in Iceland compared to that in the other Nordic countries for the years 1970–1989.

Discussion

The most striking finding of this study was an annual incidence of Type 1 diabetes of only one-half to less than one-third that found in the other Nordic countries for corresponding study periods [5, 6, 8, 15–17, 21]. Similar differences were confirmed for the prevalence rates [16, 18–20]. Interestingly, previous surveys in Iceland in the

1940s and 1950s had shown that the incidence of Type 1 diabetes was very low [22].

The Norwegian heritage of the Icelandic nation is of particular interest in relation to the comparative risk of developing Type 1 diabetes in the two countries [9]. Importantly, Reykjavik is located at about the same latitude (64° north) as the Trøndelag, Møre and Roms, and Sogn and Fjord counties on the central west coast of Norway. Furthermore, during 1931–1960 the yearly average temperature in Reykjavik was 5.0°C, whilst in the Norwegian regions it was 4.9° to 6.0°C, depending on the county [10]. In 1973–1982 the mean annual incidence per 100,000 for the Norwegian west coast counties was 19.7 [5] compared to 8.0 for 1970–1979 in Iceland. This striking difference may imply a causative role for environmental factors that are not related to latitude or ambient temperature [23–26].

A linear increase in incidence for the 20-year period studied was not found, whereas a quadratic curve better described the temporal variation. This finding contrasts with reports of a continued increase of childhood diabetes in the other Nordic countries [5–8], although a non-linear curve would also better describe the temporal pattern noted in Finland [8]. In accordance with previous studies, the incidence increased with age [1–8], but did not differ between the sexes. This contradicts findings of a higher incidence for boys during 1970–1979 in the other Nordic countries [5, 15, 16, 20]. A study from Finland for 1965–1984 also showed an overall higher incidence for boys [8], while recent data from Sweden for 1978–1987 indicate an equal sex distribution [6].

In conclusion, this study, with an ascertainment rate of 100%, has revealed a markedly low incidence of childhood Type 1 diabetes in Iceland compared to the other Nordic countries. These findings, in conjunction with recent studies from Spain, Sardinia and Malta of a relatively high incidence in the Mediterranean area [27–29], and a study from Estonia indicating a relatively low incidence [30], are inconsistent with the notion of a European north-south gradient for risk of developing Type 1 diabetes [1].

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