Cyclical Variation in the Incidence of Childhood Type 1 Diabetes in Western Australia (1985–2010)

AVENI HAYNES, MBBCHIR[1,2]
MAX K. BULSARA, PHD[3]
CAROL BOWER, PHD[2]
TIMOTHY W. JONES, MD[1,2]
ELIZABETH A. DAVIS, FRACP[1,2]

OBJECTIVE—To examine the incidence of childhood type 1 diabetes in Western Australia from 1985–2010.

RESEARCH DESIGN AND METHODS—Incidence rates were calculated for children aged 0–14 years and were analyzed by calendar year, sex, and age at diagnosis.

RESULTS—There were 1,873 cases, and the mean incidence was 18.1/100,000 person-years (95% CI: 17.5–19.2). The incidence increased by 2.3% a year (1.6–2.9%) with a sinusoidal 5-year cyclical variation of 14% (7–22%). The lowest rate of increase in incidence was observed in 0–4-year-olds.

CONCLUSIONS—The cyclical pattern in incidence observed supports the role of environmental factors in childhood type 1 diabetes.

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Between 1985 and 2002, the incidence of type 1 diabetes in children aged 0–14 years in Western Australia increased by an average of 3.2% a year (1). Since then, the continuing rise in incidence of childhood type 1 diabetes has been reported elsewhere in Australia (2) and worldwide (3). This study aimed to update the data available on the incidence of childhood type 1 diabetes in Western Australia and study patterns of incidence over the entire period of observation.

RESEARCH DESIGN AND METHODS

—Cases were ascertained from the Western Australia Children's Diabetes database, a prospective population-based diabetes register established in 1987, which is estimated to be >99% complete (1). All children classified as having type 1 diabetes based on a combination of clinical, biochemical, and autoantibody assay findings, aged <15 years, and resident in Western Australia at the time of diagnosis were included in the study. Patients with maturity-onset diabetes of the young, type 2 diabetes, or secondary diabetes were excluded. This study received approval from the Princess Margaret Hospital Ethics Committee.

Incidence rates were calculated using annual population estimates from the Australian Bureau of Statistics (4). Poisson regression was used to analyze the incidence rates by calendar year, sex, and age-group at diagnosis (0–4, 5–9, and 10–14 years) and to estimate the temporal trends. To analyze the incidence for nonlinear variation, sine and cosine functions were applied to Poisson regression models for 3-, 4-, 5-, 6-, and 7-year cycles and the Akaike Information Criterion used to assess goodness-of-fit.

RESULTS

—There were 1,873 cases (923 girls, 950 boys) of type 1 diabetes diagnosed in children aged <15 years in Western Australia between 1985 and 2010. Of these, 382 (20%) were diagnosed aged 0–4 years, 714 (38%) between 5 and 9 years, and 777 (42%) between 10 and 14 years.

From 1985 to 2010, the mean age standardized incidence rate was 18.1/100,000 person-years (95% CI: 17.5–19.2), with the incidence ranging from 11.3/100,000 in 1985 to 25.5/100,000 in 2003 (Fig. 1). The incidence increased by an average of 2.3% a year (1.6–2.9%). There was a significant sinusoidal cyclical variation in incidence of 14% (7–22%; $P < 0.001$) with a 5-year cycle providing the best model fit (Akaike Information Criterion 7.518) (Fig. 1). A sinusoidal 5-year cyclical variation in incidence was observed in both boys and girls and in all age-groups.

There was no difference in the mean incidence or incidence rate trends between boys and girls. From 1985 to 2010, the mean age standardized incidence was 17.7/100,000 person-years (95% CI: 16.9–19.3) in boys and 18.5/100,000 person-years (17.4–19.8) in girls. There was an average annual increase of 2.9% (2.0–3.8%) in boys and 1.5% (0.6–2.4%) in girls.

From 1985 to 2010, the mean incidence in 0–4-year-olds was 11.0/100,000 person-years (95% CI: 10.3–12.6), which was significantly lower than the mean incidence of 21.1/100,000 (19.5–22.6) in 5–9-year-olds and 25.5/100,000 (20.8–23.9) in 10–14-year-olds. Over the same period, there was an average annual increase in incidence of 1.3% (1.0–2.6%) in 0–4-year-olds, 2.4% (1.4–3.5%) in 5–9-year-olds, and 2.5% (1.5–3.5%) in 10–14-year-olds.

CONCLUSIONS

—In Western Australia, the incidence of type 1 diabetes in children aged 0–14 years increased by an average of 2.3% a year between 1985 and 2010, and a significant 5-year cyclical pattern in the incidence rate trend was observed.

Nonlinear temporal incidence rate trends of childhood type 1 diabetes have recently been reported in some populations (5), and a leveling off in incidence has been reported in others (6). Epidemics, or peaks in the incidence, of childhood

From the [1]Department of Endocrinology and Diabetes, Princess Margaret Hospital, Perth, Western Australia, Australia; the [2]Telethon Institute for Child Health Research, Centre for Child Health Research, The University of Western Australia, Perth, Western Australia, Australia; and the [3]Institute for Health and Rehabilitation Research, University of Notre Dame, Fremantle, Western Australia, Australia.
Corresponding author: Elizabeth A. Davis, Elizabeth.Davis@health.wa.gov.au.
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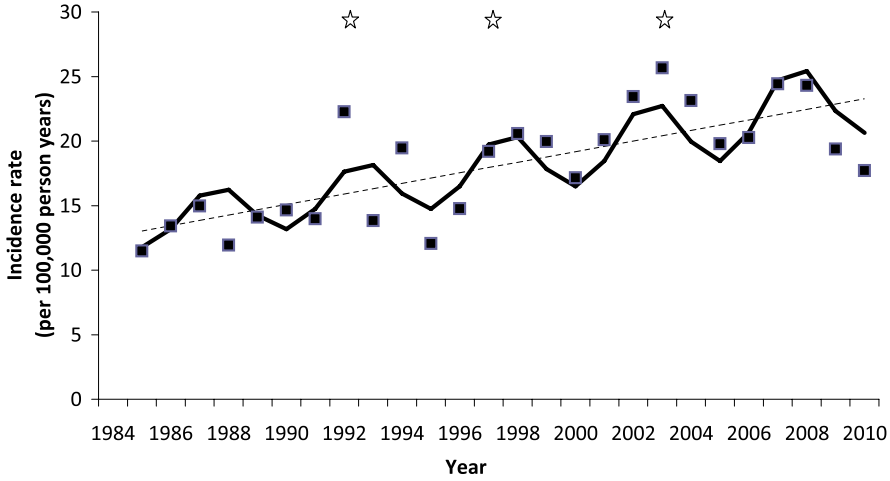

Figure 1—*Incidence of childhood type 1 diabetes in Western Australia from 1985 through 2010. Black squares, observed annual incidence; solid line, estimated 5-year cyclical trend; dotted line, estimated linear trend; and white stars, peak incidence years (1992, 1997, and 2003) reported in published study from Northeast England (11) for comparison.*

type 1 diabetes have been reported in several populations over the past few decades (7–9). A 4-year cyclical pattern in the incidence of childhood type 1 diabetes has been reported in Yorkshire, England (10), and a 6-year cyclical pattern was recently reported in Northeast England (11).

In Western Australia, a significant 5-year cyclical pattern in incidence was observed between 1985 and 2010. Of particular interest, almost identical peak and trough incidence years were found in Western Australia as those reported in Northeast England, despite the two populations having very different demographic and climatic conditions. Being on opposite hemispheres, these populations would experience opposite seasons and infectious disease cycles. Consistent with findings in many European populations, a seasonal variation in the incidence of childhood type 1 diabetes in Western Australia has been reported, with a higher number of patients diagnosed in the cooler winter and autumn months (1). The data presented in this study and those reported in Northeast England are the annual incidence rates and do not illustrate differences in seasonal variation in incidence that may occur due to the populations experiencing opposite seasons.

Factors that have a cyclical nature, and which might modify the risk of childhood type 1 diabetes in both populations, include infections. Viral infections, in particular enterovirus infections, are thought to have a role in the etiology of type 1 diabetes (12,13). One early study linked the cyclical pattern in incidence of childhood type 1 diabetes with the cyclical variation in the number of reported mumps virus infections (14), but these findings have not been replicated. As well as infections, the climate (15) and cyclical weather patterns may play a role by altering lifestyle or environmental factors that modify the risk of childhood type 1 diabetes. An alternate explanation for the cyclical pattern observed is that a trough in incidence may follow peak years due to an exhaustion of individuals at risk for the disease.

The cyclical pattern in incidence observed in Western Australia supports the role of environmental factors in childhood type 1 diabetes. These factors may either be environmental risk or protective factors that modify the likelihood of developing type 1 diabetes de novo or of progressing to clinical type 1 diabetes in those with established autoimmune prediabetes. With similar peak and trough incidence years found in Western Australia as have been reported in Northeast England, the next step is to try and identify what factors could be influencing the risk of childhood type 1 diabetes in these distinct populations during the same calendar years.

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