Is the Incidence of Diabetes Increasing in All Age-Groups in The Netherlands?

Results of the second study in the Dutch Sentinel Practice Network

DIRK RUWAARD, MD
RONALD GIJSEN, MSC
AAD I.M. BARTELDS, MD
REMY A. HIRASING, MD, PHD
HARRY VERKLEIJ, PHD
DAAN KROMHOUT, PHD, MPH

OBJECTIVE — To assess possible changes in the incidence of diabetes in all age-groups in The Netherlands during a 10-year period (1980–1983/1990–1992).

RESEARCH DESIGN AND METHODS — Since 1970, a network of sentinel stations (the Dutch Sentinel Practice Network) consisting of ~1% of the Dutch population has been in operation to gain insight into the morbidity patterns of the Dutch population as recorded by general practitioners. One of the items recorded from 1990 to 1992 was the incidence of diabetes. The first study with a similar design that registered the incidence of diabetes was conducted from 1980 to 1983.

RESULTS — The overall incidence of diabetes increased significantly by 12.1% in the period between the two studies. This overall increase can largely be attributed to a statistically significant increase in the age-group 45–64 years (30.5%). Although not statistically significant, the 36% increase of diabetes in the age-group 0–19 years is in accordance with the increase of type I diabetes based on the first and second nationwide retrospective studies covering the total Dutch population.

CONCLUSIONS — There is a marked increase in the incidence of diabetes in the age-group 45–64 years. This selective increase is probably not due to a real rise caused by changes in exposure to risk factors but to an earlier recognition of symptoms and signs of diabetes followed by blood glucose measurements and/or to more intensive case finding in general practice.

In recent decades, an increase in the incidence of type I (insulin-dependent) diabetes has been found in several countries (1–6). A study among the 1960–1970 birth cohorts of 18-year-old male army conscripts (7) and a comparison of the first (1978–1980) and second (1988–1990) nationwide retrospective studies (1988–1990) among individuals <20 years of age (8,9) revealed that the incidence of type I diabetes is also rising in The Netherlands.

Whether the incidence of diabetes is also increasing for those >19 years of age in The Netherlands is not known. One of the results of a Delphi investigation that we conducted in 1989–1990 among 33 experts on diabetes in The Netherlands indicated an average expected increase in incidence of 8% for the period 1980–2005 (10,11). The study presented here offers an opportunity to assess empirically based changes in the incidence of diabetes, especially for those >19 years of age, during a 10-year period (1980–1983/1990–1992).

RESEARCH DESIGN AND METHODS

— In The Netherlands, general practices are a useful source for gaining insight into the morbidity patterns of the population. In the Dutch health care system, everyone has their own general practitioner, who operates as a "gatekeeper." This implies that health problems will first be presented to the general practitioner and that no patient will visit a specialist without being referred by his or her general practitioner. In addition, the specialist informs the general practitioner about clinical or poliClinical findings (such as diagnosis and laboratory results). However, it should be emphasized that the morbidity patterns registered in general practice specifically reflect the health problems presented by those who make an appeal to the health care system.

Since 1970, a network of sentinel stations (the Dutch Sentinel Practice Network) has been in operation to gain insight into the morbidity patterns of the Dutch population as recorded by general practitioners (12). This network has been designed to be as representative for the Dutch population as possible (for age, sex, and degree of urbanization) and covers ~1% of the population. It was realized when recruiting the "spotter" physicians that there could be no question of a random sample of Dutch general practitioners; an expressly positive attitude on the part of the participating physicians was called for, plus an intention to participate for a number of years. Primarily physicians that had participated in the forerunner of this network (the first Dutch National Morbidity Survey), which consisted of 50 general practitioners (12), were involved. In addition, interested general practitioners who applied themselves or were recommended by others were selected, taking into account the criteria that the network should be representative for the Dutch population and cover 1% of the total. The same criteria were used when a general practitioner left the network and had to be replaced by another. To determine how representative the study sample is compared with the total Dutch population, a census is performed every 2 years. Since 1970, the net-

From the National Institute of Public Health and Environmental Protection (D.R., R.G., H.V., D.K.), Bilthoven; the Netherlands Institute of Primary Health Care (A.I.M.B.), Utrecht; the TNO Institute for Prevention and Health (R.A.H.), Leiden; and the Department of Epidemiology and Public Health (D.K.), Agricultural University Wageningen, Wageningen, The Netherlands.

Address correspondence and reprint requests to D. Ruwaard, MD, National Institute of Public Health and Environmental Protection, P.O. Box 1, 3720 BA Bilthoven, The Netherlands. E-mail: dirk.ruwaard@rivm.nl.

Received for publication 25 April 1995 and accepted in revised form 12 October 1995.

NHANES, National Health and Nutrition Examination Survey; WHO, World Health Organization.

Table 1—*Estimated incidence (per 1,000 person-years) and total number of newly diagnosed patients with diabetes in The Netherlands in 1990 according to the Dutch Sentinel Practice Network*

	Men				Women				Total			
	1	2	3	4	1	2	3	4	1	2	3	4
Age-group (years)												
0–19	10	52,236	0.2 (0.1–0.4)	372	8	50,411	0.2 (0.1–0.3)	296	18	102,647	0.2 (0.1–0.3)	668
20–44	45	89,192	0.5 (0.4–0.7)	1,605	25	88,029	0.3 (0.2–0.4)	868	70	177,221	0.4 (0.3–0.5)	2,473
45–64	132	46,255	2.9 (2.4–3.4)	4,443	143	47,336	3.0 (2.5–3.5)	4,710	275	93,591	3.0 (2.6–3.3)	9,153
65–79	110	19,438	5.7 (4.6–6.8)	3,597	121	24,922	4.9 (4.0–5.7)	4,152	231	44,360	5.2 (4.5–5.9)	7,749
≥80	23	4,186	5.5 (3.5–8.2)	732	37	8,735	4.2 (3.0–5.8)	1,270	60	12,921	4.6 (3.5–6.0)	2,002
Total	320	211,307	1.5 (1.3–1.6)	10,749	334	219,433	1.5 (1.3–1.7)	11,295	654	430,740	1.5 (1.4–1.6)	22,044

Data are 1) observed number of newly diagnosed patients in the Sentinel Practice Network in the period 1990–1992; 2) total number of person-years in the Sentinel Practice Network (1990–1992); 3) estimated incidence per 1,000 person-years, standardized to the Dutch population in 1990 (95% CI); 4) estimated total number of newly diagnosed patients in The Netherlands in 1990.

work has consisted of 60–65 general practitioners working in ~45 sentinel stations.

A committee decides annually which items will be recorded on a registration form that has to be filled in by the general practitioner and sent to the Central Project Bureau once a week. At this bureau, the forms are checked, and in the case of uncertainties, the general practitioner is contacted. One of the items recorded in 1990–1992 by 63 general practitioners (43 sentinel stations) was the incidence of diabetes, which is defined as the number of patients newly diagnosed during that period per 1,000 person-years according to the diagnostic criteria formulated in 1985 by the World Health Organization (WHO) (13). The overall denominator (expressed in person-years) represents the sum of the separate denominators per sentinel station. To estimate the denominator per sentinel station during the period 1990–1992, the number of people present in that station (according to the census of 1991) was multiplied by the registration period (mostly the full period of 3 years, in one station 2 years, and in another station half a year). For every recorded patient, a supplementary questionnaire was filled in to collect information about the diagnostic approach, the treatment given, and the complications present at age of onset.

The first time the incidence of diabetes was recorded in the Dutch Sentinel Practice Network was in the period 1980–1983 (62 general practitioners working in 46 sentinel stations). To estimate the denominator, the censuses of 1979, 1981, and 1983 were used. At that time, the WHO criteria of 1980 (14) were used instead of the 1985 criteria (13). Depending on the circumstances in which the blood glucose value was measured (whole blood/plasma, venous/capillary, fasting/2 h after a 75-g glucose load), the diagnostic cutoff levels according to the 1980 and 1985 criteria differed 0.0–0.3 mmol/l from each other. For instance, according to the 1985 criteria, the diagnostic fasting cutoff value measured in capillary whole blood amounted to ≥6.7 mmol/l, while this value was ≥7.0 mmol/l using the 1980 criteria. On the other hand, the diagnostic cutoff value in capillary whole blood 2 h after a 75-g oral glucose load was ≥11.1 and ≥11.0 mmol/l, applying the 1985 and 1980 criteria, respectively. As we recorded the glucose values in our second study (1990–1992) and retrospectively traced the glucose values of the incident cases (who were still alive) in our first study (1980–1983), it became possible to detect spurious changes in the incidence caused by differences in diagnostic criteria. It appeared that only one newly diagnosed patient (out of 654) in the second study (based on 1985 criteria) would not have been diagnosed using the 1980 criteria (a thirsty 61-year-old woman with a fasting blood glucose of 6.9 mmol/l), while all newly diagnosed patients in the first study (based on 1980 criteria) would have been diagnosed according to the 1985 criteria.

To correct for changes in incidence caused by demographic developments, all data was standardized (by 5-year age-groups and sex) to the Dutch population of 1990. Because the first study did not distinguish between men and women, we pooled these figures in the second study. This was also done with the subsequent age-groups >65 years. Changes in incidence were then calculated for the age-groups 0–19, 20–44, 45–64, and >64 years. Statistical significance was tested with the z test to compare two proportions ($P < 0.05$). In addition, the 95% CIs of the differences in incidence were estimated using the normal approximation for the binomial distribution.

RESULTS— Table 1 shows the incidence of diabetes. Note that the incidence increases up to 80 years of age, after which a decline can be seen. This applies to men as well as to women. A significant difference between men and women according to age-group (z test; $P < 0.05$) could not be found. However, the absolute number of newly diagnosed diabetic patients is the largest in the age-group 45–65 years.

Table 2 presents the changes in incidence by comparing our recent study in the sentinel network (1990–1992) with the former one (1980–1983). The figures indicate that the overall incidence of diabetes increased significantly by >12% over a period of 10 years. This overall increase can largely be attributed to a significant increase in the age-group 45–64 years. For the other age-groups, the increase is not significant, although the relative increase is most prominent in the youngest age-group.

CONCLUSIONS— To obtain incidence estimates that are less prone to chance, a rather large population size is needed. The Dutch Sentinel Practice Network, consisting of more than 140,000 people, has the largest denominator of all

Table 2—*Estimated incidence of diabetes per 1,000 person-years in 1980–1983 and 1990–1992 standardized to the Dutch population in 1990*

	1980–1983	1990–1992	Absolute increase (95% CI)	Increase (%)
Age-group (years)				
0–19	0.13	0.17	0.05 (−0.03–0.13)	35.9
20–44	0.41	0.43	0.01 (−0.09–0.12)	3.4
45–64	2.26	2.95	0.69 (0.25–1.13)	30.5
≥65	5.15	5.16	0.01 (−0.80–0.82)	0.3
Total	1.33	1.49	0.16 (0.01–0.31)	12.1

Dutch continuous morbidity registrations in primary care. The others contain 50,000 people or fewer (15–18). Nevertheless, we recorded the incidence in a 3-year period to increase the denominator even more.

To correct for an undercount of cases, the capture-recapture census method is recommended in the literature, using an independent secondary source for ascertainment (19). Even though a secondary source for validation is lacking, the incidence figures found in the Dutch Sentinel Practice Network are likely to be reliable. The network has been in operation for a long period of time, and the general practitioners who participate in it are not only highly motivated but also experienced in recording health problems. Most general practitioners have been participating for many years; ~66% of the general practitioners are still involved after a 10-year period. Besides, in the Dutch health care system, general practitioners play a central role because they operate as gatekeepers. In spite of the fact that diabetic patients are diagnosed or treated by a specialist, the general practitioner is informed by the specialist and is therefore able to record health problems detected by the specialist. According to the results of the supplementary questionnaire from our recent study (1990–1992), 17.9% of all newly diagnosed patients were recorded in this way. Nevertheless, just a few cases might have been missed at the end of the recording period because of a delay in transferring information. However, the same applies to the previous study.

On the other hand, when the incidence figures from the Dutch Sentinel Practice Network are compared with those from the relatively small samples of other continuous morbidity registrations in primary care, the incidence in the sentinel network is 1.5- to 2-fold lower (15–18). Discrepancies in the objectives, design, definition of the numerator (such as diagnostic criteria), extent and definition of the denominator, and length of the recording period are assumed to be responsible for the differences (20). For example, the Dutch Sentinel Practice Network is specially designed to obtain incidence and prevalence figures in primary practice, while other registrations focus more on recording medical consumption or include uncertain diagnoses.

This study is the first in The Netherlands to assess possible changes in the incidence of diabetes for all age-groups based on a rather large denominator. When the results of this study were compared with the former study with a similar design, it appeared that the relative increase (nearly 36%) was greatest in the age-group 0–19 years. However, the number of cases in this younger age-group is too few to obtain statistically significant changes, despite the fact that the sentinel network covers ~1% of all Dutch inhabitants and that in both studies several years were used to estimate the average annual incidence. Nevertheless, the change in incidence of diabetes in the age-group 0–19 years is indicative of an important increase. This finding is in line with the 23% increase of type I diabetes based on the first (1978–1980) and second (1988–1990) nationwide retrospective studies involving all pediatricians and internists and covering the total Dutch population (8,9). The causes of this increasing incidence, observed in several countries (1–9), are unknown.

It is striking that above 20 years of age, a statistically significant increase in the incidence is only found in the age-group 45–64 years. As stated earlier, this rise is probably not the result of changes in diagnostic criteria. Besides, it seems unlikely that changes in exposure to risk factors, especially for type II (non-insulin-dependent) diabetes, are responsible for this 30.5% age-specific increase. Three large screening projects on cardiovascular risk factors in which height and weight were measured indicated that in the period 1974–1991 there was no change in the mean BMI (kg/m^2) or marked increase in the age-adjusted prevalence of obesity (BMI ≥30 kg/m^2) in the Dutch population (21,22). Data from the last screening project among 36,000 men and women aged 20–59 years showed a stable BMI in the period 1987–1991, with a slight significant increase in obesity of 0.3% per year for men. The mean prevalence of obesity amounted to 7.4% for men and 9.0% for women, respectively (22). A marked change in the prevalence of physical inactivity in the period 1987–1991 was not observed either (23).

Recently, general practitioners have become very aware of diabetes as a public health problem. In 1988, the Dutch College of General Practitioners published its *Standard Diabetes Mellitus Type II* (24). This standard contains guidelines on the diagnosis, treatment, and support of non–insulin-using type II patients. One of the recommendations is to examine every person with an impaired glucose tolerance annually. In 1988–1990 the Steering Committee on Future Health Scenarios emphasized the phenomenon of underreporting diabetes and the importance of the disease as a major and growing cause of prolonged ill health and premature mortality (10). The Steering Committee brought to the attention of medical practitioners the results of the second National Health and Nutrition Examination Survey (NHANES II, 1976–1980) carried out in the U.S. It was found that diagnosed patients in the age range 20–74 years represent only 50% of all patients with diabetes (25). Recently, it appeared that in The Netherlands, many individuals also suffer from undiagnosed disturbances in glucose metabolism (26–28). In a cross-sectional study among 2,472 people aged 50–74 years in the Dutch town of Hoorn, the prevalence of previously diagnosed diabetes was 4.2%, while diabetes was newly diagnosed in 4.8% by means of an oral glucose tolerance test (28). The Hoorn Study findings were in line with those from NHANES:

roughly 50% of patients with diabetes were undiagnosed. In accordance with pronouncements in the literature (29,30), the Steering Committee is cautious about the establishment and administration of large screening programs for type II diabetes. It was recommended instead to explore the possibilities of case findings in general practice among people >50 years of age with obesity and/or a positive family history of type II diabetes and/or the existence of complications that might be attributable to diabetes. These developments may have influenced the general practitioners' diagnostic behavior and might be responsible for the increase found in the age-group 45–64 years, because this group is of special interest with respect to case-finding activities in general practice.

To verify this hypothesis, a questionnaire was sent to the general practitioners who participated during both recording periods. It was confirmed that for this age-group there is a tendency to measure blood glucose in those who make an appeal to the health care system for other health problems (case finding). On the other hand, the general practitioners observed that people are better able to recognize symptoms associated with diabetes, whereas a greater alertness on the part of the general practitioner leading to earlier recognition may also be of importance. In addition, blood glucose measurements to confirm the diagnosis conducted by the general practitioner when symptoms are found are common nowadays (replacing the less sensitive measurements of glucose in the urine used in the past).

To underpin these observations quantitatively, it is valuable to compare the use of diagnostic tests and the presence of symptoms in newly diagnosed patients over time. An increase in case-finding activities will be accompanied by a decline in the existence of initial symptoms. However, when an increase in case-finding activities as well as in early recognition of symptoms and signs is evident, the results will be difficult to interpret. Unfortunately, because a supplementary questionnaire was not used in the former study, it is difficult to establish changes in the diagnostic approach. The recent study indicated that in addition to glucose measurements to establish the diagnosis, 65.4% of the cases also initially presented symptoms and signs associated with diabetes.

Our findings illustrate that to interpret trend data, one must be aware of different kinds of developments that not only are confined to etiological factors per se, but also take into account changes in health care practice. This is necessary not only to interpret time trends in the incidence (and prevalence) of type II diabetes found within one study, but also to make comparisons between studies and countries. The ideal solution for disentangling real trends from trends due to changes in the proportion of diagnosed and undiagnosed patients is to link periodic or continuous morbidity registrations (physician-diagnosed cases) both in time and on an individual level with intermittently performed population-based (screening) surveys. It is worthwhile to explore the most cost-effective ways to achieve this ideal.

Acknowledgments— The study was supported by grant 89–111 from the Ministry of Health, Welfare and Sport.

We thank the participating general practitioners and the secretary of the Central Project Bureau of the Dutch Sentinel Practice Network for efforts in recording and collecting the data.

References

1. Bingley PJ, Gale EAM: Rising incidence of IDDM in Europe. *Diabetes Care* 12:289–295, 1989
2. Joner G, Søvik O: Increasing incidence of diabetes mellitus in Norwegian children 0–14 years of age, 1973–1982. *Diabetologia* 32:79–83, 1989
3. Diabetes Epidemiology Research International Group: Secular trends in incidence of childhood IDDM in 10 countries. *Diabetes* 39:858–864, 1990
4. Nyström L, Dahlquist G, Rewers M, Wall S: The Swedish Childhood Diabetes Study: an analysis of the temporal variation in diabetes incidence, 1978–1987. *Int J Epidemiol* 19:141–146, 1990
5. Tuomilehto J, Rewers M, Reunanen A, Lounamaa P, Lounamaa R, Tuomilehto-Wolf E, Åkerblom HK: Increasing trend in type 1 (insulin-dependent) diabetes mellitus in childhood in Finland. *Diabetologia* 34:282–287, 1991
6. Green A, Andersen PK, Svendsen AJ, Mortensen K: Increasing incidence of early onset type 1 (insulin-dependent) diabetes mellitus: a study of Danish male birth cohorts. *Diabetologia* 35:178–182, 1992
7. Drykoningen CEM, Mulder ALM, Vaandrager GJ, LaPorte RE, Bruining GJ: The incidence of male childhood type 1 (insulin-dependent) diabetes mellitus is rising rapidly in The Netherlands. *Diabetologia* 35:139–142, 1992
8. Vaandrager GJ, Bruining GJ, Veenhof EJ, Drayer NM: Incidence of childhood diabetes in the Netherlands: a decrease from north to south over North-Western Europe? *Diabetologia* 27:203–206, 1984
9. Ruwaard D, Hirasing RA, Reeser HM, Bakker K, Heine RJ, Geerdink RA, Bruining GJ, Vaandrager GJ, Verloove-Vanhorick SP: Increasing incidence of type I diabetes in The Netherlands: the second nationwide study among children under 20 years of age. *Diabetes Care* 17: 599–601, 1994
10. Steering Committee on Future Health Scenarios: *Chronic Diseases in the Year 2005. Volume 1: Scenarios on Diabetes Mellitus 1990–2005*. Dordrecht, The Netherlands, Kluwer, 1991
11. Ruwaard D, Hoogenveen RT, Verkleij H, Kromhout D, Casparie AF, van der Veen EA: Forecasting the number of diabetic patients in The Netherlands in 2005. *Am J Public Health* 83:989–995, 1993
12. Bartelds AIM, Fracheboud J, van der Zee J: *The Dutch Sentinel Practice Network: Relevance for Public Health Policy*. Utrecht, The Netherlands, The Netherlands Institute of Primary Health Care, 1989
13. World Health Organization: *Diabetes Mellitus: Report of a WHO Study Group*. Geneva, World Health Org., 1985 (Tech. Rep. Ser., no. 727)
14. World Health Organization: *WHO Expert Committee on Diabetes Mellitus*. Geneva, World Health Org., 1980 (Tech. Rep. Ser., no. 646)
15. van de Lisdonk EH, Bosch WJHM, Huygen FJA, Lagro-Jansen ALM: *Ziekten in de huisartspraktijk (Diseases in general practice)*. Utrecht, The Netherlands, Wetenschappelijke Uitgeverij Bunge, 1990
16. Lamberts H, Brouwer HJ, Mohrs J: *Reason for Encounter- and Episode- and Process-Oriented Standard Output From the Transition Project*. Parts 1 and 2. Amsterdam, Department of General Practice, 1991
17. Oskam SK, Brouwer HJ, Mohrs J: *TRANS, an Interactional Access Program for Standard Output of the Transition Project*. Amsterdam, Department of General Practice, 1994
18. Metsemakers JFM, Höppener P, Knottnerus JA, Limonard CHBG: *Health Problems and Diagnoses in Family Practice*. Maastricht, The Netherlands, Registration Network Family Practices, University of Limburg, 1992

19. LaPorte RE, McCarthy D, Bruno G, Tajima N, Baba S: Counting diabetes mellitus in the next millennium: application of capture-recapture technology. *Diabetes Care* 16:528–534, 1993
20. Meyboom-de Jong B: Morbidity registration in general practice in The Netherlands. *Huisarts & Wetenschap* 36 (Suppl.): 49–53, 1993
21. Blokstra A, Kromhout D: Trends in obesity in young adults in The Netherlands from 1974 to 1986. *Int J Obesity* 15:513–521, 1991
23. Verschuren WMM, Smit HA, van Leer EM, Berns MPH, Blokstra A, Steenbrink-van Woerden JA, Seidell JC: *Prevalentie van risicofactoren voor hart-en vaatziekten en veranderingen daarin in de periode 1987–1991: Eindrapportage Peilstationsproject Hart-en Vaatziekten 1987–1991*. Bilthoven, The Netherlands, National Institute of Public Health and Environmental Protection, 1994 (Report no. 528901011)
24. Nederlands Huisartsen Genootschap (Dutch College of General Practitioners): *NHG-Standard Diabetes Mellitus Type II*. Utrecht, The Netherlands, Nederlands Huisartsen Genootschap, 1988
25. Harris MI, Hadden WC, Knowler WC, Bennett PH: Prevalence of diabetes mellitus and impaired glucose tolerance and plasma glucose levels in U.S. population aged 20–74 yr. *Diabetes* 36:523–534, 1987
26. Cromme PVM: *Glucose Tolerance in a Typical Dutch Community*. Thesis. Bussum, The Netherlands, Medicom Europe B.V., 1991
27. Feskens EJM, Bowles CH, Kromhout D: Intra- and interindividual variability of glucose tolerance in an elderly population. *J Clin Epidemiol* 44:947–953, 1991
28. Mooy JM, Grootenhuis PA, de Vries H, Heine RJ, Bouter LM: The Hoorn Study: disorders of glucose tolerance in a general Caucasian population (Abstract). *Neth J Med* 41:A29–A30, 1992
29. Singer DE, Samet JH, Coley CM, Nathan DM: Screening for diabetes mellitus. *Ann Intern Med* 109:639–649, 1988
30. U.S. Dept. of Health and Human Services: *Screening for Diabetes: No. 16. Guide to Clinical Preventive Services*. Atlanta, GA, Centers for Disease Control, 1989