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The epidemic of type 2 diabetes is a statistical artefact

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In recent years it has been claimed, with increasing intensity, that the world is experiencing an ongoing epidemic of diabetes. Linked to the increasing prevalence of obesity, this repeated assertion has resulted in increased awareness of diabetes as a public health problem and has stimulated efforts to develop measures for the primary prevention of diabetes. However, it is important to emphasise that the apparent ‘epidemic’ reflects an increasing prevalence of diabetes, as documented in repeated surveys of the same source population and discussed by Colagiuri et al. in this issue of *Diabetologia* [1]. Before we can accept the notion of a diabetes epidemic there is good reason to take a closer look at the epidemiological mechanisms underlying the changing demography of the condition. The prevalence of a chronic disease, such as diabetes, at a given point in time is the net result of the accumulated number of new cases (incidence) minus the accumulated number of deaths in the patient population up to that point in time. When the incidence is equal to the mortality in a demographically stable population, this population is considered to be in epidemiological equilibrium. Any change in incidence and/or mortality will disturb this equilibrium, and the preva-

lence of diabetes will be affected by changes in both incidence and mortality. Støvring et al. have reported the epidemiological characteristics of drug-treated diabetes in a Danish community [2]. Further scrutiny of the data set offers us the opportunity to examine possible explanations for the increasing prevalence of diabetes, as currently experienced worldwide [3, 4].

The Fyn county study of drug-treated diabetes, 1992–1999

Fyn County, with approximately 470,000 inhabitants, may be considered a demographically representative (9%) sample of the total Danish population. Since 1992, all registered prescriptions, which contain unique personal identification data, have been recorded in the Odense Pharmaco-Epidemiological Database [2]. Information on death or migration was obtained by linkage to the central Danish population register for all those identified as having received at least one prescription for diabetes from 1992–1999. For the purpose of the present study, data were obtained for the extended study period (1992 through 2003). Because of a lack of information on the time of diagnosis of diabetes, operational definitions of the basic epidemiological measures were established using a run-in period of 1 year [2]. Thus, the prevalence population of patients receiving treatment at the beginning of a year included subjects with at least one prescription for a diabetes drug during the previous year. For those judged to be untreated at the start of the year, incidence was estimated on the basis of those subjects who redeemed at least one prescription for a diabetes drug during the calendar year. Mortality was based on the deaths during a calendar year among subjects receiving treatment at the beginning of the year. This approach reduces time-dependent misclassification and was used for the detailed analyses of incidence and mortality. On the other hand, incidence may be overestimated owing to the inclusion of individuals who stopped and then restarted, drug treatment. The prevalence also excludes diabetes not treated with medication.

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Fig. 1 Estimated annual incidence (first prescription for a glucose-lowering drug without prescriptions during the previous year) (*white triangles*), number of deaths among the population of patients registered as receiving glucose-lowering treatment (*white squares*)

and the end-year prevalence of patients with at least one prescription for a glucose-lowering drug during the year (*white circles*) in Fyn county, Denmark from 1993–2003

An alternative approach was used to estimate the current and future prevalence of drug-treated diabetes in the study population. Owing to a lack of information on migrations during the period from 2000–2003, this part of the analysis was restricted to the period from 1993–1999. The first year of registration (1992) was used as the run-in period, and any subsequent first-time registered prescription diabetes therapy was considered to represent an incident event of drug-treated diabetes. This allowed estimation of the annual incidence and the incidence rates for the period from 1993–1999. Information on death or migration (the latter representing very small numbers) allowed estimation of annual mortality and end-year prevalence for each year from 1992–1999. Trends in the incidence and mortality rates were used to project the future prevalence up to 2010, with the additional assumption that no further changes in prognosis will take place after 2000. Even though this approach suffers from potential bias with respect to overestimating increasing trends in prevalence, it appeared that there were only marginal differences between the two approaches in terms of annual incidence and death.

Epidemiological characteristics

The prevalence of drug-treated patients increased from around 6,400 to approximately 9,950 over the registration period (Fig. 1). The corresponding annual increases ranged from 2.1% (1996) to 6.4% (2003). Figure 1 also illustrates the trends in the underlying determinants of this prevalence. The annual incidence remained roughly constant at around 1,000 from 1993–1999, followed by an increase to around 1,550 in 2003. The annual number of deaths increased only slightly, reflecting an increasing prevalence (increasing the number of patient-years at risk of death) and a declining mortality rate.

Figure 2 shows the projection of the future prevalence of patients with a history of drug-treated diabetes. The prevalence is projected to more than double between 1993 and 2010. Since this projection assumes that the incidence remains stable, as seen for the period from 1993–1999 (Fig. 1), the major driving force behind the increase is the gap between the (stable) incidence level and the (slightly decreasing) mortality, and not increasing incidence. If the

Fig. 2 Estimated end-year prevalence of patients who have previously received prescriptions for a glucose-lowering drug (regardless of current treatment) in Fyn county, Denmark from 1993–1999, with projection through 2010

incidence is truly increasing from 2000 onwards, as suggested in Fig. 1, this will certainly accelerate the increase in prevalence. In summary, this supplementary analysis shows a sharp rise in the prevalence of individuals registered with at least one prescription for diabetes therapy. This increase is not caused by an increasing incidence but by a reduced mortality, with the result that new cases enter the population faster than patients are removed. The marked gap between incidence and mortality, noted from the beginning of the registration period, suggests that mortality had already started to decline several years before the period of observation. Alternatively, an increase in incidence may have previously occurred but reached a plateau before the period of observation.

Implications

This analysis shows that the number of Danish individuals needing at least one prescription for diabetes is currently increasing at an annual rate of about 5%. This increase does not reflect an increasing incidence. It can be fully explained by a stable incidence rate in combination with a mortality rate that is declining, and that may have been falling over a much longer period. From this perspective, the increasing prevalence of diabetes is a success story for those involved in the clinical management of the condition. The analysis also shows that, in Denmark at least, an increasing prevalence of overweight and obesity has not—so far—had a major affect on the prevalence of drug-treated diabetes. If this should change, the Danish population is likely to witness a more dramatic rise in the future prevalence of

diabetes. This, in itself, justifies intensified efforts to establish community-based programmes aimed at the primary prevention of diabetes. However, given that, at present, the most important driving influence of the rising prevalence of diabetes is the huge gap between incidence and mortality, the effect of primary prevention should not be overestimated.

Although the data presented here are restricted to individuals with at least one registered prescription for a drug for diabetes, we believe that the general epidemiological features of this model may be generalised to most developed (Westernised) populations. The situation in the developing part of the world may be quite different as a result of rapid demographic changes associated with an increasing incidence of diabetes and, perhaps, with declining mortality. Continued monitoring of incidence and mortality, together with the resulting prevalence of disease will be needed to characterise the 'diabetes epidemic' more fully around the world.

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