Routine Data Sources Challenge International Diabetes Federation Extrapolations of National Diabetes Prevalence in Switzerland

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OBJECTIVE—Information on diabetes prevalence in the general population is scarce and often based on extrapolations. We evaluated whether prevalence could be estimated from routine data sources.

RESEARCH DESIGN AND METHODS—The sources were *1*) hospital discharges (2008, *n* = 828,171), *2*) death registry (2007/2008, *n* = 118,659), and *3*) Swiss Health Survey (SHS; 2007, *n* = 18,665). Persons without diabetes as underlying cause of death (death registry) or principal diagnosis (hospital discharges) were regarded as surrogate for a general population random sample.

RESULTS—In those aged 20–84 years, 4.5% of men and 3% of women were expected to have diabetes. By source, estimations were 4.4 and 2.8% (hospital discharges), 3.8 and 3.1% (death registry), and 4.9 and 3.7% (SHS) for men and women, respectively. Among sources, age–sex patterns were similar.

CONCLUSIONS—In countries with adequate data quality, combination of routine data may provide valid and reliable estimations of diabetes prevalence. Our figures suggest that International Diabetes Federation extrapolations substantially overestimate diabetes prevalence in Switzerland.

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In most countries, information on diabetes prevalence is scarce and, as in Switzerland, often based on extrapolations from other countries (1–5). We explored whether the combination of three routine data sources (hospital discharges, death registry, health survey) allows a more valid prevalence estimation. We hypothesize that in Switzerland diabetes remains rarely undetected in inpatients and that the risk of persons with diabetes dying or being hospitalized for a reason other than diabetes (e.g., accident, cancer) is approximately the same as that of persons without diabetes. In that sense, hospitalized or deceased persons with another underlying cause/principal diagnosis other than diabetes may be regarded as a surrogate for a general population sample. In contrast, persons with diabetes as an underlying cause/principal diagnosis are likely to have a substantially increased risk of hospitalization and death compared with persons without diabetes and should thus not be part of the surrogate sample.

RESEARCH DESIGN AND METHODS

Swiss Health Survey

The Swiss Health Survey (SHS) provides nationally representative information on the population aged ≥15 years (6). Sampling is restricted to persons who have a landline phone and who understand a national language. In 2007, 18,665 (66%) people participated in the interview. We defined diabetes with "Were you ever told by a physician you have diabetes?"

Hospital discharges

Inpatient hospital admissions in Switzerland are routinely registered (7). Although anonymous, hospitalizations of the same individual can be merged. One principal diagnosis (generally corresponding to the main reason for hospitalization) and up to 29 additional diagnoses (previously known or detected during hospitalization) are assessed, resulting in approximately 4 million diagnoses relating to 1.0 million persons (2008). Diagnoses are coded according to *International Statistical Classification of Diseases, 10th Revision* (ICD-10; Diabetes: E10–E14). We excluded individuals with principal diagnoses of ICD-10 Chapters "Z," "R," and "O," leaving 1,146,203 hospitalizations from 828,171 individuals with Swiss residence. Only persons with diabetes as an additional (but not principal) diagnosis were included.

Death registry

In principle, the same concept was used as for hospital discharges. Only persons with diabetes as concomitant (but not underlying) cause of death were included. In Switzerland, death is certified by a physician, including information on the underlying cause and up to two concomitant diseases (8). By excluding ICD-10 Chapter "R," 118,659 deaths in 2007–2008 could be analyzed. For 28.3% of these, one concomitant cause of death was registered, and for 41.7%, two concomitant causes of death were registered.

It can be assumed that physicians' diagnosis of diabetes in all three sources was generally based on blood glucose only (random ≥11.1 mmol/L or fasting ≥7 mmol/L). Overall rates were age standardized using the World Health

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Organization standard population "Europe." The number of individuals with diabetes was obtained by multiplication of age- and sex-specific prevalence rates with the respective population counts in 2008.

A Poisson regression model including age, period, sex, and interaction of sex and period was calculated to obtain *P* values for increase in diabetes prevalence in 1995–2008 and for the difference in increase between men and women.

RESULTS

SHS

In 2007, 4.9% of men and 3.7% of women aged 20–84 years reported a diagnosis of diabetes (Table 1). Prevalence peaked in men aged 75–84 years (16.1%) and women aged 85–94 years (12.0%). By projecting these rates to the general population aged 20–84 years in 2008, 279,000 people had diabetes.

Hospital discharges

Of 823,584 inpatients with principal diagnosis other than diabetes, there were 47,566 (5.8%) with diabetes as an additional diagnosis. Prevalence peaked at age 75–84 years (men: 14.8%, women: 11.1%). By extrapolating prevalence rates to the general population, 237,200 people had diabetes.

Death registry

Among the 118,659 individuals with an eligible underlying cause of death, a code for diabetes was found in 12,018 (10.1%). By limiting to diabetes coded exclusively as concomitant disease, the maximal prevalence was 9.9% in men (aged 65–74 years) and 9.3% in women (aged 75–84 years). Extrapolating prevalence rates to the general population resulted in 225,100 people with diabetes.

Trends

Death registry data showed a continuous increase in diabetes prevalence in 1995–2008 ($P < 0.001$ for both sexes), particularly in elderly persons and in men (increase 1995–2008, men vs. women: $P < 0.001$). A similar increase was also suggested by the SHS (Supplementary Fig. 1).

CONCLUSIONS—When no national diabetes prevalence figures are available, routine statistics from hospital discharges, death registry, and health survey can offer an alternative. The prevalence in

Table 1—*Proportions of diabetes and extrapolated number of people with diabetes in Switzerland by sex according to three different data sources*

Data source	Year	With diabetes (n)*	Proportion with diabetes (%)†				Estimated with diabetes (n)‡		
			Men	Women	Total	95% CI	Men	Women	Total
Aged 20–84 years, population in 2008: 5.844 million									
1: Hospital discharges, additional diagnosis	2008	41,495	4.4	2.8	3.6	3.6–3.6	137,000	100,000	237,000
2: Death registry, concomitant cause	2007/2008	5,877	3.8	3.1	3.5	3.4–3.6	116,000	109,000	225,000
	2003/2004	5,392	3.4	2.7	3.1	3.0–3.2			
	1999/2000	5,332	3.1	2.7	2.9	2.8–3.0			
	1995/1996	4,366	2.3	2.1	2.2	2.1–2.3			
3: SHS, ever diagnosed	2007	927	4.9	3.7	4.3	4.0–4.6	151,000	128,000	279,000
	2002	791	4	3.2	3.6	3.3–3.9			
	1997	396	3.5	2.9	3.2	2.9–3.5			
1–3: Combination of the three data sources	2007/2008		3.8–4.9	2.8–3.7	3.5–4.3		116,000–151,000	100,000–128,000	225,000–279,000
Aged 0–19 and 85+ years, population in 2008: 1.804 million									
1: Hospital discharges, additional diagnosis	2008						7,000	13,000	20,000
All ages, population in 2008: 7.648 million									
1–3: Combination of the three data sources							123,000–158,000	113,000–141,000	245,000–299,000

*In the study population (men and women). †Age standardized. ‡In the general population.

Switzerland can be estimated at 3.5–4.3%, corresponding to 245,000–300,000 people with diabetes. The age–sex patterns were strikingly similar among the three data sources (Supplementary Fig. 1), e.g., a higher prevalence in men in virtually all age classes.

Our approach underestimates rather than overestimates diabetes prevalence. For inpatients, the proportion of undiagnosed diabetes is expected to be small. However, individuals with the highest risk of diabetes were not included in our analysis because these persons are likely to be hospitalized with diabetes as a principal instead of only additional diagnosis. In the death registry, multimorbidity may cause increased "competition" of mentions of concomitant causes of death in decedents aged ≥65 years, with diabetes not being mentioned in favor of other concomitant conditions. In addition, diabetes may not be captured in sudden deaths. Self-reporting individuals in the SHS may not be aware of the disease (9–12). From all three sources, underestimation could also be expected because an oral glucose tolerance test is not routinely administered in a clinical setting. Some overestimation of our figures could be expected because of the generally increased morbidity and mortality of diabetic patients increasing their likelihood of hospitalization and death also due to other conditions or a tendency of study participants to overreport disease (13).

Published extrapolations of diabetes prevalence in Switzerland in 2010 suggested higher figures than our estimations: 350,000–630,000 (2–5). For 2010, the International Diabetes Federation predicted a number twice as high as our highest estimate, implying one of the highest prevalence rates in the Western world (2). Accordingly, Switzerland would have a higher diabetes prevalence than countries with a three times higher obesity prevalence and markedly higher cardiovascular disease mortality (14). Therefore, even considering the maximum extent of potential underestimation arising from our approach, our estimates appear more realistic. In fact, our highest estimates for Switzerland were in line with 2010 figures for European countries with a low prevalence of diabetes, such as France, Belgium, the Netherlands, and Sweden, and still somewhat higher than those for the U.K. (2,12), but definitively lower than those from neighboring Germany (2,9,15). In Switzerland, the proportion of undiagnosed diabetes can be expected to be similar to that of France (i.e., 20%), and a part of the increase in diabetes prevalence may relate to decreasing proportions of undiagnosed cases (12). Nevertheless, the magnitude of the increase in diabetes prevalence in 1995–2008 suggests that diabetes prevention should be reinforced in Switzerland, particularly in men.

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M.B. conceived the study, conducted data analysis, sketched a first draft of the manuscript, and reviewed and edited the manuscript. U.Z. analyzed hospital discharge data and reviewed and edited the manuscript. D.F. wrote most parts of the manuscript, added background knowledge, substantially contributed to discussion, and reviewed and edited the manuscript.

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