Impact of Recent Increase in Incidence on Future Diabetes Burden

U.S., 2005–2050

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In an earlier study, we had forecasted 39 million with diagnosed diabetes in 2050 in the U.S. (1,2). However, since then, national diabetes incidence increased (3) and the relative risk of death among people with diabetes declined (4,5). These changes will impact future forecasts.

Incorporating these changes, we now project 48.3 million people with diagnosed diabetes in the U.S. in 2050. We also present age-, sex-, and race/ethnicity-specific forecasts, with Bayesian CIs, of the number of people with diagnosed diabetes through 2050.

RESEARCH DESIGN AND METHODS — We used a discrete-time (1-year intervals), incidence-based Markov model with three states (no diagnosed diabetes, diagnosed diabetes, and death) (1). In each cycle of the model, projections are developed for 808 population subgroups defined by age, sex, and race/ethnicity.

We estimated the age-, sex-, and race/ethnicity-specific prevalence and incidence of diabetes from the U.S. National Health Interview Survey (6–9) and modeled data for 1984–2004 to improve the precision of 2004 estimates.

Models were fit using Bayesian methods with improper flat priors applied to logistic regression. We assessed adequacy of model fit using posterior predictive *P* values (10). Estimated prevalence of diagnosed diabetes for 2000 and 2004 were 4.35 and 5.37%, respectively, and estimated incidence were 0.42 and 0.53% per year, respectively. The age-, sex-, and race/ethnicity-specific 2004 prevalence estimates were combined with U.S. population data for 2004 (11) to determine the initial distribution of individuals across disease states. Additionally, census projections of U.S. live births, mortality rates, and net migration were required (11).

Estimates of the relative risk of mortality for people with diabetes were drawn from updates of a published study using Bayesian methods applied to logistic regression models (5). These estimates were sex- and age-group–specific for adults (aged ≥18 years) in four age categories.

Probabilities of remaining in the no-diabetes and diabetes states vary over time, since mortality rates are time varying. The 1-year probability of remaining with no diabetes equals $(1 - P_{ND\text{-}D} - P_{t\ ND\text{-}Death})$, where $P_{ND\text{-}D}$ is the time-independent incidence rate to diagnosed diabetes and $P_{t\ ND\text{-}Death}$ equals the time-varying no-diabetes mortality rate.

We derived posterior distributions of all unknown parameters (age-, sex-, race/ethnicity-specific prevalence and incidence and age- and sex-specific relative risk) and propagated the uncertainty in these distributions through the Markov projection model. In fitting the models, we obtain 5,000 samples from the posterior distributions. The projection model is then run and results saved using each of these 5,000 samples. This gives a sample from the posterior distribution of the projection results. Means of these posterior distributions are our estimates, and quantiles (0.025, 0.975) of these posterior distributions are our CIs.

RESULTS — Total prevalence more than doubles from 2005 to 2050 (from 5.62 to 12.00%), and all age-specific prevalence are expected to rise steadily (Table 1). Increases in the number of individuals with diabetes are projected for both sexes (men by 174%: from 7.59 million in 2005 to 20.81 million in 2050; and women by 220%: from 8.59 million to 27.47 million, respectively) and for all age-groups. These increases are largest for the two oldest age-groups: 220% among those aged 65–74 years and 449% among those aged ≥75 years. The number of women aged ≥75 years with diabetes will rise 470% (from 1.72 to 9.80 million), and the number of men aged ≥75 years will rise 423% (from 1.15 to 6.01 million).

Diabetes prevalence is projected to increase by 99% among non-Hispanic whites (from 5.35 to 10.64%), by 107% among non-Hispanic blacks (from 7.39 to 15.29%), by 127% among Hispanics (from 5.47 to 12.39%), and by 158% among other races (from 5.42 to 14.01%). Increases in the number of individuals with diabetes will be largest for minority groups; between 2005 and 2050, the number is projected to increase 481% among Hispanics, 208% among blacks, and 113% among whites. The age-race/ethnicity group with the largest increase will be for blacks aged ≥75 years (increased 606%).

CONCLUSIONS — We project that the number of individuals with diagnosed diabetes in the U.S. will increase by 198% from 16.2 million in 2005 to 48.3 million in 2050. This projection for 2050 is 9.3 million people higher than our earlier estimate (1). Eighty-seven percent of the additional 9.3 million is explained by the increase in national diabetes incidence between 2000 and 2004 (3) and 11% by

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Table 1—*Forecasts of the prevalence and number of people with diagnosed diabetes by age-group and selected years*

	Age-group (in years)					
	0–19	20–44	45–64	65–74	≥75	All ages
2005						
Prevalence (%)	0.33	2.39	10.12	18.34	15.99	5.62
*n**	0.26	2.38	7.26	3.40	2.88	16.18
95% CI	(0.22–0.30)	(2.27–2.49)	(6.98–7.53)	(3.28–3.52)	(2.74–3.02)	(15.59–16.75)
2010						
Prevalence (%)	0.41	2.91	11.60	20.68	18.93	6.84
*n**	0.33	2.90	9.30	4.38	3.62	20.52
95% CI	(0.25–0.41)	(2.72–3.08)	(8.90–9.70)	(4.20–4.56)	(3.38–3.86)	(19.75–21.32)
2020						
Prevalence (%)	0.46	3.59	14.52	23.32	24.20	8.88
*n**	0.38	3.77	11.77	7.31	5.60	28.84
95% CI	(0.25–0.55)	(3.43–4.13)	(11.05–12.48)	(6.90–7.73)	(5.16–6.05)	(27.35–30.38)
2030						
Prevalence (%)	0.47	4.00	15.90	25.96	27.69	10.38
*n**	0.42	4.41	12.40	9.82	9.35	36.41
95% CI	(0.27–0.61)	(3.96–4.92)	(11.57–13.21)	(9.20–10.44)	(8.63–10.08)	(34.23–38.63)
2040						
Prevalence (%)	0.47	4.07	16.72	28.70	30.32	11.35
*n**	0.46	4.69	14.27	9.63	13.71	42.76
95% CI	(0.30–0.66)	(4.16–5.29)	(13.30–15.25)	(9.03–10.24)	(12.61–14.83)	(40.02–45.54)
2050						
Prevalence (%)	0.48	4.18	17.76	30.10	32.69	12.00
*n**	0.50	5.19	15.90	10.88	15.81	48.28
95% CI	(0.32–0.73)	(4.59–5.87)	(14.79–17.00)	(10.22–11.58)	(14.47–17.17)	(45.05–51.53)
% change 2005–2050						
Prevalence (%)	45	75	75	64	104	114
*n**	92	118	119	220	449	198

*Forecast of the number of individuals diagnosed with diabetes (in millions).

the recent decline in relative risk of mortality among individuals with diabetes (4,5). Other local and regional studies confirm increases in diabetes incidence (12–14), and the reductions in relative risk of mortality may reflect decreases in risk factors and improved diabetes quality of care (15–17).

Our projections have limitations. We assume constant 2004 diabetes, but this may be unlikely as obesity prevalence continues to increase (18). We also assume no advances in prevention, no possibility of a cure, no increases in life expectancy, no increases in screening, or no changes in diagnostic criteria. Diabetes was determined by self-report, but the validity of self-report is high (19). As we cannot distinguish diabetes types, our projections largely reflect type 2 diabetes, the predominant form of diabetes (20). We assume the middle series of the census projections, but these population projections for racial/ethnic minority groups may be underestimates.

Our projections, however, have particular strengths. The model is based on incidence and uses nationally representative age-, sex-, and race/ethnicity-specific data on incidence. The assumptions about relative risks were robust in sensitivity analysis. The Bayesian CIs account for uncertainty in model transition rates, including incidence, and provide an easily interpretable range for the projections. While we project 48.3 million individuals with diagnosed diabetes in 2050, we are 95% certain that this estimate will fall between 45 and 51.5 million.

Our revised projection (assuming constant 2004 national incidence rates) of the future national diabetes burden appears more alarming than previously estimated (1). For a chronic disease, such as diabetes, small shifts in incidence have large implications for future prevalence of and numbers with the disease. If incidence rates continue to rise, the impact on future numbers with diabetes, and consequent health care costs, will be much more devastating. Implementation of evidence-based primary prevention (21) is thus an urgent national priority.

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