The impact of diabetes on work-force participation: Results from a national household sample

WORKING DRAFT

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Abstract

Background. Diabetes is a highly prevalent condition with substantial associated morbidity. The economic impact of diabetes is dramatic, with estimated total costs of $98 billion in 1997. We sought to investigate the effects of diabetes on work-force participation, including absenteeism, retirement, and disability.

Methods. We used the first wave of the Health and Retirement Study (HRS) as a data source. The likelihood of falling into various work-related categories, by diabetes status, was estimated using logistic regression; duration of being in different states of participation was estimated using OLS regression. We then estimated the economic impact of diabetes using the estimates of lost time due to disability, absenteeism, and early retirement combined with median salaries in the HRS sample.

Results. Diabetes is a significant predictor of self-rated disability (OR = 3.1), of not working due to health impairments (OR = 2.4), and of receiving SSI or VA disability (OR = 2.6 and 3.0, respectively). Subjects with diabetes also missed more work time than those without (incremental missed days per year = 2.7). These changes in work-force participation equate to (up until wave 1 of the HRS) to an incremental loss of $57.8 billion in income, and another $7.8 billion in disability payments.

Conclusion. Diabetes has a profound economic impact in the US. These figures should be considered when evaluating the cost-effectiveness of diabetes interventions and to inform and improve the allocation of resources for chronic disease management.

Background

Diabetes has staggering health and economic effects. There are an estimated 10-15 million people with diabetes in the United States [1] and given the aging of the population and the dramatic increase in obesity in the US, the prevalence of diabetes is expected to increase substantially over the next several decades.[2] In 1997, a cross-sectional analysis found that the direct medical cost of diabetes care was over $44 billion.[3] However, the effects of lost productivity were even more substantial; the total indirect costs were $54.1 billion, consisting of $17.0 billion attributed to premature mortality and $37.1 billion for disability.[3]

The indirect costs of diabetes are largely related to the disability resulting from complications of the disease, rather than to the disease itself. Microvascular diabetes complications, such as retinopathy, nephropathy and neuropathy, are the leading causes of blindness, end stage renal disease and non-traumatic amputation, respectively, in the US.[4] Even more important is macrovascular disease (including coronary artery disease, stroke, and peripheral vascular disease). Patients with diabetes have two to four times the risk of macrovascular disease and mortality compared to age and sex-matched controls; as a result, over 70% of patients with diabetes die from these complications.[5-11]

Although the numbers of disabling diabetes complications are staggering, many are preventable, and appropriate therapy could lead to substantial reductions in complications and associated disability. However, the true economic impact of diabetes remains unclear. While there are a number of past studies into the costs of chronic illnesses such as diabetes, these analyses have substantial limitations and often reach widely disparate conclusions because of differences in data sources and methodology. For example, these studies have been forced to look at indirect costs by compiling data from multiple sources, have had non-representational data sources, or have not examined the economic impact of diabetes-related disability.[3,12-14] To date, no studies have been able to use a consistent or representative data source to identify the impact of diabetes on work-force participation.

In order to overcome these limitations, we analyzed the effects of diabetes on work-force participation and lost productivity using the Health and Retirement Study (HRS), a longitudinal survey designed to follow a national sample of US adults born between 1931 and 1941 (and their spouses) as they make the transition from active working status into retirement. This report focuses on a cross-sectional analysis of the association between diabetes and work-force participation in wave 1 (1992) of the HRS.

Methods

Data

We used the Health and Retirement Study (HRS) as our data source. The HRS is a longitudinal survey designed to follow a national sample of US adults born between 1931 and 1941 (and their spouses) as they make the transition from active working status into retirement. The Health and Retirement Study was funded by the National Institute on Aging and is conducted by the Institute for Social Research at the University of Michigan. Approximately 70,000 households obtained from an area probability sample were screened to identify all age-eligible respondents (51 to 61 years of age). The HRS is a nationally representative survey of households, not of individuals. If a spouse is outside of the age range specified in the study, they are still included in the dataset; therefore, the HRS is not a perfectly representative sample of those 51 to 61 years of age at the time of the study.

Census tracts containing a high density of African-Americans and Florida residents were over-sampled 2:1. All spouses were interviewed regardless of age because of the frequency of dual-earner couples and the influence of spouses in the retirement decision. The overall response rate was approximately 82%. Detailed information was collected for multiple domains including: demographics, health status, housing, family structure, employment of respondent, work history, disability, retirement plans, net worth, income, and health and life insurance. To date, 5 waves of data collection have been completed. For these analyses, we primarily focused on the impact of diabetes on labor force participation in wave 1 of the HRS; that is, we estimate the economic impact of diabetes through the start of the study. We are also analyzing the longitudinal impact of diabetes through the first 5 waves of the HRS; however, because the wave 5 data are in preliminary release, we do not include them in this report. We will briefly summarize the rates of ongoing changes in work-force participation through the first 4 waves of the study.

Variables

Classification of disability and work status

The HRS has detailed information on the work status of the study participants. For the purposes of our analyses, we focused on several key work-related variables. The first general classification was whether subjects were currently working. For those who were currently working, we assessed the number of sick days. Subjects who were not currently working were subdivided into those who were homemakers, those who were retired, and those who were disabled. Some subjects claimed to be retired but still working (12.7% of the retired) or disabled but still working (1.8% of the disabled). For the primary analyses, these subjects were included as retired or disabled, respectively, although sensitivity analyses were conducted excluding them from the analyses.

For the purposes of economic analyses of disability, we defined disability as subjects that had health-related conditions limiting their ability to work. Subjects who did claim a health-related limitation in work-status were subdivided into those who could not work at all, or those who could only work part-time due to their health condition. We also used data on disability applications and receipt of disability payments from Social Security

Disability (SSI), the Department of Veterans Affairs (VA), and workers compensation programs (WC).

Classification of Diabetes Mellitus Status

All respondents were asked: "Have you ever had diabetes?" If a respondent answered "yes," he/she was assumed to be diabetic. A follow-up question also asked if a the subject was currently diabetic; fewer subjects reported having diabetes now than ever having diabetes. For the sake of this analysis, we used the first question to define diabetes. This may include patients with glucose intolerance, medication-induced diabetes, or gestational diabetes; however, as these groups often have elevated risks of complications, particularly cardiovascular disease,[15-17] we elected to include them as part of the overall population with diabetes. Follow-up questions were also asked about treatment regimens for diabetes – diet, oral agents, or insulin. In order to test a for a dose-response relationship, we generated a diabetes severity score ranging from "0" for subjects without diabetes to "3" for subjects with diabetes who were treated with insulin.

Demographic Variables

The sociodemographic measures included in the analysis as independent variables were age, race (White, African-American, Hispanic, Asian, other), gender, living situation (unmarried living alone, unmarried living with others, married), and level of education (grade school, high school, college, graduate school). We did not include income as a covariate because for the disabled, we did not have specific measures of income prior to the onset of disability.

In analyses to try and better understand the sources of diabetes-related disability, we included diabetes complications in the models; this included conditions such as coronary heart disease, congestive heart failure, stroke, visual impairment, kidney/bladder problems, and foot problems, all of which may be attributed to diabetes. However, we will focus on the more detailed analyses of the sources of diabetes-related disability in a separate report.

Analyses

All analyses were done using survey weights to account for complex survey design. Analyses were conducted using Stata Version 7.0 (Stata corporation, College Station, TX).

Our main outcome measures were work absenteeism, retirement and retirement age, disability and duration of disability, not working due to health-conditions, and disability insurance claims (SSI, VA, WC). For binomial outcomes, we estimated the association between diabetes status and the outcome first using survey-weighted contingency tables analyses for bivariate comparisons, and then using survey-weighted logistic regression in multivariate analyses to control for demographic conditions.

For the estimates of duration of outcomes, we first examined the distribution of outcomes; those that approximated normality were compared between diabetes and non-diabetes using survey-weighted t-tests for comparisons of means, and survey-weighted

OLS regression, conditional on being in the state tested, to test if there was an incremental effect of diabetes on duration of outcomes such as disability or retirement. For those with non-normal distributions, we compared means using non-parametric tests, and then used log-transformed values in OLS regression to estimate the association between duration of outcome and diabetes. Results were retransformed into the original units using Duan's smearing estimate to predict the conditional mean in the original metric.

For lost work time due to disability and sick days, the economic impact of diabetes was then estimated by multiplying median wages times the estimated increase in lost productivity predicted by the models. For estimates of SSI, VA, and WC disability payments, we used the levels of income from these sources that were reported by participants, and multiplied these times the increased risks of receiving disability payments associated with diabetes.

We initially planned to use 2-part models to estimate the economic impact of diabetes; however, because we found no differences between the duration of the various health outcomes between the diabetes and non-diabetes groups even in bivariate analyses, we elected to use unadjusted mean estimates of duration from the general population. For estimates of incremental sick time lost, we assumed that the incremental effect was constant over the duration of diabetes and applied the lost productivity estimates across the duration of diabetes. We tested this assumption by examining the association between diabetes duration and sick time; in this sample, we found no association between the two.

All estimates were extrapolated to the US population using the survey weights provided with the HRS to evaluate the total economic impact of diabetes.

Results

Descriptive statistics

Table 1 shown the descriptive statistics of the HRS population, broken down into the population with and without diabetes. The survey-weighted prevalence of diabetes in the HRS population is 9.9% (n=1390), which translates to about 2.3 million people in the US population. This prevalence is similar to other prevalence estimates of diabetes in this age population.[1,18] The population with diabetes is older, more likely to be male, more likely to be African-American or Hispanic, and less educated than those without diabetes. Not surprisingly, those with diabetes report substantially higher rates of diabetes complications; they have much higher rates of coronary heart disease, congestive heart failure, stroke, visual impairment, kidney/bladder problems, foot problems and hypertension than those without diabetes. General self-rated health status is also substantially worse in patients with diabetes than in those without (data not shown).

Table 2 shows the unadjusted survey-weighted proportions and means of the work-force specific characteristics of the population with and without diabetes. Subjects with diabetes have substantially higher rates of work absence, disability, and probability of being retired than those without diabetes. However, among those who had retired or were disabled, subjects with diabetes did not retire earlier or have longer duration of disability than those without diabetes.

Probabilities of being in different work-force states

Table 3 shows the logistic regression estimations of the impact of diabetes on the odds and probabilities of being in the various work-force conditions. These odds and probabilities are adjusted for demographic factors including age, education level, gender, race, and marital status. After adjustment for demographics, subjects with diabetes had higher probabilities of self-rated disability (OR = 3.6), of any health-related work impairment (OR = 2.6), of not working due to a health impairment (OR = 2.4), and of receiving either SSI disability (OR = 2.6) or VA disability (OR = 3.0). However, subjects without diabetes were not more likely to have retired or to receive workers compensation. In addition, subjects with diabetes were not more likely to be working only part-time due to a health impairment (not shown in table).

We also performed OLS regression to estimate the duration of outcomes in the diabetes and non-diabetes group. For most outcomes, no differences were detectable between the diabetes and non-diabetes group in bivariate or multivariate analyses; thus, we do not report any association between diabetes and these outcomes. For sick days in the prior year, however, we did find a significant difference between the diabetes and non-diabetes group. Because the distribution of sick-days was skewed, we log-transformed the data and performed OLS regression on the transformed data, adjusting for demographics. In this model, diabetes remained a significant predictor of sick days; the coefficient for diabetes in the log model was 0.21 (p=.047). When re-transforming into days using Duan's smear estimates, this equated to an incremental increase of 2.7 sick days per year for subjects with diabetes.

Economic impact

Table 4 shows the estimated economic impact that diabetes incurs through its effects on work-force participation. The majority of the lost income is due to the high incremental risk of not working due to health impairments; this 12% incremental risk, with an average duration of nearly 8 years, leads to an incremental lost income of approximately $49 billion, assuming a median salary of $23,000 (in 1992 dollars) for the HRS sample. Similarly, health-related absenteeism is higher in patients with diabetes than without, at an average of 2.7 days per year; this absenteeism does not vary by duration of diabetes, so that this 2.7 days per year, over a mean duration of 9.7 years, equates to an incremental loss of 26.2 days of work for those with diabetes. This translates into $5.7 billion in lost salary. [consider replacing with lost economic output rather than salary]

The costs to the federal government of diabetes-related SSI and VA disability are $8.8 billion and $2.1 billion, respectively, based upon the average payments reported by the participants in the HRS.

Prospective analyses

In preliminary analyses of the prospective association between diabetes and disability, we found that the 6-year risk of disability in those with diabetes at baseline was about 12.9%, compared to 5.0% in the general population ($p<0.001$). The OR for disability, adjusted for demographic factors, was 2.6; this compares to an adjusted OR of 3.1 in the cross-sectional models. Also at 6 years of follow-up, the risk of not working due to a health impairment was 73.3% in the diabetes population, compared to 59% in the non-diabetic population (p=0.004), and the adjusted OR of is 1.7, compared to 2.4 in the cross-sectional analyses. We will be quantifying the detailed economic effects of these longitudinal changes over time in future reports.

Discussion

Diabetes is a major cause of morbidity and mortality. The morbidity associated with diabetes is diverse, ranging from visual impairment to amputation to coronary heart disease, and is often disabling.[4] We sought to better quantify the impact of diabetes on work-force participation, and to estimate the economic costs of changes in levels of work-force participation.

As in prior studies, we found a very high economic cost associated with diabetes. In 1997, according to American Diabetes Association estimates, the indirect costs of diabetes totaled $54 billion dollars.[3] However, this figure was not estimated over a consistent time-frame; rather, it included both 1997 lost productivity estimates and also future estimates due to increased mortality. We sought to estimate, using a single data source and a consistent time frame, the costs associated with lost productivity in the living cohort of patients with diabetes.

We found that in the US cohort of people aged 51 to 61 years old in 1992 who had diabetes, the total loss in income due to health-related work impairment was already an *incremental* $57.8 billion dollars compared to those without diabetes, and Social Security and VA disability payments had amounted to an incremental $7.8 billion dollars.

There are several limitations to these analyses. The major limitations relate to the use of cross-sectional data. Recall bias is clearly an issue, and may adversely affect our estimates; however, as there is data suggesting that health conditions are “telescoped”, that is, felt to have occurred sooner than they actually did, this makes it most likely that we have underestimated the economic impact of diabetes. Further, this leads to difficulties in accurately estimating whether disability or diabetes came first. In the disabled with diabetes, the average duration of diabetes was longer than the average duration of disability, but in about 1/3 of patients, disability appears to precede the onset of diabetes. Estimating the effect of this is difficult, because it is generally believed that diabetes onset is anywhere from 4 to 10 years prior to usual diagnosis. Thus, we will be concentrating on longitudinal evaluations of the rates of disability in patients with diabetes in ongoing work; the preliminary analyses reported above suggest that diabetes remains a strong risk factor for disability, although the association is slightly less than that seen in cross-sectional analyses, as one would expect. Another limitation imposed by the cross-sectional nature of these analyses is that we cannot estimate the impact of mortality on lost productivity. This will also be addressed in longitudinal evaluations using the HRS dataset.

The economic impact of diabetes on economic productivity in the US is substantial and is likely to worsen as the prevalence of diabetes increases over the next several decades. However, because many diabetes complications are preventable, there is hope that some of this economic impact can be attenuated with improved delivery of key components of diabetes care. Because of the possibility of defraying these losses in productivity, economic analyses of diabetes treatment programs should explicitly consider these costs, and should be considered by policy-makers and those who allocate health-care resources.

Table 1. Characteristics of Health and Retirement Study Population

(results weighted to reflect sampling design)

Demographic Characteristics	Population without diabetes	Population with diabetes
Estimated population size (US)	23,587,252	2,335,715
Age (years)	56.0	56.5
Gender		
Male	47.7%	49.5%
Female	52.3%	50.5%
Race		
White	82.3%	70.7%
Black	9.0%	17.3%
Hispanic	5.7%	8.9%
Asian	1.4%	1.5%
Other	1.0%	1.6%
Educational Level		
Grade School	10.3%	17.4%
High School	56.3%	57.0%
College	21.4%	17.8%
Graduate School	11.9%	7.9%

Health Status Characteristics

Coronary Artery Disease	7.4%	17.5%
Congestive Heart Failure	1.5%	5.6%
Stroke	2.6%	6.2%
Visual acuity		
Good	88.9%	78.8%
Fair	8.5%	14.4%
Poor	2.6%	6.8%
Kidney or bladder problems	10.2%	19.2%
Hypertension	38.0%	63.3%
Smoking		
Never	35.9%	32.2%
Former	37.1%	43.3%
Current	27.0%	24.5%

Table 2. Work-status characteristics of subjects with and without diabetes

Work-status characteristic	Population without diabetes	Population with Diabetes	p-value for comparison
Sick days, prior year	4.0 days	6.6 days	0.005
Probability of retirement	9.0%	12.0%	0.010
Retirement age	52.5 years	51.3 years	0.100
Probability of self-rated disability	7.5%	22.9%	<0.001
Duration of disability	9.0 years	8.5 years	0.363
Any health-related work impairment	18.4%	40.2%	<0.001
Not working due to health impairment	7.3%	19.2%	<0.001
Duration of not working due to health impairment	8.2 years	7.6 years	0.263
Probability of receiving SSI	5.5%	15.8%	<0.001
Probability of receiving VA benefits	0.4%	1.5%	0.022
Probability of receiving worker's compensation	1.1%	1.7%	0.139

Table 3. Adjusted odds and probabilities estimating the impact of diabetes on work-force participation

Work-force characteristic	Adjusted odds-ratio for diabetes (95% CI)	Predicted probability of outcome	Incremental probability vs. those without diabetes
Retirement	1.3 (0.99, 1.8)	12.8%	NS*
Self-reported disability	3.1 (2.5, 3.8)	23.5%	15.6%
Any health-related work impairment	2.6 (2.2, 3.0)	40.7%	21.5%
Not working due to health-related work impairment	2.4 (2.0, 3.0)	19.7%	12.0%
Receiving SSI disability	2.6 (2.1, 3.3)	16.3%	10.5%
Receiving VA disability	3.0 (1.3, 7.0)	1.4%	1.0%
Receiving worker's compensation	1.6 (0.9, 2.7)	1.7%	NS*

*NS – increase in risk is not statistically significant after adjustment for demographics, so no incremental risk calculated

Table 4. Estimated economic impact of diabetes over lifetime of HRS cohort (through 1992)

Work-force characteristic	**Average incremental cost per subject**	**Estimated total cost, US population with diabetes**
Not working due to health impairment	$20,976	$49.0 billion
Social security disability claims	$3773	$8.8 billion
VA disability claims	$918	$2.1 billion
Sick-days	$2459	$5.7 billion
TOTAL	$28,126	$65.6 billion

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