# The Impact of Diabetes on Employment and Work Productivity

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**OBJECTIVE** — The purpose of this study was to longitudinally examine the effect of diabetes on labor market outcomes.

**RESEARCH DESIGN AND METHODS** — Using secondary data from the first two waves (1992 and 1994) of the Health and Retirement Study, we identified 7,055 employed respondents (51–61 years of age), 490 of whom reported having diabetes in wave 1. We estimated the effect of diabetes in wave 1 on the probability of working in wave 2 using probit regression. For those working in wave 2, we modeled the relationships between diabetic status in wave 1 and the change in hours worked and work-loss days using ordinary least-squares regressions and modeled the presence of health-related work limitations using probit regression. All models control for health status and job characteristics and are estimated separately by sex.

**RESULTS** — Among individuals with diabetes, the absolute probability of working was 4.4 percentage points less for women and 7.1 percentage points less for men relative to that of their counterparts without diabetes. Change in weekly hours worked was not statistically significantly associated with diabetes. Women with diabetes had 2 more work-loss days per year compared with women without diabetes. Compared with individuals without diabetes, men and women with diabetes were 5.4 and 6 percentage points (absolute increase), respectively, more likely to have work limitations.

**CONCLUSIONS** — This article provides evidence that diabetes affects patients, employers, and society not only by reducing employment but also by contributing to work loss and health-related work limitations for those who remain employed.

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The medical care costs associated with diabetes create a considerable economic burden for patients, families, and society (1,2). Productivity losses from diabetes have been estimated to be almost half ($40 billion) of the medical costs ($92 billion) associated with diabetes in 2002 (1). As the prevalence of diabetes in the U.S. has increased (3), so too have associated economic burdens (4). The increased prevalence (5) among younger individuals suggests that diabetes will become more common in the working-age population. Consequently, employment and work productivity of individuals with diabetes are important issues for patients, families, employers, and policy makers. In this study, we examine the effect of diabetes on labor market outcomes of employed U.S. adults aged 51–61 using longitudinal data from the Health and Retirement Study (HRS).

Several studies have found negative associations between diabetes and employment outcomes (6–10). The magnitude of the effect of diabetes on employment varies from 4 to 22 percentage points. Diabetes can affect employment in a number of ways. First, diabetes complications may prevent working entirely or increase absenteeism for those who work (11). Second, productivity while at work may also be impaired (12). Third, individuals with diabetes may face employment discrimination. In some cases, especially because of the risk of hypoglycemia, employers may restrict access to the jobs designated as safety sensitive (8) or discriminate against individuals with diabetes because of their concerns about low productivity (13,14). In a longitudinal study, Vijan et al. (15) found that diabetes had a profound negative effect on economic productivity due to early retirement, increased sick days, disability, and mortality.

Our study contributes to this literature in several important ways. First, we separate and analyze the effect of diabetes by sex on employment, change in hours worked, work-loss days, and work limitations among those employed. Second, the models we use to predict labor market outcomes control for a number of other chronic conditions, BMI, and job characteristics that have been omitted in previous research. Finally, we explore the health-related reasons for quitting work by diabetic status among previously employed individuals.

## RESEARCH DESIGN AND METHODS

We used data from the first two waves (1992 and 1994) of the HRS, which is a national longitudinal cohort study funded by the Institute on Aging and is conducted by the Institute for Social Research at the University of Michigan. The HRS is designed to provide data for researchers, policy analysts, and program planners examining retirement and aging and has been described elsewhere (16). The first wave selected a nationally representative sample of older people aged 51–61 in 1992 and their spouses regardless of age (17). Because only one member of the household must be in the age range of the sample frame, the HRS dataset departs somewhat from national representativeness.

The HRS has several advantages over other data sources for this study. First, the HRS is one of the few surveys that include respondents' self-reported demographic characteristics, health and disability status, employment status, family structure,

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**Abbreviation:** HRS, Health and Retirement Study.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

and economic and financial characteristics. Second, the HRS is longitudinal. Third, in validation studies, the HRS data are found to be of high quality (18,19). For example, economic and financial status measures were found to be internally consistent (20), and a high level of concurrent, discriminant, and construct validity among the HRS health measures was found (19).

In the first interview, individuals who replied "yes" to the question, "Has a doctor ever told you that you have diabetes or high blood glucose?" constituted the study group with diabetes. Respondents who said "no" to the same question were categorized as the comparison group without diabetes. We restricted the analytical sample to age-eligible respondents and their spouses who participated in both interviews, were employed in the first interview, and were aged <65 years in the second interview, which occurred 2 years after the first interview. The first wave contained 8,370 employed respondents. Of these respondents, 736 (8.8%) were lost to follow up in the second interview, 174 of whom died between the first and second interviews. Of the remaining respondents, 779 patients were ≥65 in the second interview. We excluded 85 respondents who reported diabetes at wave 1 but not in wave 2. An additional 100 individuals with incident diabetes in the second interview were excluded because we did not know the onset of diabetes relative to changes in labor supply. These exclusions along with the exclusion of missing observations ($n = 110$) resulted in a sample of 7,055 respondents, 490 of whom reported having diabetes in the first interview.

### Analytical variables

The self-reported labor market outcomes examined were employment status (working versus not working for pay outside of the home), change in aggregate usual hours worked per week for up to two jobs, the number of health-related work-loss days in the past 12 months, and the presence of any work limitation because of health. In the HRS, work limitations was determined by asking subjects if they had any impairments or health problems at the time of the interview that limited the kind or amount of paid work they could do. The presence of diabetes in the first interview was the primary explanatory variable of interest. We hypothesized that diabetes decreases the likelihood of subsequent employment and hours worked and increases absenteeism and work limitations.

Health status has important influences on individual labor market outcomes (21–23). Therefore, we controlled for health status using two self-reported proxy measures available in the HRS. First, BMI, which is defined as weight in kilograms divided by the square of height in meters, has been shown to be a good predictor of subsequent mortality, self-reported health status, presence of chronic conditions, and labor force participation (6,24,25). The second measure of health status included in the models was the number of other chronic health conditions reported. Up to seven other health conditions were included: hypertension, heart disease, chronic lung disease, stroke, cancer, arthritis, and psychiatric problems. Because many of these conditions are known to coexist with diabetes, the inclusion of these conditions in multivariable models would tend to diminish the observed effect attributable to diabetes, and, thus, help to isolate the independent effect of diabetes on labor supply.

We controlled for job and financial characteristics, which may have influenced the decision to work. These included self-employment status (self-employed versus working for other employer), occupation type (white collar, blue collar, or service sector), physical demands of the job, and household financial wealth defined as the total value of respondent's and spouse's housing equity plus nonhousing equity (e.g., value of vehicles, bank accounts, investments, retirement funds, and business equity). A score indicating physical demands of the job was created in the following fashion. Respondents were asked on a scale from 1 (all of the time) to 4 (none of the time) how often their current job required physical effort; lifting heavy loads; and stooping, kneeling, or crouching. Physical demands at the job were measured as the average response over these items. Demographic variables such as age, education, marital status, and race and ethnicity were also included in the multivariable models to control for their effects on the outcomes of interest. All covariates were measured in the first interview.

### Analysis

In pairwise comparisons between diabetic and nondiabetic subgroups, $t$ tests were performed to detect significant differences ($P < 0.05$) in sociodemographic characteristics in the first interview and labor market outcomes in the second interview between these groups. We examined independent predictors of employment in the second interview among workers by estimating a multivariate probit model. For ease of interpretation, the probit estimates were translated into derivatives of the probability of working with respect to the independent variables. Therefore, our probit model results show the absolute increase/decrease in the probability of working associated with 1 unit of change in each independent variable separately at the mean for all other covariates. Because diabetes is a binary variable in our analysis, results associated with diabetes show the change in the absolute probability of working for individuals with diabetes relative to individuals without diabetes. In addition, we modeled the relationships between diabetes and change in weekly hours worked, work-loss days annually, and the presence of work limitations. Because these three outcomes were available only for those who were employed in the second interview, we used conditional linear mean functions for change in hours worked and work-loss days and a conditional probit for the presence of work limitations for those working. We performed separate analyses for men and women given their differences in workforce participation, job type, and job attachment (26). We report our results with and without the inclusion of health status measures.

Finally, among individuals who were not working in wave 2, we explored the extent of self-reported health-related reasons for quitting work with simple logistic regressions, controlling for diabetic status in the first interview. Health-related reasons were identified by self-reported disability, leaving the job because of poor health, and work disability (i.e., the presence of a health limitation(s) that prevented working altogether).

## RESULTS

### Descriptive results

Table 1 provides descriptive statistics for sociodemographic and economic characteristics of workers in wave 1 (1992), as well as labor market outcomes in wave 2 (1994), stratified by diabetes status. Almost 7% of the sample had diabetes in wave 1. The average time since diagnosis (±SD) for individuals with diabetes was 9 ± 8.8 years. Almost half of the individ-

**Table 1—*Wave 1 sample characteristics in 1992 and wave 2 employment characteristics in 1994 stratified by diabetes status among the HRS respondents (51–61 years of age)***

| | Individuals with diabetes | Individuals without diabetes | Total |
|---|---|---|---|
| *n* | 490 | 6,565 | 7,055 |
| Sample characteristics in wave 1 | | | |
| Age at interview | | | |
| Mean age (years) | 55.0 ± 4.5* | 53.9 ± 4.8 | 54.0 |
| Age categories (%) | | | |
| ≤52 | 13.7* | 19.0 | 18.6 |
| 53–57 | 36.5* | 42.8 | 42.4 |
| 58–61 | 34.5* | 27.0 | 27.5 |
| ≥62 | 15.3* | 11.2 | 11.5 |
| Sex (%) | | | |
| Female | 47.1† | 52.6 | 52.2 |
| Race (%) | | | |
| White | 63.1* | 77.1 | 76.1 |
| African American | 26.5* | 14.3 | 15.1 |
| Hispanic | 8.4 | 6.7 | 6.9 |
| Other | 2.0 | 1.9 | 1.9 |
| Education (%) | | | |
| Less than high school | 28.4* | 19.3 | 19.9 |
| High school | 34.9 | 38.4 | 38.2 |
| Some college | 21.4 | 21.4 | 21.4 |
| College | 15.3* | 20.9 | 20.5 |
| Marital status (%) | | | |
| Single (never married, divorced, widowed) | 21.6 | 18.0 | 18.2 |
| Health status | | | |
| Presence of diabetes (%) | | | 7 |
| Years since diabetes diagnosis | 9.0 ± 8.8 | | |
| Self-reported oral medication use for diabetes (%) | 47.6 | | |
| Self-reported insulin use (%) | 23.5 | | |
| BMI (kg/m$^2$) | 30.3 ± 6.7* | 26.7 ± 4.6 | 26.9 |
| Presence of other chronic conditions (%) | 77.1* | 54.1 | 55.6 |
| Number of other chronic conditions | 1.3 ± 1.0 | 0.8 ± 0.9* | 0.8 |
| Occupation (%)‡ | | | |
| Service sector | 22.9* | 14.8 | 15.3 |
| Blue collar | 30.4 | 27.0 | 27.3 |
| White collar | 46.7* | 58.2 | 57.4 |
| Other | | | |
| Physical demands at work | 2.1 ± 0.9 | 2.0 ± 0.9 | 2.0 |
| Self-employed (%) | 14.9 | 17.5 | 17.3 |
| Wealth ($1,000) | $139.9 ± 297.2* | $236.4 ± 498.2 | $229.7 |
| Children <18 living at home (%) | 16.9 | 15.3 | 15.5 |
| Employment characteristics in wave 2 | | | |
| Working for pay (%) | 78.0* | 86.8 | 86.2 |
| Weekly hours worked§ | 41.3 ± 13.1 | 42.1 ± 13.0 | 42.0 |
| Work-loss days§ | 6.7 ± 20.0* | 4.21 ± 3.9 | 4.3 |
| Work limitations (%)§ | 20.1* | 8.2 | 9 |

Data are means ±SD or sample percentages. *$P < 0.05$; †$P < 0.01$. ‡We used the following two-digit 1980 U.S. Census Occupation Code and masked for public release by HRS for public release. The numbers in parentheses in the codeframe are the 1980 U.S. Census Occupation Codes that map into the code category. 01, Managerial specialty operation (003–037); 02, Professional specialty operation and technical support (043–235); 03, Sales (243–285); 04, Clerical, administrative support (303–389); 05, Service: private household, cleaning and building services (403–407); 06, Service: protection (413–427); 07, Service: food preparation (433–444); 08, Health services (445–447); 09, Personal services (448–469); 10, Farming, forestry, fishing (473–499); 11, Mechanics and repair (503–549); 12, Construction trade and extractors (553–617); 13, Precision production (633–699); 14, Operators: machine (703–799); 15, Operators: transport, etc. (803–859); 16, Operators: handlers, etc. (863–889); White collar included categories 01–04, service sector included categories 05–09, and blue collar included categories 10–16. §Among those who work in wave 2.

**Table 2—*Probability of working, probability of work limitations, and annual work-loss days in wave 2 among workers in wave 1 (51–61 years of age in wave 1), women and men****

| | Employment | | Work productivity | | | |
|---|---|---|---|---|---|---|
| | | | Presence of work limitations | | No. of work-loss days | |
| | I | II | III | IV | V | VI |
| Women | | | | | | |
| Sample size | 3,670 | 3,670 | 3,146 | 3,146 | 3,146 | 3,146 |
| Variables | | | | | | |
| Diabetes | −0.059 ± 0.026† | −0.044 ± 0.026 | 0.107 ± 0.030‡ | 0.060 ± 0.024† | 3.107 ± 1.005‡ | 2.050 ± 1.017‡ |
| BMI | | 0.014 ± 0.006† | | −0.003 ± 0.005 | | 0.197 ± 0.301 |
| $BMI^2$ | | −0.0002 ± 0.0001 | | 0.0001 ± 0.0001 | | −0.001 ± 0.005 |
| No. of other chronic conditions | | −0.020 ± 0.006‡ | | 0.046 ± 0.005‡ | | 1.395 ± 0.271‡ |
| Men | | | | | | |
| Sample size | 3,362 | 3,362 | 2,891 | 2,891 | 2,891 | 2,891 |
| Variables | | | | | | |
| Diabetes | −0.090 (0.025)‡ | 0.071 ± 0.025‡ | 0.104 ± 0.028‡ | 0.054 ± 0.023‡ | 1.662 ± 1.164 | 0.897 ± 1.180 |
| BMI | | 0.011 ± 0.010 | | −0.012 ± 0.009 | | −0.534 ± 0.567 |
| $BMI^2$ | | −0.0001 ± 0.0001 | | 0.0003 ± 0.0001 | | 0.011 ± 0.010 |
| No. of other chronic conditions | 0.104 ± 0.028 | −0.023 ± 0.006‡ | | 0.050 ± 0.005‡ | | 1.427 ± 0.359‡ |

*Data are partial derivatives of probability (marginal effects ± SE) with respect to independent variables. The derivatives are computed as the difference in probabilities as the dummy variable takes on the values 0 and 1, with the other variables at the sample means. All models include the following covariates: age, race/ethnicity, education, marital status, self-employment, household wealth, presence of children aged ≤18 years, and occupational categories. Models II, IV, and VI also include BMI, BMI squared ($BMI^2$), and the number of other chronic conditions. †$P < 0.05$, ‡$P < 0.01$.

uals with diabetes reported that they were taking oral medications whereas nearly one in four was using insulin to control their diabetes. Individuals with diabetes were on average 1 year older and were more likely to be male and single compared with working adults without diabetes. In addition, a significantly greater proportion of the diabetic sample was African American (26.5%) compared with individuals without diabetes (14.3%). Persons with diabetes had less total wealth, were less likely to be classified as white collar, and had lower educational attainment relative to those without diabetes. Individuals with diabetes also had significantly higher BMI and more chronic health conditions.

Two years later, 86% of individuals without diabetes and 78% of those with diabetes were employed. Among those working at the second interview, individuals with diabetes did not work fewer hours per week on average but had more work-loss days and work limitations than those without diabetes, suggesting that diabetes affects work productivity.

## Multivariate results

**Employment.** The probit estimates of the differences in the absolute probability of working in wave 2 are shown in Table 2. These data are shown for both men and women. The first model controls for sociodemographic characteristics and occupation, whereas the second model includes BMI and the number of other chronic health conditions. In both models, the effect of diabetes on the probability of working was negative, although the magnitude of the effect and its significance varied by sex across models. In the first model, the probability of working was 5.9 percentage points less for women with diabetes and 9.0 percentage points less for men with diabetes relative to their same-sex counterparts without diabetes. With the inclusion of BMI and chronic conditions in the model, the effect of diabetes diminished to 4.4 and 7.1 percentage points for women and men, respectively. However, the effect of diabetes for women was marginally significant ($P < 0.10$).

**Work productivity.** Table 2 also presents the results from the probit model predicting the effect of diabetes on the probability of work limitations and from the ordinary least-squares model predicting annual work-loss days for individuals who were working in the second interview. After adjustment for sociodemographic and occupation characteristics, diabetes is a predictor of both work limitations and work-loss days, suggesting that, among those working, diabetes may reduce performance in the workplace. As expected, the effect of diabetes was smaller in the models that controlled for other health status indicators. The relationship of diabetes with the presence of work limitations was statistically significant for both men and women. Men and women with diabetes were between 5 and 6 percentage points more likely to have work limitations compared with those without diabetes. The association between diabetes and work-loss days was greater for women than men. Women with diabetes had two more work-loss days per year compared with women without diabetes. Diabetes was not associated with work-loss days among men nor was it associated with a change in average hours worked per week for both men and women (results not shown).

**Health-related reasons for not working.** Among the individuals employed in the first interview who were not working 2 years later, we also examined the relationship between diabetes and self-reported health-related reasons for not working (Table 3). Nonworking individuals with diabetes were more likely to report being disabled compared with nonworking individuals without diabetes

**Table 3—*Unadjusted ORs from logit models of self-reported health-related reasons for not working in wave 2 among employees in wave 1 (51–61 years of age)***

| Outcomes | OR associated with diabetes | 95% CI |
|---|---|---|
| Disabled (employment status) | 2.1 | 1.1–3.8 |
| Poor health | 3.1 | 2.1–4.7 |
| Work disabled (health limitation kept from working altogether) | 3.6 | 2.4–5.5 |

*n* = 977.

(odds ratio [OR] 2.1 [95% CI 1.1–3.8]). When compared with the latter group, nonworking individuals with diabetes were also more likely to report quitting work because of poor health 3.1 [2.1–4.7]) and being work disabled (3.6 [2.4–5.5]).

**CONCLUSIONS** — As diabetes becomes more prevalent in the population, its effects on employment and work productivity are likely to become more pressing for society. Our findings are consistent with the associations reported in cross-sectional studies, and they provide new evidence that diabetes significantly decreases the probability of subsequent employment. Even after controlling for other factors presumed to be relevant to the decision to work, such as other chronic health conditions and job characteristics, we found that diabetes reduced the absolute likelihood of working by 4.4 percentage points for women and 7.1 percentage points for men.

Although this study did not explicitly measure presenteeism (i.e., reduced productivity while working), we found that diabetes was associated with the presence of work limitations. Diabetes was also associated with increased absenteeism. These findings suggest that diabetes may result in productivity losses for employers. Employees may experience lost wages if their work-loss days extend beyond an allotment of paid sick leave. Previous research indicates that the risk of diabetes might be reduced through workplace wellness programs that target diabetes prevention as well as other health improvement strategies (27). By reducing the incidence of diabetes, these programs may also prevent/reduce future losses in employment and work productivity. Additional studies are needed to understand whether the costs of such employer-sponsored programs are offset by preventing or reducing productivity losses due to diabetes.

Among individuals who were working in the first interview but not working 2 years later, we found that health-related reasons for leaving the workforce were more common among those with diabetes compared with individuals without diabetes. For example, compared with their counterparts without diabetes, former employees with diabetes were 2 to 3 times more likely to report that they stopped working due to a recent deterioration in their health. Because diabetes is a progressive disease, one may speculate that the occurrence or progression of diabetes complications may have led these individuals to stop working. Therefore, the prevention of both diabetes and its complications through medication, diet, and exercise are likely to yield economic benefits in addition to preserving health status and quality of life for individuals who are at risk for developing or who already have diabetes (1,15,27).

We note several important limitations. First, the HRS does not provide longitudinal data on employment status before a diagnosis of diabetes. Such data with a longer work history would have been useful to support the causal inferences regarding employment and work disability due to diabetes. Second, we used self-reported diabetes information, which may be subject to error. For example, respondents who reported a diagnosis of diabetes previously may include patients with gestational diabetes mellitus, medication-induced diabetes, and glucose intolerance (16). Third, data available within the HRS do not enable us to adjust for the severity of diabetes (e.g., the presence or absence of diabetes-related complications) and the control of diabetes (e.g., GHb). Therefore, our results do not address possible differential effects on labor market outcomes by the severity of diabetes or resultant complications cited in previous literature (8,10). Our results also do not address how successful management of diabetes may affect labor market outcomes. Fourth, our sample is limited to the individuals who responded to the first two waves of the HRS. The implication of this fact is that individuals are healthy enough to be alive and employed in the first interview and are still alive 2 years later. We found that individuals with diabetes experienced a disproportionate share of comorbidities or death (results not shown). Therefore, our estimates probably underestimate the impact of diabetes on labor market outcomes, which may explain why our effect sizes are smaller than those that have been previously reported (7,8,10). Fifth, presenteeism, which is an important source of lost productivity, was not measured in this study. Finally, study findings presented are based on 1992 and 1994 data, which may not reflect recent treatments for diabetes or case management efforts to increase adherence with prescribed treatments. Nevertheless, the main finding, reduced employment and work productivity associated with diabetes, is likely to exist today.

In summary, our results provide evidence that diabetes affects patients, employers, and society not only by reducing employment but also by contributing to work loss through absenteeism and health-related work limitations in the workplace. The economic burden associated with diabetes is likely to increase as diabetes becomes more prevalent. Moreover, the overall work loss associated with diabetes (a highly prevalent disease) at a population level is likely to be much larger compared with that of less prevalent diseases such as cancer, which lead to greater individual work loss (28,29). New successful drug therapies and medical advancements in managing diabetes may reduce this burden (6). However, the challenge will be in translating these advances into practice so that individuals can enjoy healthy lives and so that society can reap the rewards of a productive and healthy working population.

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