# Impact of Diabetes on Work Cessation

## Data from the GAZEL cohort study

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**OBJECTIVE**—To measure the impact of diabetes on work cessation, i.e., on the risks of work disability, early retirement, and death while in the labor force.

**RESEARCH DESIGN AND METHODS**—We used data from the GAZEL prospective cohort of 20,625 employees of the French national gas and electricity company "EDF-GDF." We identified 506 employees with diabetes and randomly selected 2,530 nondiabetic employed control subjects matched for major sociodemographic and occupational characteristics. Using a multistate Cox model, we estimated hazard ratios (HRs) comparing the risks of transition from employment to disability, retirement, and death over time between participants with versus without diabetes.

**RESULTS**—Employment rate decreased more rapidly in participants with diabetes (51.9 and 10.1% at 55 and 60 years, respectively) compared with nondiabetic participants (66.5 and 13.4%, respectively). Participants with diabetes had significantly increased risks of transition from employment to disability (HR 1.7 [95% CI 1.0–2.9]), retirement (HR 1.6 [1.5–1.8]), and death (HR 7.3 [3.6–14.6]) compared with participants without diabetes. Between 35 and 60 years, each participant with diabetes lost an estimated mean time of 1.1 year in the workforce (95% CI 0.99–1.14) compared with a nondiabetic participant.

**CONCLUSIONS**—Our results provide evidence for a profound negative impact of diabetes on workforce participation in France. Social and economic consequences are major for patients, employers, and society—a burden that is likely to increase as diabetes becomes more and more common in the working-aged population.

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Worldwide, 285 million people aged 20–79 years are estimated to have diabetes in 2010, and the prevalence is expected to rise substantially in the coming decades (1). Diabetes confers an increased risk of disability (2–4). Moreover, complications of diabetes constitute major causes of morbidity—ranging from visual impairment to amputation to coronary heart disease and premature mortality (1).

Diabetes most often appears in middle-aged adults, and the majority of individuals diagnosed with diabetes are of working age (1). Several studies have shown that employment rate of people with diabetes is substantially reduced compared with the nondiabetic population in the U.S., with major economic consequences (5–8). Understanding the processes leading to such a reduced employment rate in the growing population of people with diabetes may provide insights into strategies for limiting the burden of the disease for individuals and society, although prospective studies aimed at understanding these processes have remained limited. Data from the Health and Retirement Study in the U.S. suggested that among working-aged individuals, work cessation occurred more frequently in those with diabetes versus those without prevalent diabetes at baseline in 1992 (9) as a result of higher rates of disability, retirement, and premature death (10). However, these analyses were restricted to the prevalent cases of diabetes that were followed during a limited amount of time, and they did not account for occupational characteristics before diabetes occurrence. Thus they do not provide an accurate estimate of the overall relative burden of diabetes on work cessation.

The current study aimed at quantifying the impact of diabetes on work cessation. More specifically, our objectives were *1*) to prospectively measure diabetes-associated risks of work disability, early retirement, and premature death from the time of diabetes onset, accounting for differences in occupational characteristics before diabetes onset and *2*) to estimate the amount of time lost in employment for individuals with diabetes compared with those without diabetes.

## RESEARCH DESIGN AND METHODS

### Study design

The GAZ and ELectricité (GAZEL) cohort was established in 1989 among employees of the French national electricity and gas company "EDF-GDF." In January 1989, all male employees, then aged 40–50 years, and all women employees, then aged 35–50 years, were invited to participate in the cohort. Of the 44,922 subjects (31,411 men and 13,511 women) asked to participate, 20,625 (45.9%) accepted: 15,011 men and 5,614 women. Higher participation was associated with male sex, being married, having children, holding a managerial status, and residing in some regions of France (11). EDF-GDF employees hold civil-servant–like status that entails job security. Typically, they are hired when they are in their 20s and stay with the company until retirement. Since enrollment, they have been followed prospectively through a yearly self-administered questionnaire, including a large set of information on health—such as self-reported diabetes—and its determinants. Less than 1% of the participants has been lost to follow-up since 1989 (11).

### Study population

In this study, we included GAZEL participants free of diabetes at baseline in 1989 who were subsequently classified as patients with diabetes during follow-up since they were still employed and a matched sample of nondiabetic participants.

Participants were classified as patients with diabetes if they consistently self-reported diabetes in the yearly questionnaire.

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Consistent report of diabetes was defined based on the combination of response rate to the yearly questionnaire and frequency of self-reports of diabetes in the completed questionnaires. Those reporting diabetes inconsistently across time (i.e., less than once every 3 years following the first occurrence of self-reported diabetes) were classified as nondiabetic participants. For participants classified as patients with diabetes, the year of diabetes onset was that of the first occurrence of self-reported diabetes if the questionnaire of the preceding year indicated the absence of diabetes. In the case of missing questionnaires between the last year with no diabetes reported and the first year with diabetes reported, the year of diabetes onset was randomly assigned between these 2 years.

Nondiabetic participants were matched to those with diabetes for major sociodemographic and occupational determinants of workforce participation, i.e., sex and characteristics at the time of hiring in EDF-GDF, including calendar year, age, and occupational grade. Nondiabetic referents also had to be employed at the time they were matched to participants with diabetes. Five nondiabetic participants were randomly matched to each participant with diabetes.

### Variables of interest

We obtained information on occupational status throughout the career in EDF-GDF (including characteristics at the time of hiring, retirement date, pension for disability or long-standing illness, and sickness absences) as well as on mortality from the company administrative records. Because retirement pensions are paid by EDF-GDF, these records provide comprehensive and accurate information. Legal age of retirement for EDF-GDF employees is between 55 and 60 years, mainly depending on the type of job: manual/unskilled workers are allowed to retire earlier. Participants were considered in disability if they had been granted a pension for disability or long-standing illness or if they had sick leave of more than 365 days.

BMI at age 50 years was obtained using self-reported height and weight and categorized as normal or underweight ($<$25.0 kg/m$^2$), overweight (25.0-29.9 kg/m$^2$), or obese (30.0 kg/m$^2$ or more).

### Statistical analysis

Analysis was based on data collected as of 31 December 2007 and restricted to the age range of 35–60 years. Participants with diabetes were accounted for in the nonexposed group until diabetes onset and then in the exposed group starting from the year of diabetes onset. Probabilities of disability, retirement, and death at each point of the age range were estimated separately for participants with and without diabetes using the Kaplan-Meier method. Using a multistate Cox model, we estimated hazard ratios (HRs) comparing the risks of transition from employment to each of these categories of inactivity between participants with versus without diabetes. These HRs automatically accounted for characteristics used as matching criteria. In addition, further adjustment for BMI at age 50 years was performed. The proportional hazard hypothesis was verified based on the correlation between Schoenfeld residuals and time. Using the predicted probabilities of being in each of the four states of the model over time, we then estimated the difference in the amount of time spent out of the workforce between 35 and 60 years according to diabetes status. Confidence interval of this difference was estimated using the bootstrap percentile method.

Statistical analyses were performed using SAS 9.1 and R software with the packages *survival* and *mstate*.

## RESULTS

### Sample characteristics

Among the 20,625 participants included in the GAZEL cohort, 20,318 reported that they were free of diabetes in the baseline self-questionnaire in 1989. Among them, 981 were subsequently classified as patients with diabetes during follow-up. Of these 981 participants with incident diabetes, 508 were still employed at the time of diabetes onset and were thus considered as the exposed group in our study. Two of them were excluded because they did not have nondiabetic counterparts with comparable characteristics with regard to matching criteria, and each of the 506 remaining was matched to five nondiabetic participants. Thus the final sample consisted of 3,036 participants: 506 with diabetes and 2,530 without diabetes. As of 31 December 2007, 3.5% of these 3,036 participants were dead, 89.6% were retired, 0.8% were disabled, and 6.1% were still employed.

Characteristics of the study population according to diabetes status are shown in Table 1. As in the entire cohort, participants were mostly men. Half of them had been hired in EDF-GDF in the years 1957–1966 as they were in their 20s (mean age 22.8 years). The large majority (over 80%) had been hired on a low occupational position, i.e., either as manual workers or clerks. Upward occupational mobility was frequent, and as a result, only a minority (29.8% of participants with diabetes and 24.3% of those without diabetes) were still holding a low occupational position at 35 years.

Among the 506 participants with diabetes, mean age at diabetes onset was 51.6 years (minimum: 39; maximum: 60 years). At age 50 years 190 participants had diabetes; this number was 427 at age 55 years and 506 at age 60 years. Almost half (45.6%) of participants with diabetes were overweight, and one-third (33.4%) were obese at 50 years. This was the case only for 40.7 and 5.7% of nondiabetic participants, respectively.

### Employment status of participants with and without diabetes over time

All of the 3,036 participants were employed as they were aged 35 years, and the large majority (95.3% of those with diabetes and 96.4% of those without diabetes) were still working as they reached the age of 50 years. Subsequently, employment rate decreased more rapidly in participants with diabetes (51.9 and 10.1% at ages 55 and 60 years, respectively) compared with those without diabetes (66.5 and 13.4%, respectively). At the age of 55 years, a higher proportion of participants with versus without diabetes were retired (39.5 vs. 28.2%, respectively; $P < 0.001$) or had died (2.9 vs. 1.1%, respectively; $P = 0.003$). At the age of 60 years, a higher proportion of participants with versus without diabetes were work disabled (5.0 vs. 1.4%, respectively; $P < 0.001$).

### Frequency of work disability, retirement, and death over time

Overall, between the ages of 35 and 60 years, work disability occurred in 15 employed participants with diabetes and 162 without diabetes; retirement occurred in 399 employed participants with diabetes and 2,222 without diabetes; death occurred in 13 employed participants with diabetes and 22 without diabetes (Table 2).

Figure 1 shows the probabilities of disability, retirement, and death by diabetes status at each point of the age range between 50 and 60 years—the period during which most of the work cessation

**Table 1—*Characteristics of the study population according to diabetes status***

| | Participants with diabetes | Participants without diabetes |
|---|---|---|
| *n* | 506 | 2,530 |
| Sex | | |
| Men | 419 (82.8) | 2,095 (82.8) |
| Women | 87 (17.2) | 435 (17.2) |
| Calendar year at the time of hiring in EDF-GDF | | |
| 1957–1966 | 247 (48.8) | 1,239 (49.0) |
| 1967–1976 | 190 (37.6) | 947 (37.4) |
| 1977–1987 | 69 (13.6) | 344 (13.6) |
| Age at the time of hiring in EDF-GDF (years) | | |
| 15–19 | 170 (33.6) | 873 (34.5) |
| 20–29 | 262 (51.8) | 1,303 (51.5) |
| 30 or more | 74 (14.6) | 354 (14.0) |
| Occupational grade at the time of hiring in EDF-GDF | | |
| Managers or executives | 47 (9.3) | 235 (9.3) |
| Associates professionals or technicians | 34 (6.7) | 170 (6.7) |
| Clerks | 189 (37.4) | 945 (37.4) |
| Manual workers | 232 (45.8) | 1,160 (45.8) |
| Missing | 4 (0.8) | 20 (0.8) |
| Occupational grade at 35 years | | |
| Managers or executives | 75 (14.8) | 420 (16.6) |
| Associates professionals or technicians | 252 (49.8) | 1,369 (54.1) |
| Clerks | 66 (13.0) | 290 (11.5) |
| Manual workers | 85 (16.8) | 325 (12.8) |
| Missing | 28 (5.5) | 126 (5.0) |
| Age at the time of diabetes onset (years) | | |
| 35–44 | 28 (5.5) | — |
| 45–54 | 364 (71.9) | — |
| 55 or more | 114 (22.5) | — |
| BMI at 50 years (kg/m$^2$) | | |
| Normal or underweight | 97 (19.2) | 1,217 (48.1) |
| Overweight | 231 (45.6) | 1,030 (40.7) |
| Obese | 169 (33.4) | 145 (5.7) |
| Missing | 9 (1.8) | 138 (5.5) |

Values are *n* (%).

events occurred. Among both participants with and without diabetes, the probabilities of disability, retirement, and death continuously increased with age, with a steep increase in the probability of retirement at 55 years. The increase in the probability of disability was consistent across diabetes groups between 50 and 54 years but steeper among participants with diabetes thereafter.

### Impact of diabetes on the risk of work cessation over time

As shown in Table 2, participants with diabetes had a significantly increased probability of transition from employment to disability (HR 1.7 [95% CI 1.0–2.9]), to retirement (HR 1.6 [1.5–1.8]), and to death (HR 7.3 [3.6–14.6]) compared with participants without diabetes. After adjustment for BMI, the increase in the risks of retirement (HR 1.6 [1.5–1.8]) and death (HR 8.0 [3.8–17.0]) associated with diabetes remained unchanged, although the diabetes-associated risk of disability was reduced and no longer significant (HR 1.4 [0.8–2.4]). The impact of diabetes on disability and death was consistent over time. In contrast, diabetes effect on retirement significantly decreased over time, with the HR decreasing (from HR 2.1 [1.7–2.5] to 1.5 [1.3–1.7]) between 35 and 55 years thereafter when most of the participants retired regardless of diabetes status.

Between the ages of 35 and 60 years, we estimated that each participant with diabetes lost an average time of 1.1 years in the workforce (95% CI 0.99–1.14) compared with a nondiabetic participant, whose retirement accounted for 0.70 year of this loss (95% CI 0.62–0.78), death for 0.28 year (95% CI 0.20–0.35), and disability for 0.09 year (95% CI 0.02–0.15).

### Sensitivity analysis

Our definition of diabetes, based on a pattern of consistent self-report, is likely to have excluded the milder cases of disease. To capture these less severe cases, analyses were repeated using an alternative definition of diabetes in which all 773 cases with any mention of diabetes in the yearly questionnaire were classified as having diabetes, regardless of the consistency of this self-report. Although the effect of diabetes on disability was unchanged (HR 1.6 [95% CI 1.1–2.4]), the effects on retirement (HR 1.3 [1.1–1.4]) and death (HR 2.3 [1.2–4.2]) were lower than the estimates reported in Table 2. However, these effects remained significant. Likewise, the estimated average time of lost employment among participants with diabetes was decreased

**Table 2—*Risk of work disability, retirement, and death among participants with diabetes compared with those without diabetes***

| | Participants with diabetes | | Participants without diabetes | | HR [95% CI] | |
|---|---|---|---|---|---|---|
| | Number of events | Incidence rate per 1,000 person-years | Number of events | Incidence rate per 1,000 person-years | Accounting for matching criteria* | Additionally adjusted for BMI at age 50 years |
| Employment | | | | | | |
| To disability | 15 | 7.9 | 162 | 2.7 | 1.7 [1.0–2.9] | 1.4 [0.8–2.4] |
| To retirement | 399 | 209.1 | 2,221 | 37.6 | 1.6 [1.5–1.8] | 1.6 [1.5–1.8] |
| To death | 13 | 6.8 | 22 | 0.4 | 7.3 [3.6–14.6] | 8.0 [3.8–17.0] |

*Matching criteria were sex and calendar year, age, and occupational grade at the time of hiring in EDF-GDF.

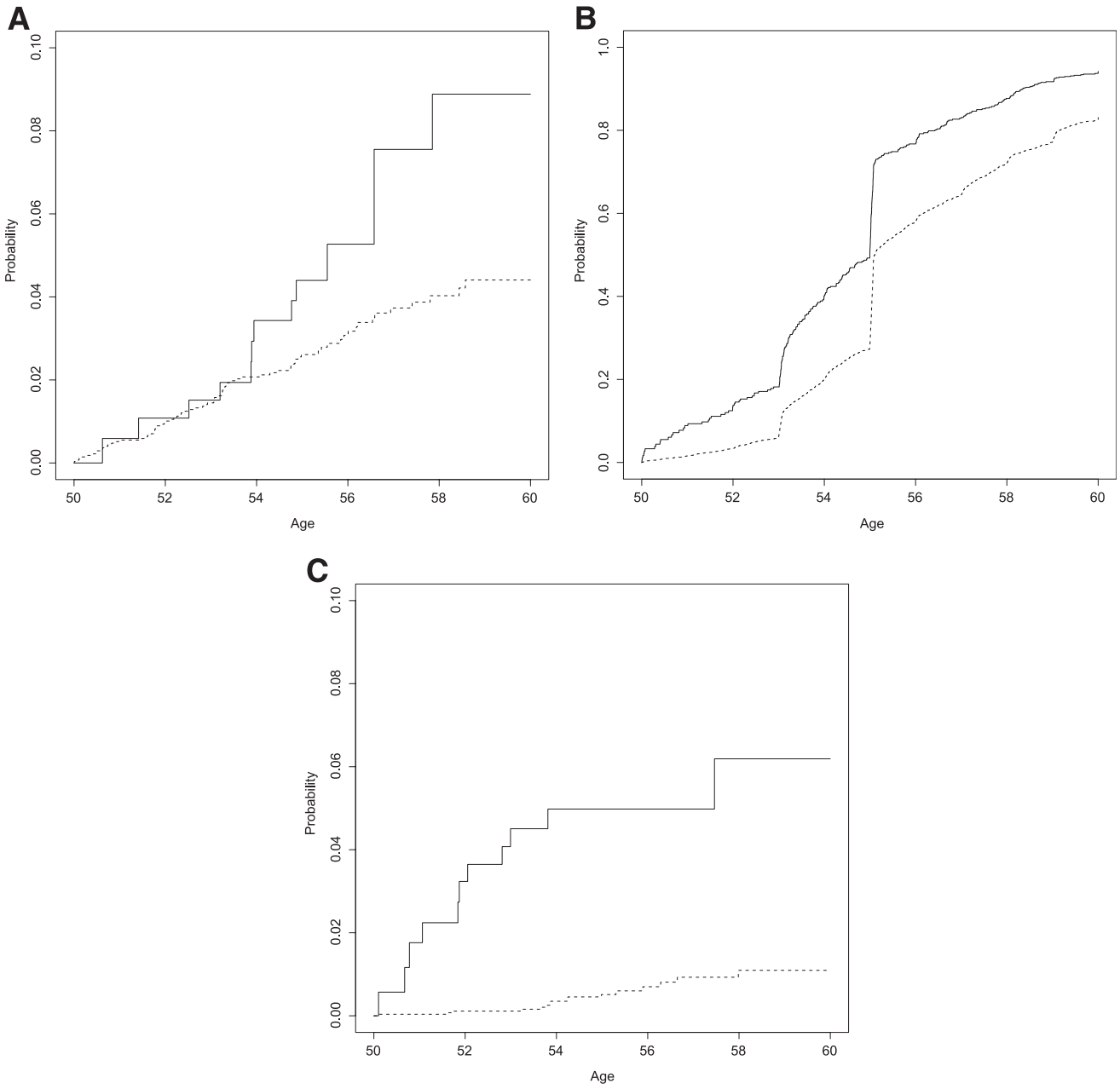


**Figure 1—***Probability of work disability* (A)*, retirement* (B)*, and death* (C) *according to age between 50 and 60 years among participants with (solid line) and without (dashed line) diabetes.*

(0.59 year [0.52–0.66]) but remained significant.

**CONCLUSIONS**—Our results provide evidence for a profound negative impact of diabetes on workforce participation in France. Indeed, we found that, among employees of the GAZEL cohort, diabetes is associated with an overall 60–70% increase in the risks of work disability and early retirement and with a sevenfold increase in the risk of death while in the labor force. The effect of diabetes on disability is largely attributable to obesity. These substantially increased risks of work cessation associated with diabetes translate into an absolute decrease of over 1 year spent in employment between 35 and 60 years for employees with diabetes compared with those without diabetes. Retirement accounts for the major part (64%) of this difference.

Strengths of this study, which lend weight to these conclusions, include prospective data from a large occupational cohort, constituted of a diverse population of white- and blue-collar employees from all regions of France, with long-term follow-up that is almost 100% complete. Available information on occupational status throughout the career in the company is particularly comprehensive and accurate since it has been obtained directly from the company administrative records. In addition to ensuring highly reliable measures of the outcomes of interest, such information allowed us to account for occupational characteristics early in an individual's career in our analyses and thus to provide estimates of the burden of diabetes independent of these major occupational determinants of workforce participation.

Our study has several limitations. First, information on diabetes was self-reported. Although accuracy of diabetes self-report is high (12), such a definition excludes undiagnosed cases of the disease, which are incorrectly considered as free of diabetes. However, only 13% of diabetic adults aged 55–74 years are estimated to be undiagnosed in France (13). Moreover, to be considered as patients with diabetes, participants in our study had not only to self-report diabetes once during follow-up but also to consistently self-report the disease over time after the first report. This probably improved the identification of true cases of diabetes compared with a definition based on a unique occurrence of self-reported diabetes. Although our definition may have led to exclude some cases of diabetes episodically self-reported, internally consistent results are obtained using either definition, as shown in our sensitivity analysis. In addition, available data did not allow us to distinguish between type 1 and type 2 diabetes. However, because our analyses were restricted to incident cases of diabetes occurring after enrollment in the GAZEL cohort, i.e., after the age of 35 years, our results mostly pertain to type 2 diabetes.

There are several considerations suggesting that the magnitude of diabetes impact on workforce participation may have been underestimated in our study. First, EDF-GDF employees have a particularly high level of job security; moreover, some categories of workers (e.g., those self-employed and agricultural workers), whose occupational status may be particularly vulnerable to health problems, are not represented in the company (11). Second, to provide valid estimates of the impact of diabetes on work cessation, our analyses were restricted to incident cases of diabetes appearing after enrollment in the cohort, i.e., later than 1989. Thus cases of diabetes that occurred earlier in employees' careers were excluded. The impact of these early-onset cases on work cessation before 1989 could not be accounted for in our study since the GAZEL cohort was restricted to employees still working in 1989. However, a complementary analysis suggested that the diabetes-related increase in the risk of disability during follow-up may be more marked for cases prevalent in 1989 (results not shown). Third, because a large proportion of EDF-GDF employees are given the opportunity to retire between 55 and 60 years, retirement before 55 years rather than 60 years may constitute a better indicator of early retirement in this population. Diabetes-related increase in the risk of early retirement was substantially higher between 35 and 55 years (HR 2.1 [95% CI 1.7–2.5]) than between 35 and 60 years (HR 1.6 [95% CI 1.5–1.8]).

To our knowledge, this study is the first to provide evidence for a significant impact of diabetes on work cessation in France, a country with a system of universal social protection. Our findings of increased risks of disability, retirement, and death among employees with versus without diabetes are consistent with reports based on data from the Health and Retirement Study in the U.S. (9,10). This shows that such deleterious consequences of diabetes on workforce participation occur in the context of very different systems of social protection.

Diabetes is unevenly distributed across socioeconomic strata, with higher prevalence of the disease reported in the most deprived groups of the population (14,15). This suggests that individuals with diabetes may be more prone than others to hold adverse occupational conditions, exposing them to an increased risk of unemployment. This could explain, at least in part, the differences formerly reported between individuals with versus without diabetes with regard to employment status (6–10,16). In our study, all participants were employed by the same company and thus benefited from a comparable level of job security; moreover, we were able to provide estimates accounting for occupational characteristics before diabetes onset. Thus our findings add significant knowledge to the existing literature by providing evidence for an independent effect of diabetes on work cessation.

Further research is needed to ascertain the generalizability of our results outside the GAZEL cohort study, and more generally outside France. The French pattern of early transitions out of employment is characterized by a low age of retirement and by the importance of transitions through unemployment insurance and preretirement schemes, resulting in lower recourse to disability compared with other countries (17). Despite these differences, data from the Survey of Health, Ageing and Retirement in Europe (SHARE) suggest that the overall burden of health impairment on work cessation does not differ in France compared with other European countries (18). This suggests that although the patterns of transitions out of employment are likely to be country specific, the negative impact of diabetes on workforce participation that we show might be fairly generalizable to other settings. Our results pertain to the population of working age, i.e., aged less than 60 years in France, a country with universal access to a high quality of medical care. The impact of diabetes on work cessation might be even greater in countries with older retirement ages or lower access to quality healthcare.

Diabetes can affect individuals' ability to maintain employment through different pathways. This can happen directly through impairment of bodily functions arising from diabetes complications, including loss of vision, amputations, or mobility limitations (16,19); workplace discrimination encountered by employees with diabetes may also play a role (20). Moreover, because diabetes is frequently associated with other health problems, comorbidities can constitute additional barriers to employment. Obesity has been shown to impair employment status in several studies (21–24); in addition, our results suggest that differences in BMI between employees with versus without diabetes explain a significant part of the effect of diabetes on disability. Studies also suggest that macrovascular comorbid conditions (25) and depression (19) are associated with higher rates of unemployment among people with diabetes.

In conclusion, the current study provides evidence that diabetes substantially weighs on employees' chances of maintaining in employment. This effect of diabetes has major social and economic consequences for patients, employers, and society, a burden that is likely to increase as diabetes becomes more and more common in the working-aged population. Limiting the social and economic burden of diabetes is a major challenge to be addressed at different levels, including the health care system, employers, and social workers.

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E.H. ran all of the analyses and wrote the manuscript. A.G. provided statistical advice and reviewed and edited the manuscript. S.B. researched data and reviewed and edited the manuscript. R.D.-S. generated the study hypothesis, supervised the analyses, and wrote the manuscript.

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