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Gender Heterogeneity in Self-reported Health: The Case of Diabetes*

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Abstract

In this paper, we investigate the gender gap in diabetes misreporting using the French *Constances* cohort. We show that diabetes unawareness is more frequent among men than among women, even after conditioning on individual characteristics. As a second step, we investigate the causes of the gender gap in diabetes misreporting. We find no strong evidence that women would be more aware that they are diabetic because they have greater opportunities to undergo a blood test. In contrast, we find suggestive evidence that women are more aware than men of their parents' health and hence of their own medical history.

JEL Codes: I10, I12, J18

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Introduction

There is extensive evidence in the literature that self-reported health is subject to reporting heterogeneity. Such heterogeneity exists in a large number of dimensions including education (Bago d'Uva et al., 2011; Schneider et al., 2012), income (Etilé and Milcent, 2006; Johnston et al., 2009) and age (Bago d'Uva et al., 2008; Lindeboom and Van Doorslaer, 2004). Another striking dimension of heterogeneity is gender: men tend to report better self-rated health than women, although their probability of dying is higher than women's throughout their life – see Oksuzyan et al. (2018) and Cambois et al. (2011).

Men's reporting behaviour is an issue for public health if they overstate their health status because they are unaware that they are sick. This issue is particularly relevant in the case of silent diseases since individuals may suffer from a pathology without being aware of it – at least in the first phases of the disease. This unawareness may generate serious health consequences since information on one's health status has been shown to have a critical impact on treatment and on healthy behaviours - see Slade (2012) and Zhao et al. (2013).

In this paper, we study reporting errors concerning one of the most fast-growing silent chronic diseases in the world, namely diabetes. According to the World Health Organization, the global prevalence of diabetes among adults over 18 years of age has risen from 4.7% in 1980 to 8.5% in 2014. Diabetes affected more than 400 million individuals in the world at that date (WHO, 2016). In 2015, 30.2 million US adults aged 18 or older (i.e. 12.2% of all U.S. adults) had diabetes of which 7.2 million (23.8%) were not aware of it or did not report having diabetes (CDCP, 2017).

Being aware of the fact that one is affected by diabetes is however of crucial importance since, if diagnosed early enough, diabetes can be treated by changes in lifestyles (increasing exercise, stopping smoking, losing weight and reducing alcohol consumption) and diets (reducing carbohydrate and fat intake) without necessarily taking medication. In contrast, late diagnosis will impose taking insulin while untreated diabetes can lead to severe complications including brain damage, blindness, limb amputation, heart attacks, or kidney damage.

In this paper, we investigate the gender dimension of misreporting of diabetes using the French *Constances* Cohort. This cohort contains 186,501 individuals enrolled between 2012 and 2019 whom we observe upon enrolment. It has information on self-reported diabetes as well as individual glycemia as measured through a blood test. It also contains a wealth of individual characteristics and extensive information on individuals' personal and family medical history. We first investigate the heterogeneity in diabetes reporting across gender. We find that diabetes unawareness is more frequent among men than among women, even after conditioning on a number of individual characteristics such as age, education, occupation and income. As a second step, we investigate the causes of the gender gap in diabetes misreporting. We find no strong evidence that women would be more aware that they are diabetic because they have greater opportunities to undergo a blood test. In contrast, we find suggestive evidence that women are more aware than men of their parents' health and hence of their own medical history.

Our paper relates to two strands of the literature. The first one focuses on differences in health-reporting behaviour across gender. The starting point of this literature is the observation that women tend to report poorer health than men in many dimensions: disability, functional limitations, depression - see Palacios-Ceña et al. (2012), Oksuzyan et al. (2010) and Salk et al. (2017). Several explanations have been put forward to account for this gap. Case and Paxson (2005) provide evidence that women suffer more from non-acute disabling health troubles while men would suffer more from lethal conditions. Other studies suggest that social roles are crucial in explaining why women are disadvantaged as regards self-reported health (Bambra et al., 2009). An alternative explanation is that women would be more willing to admit health problems (Caroli and Weber-Baghdiguian, 2016; Courtenay, 2000). However, recent evidence provided by Oksuzyan et al. (2019) suggests that there is no robust gender gap in health reporting, the main difference being between younger individuals who tend to under-report good health and older ones who tend to over-report it, be they men or women. In this paper, we consider gender heterogeneity in health-reporting behaviour regarding one specific condition, i.e. diabetes. Our data allow us to compare self-reports with the results of biological analyses (blood glucose dosage), which is usually not done in the above-mentioned literature. Researchers typically develop methods to assess the effect of gender on under or over-reporting of good/bad health using only self-reported information (on self-rated health, chronic conditions, functional limitations etc.) - see Jürges (2007). In the present research we go one step further and compare those self-reports to the results of more objective blood analyses. We show that men consistently under-report their diabetes as compared to what is revealed by the blood glucose dosage. This is also the case for women but to a lesser extent.

Our research also relates to the literature on undiagnosed diabetes. Scholars in epidemiology have extensively studied the scope of undiagnosed diabetes in a wide array of countries including the United-States (Dall et al., 2019; Mendola et al., 2018), Canada (Rosella et al., 2015), Denmark (Holm et al., 2016), Germany (Heidemann et al., 2016), but also Taiwan (Goldman et al., 2003) and mainland China (Ning et al., 2016). They emphasise the importance of clinical characteristics such as obesity, sedentary lifestyles and hypertension as factors associated with undiagnosed diabetes. Wilder et al. (2005) conjecture that socio-economic status as measured by income and education could be an important factor too, since individuals from higher socio-economic backgrounds should be "more efficient acquirers of information than others". Yet, he does not find any evidence of this in the United-States. In this paper, we show that one of the reasons why women tend to be more aware of the fact that they have diabetes than men is indeed that they have better information, in particular about their parent's health and hence their own medical history. This suggests that information acquisition is indeed crucial in fighting undiagnosed diabetes.

1 Empirical Strategy

1.1 Objective and Subjective diabetes

We first estimate separately the probability that an individual reports and objectively suffers from diabetes using a linear probability model:

$$Subj_i = \alpha_0 + \alpha_1 M_i + \boldsymbol{X_i}\alpha_2 + \epsilon_i \tag{1}$$

where $Subj_i$ is equal to 1 if the individual self-reports diabetes and 0 otherwise. M_i is a dummy variable equal to 1 if the individual is a male and 0 otherwise. $\boldsymbol{X_i}$ is a vector of individual-level controls and ϵ_i the error term.

$$Obj_i = \gamma_0 + \gamma_1 M_i + \boldsymbol{X_i}\gamma_2 + \mu_i \tag{2}$$

where Obj_i is equal to 1 if the individual objectively suffers from diabetes and 0 otherwise. We report standard errors robust to heteroscedasticity given it is inherent to linear probability models.

To assess whether the difference in the point estimates on M_i is significant or not across self-reported and objective diabetes, we proceed in the following way. We define a new variable y_{is} capturing either self-reported or objective diabetes. More precisely, for each individual in our sample, we generate two observations: one for which $y_i = 0$ if $Subj_i = 0$ and $y_i = 1$ if $Subj_i = 1$ and a second observation for which $y_i = 0$ if $Obj_i = 0$ and $y_i = 1$ if $Obj_i = 1$. We then estimate the following linear probability model:

$$y_{is} = \beta_0 + \beta_1 S_i + \beta_2 M_{is} + \beta_3 S_i \times M_{is} + \boldsymbol{X_{is}}\beta_4 + \boldsymbol{X_{is}} \times M_{is}\beta_5 + u_{is} \quad (3)$$

where S_i is a dummy variable which we set equal to 1 when the dependent variable is self-reported diabetes (subscript $s = 1$) and to 0 when it is objective diabetes (subscript $s = 0$). Given that we have duplicated individual observations, we report robust standard errors that allow for clustering at the individual level.

In this setting, β_1 captures the difference between the intercepts of equations (1) and (2). β_2 captures the difference in objective diabetes (for $S_i = 0$) between men and women. β_3 is our coefficient of interest. It measures the difference in unawareness across women and men: $\beta_3 < 0$ hence implies that males are more unaware that they are diabetic than women. It is identical to the difference between α_1 and γ_1 in equations (1) and (2), but the advantage of estimating this new model is that it allows us to test whether this difference is statistically significant.[1]

1.2 Diabetes unawareness

As standard in the literature, we then model the probability that an individual be unaware that she is diabetic, conditional on being so (false negatives reporting):

$$U_i = a_0 + a_1 M_i + \boldsymbol{X_i} a_2 + \nu_i \quad (4)$$

[1]Alternatively, we can also estimate equations (1) and (2) using a Seemingly Unrelated Regression model. Given that both equations include identical explanatory variables, the corresponding generalised least squares is identical to equation-by-equation ordinary least squares but it allows to obtain the estimated covariance between α_1 and γ_1 that is necessary to draw inference about the difference between the two coefficients. The test statistics provides similar results - see Greene (2018).

where U_i is a dummy variable equal to 1 if individual i does not report diabetes while the blood test realised by a nurse indicates that she is diabetic. It is equal to 0 if the individual who objectively suffers from diabetes reports to do so.

However, estimates obtained with this specification are likely to suffer from selection bias since reporting errors are observed only for individuals who are sick. In particular, we do not know whether individuals who do not objectively suffer from diabetes would have misreported it had they been sick. To deal with selectivity issues, researchers sometimes jointly model the propensity for an individual to be objectively sick and the propensity to misreport in the entire population - see Van de Ven and Van Praag (1981). For the model to be identified, though, some variables affecting the probability of being objectively sick have to be excluded from the misreporting equation. In their study of misreports of hypertension, Johnston et al. (2009) suggest using information on whether the individuals' fathers and mothers died from cardiovascular diseases before or after 60 years old. In our data, we know whether parents suffer/suffered from diabetes. However, including this variable in our analysis is likely to violate the exclusion restriction. Parental diabetes indeed probably affects the probability that the individual objectively suffers from diabetes but also the probability that she is aware of it, if individuals with diabetic medical history go more often to the doctor's and/or doctors are more likely to prescribe a blood test for them. In the absence of any good candidate for the exclusion variable, we choose not to correct for selection bias in our estimates, keeping in mind that this is a limitation of our empirical strategy.

2 Data

2.1 The *Constances* Cohort

Our data source is *Constances*, a large cohort recently set up by the French Institute for Medical Research (*INSERM*), meant to be representative of the French population aged 18–64 affiliated with the National Health Insurance (*Sécurité Sociale*) - see Zins et al. (2015) and Ruiz et al. (2016). Data collection started in 2012 and expanded over 8 years. The *Constances* cohort covers 85% of the population, excluding farmers, self-employed individuals and undocumented migrants. Participants are randomly selected and invited to undergo a health examination at one of the 22 health-screening centers run by the National Health Insurance throughout the country. During this day-long baseline visit, rich medical data are collected, based on blood, respiratory, physical, and cognitive tests. Respondents are also asked to complete questionnaires regarding their health status, health behaviours, socioeconomic characteristics, and occupational trajectories.

By 2019, *Constances* covered 186,501 individuals. Their geographical distribution matches the national distribution of the health-screening centers where they have been recruited. Compared with non-participants, participants were more likely to be males, aged 40 or more, be out of the labor force, be in highly-skilled occupations when employed, earn above-average income, have regular medical check-ups, and not to suffer from any chronic health problem. The *Constances* study was approved by bodies regulating ethical data collection in France[2], and all participants signed a written consent.

2.2 Variables and Descriptive Statistics

The cohort has information on self-assessed health and unusually rich information on more objective health measures, including diabetes, BMI, waist and hip size, vision, audition and blood pressure. Information on self-reported diabetes was obtained from answers to the following question asked in the written questionnaire: "Has a health professional (doctor or other) ever told you that you had diabetes (apart from gestational diabetes)?"[3] Individuals were also asked whether they were under treatment for diabetes: "Do you currently use any medication (tablets or insulin) for diabetes?".[4] We classified individuals as objectively suffering from diabetes if the value of their fasting glucose was greater than or equal to 7 mmol/L (126 mg/dL) or if they used anti-diabetic medications (oral hypoglycemic agents or insulin) at the time of the survey.[5] Consistent with the notations defined in Section 1, people were then coded as having $Obj_i = 1$ if they had objective diabetes and $Obj_i = 0$ otherwise. Individuals reporting that they had been diagnosed with diabetes by a health professional were considered as self-reporting diabetes.

[2] Comité Consultatif pour le Traitement des Informations Relatives à la Santé (CCTIRS) and Commission Nationale Informatique et Liberté (CNIL).

[3] *Un professional de santé (médecin ou autre) vous a-t-il déjà dit que vous étiez atteint(e) de diabète (en dehors d'un diabete gestationnel)?*

[4] *Actuellement, êtes-vous traité(e) pour votre diabète par des comprimés? Actuellement, êtes-vous traité(e) pour votre diabète par une ou plusieurs injections d'insuline?*

[5] According to the WHO, diabetes is defined as having fasting blood glucose equal to or higher than 7 mmol/L, or being on medication for raised blood glucose, or having a history of diagnosis of diabetes. `https://www.who.int/news-room/fact-sheets/detail/diabetes`

They were coded as having $Subj_i = 1$, while individuals not reporting diabetes were coded as having $Subj_i = 0$. Eventually, as standard in the literature in epidemiology - see, for example Menke et al. (2015) and Geiss et al. (2018) -, we recoded individuals reporting that they had diabetes ($Subj_i = 1$) but whose glycemia was found to be normal and who were not under treatment at the time of the survey as having objective diabetes ($Obj_i = 1$).[6] This is motivated by the fact that, in the early stages of the disease, diabetes can be treated by changing health behaviours only, without taking any medication. Those individuals, however, represent a limited proportion of our sample: 19.69% of people self-reporting diabetes and 13.01% of those eventually coded as having diabetes ($Obj_i = 1$).

The *Constances* cohort also provides information on a number of individual characteristics such as age, marital status, education (5 classes), income (7 classes), employment status as well as the health-screening center in which the individual has been invited, that we use as controls in our main regressions. It also contains objective measurements of blood pressure made by a doctor or a nurse, as well as self-reported hypertension. We use this information in secondary analyses after coding Objective Hypertension as equal to 1 if systolic blood pressure was found to be greater or equal to 140 or diastolic blood pressure was greater or equal to 90 (and 0 otherwise).[7] As for diabetes, self-reported hypertension is set equal to 1 if the individual reports that a health professional has diagnosed her with hypertension and 0 otherwise. Eventually, the *Constances* cohort also has information on whether individuals have any children and whether women have ever taken a contraceptive pill.

We exclude pregnant women from our analysis since the self-reports we use exclude gestational diabetes. We also exclude individuals who are below age 25 and those for whom information on either subjective or objective diabetes, or individual characteristics is missing. Our final sample contains 157,107 individuals.

Table 1 provides descriptive statistics for diabetes in France from the *Constances* data. The prevalence of objective diabetes is 3.8% in the entire population. This proportion is higher for men (5.3%) than for women (2.5%). Interestingly, the difference between objective and subjective diabetes is higher for men (2 versus 0.6 percentage points), suggesting that they are

[6] In what follows, we check that our results are robust to considering those individuals as NOT suffering from objective diabetes.

[7] According to the WHO, patients are defined as suffering from hypertension if their systolic blood pressure is found to be $\geq$ 140 mmHg and/or their diastolic blood pressure is $\geq$ 90 mmHg, on two different days apart. `https://www.who.int/news-room/fact-sheets/detail/hypertension`

less aware of the fact that they have diabetes. This finding is consistent with the fact that the proportion of false negatives, i.e. of individuals who are diabetic but do not report to be so, turns out to be higher for men (38.3%) than for women (25.8%) - see Table 1. Overall, the proportion of individuals who do not know that they have diabetes is not negligible (33.9%).

Appendix Table A1 provides information on the differences across men and women with regard to objective and self-reported hypertension, whether individuals have children along with individual characteristics such as age, marital status, highest diploma, income, employment status, the year when respondents were surveyed and the health-screening center they were enrolled in. It also has information as to whether women have ever taken a contraceptive pill or not.

3 Results

We first estimate separately the probability of suffering from and reporting diabetes - see equations (1) and (2). Results in Table 2 show that men have a higher probability of being diabetic and of reporting diabetes than women. However, the gender difference in self-reported diabetes is lower (+1.3 percentage points when estimated with controls) than the difference in objective diabetes (+2.6 percentage points), thus suggesting that men tend to be less aware than women that they suffer from diabetes.[8]

To check whether this difference in awareness across gender is significant at conventional levels, we estimate equation (3). The coefficient of the interaction term (β_3) indeed captures the difference between subjective and objective diabetes across genders. As shown in Table 3, the corresponding point estimate is as large as -0.013 when estimated with controls. As expected, this value is exactly the same as the difference in point estimates between columns (3) and (4) of Table 2. With a standard error of 0.001, this difference turns out to be significant at the 1% level, confirming that men are more unaware than women that they have diabetes.[9]

We then estimate the probability for an individual to be unaware of the fact that she is diabetic, conditional on being diabetic. Results in Table 4 show that men have a higher probability than women of being unaware that they suffer from diabetes (+12.5 as compared to

[8]Detailed regression results are presented in Appendix Table A2.

[9]We obtain similar results if we code individuals who report having diabetes but who do not take any medication and have normal glycemia as *NOT* suffering from objective diabetes - see Appendix Table A4.

+11.3 percentage points, when estimated without and with controls).[10] The detailed regression results are provided in Table A3. Diabetes unawareness tends to increase with age although at a slightly decreasing rate and it is lower for highly-educated individuals. We find that high-income individuals suffering from objective diabetes tend to misreport more than low-income individuals. This result is quite counterintuitive since high-income people should have better access to medical care since they are less financially constrained. However, anecdotical evidence reported by doctors suggests that high-income patients who have been diagnosed with diabetes may be more prone to deny or repress that they are sick than low-income patients since diabetes is often considered as a "working-class" disease. In turn, denial or refusal to recognize diabetes may lead to forgetfulness, negligence and misinterpretation of symptoms (Lacroix and Assal, 2011).

So far, we have provided evidence that, as regards diabetes, men have poorer information than women about their own health condition. Whether this difference is specific to diabetes or extends to other initially silent health conditions is an open issue. The *Constances* survey contains objective measurements of blood pressure made by a doctor or a nurse, as well as self-reported hypertension. Investigating the gender gap in unawareness of hypertension is interesting since this condition is much more widespread than diabetes: in our data 28.6% of individuals suffer from objective hypertension as compared to 3.8% for diabetes. To do so, we reestimate equation (4) with hypertension as a dependent variable. Results are shown in Table 5. As can be seen in cols. (1) and (2), men are more unaware than women that they suffer from hypertension - with a 8.6 and 5.5 percentage point difference when estimated without and with controls respectively, significant at the 1% level. This result is consistent with what Johnston et al. (2009) find for the USA, although it has to be interpreted with caution since our measure of objective hypertension is cruder that what we have for diabetes to the extent that we have no information on the intake of blood pressure medication.

[10] We obtain similar results if we code individuals who report having diabetes but who do not take any medication and have normal glycemia as *NOT* suffering from objective diabetes. As shown in Appendix Table A5, the point estimates are smaller in size but still significant at the 1% level.

4 Mechanisms

In this section we investigate the reasons why women may be more aware than men that they are diabetic. We particularly focus on one of them, i.e. information acquisition.

The first reason why women's unawareness is lower than men's may be that the former acquire more information about their own health because they have to go to the doctor's and have a blood test in some circumstances that do not occur to men. In France, this is the case for women who want to take a contraceptive pill. Those pills are only sold on prescription, which requires that the woman goes to the doctor's. Moreover, French Health Authorities recommend that a blood test (including a glycemia dosage) be done before the first prescription and be repeated every 5 years as long as the treatment in maintained - HAS (2019). In our data, more than 85% of women have taken a contraceptive pill at some point in their life. This could explain why women are, on average, more aware than men that they have diabetes, if they have been diagnosed thanks to the compulsory blood test. To test this assumption, we reestimate equation (4) taking men as a reference and considering separately women who have ever taken a contraceptive pill and women who have not - see Table 6, Panel A. The results show that whatever the set of variables we control for in our regression, there is no significant difference across both types of women - with a p-value higher than 0.37 in all specifications. This suggests that women who have taken a contraceptive pill at some point in their life are not more aware than women who have not.

Another occasion for women to be diagnosed as diabetic is during pregnancy. All women indeed see a doctor or midwife several times during their pregnancy, which is costless to them since the corresponding expenditures are entirely covered by universal State-provided health insurance. At the start of the pregnancy women undergo a blood test to check, among others, for gestational diabetes. We exclude this form of diabetes from our sample, but it may still be the case that women who were diagnosed during pregnancy were re-checked after they have given birth and discovered at this point that they also suffered from non-gestational diabetes. Given that this opportunity of diagnosis does not exist for men, this could explain the gap in awareness that we observe across genders. To check for this possibility, we re-estimate equation (4) taking men who do not have children as a reference. As can be seen on Table 6 - Panel B, when controlling linearly for individual characteristics - see col (2) -, women with children appear to be significantly more aware of their diabetic condition than women without children (with a p-value of the difference of 0.0152). However, this is also the case for men with children (although the point estimate is not significant at conventional levels) so that, when checking whether the gap in awareness is larger across women with and without children than across men with and without children, we find that the difference is only marginally significant (with a p-value of 0.0878). Moreover, this difference is not robust to including a full set of controls interacted with gender in our regression - see col (3) of Table 6 - since the p-value then goes up to 0.1724. This suggests that individuals who have children (both men and women) tend to be marginally more aware of their health condition, but that this effect is not significantly larger for women. So, it does not seem to be the case that women are more aware of being diabetic because they have more opportunities to undergo blood analysis.

Given that diabetes has a strong genetic component, another reason for women to be more aware that they have diabetes could be that they have more information than men about their medical history. This could well be the case since women tend to be in charge of elderly parents: as emphasized by Norton (2000), beyond spouses, and in particular wives, "The other most common informal caregiver is a child, usually a daughter". If women have closer contacts with their parents than men, they are more likely to know whether the former suffer (or suffered) from diabetes. They are also more likely to discuss the matter with their doctor during a visit and hence be tested and diagnosed. In the *Constances* questionnaire, respondents are asked to report whether their father and mother suffer/suffered from a number of health conditions including diabetes, hypertension, asthma, stroke and angina pectoris. We use these as dependent variables and regress each of them on respondents' individual characteristics including gender. As evidenced in Table 7, whatever the health condition we consider, women's parents appear to be in poorer health than men's parents. However, once controlled for children's age, women's parents have, a priori, no reason be so. So, we interpret our findings as suggesting that women have better information than men do about their parents' health so that they are more likely to have accurate information about their own medical history. In turn, this increases the probability that they be diagnosed, in particular as compared to men.

5 Discussion

In this paper we have shown that diabetes unawareness is more widespread among men than among women. The evidence we provide is twofold. When estimating the probabilities of suffering from objective and self-reported diabetes separately on our full sample of individuals, we find that men both suffer more from and report more diabetes but that the gender gap is larger for objective than for self-reported diabetes. Moreover, among individuals with blood glucose higher than normal, the fraction of those who are unaware of their condition is larger among men than among women. This suggests that men are less aware than women that they have diabetes. We also show that the same result holds for another mostly silent condition, i.e. hypertension. Should these results extend to other dimensions of health, this would suggest that using self-assessed health to measure the gender health gap is likely to underestimate the true difference across men and women.

As a second step, we investigate the causes of the gender gap in diabetes misreporting. We find no strong evidence that women are more aware that they are diabetic because they have greater opportunities to undergo a blood test due to the intake of a contraceptive pill or to pregnancy. In contrast, we find suggestive evidence that women are more aware than men of their parents' health. This suggests that women have better information than men about their medical history, which could explain why they tend to be better diagnosed than men. Of course, other differences across genders could account for this gap, such as higher risk aversion among women - Eckel and Grossman (2008) - or the fact that women might consult a doctor more frequently than men do - White and Witty (2009).[11] As conjectured for high-income patients, men may also be more prone to deny or repress that they have diabetes. Such denial is a defense mechanism proposed by Anna Freud (Freud, 2018) which involves refusing to perceive or denying that a situation exists because it is "too much to handle". This issue is particularly relevant in the case of silent diseases since individuals may suffer from a pathology without any symptom. Unfortunately, our data do not have information on these dimensions so that we cannot assess how important they may be with respect to the information channel.

As emphasised in the literature - Kahn (1999) -, the fact that men are more unaware than women that they are diabetic is a problem for public policy to the extent that unawareness

[11] The existence of a gender gap in doctors' visits has recently been challenged - see e.g. Hunt et al. (2011) and Wang et al. (2014).

negatively affects individuals' healthy behaviors. This seems to be the case in the *Constances* cohort. As a crude test, we consider the population of individuals with blood glucose higher than normal (hence suffering from objective diabetes). On this subsample, we investigate whether diabetes unawareness has any impact on the probability that individuals be on diet and that they practice physical activity.[12] As can be seen in Table 8 - cols (1) and (5) - both probabilities are lower for individuals who are unaware of their condition as compared to individuals who know that they are sick. Similarly, individuals who are not aware of being diabetic are more likely to consume sugar and fruit juice (while the probability of drinking sodas is not significantly different) - cols (2) to (4).[13] We interpret these differences as providing suggestive evidence that individuals who are not aware that they suffer from diabetes are more likely to adopt unhealthy behaviours that may contribute to worsen their condition.

Our findings suggest that information is crucial to contrast the expansion of diabetes. Rather than imposing systematic blood tests, in particular to men - which would be extremely expensive -, our results suggest that encouraging them to recover information about their medical history could be a first step towards better diagnosis. This could be done by doctors during visits but also through press and social-media campaigns to reach individuals who are reluctant to consult a doctor on a regular basis.

[12]Individuals are considered to be on diet when they answer Yes to the following question: "Are you currently on diet?". They are considered to practice physical activity if they report that they have practiced sport regularly for at least 2 hours a week in the past 12 months.

[13]In the *Constances* survey, individuals are asked: "How often do you consume the following drinks? Never or almost never, less than once a week, approximately once a week, twice to three times a week, four to six times a week, once a day or more". For each soft drink, we build a dummy variable taking value 0 if the individual answers "Never or almost never" and 1 otherwise. Regarding sugar, the question is: "How much sugar do you have per day (number of cubes or teaspoons)? Never or rarely, one or two, three or four, five or more". We build a dummy variable taking value 0 if the individual answers "Never or rarely" and 1 otherwise.

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Table 1: Prevalence of Self-reported and Objective Diabetes by Gender

	All (1)	Males (2)	Females (3)	T–test (4)
Objective diabetes	0.038	0.053	0.025	0.03***
Subjective diabetes	0.025	0.033	0.019	0.01***
Unaware of diabetes	0.339	0.383	0.258	0.13***
N	157,107	74,018	83,089	157,107

Note: ***Statistically significant at the 1% level; ** at the 5% level; * at the 10% level. Columns (2) and (3) report the mean prevalence for males and females, respectively. Column (4) reports the test for equal means. Individuals are considered to be "unaware of diabetes" when they objectively suffer from this condition while not reporting to do so.

Table 2: Self-reported and Objective Diabetes

	Self-reported diabetes (1)	Objective diabetes (2)	Self-reported diabetes (3)	Objective diabetes (4)
Man	0.014***	0.027***	0.013***	0.026***
	(0.001)	(0.001)	(0.001)	(0.001)
Controls	No	No	Yes	Yes
R^2	0.002	0.005	0.025	0.039
N	157,107	157,107	157,107	157,107

Note: Control variables include marital status, age, age squared, full-time and part-time employment, highest diploma (5 classes), income (7 classes), a dummy variable for the health-screening center individuals were enrolled in and year dummies. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Double Sample Model – Diabetes

	Probability of diabetes (1)	Probability of diabetes (2)
Subjective diabetes	-0.007***	-0.019**
	(0.000)	(0.008)
Man	0.027***	0.026***
	(0.001)	(0.001)
Subjective diabetes × Man	-0.014***	-0.013***
	(0.001)	(0.001)
Controls	No	Yes
R^2	0.005	0.034
N	314,214	314,214

Note: Control variables include marital status, age, age squared, full-time and part-time employment, highest diploma (5 classes), income (7 classes), a dummy variable for the health-screening center individuals were enrolled in and year dummies. In col (2), interaction terms between the previous controls and *Subjective diabetes* are included. Standard errors are clustered at the individual level. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Diabetes Unawareness

	Unaware of diabetes (1)	Unaware of diabetes (2)
Conditional on being diabetic		
Man	0.125***	0.113***
	(0.012)	(0.013)
Controls	No	Yes
R^2	0.016	0.048
N	6,025	6,025

Note: Control variables include marital status, age, age squared, full-time and part-time employment, highest diploma (5 classes), income (7 classes), a dummy variable for the health-screening center individuals were enrolled in and year dummies. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Hypertension Unawareness

	Unaware of hypertension (1)	Unaware of hypertension (2)
Conditional on suffering from hypertension		
Man	0.086***	0.055***
	(0.005)	(0.005)
Controls	No	Yes
R^2	0.007	0.072
N	42,169	42,169

Note: Control variables include marital status, age, age squared, full-time and part-time employment, highest diploma (5 classes), income (7 classes), a dummy variable for the health-screening center individuals were enrolled in and year dummies. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Contraceptive Pill, Having at least one Child and Unawareness Differences

	Unaware of diabetes (1)	Unaware of diabetes (2)	Unaware of diabetes (3)
Panel A – Conditional on being diabetic			
(Ref: Man)			
Woman ever taken Contraceptive Pill	-0.122***	-0.112***	-0.105***
	(0.013)	(0.014)	(0.015)
Woman never Pill	-0.131***	-0.112***	-0.131***
	(0.027)	(0.027)	(0.027)
Controls	No	Yes	Yes
Controls × Woman	No	No	Yes
Woman(Pill - No Pill) p-value	0.7329	0.9964	0.3730
R^2	0.015	0.048	0.059
N	5,798	5,798	5,798
Panel B – Conditional on being diabetic			
(Ref: Man with no child)			
Man with at least one child	0.005	-0.008	-0.009
	(0.016)	(0.017)	(0.017)
Woman with at least one child	-0.125***	-0.127***	-0.125***
	(0.017)	(0.018)	(0.018)
Woman without child	-0.096***	-0.073***	-0.077***
	(0.024)	(0.024)	(0.025)
Controls	No	Yes	Yes
Controls × Woman	No	No	Yes
Woman(Child - No Child) p-value	0.1991	0.0152	0.0370
Man(Child - No Child) - Woman(Child - No Child)			
p-value	0.2243	0.0878	0.1724
R^2	0.015	0.049	0.059
N	5,854	5,854	5,854

Note: Control variables include marital status, age, age squared, full-time and part-time employment, highest diploma (5 classes), income (7 classes), a dummy variable for the health-screening center individuals were enrolled in and year dummies. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Parents' Health Conditions

	Diabetes	Stroke	Hypertension	Asthma	Angina pectoris
	(1)	(2)	(3)	(4)	(5)
Mother's Health Condition					
Woman	0.006***	0.011***	0.076***	0.007***	0.008***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
Controls	No	No	No	No	No
R^2	0.000	0.001	0.009	0.001	0.001
N	154,796	154,796	154,796	154,796	154,796
Woman	0.009***	0.012***	0.077***	0.006***	0.009***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
Controls	Yes	Yes	Yes	Yes	Yes
R^2	0.018	0.021	0.024	0.008	0.012
N	154,796	154,796	154,796	154,796	154,796
Father's Health Condition					
Woman	0.011***	0.005***	0.039***	0.004***	0.004***
	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)
Controls	No	No	No	No	No
R^2	0.000	0.000	0.003	0.000	0.000
N	154,796	154,796	154,796	154,796	154,796
Woman	0.011***	0.005***	0.037***	0.004***	0.004***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
Controls	Yes	Yes	Yes	Yes	Yes
R^2	0.006	0.014	0.008	0.007	0.006
N	154,796	154,796	154,796	154,796	154,796

Note: Control variables include marital status, age, age squared, full-time and part-time employment, highest diploma (5 classes), income (7 classes), a dummy variable for the health-screening center individuals were enrolled in and year dummies. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Diabetes Unawareness and Healthy Behaviours

	Diet	Sugar cons.	Soda cons.	Juice cons.	Physical activity
	(1)	(2)	(3)	(4)	(5)
Unawareness	-0.248***	0.207***	0.105**	0.115***	-0.033***
	(0.011)	(0.016)	(0.043)	(0.014)	(0.012)
Controls	No	No	No	No	No
R^2	0.084	0.085	0.116	0.049	0.028
N	5,459	3,856	520	5,262	5,905
Unawareness	-0.239***	0.211***	0.115***	0.106***	-0.034***
	(0.011)	(0.016)	(0.044)	(0.015)	(0.012)
Controls	Yes	Yes	Yes	Yes	Yes
R^2	0.087	0.090	0.121	0.051	0.029
N	5,459	3,856	520	5,262	5,905

Note: Control variables include marital status, age, age squared, full-time and part-time employment, highest diploma (5 classes), income (7 classes), a dummy variable for the health-screening center individuals were enrolled in and year dummies. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

A Appendix

Table A1: Descriptive Statistics

	All	Males	Females	T–test
Objective hypertension	0.286	0.362	0.218	0.14***
Self-reported hypertension	0.120	0.140	0.102	0.04***
Hypertension Unawareness	0.578	0.613	0.527	0.09***
Having at least one child	0.653	0.600	0.700	-0.10***
Ever taken contraceptive pill	-	-	0.855	-
Living with a partner	0.752	0.783	0.724	0.06***
Age	48.407	48.700	48.145	0.55***
Highest diploma:				
No diploma	0.029	0.033	0.026	0.01***
Lower-secondary general education	0.059	0.053	0.064	-0.01***
Lower-secondary professional education	0.167	0.203	0.135	0.07***
High-school diploma	0.154	0.148	0.159	-0.01***
Tertiary education	0.591	0.563	0.616	-0.05***
Income category:				
Less than 450 Euros	0.004	0.005	0.003	0.00***
Between 450 and 1000 Euros	0.029	0.027	0.030	-0.00**
Between 1000 and 1500 Euros	0.064	0.056	0.072	-0.02***
Between 1500 and 2100 Euros	0.110	0.098	0.120	-0.02***
Between 2100 and 2800 Euros	0.153	0.146	0.159	-0.01***
Between 2800 and 4200 Euros	0.306	0.313	0.301	0.01***
More than 4200 Euros	0.283	0.310	0.260	0.05***
Don't know	0.006	0.005	0.007	-0.00***
Refuse to answer	0.044	0.039	0.048	-0.01***
Employment status:				
Full time	0.697	0.705	0.691	0.01***
Part time	0.110	0.044	0.169	-0.13***
Year of the survey:				
2012	0.048	0.047	0.050	-0.00**
2013	0.111	0.108	0.114	-0.01***
2014	0.136	0.139	0.134	0.00**
2015	0.166	0.167	0.164	0.00
2016	0.187	0.193	0.182	0.01***
2017	0.190	0.186	0.194	-0.01***
2018	0.146	0.145	0.147	-0.00
2019	0.016	0.017	0.015	0.00*

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	All	Males	Females	T–test
Health-screening center:				
Angoulême	0.037	0.034	0.040	-0.01***
Auxerre	0.016	0.015	0.017	-0.00**
Bordeaux	0.064	0.064	0.065	-0.00
Le Mans	0.024	0.023	0.025	-0.00**
Lille	0.018	0.019	0.018	0.00
Lyon	0.027	0.027	0.027	0.00
Marseille	0.055	0.056	0.054	0.00
Nancy	0.067	0.068	0.066	0.00*
Nîmes	0.048	0.048	0.048	0.00
Orléans	0.069	0.071	0.067	0.00**
Paris-CPAM	0.033	0.032	0.034	-0.00
Paris-IPC	0.037	0.037	0.037	-0.00
Pau	0.106	0.108	0.104	0.00*
Poitiers	0.068	0.067	0.069	-0.00
Rennes	0.046	0.047	0.046	0.00
Saint-Brieuc	0.021	0.021	0.021	0.00
Saint-Nazaire	0.045	0.045	0.045	0.00
Toulouse	0.063	0.061	0.065	-0.00***
Tours - La Riche	0.031	0.032	0.030	0.00*
N	157,107	74,018	83,089	157,107

Table A2: Objective versus self-reported diabetes - Detailed Regression Results

	Self-reported diabetes (1)	Objective diabetes (2)	Self-reported diabetes (3)	Objective diabetes (4)
Man	0.014***	0.027***	0.013***	0.026***
	(0.001)	(0.001)	(0.001)	(0.001)
Living with a partner			0.009***	0.012***
			(0.001)	(0.001)
Age			-0.002***	-0.002***
			(0.000)	(0.000)
Age^2			0.000***	0.000***
			(0.000)	(0.000)
Highest diploma (ref: no diploma):				
Lower-secondary general education			-0.016***	-0.025***
			(0.004)	(0.005)
Lower-secondary professional education			-0.020***	-0.029***
			(0.004)	(0.005)
High-school diploma			-0.023***	-0.035***
			(0.004)	(0.004)
Tertiary education			-0.024***	-0.039***
			(0.004)	(0.004)
Income category (ref: +4200 Euros):				
Less than 450 Euros			0.048***	0.071***
			(0.009)	(0.011)
Between 450 and 1000 Euros			0.050***	0.061***
			(0.004)	(0.004)
Between 1000 and 1500 Euros			0.029***	0.038***
			(0.002)	(0.003)
Between 1500 and 2100 Euros			0.019***	0.026***
			(0.002)	(0.002)
Between 2100 and 2800 Euros			0.013***	0.016***
			(0.001)	(0.002)
Between 2800 and 4200 Euros			0.006***	0.008***
			(0.001)	(0.001)
Don't know			0.013**	0.022***
			(0.005)	(0.006)
Refuse to answer			0.006***	0.012***
			(0.002)	(0.003)
Employment status (ref: not working):				
Full-time			-0.003**	-0.003**
			(0.001)	(0.002)
Part-time			0.001	0.002
			(0.001)	(0.001)
Year dummies	No	No	Yes	Yes
Health-screening center dummies	No	No	Yes	Yes
R^2	0.002	0.005	0.025	0.039
N	157,107	157,107	157,107	157,107

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A3: Diabetes Unawareness - Detailed Regression Results

	Diabetes Unawareness (1)	Diabetes Unawareness (2)
Man	0.125***	0.113***
	(0.012)	(0.013)
Living with a partner		-0.003
		(0.016)
Age		0.029***
		(0.006)
Age^2		-0.000***
		(0.000)
Highest diploma (ref: no diploma):		
Lower-secondary general education		-0.007
		(0.028)
Lower-secondary professional education		-0.005
		(0.026)
High-school diploma		-0.009
		(0.027)
Tertiary education		-0.055**
		(0.026)
Income category (ref: +4200 Euros):		
Less than 450 Euros		-0.048
		(0.067)
Between 450 and 1000 Euros		-0.138***
		(0.031)
Between 1000 and 1500 Euros		-0.082***
		(0.027)
Between 1500 and 2100 Euros		-0.053**
		(0.024)
Between 2100 and 2800 Euros		-0.052**
		(0.022)
Between 2800 and 4200 Euros		-0.011
		(0.019)
Don't know		0.084
		(0.085)
Refuse to answer		0.020
		(0.031)
Employment status (ref: not working):		
Full time		0.018
		(0.017)
Part time		-0.016
		(0.024)
Year dummies	No	Yes
Health-screening center dummies	No	Yes
R^2	0.016	0.048
N	6,025	6,025

Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table A4: Double Sample Model – Diabetes (no recoding)

	Probability of diabetes (1)	Probability of diabetes (2)
Subjective diabetes	-0.0004	-0.025**
	(0.0004)	(0.010)
Man	0.030***	0.029***
	(0.001)	(0.001)
Subjective diabetes × Man	-0.016***	-0.015***
	(0.001)	(0.001)
Controls	No	Yes
R^2	0.005	0.035
N	314,214	314,214

Note: Control variables include marital status, age, age squared, full-time and part-time employment, highest diploma (5 classes), income (7 classes), a dummy variable for the health-screening center individuals were enrolled in and year dummies. In col (2), interaction terms between the previous controls and *Subjective diabetes* are included. Standard errors are clustered at the individual level. *** p<0.01, ** p<0.05, * p<0.1.

Table A5: Diabetes Unawareness (No recoding)

	Unaware of diabetes (1)	Unaware of diabetes (2)
Conditional on being diabetic		
Man	0.071***	0.067***
	(0.014)	(0.015)
Controls	No	Yes
R^2	0.005	0.042
N	5,241	5,241

Note: Control variables include marital status, age, age squared, full-time and part-time employment, highest diploma (5 classes), income (7 classes), a dummy variable for the health-screening center individuals were enrolled in and year dummies. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.